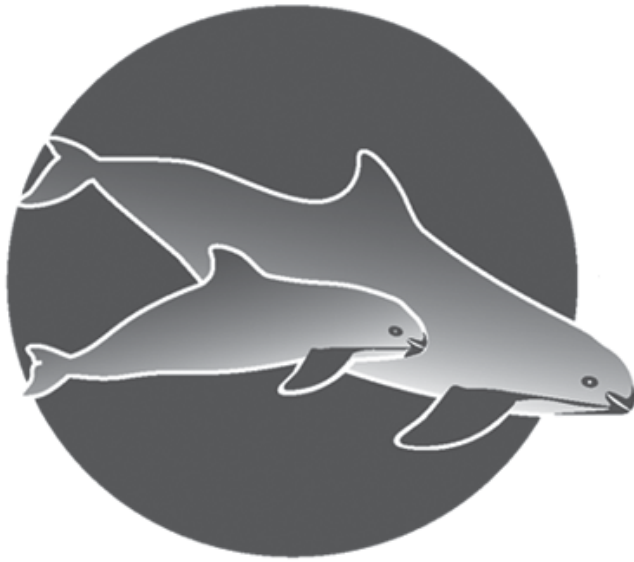


16th Biennial Conference



on the Biology of
Marine Mammals

San Diego, CA, USA
12 - 16 December 2005



Society for Marine Mammalogy

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INTRODUCTION

The Scientific Program Committee has designed this Abstract Book as a companion to the Program Book for the 16th Biennial Conference on the Biology of Marine Mammals. All the abstracts of presentations to be delivered at the meeting are included. In addition, we have added abstracts by authors who were accepted as presenters but could not attend. Twelve hundred abstracts are published here, ordered alphabetically by the last name of the first author. There is an index of all authors at the back. A companion index by first author is provided in the Program Book so readers can identify sessions for presentations of interest.

Because SMM restricts the number of concurrent sessions that can be scheduled, it has instituted a review process for choosing contributions for acceptance as spoken presentations. There were also minimum requirements for poster acceptance at this meeting. A panel of three peer experts is chosen by the Scientific Program Committee to score abstracts for “originality”, “quality”, “importance”, and “presentation” using a scale from 1 to 5. The resulting scores are used to eliminate contributions and to assign contributions to the available spoken sessions.

Twelve-hundred and eighty-one abstracts were received for the 16th Biennial Conference to fill 306 spoken and approximately 950 poster slots. The Scientific Program Committee assigned each abstract to one of 12 sub-committees for review and recruited 273 expert reviewers (page 4), each of whom was assigned approximately 15 abstracts. The reviews were “blind” - that is, the reviewers did not know the name and affiliation of authors during scoring.

An abstract could receive between 4 and 20 points from each reviewer, which were averaged to produce a raw average score. When raw average scores were summarized by expert and committee it became clear that reviewers could differ substantially from one another (95% CI of scores ranged from 10.8 to 17.1). Also, some reviewers read many abstracts and some read only a few. The imbalances were great enough to make the process of selecting spoken and poster presentations potentially unfair (*i.e.*, an abstract might receive an especially ‘tough’ or ‘easy’ review). Therefore, a correction factor had to be added to ensure that reviewer scores averaged to the mean of all scores. However, to ensure that reviewer judgements were reflected in the corrected score, the value was constrained by the minimum and maximum score of three. This process was similar to fair scoring procedures used by organizations such as NSF that rely heavily on peer review. Abstracts were sorted by corrected score and assigned to spoken and poster sessions. Contributions with corrected scores below the 95th percentile were regretfully turned down.

Based on what we’ve read, the quality of the work presented at this meeting will be excellent. Because almost three quarters of the available slots have been assigned to posters, we expect the poster sessions to be a particularly important component of this meeting. We are certainly looking forward to seeing the results of everyone’s hard work.

A few editorial notes about the Abstract Book: We have used Rice (1998) as the source reference to correct common and taxonomic names in abstracts where obsolete or improperly-spelled names were given (*e.g.*, *Physeter catodon* was changed to *Physeter macrocephalus*). In cases where the taxonomic status of a species is still uncertain, we made no changes (*e.g.*, *Zalophus californianus wolfebaecki* vs. *Zalophus wolfebaecki*). Some abstracts were edited for space reasons (*e.g.*, multiple paragraphs were combined into one).

The Scientific Program Committee

Rice, D.W. 1998. Marine Mammals of the World: Systematics and Distribution. Special Publication Number 4, Society for Marine Mammalogy.

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The Scientific Program Committee thanks the many individuals who reviewed abstracts – without you, the program would not have been possible!

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Using Line Transects to Estimate the Size of the Polar Bear Population in the Barents Sea Area

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The archipelagos of Svalbard (Norway) and Franz Josef Land (Russia), and the sea areas between and to the north of these islands, host the Barents Sea polar bear population. The delineation of this population is based on a combination of satellite telemetry data, capture-recapture data, and genetic structure. After about a century of hunting in the Norwegian sector, leading to over-exploitation, polar bear hunting in the area has been prohibited since 1973. It has long been a demand for an estimate of the size of the Barents Sea polar bear population, not least for management purposes and to provide the possibility of monitoring future trends in population growth. In August 2004, such a survey was conducted. One helicopter covered the largest land areas of Svalbard. A second helicopter operated from a research vessel platform, and covered areas with sea ice, including the ice edge, and the Franz Josef Land archipelago. Although total count of bears was employed locally in some areas, most survey areas were covered by line transects. The helicopters flew 100 nautical miles/h at 200 feet. A GPS trackline and GPS positions recorded above the points where the bears were first seen were used to measure bear-line distances, and to calculate densities of bears within different areas and habitats. To cope with incomplete coverage in some areas north of the ice edge due to periods of bad weather, we combined data from the lines with 185 satellite telemetry data positions from 34 bears over 10 years sampled during the same part of the year. Providing a ratio estimator, an estimate of density with variance based on both sources of data was calculated. Adding total counts to this estimate, we got a total estimate of 2,997 bears for the Barents Sea population, with 95% CI from 2,299 to 4,116.

Estimating Space Use and Environmental Preference from Telemetry Data

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An increasing number of papers in applied ecology are concerned with where a particular organism is, why it is there and where else it could be. These objectives are typically approached by collecting data on the animals' use of space, relating these observations to prevailing environmental conditions and employing these relations to predict usage at other points in space. In recent decades, radio- and satellite-telemetry increased the volume of data on animal spatial distributions and, consequently, the number of studies on space use and environmental preference. However, such analysis of animal preferences for different habitats from telemetry data presents us with formidable analytical challenges. These include the non-independence of successive animal locations, the unequal detectability of the animal in different environments, the arbitrary definition of which habitats are accessible to the animal, the classification of habitats, the animal's non-linear responses to combinations of environmental conditions and the need to make population inferences from few individuals. Here we review these problems, and for the first time propose an analytical framework that can deal with all of them at once. We use generalized additive mixed models (GAMMs) to explicitly model the hierarchical structure of the data; a population of animals from which we sample few individuals each of which provides

a set of correlated locations in space and time. We include smoothing splines to allow for non-linear responses to environmental variables and make appropriate adaptations to deal with the remaining problems. We illustrate this framework by applying it to an extensive data set on the distribution of a central-place forager, the grey seals (*Halichoerus grypus*) from the east coast of Scotland.

The Feasibility of CRITTERCAM on West Indian Manatees

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attachment methods were tested on wild and captive manatees. With few modifications, a peduncle belt/tether apparatus, a design based on previous instrumentations, proved to be the most successful method. A belt of polypropylene strips contained in a surgical tubing sleeve was secured around the peduncle by a dissolving magnesium nut. A 4.5' nylon rod was attached at the mid-dorsal point of the belt and CRITTERCAM was attached to the distal end of the rod. An electronically activated mechanism (a 'burn-wire'), released the CRITTERCAM from the tether. Field trials were conducted from May 4-14, 2004 in Southern Lagoon and Drowned Cays, Belize on wild manatees (n=10, 6 males, 4 females). Trials tested the animals' reaction to the system, orientation of the camera for effective data collection, and performance of the release mechanisms. An ultrasonic transmitter in the belt and a VHF transmitter on the CRITTERCAM were used for tracking and recovery. Attachment time ranged from 10 minutes (malfunction of electronic release) to 18 hours. The system recorded video, audio, temperature and depth. Films were reviewed after each deployment to determine if modifications were necessary for the next trial. Video recordings ranged from 4 minutes to 321 minutes. Immediately following release, most manatees were observed swimming rapidly, with several displaying normalized behavior minutes later; other individuals immediately left the area. Video analysis revealed animals resting, traveling, vocalizing, and socializing with other animals; behaviors that are difficult to impossible to observe through traditional field study techniques. Future modifications will include developing a release mechanism that functions in both fresh and saline aquatic environments, and devising a camera attachment that allows the exchange of CRITTERCAMs in situ.

Historical Distribution of Large Whales in Newfoundland and Labrador

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In Newfoundland and Labrador, the lack of recent cetacean distribution data, combined with significant whale population reductions through commercial whaling, has limited studies of these whales' traditional habitat use. We studied blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), humpback (*Megaptera novaeangliae*), and sperm (*Physeter macrocephalus*) whales in this region using whaling records as proxies for distribution patterns. Shore-based whaling in Newfoundland and Labrador covered all coasts, began in 1898, and peaked in 1905 with 18 stations. Kill locations are summarised for 1898-1917, 1923-1937, 1939-1951, and 1952-1972, as well as seasonally. Initially, two times more whales were taken on the south and southeast coasts of Newfoundland in the first whaling period than in all other regions combined. In the latter whaling phases kills in coastal Labrador and north-eastern Newfoundland increased more than four and three fold, respectively, while south coast catches dropped six fold. Most fin and blue whales were taken along the south coast of Newfoundland in early whaling days, later shifting to the coast of Labrador as Newfoundland populations were depleted. Sei whales were the least hunted and

historic kill locations followed the same pattern as the fin whale. Humpback whale kills were most common on the southeast and south coasts, before shifting to coastal Labrador in later whaling phases. The overall and seasonal distribution of sperm whale kills was limited primarily to the coast of Labrador and was four times higher in the summer than in the fall. Seasonal kill distributions for baleen species favoured the south coast in the spring, and the coast of Labrador along with the northeast coast of Newfoundland in the summer. These whaling patterns will be combined with recent small-scale marine mammal and prey surveys, and primary productivity and hydrographic data, to derive detailed models of critical habitat for these whales.

Seasons Change! — Dramatic Shift of Harbor Seal (*Phoca vitulina*) Phenology in the Southeastern North Sea

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Intensive population monitoring of harbor seals in NW Germany over three decades has produced an intriguing and mainly unintended result. Serial counts of newborn seals in the birth season and records of live strandings indicate a gradual, strictly linear longterm shift towards earlier birth dates. Both the magnitude of this effect and its explicit description may be unique. From 2–3 counts of seal pups per year, which follow a sinoid curve over most of the birth season, ‘mean birth dates’ were estimated. These dates shifted by as much as $-0.68 \text{ d/y} \pm 0.050 \text{ SE}$ from 1975 through 2004 ($N = 15$), which equals 20 days within 30 years. A test on curvature was negative ($P = 0.46$). Mean annual find dates of live stranded pups from 1991–2004 followed exactly the same trend ($-0.67 \text{ d/y} \pm 0.067 \text{ SE}$), confirming that the process continued in recent years. Neither changes in the population trend within 1975–2004 nor the epizootic mass mortalities of 1988 and 2002 had any detectable influence. Rapidly shifting phenology means that single surveys made at fixed times of the year will not yield data of the desired quality. In the study area, counts made e.g. in late August of 2004 would have been 20% lower than at the same time and stock size in 1975. There are yet no plausible hypotheses about the ultimate and proximate causes of the phenomenon. In particular, the magnitude of the shift is hard to explain by a selective process or by demographic change. This raises the question if individual seal females may be able to gradually change their implantation date, rather than implant at a genetically fixed time of year. Clues from the literature may suggest an oscillating longterm pattern of harbor seal phenology in the SE North Sea and NE Pacific.

Stranding of *Indopacetus pacificus* in Davao, Philippines

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Longman’s beaked whale, *Indopacetus pacificus*, is only known from six specimens. Previous sightings of *Indopacetus pacificus* alive at sea in the Philippines were unconfirmed. Here we describe a specimen from the stranding in Davao, Philippines on January 2004. This is the first live stranding recorded for this species. Due to lack of available equipment and knowledge on stranding response the locals were unable to return the animal to deeper water and it died the next day. All internal organs were removed and disposed of without documentation and measurements, except for a portion of the digestive tract, the penis and liver, which were stored in a freezer. The carcass was then blast frozen whole. It was approximately 5.73 m in length, weighing 2.5 tons. The external appearance, features of the skull, and vertebral count of the specimen were compared with the descriptions of specimens of *Indopacetus pacificus* by Dalebout et al.

(2003) and Moore (1968). The color pattern was similar to that described by Dalebout et al (2003) except that the darkest hue was grey and not black. Number and position of teeth, rib count and number of fused vertebrae were consistent with Dalebout et al.’s (2003) specimens. The diagnostic osteological features described by Moore (1968) were also observed in this specimen. Samples of the skin and blubber have been saved for molecular and genetic analysis. Unfortunately, due to lack of funding, skills and capacity in marine mammal taxonomy the bones were mounted for display at the Bureau of Fisheries and Aquatic Resources, Davao City, Philippines. The current condition of this specimen at its present location is insecure and the future study of the species in the country is uncertain.

Association Patterns of Bottlenose Dolphins in Costa Rica: Constant Companions and Casual Acquaintances

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Bottlenose dolphins (*Tursiops* spp.) live in societies with frequent changes in female membership and strong male bonds. However, little is known about this species in tropical waters. We analyzed photographs taken from boat-based surveys in 1991–1992 to estimate single association indices (COA), digitally measure dolphin-inflicted scars, and describe association patterns of bottlenose dolphins in Golfo Dulce, Costa Rica. We observed 25 adult females (14 receptive and 11 non-receptive based on estimated age of calf), 11 adult males, 20 adults of unknown sex, 12 calves, and 11 neonates. We identified 75% of adults within the first three months of the 16-month study, sighted each adult $24.2 \pm \text{SD } 13.16$ times, and estimated a population of $80.2 \pm 95\% \text{ CI } 77.5\text{--}87.6$ dolphins. Dolphin groups averaged $7.0 \pm \text{SD } 4.46$ individuals ($n=323$ sightings). Associations within classes (calves and neonates, males, females, adults) were higher than associations between classes ($t=2.52$, $p=0.006$, $n=1093$). The best fit model of lagged association rates for all adults was one of constant companions and casual acquaintances. Based on permutation tests of COAs, males formed long-term associations ($p=0.021$) whereas females formed short-term ones ($p<0.001$). Sixty-four percent of males formed stable pairs or trios ($\text{COAs} > 0.40$); while only 16% of females associated with one another in stable pairs. COAs and lagged association rates indicated that associations with receptive females were stronger in male pairs/trios than in males with no associates, and that male pairs/trios preferentially associated with receptive females than with non-receptive females. The amount of dorsal fin differed among males ($10.2 \pm \text{SD } 1.17\%$), receptive females ($0.42 \pm \text{SD } 1.36\%$), and non-receptive females ($2.2 \pm \text{SD } 2.78\%$; $F_{2,21}=7.92$, $p=0.003$). Results indicate that most females formed a fluid network and most males formed strong bonds. It remains to be explored why non-receptive females suffered more aggression than receptive females and whether male pairs/trios had a higher RS than non-associated males.

Unravelling the Genetic Basis for Heterozygosity – Fitness Correlations in Diseased California Sea Lions

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Low genetic heterozygosity has been associated with susceptibility to pathogens in vertebrates. However, it remains unclear whether the mechanism is related to genome-wide or single-locus effects, in particular from a subset of markers lying close to genes under balancing selection. Previously, we reported heterozygote advantage for disease resistance in stranded California sea lions. We have now reanalyzed our data to investigate whether one or more genetic markers could be driving the effects by associative overdominance, rather than all markers contributing equally (i.e., inbreeding depression). We randomly combined markers to calculate heterozygosity-heterozygosity correlations (HHC) for each disease and sought associations between both independent sets of markers. Over all conditions and separately, significant correlations that ranged from 0.10 to 0.29 were observed.

Moreover, the relationship between heterozygosity and mean HHC was highly significant ($r^2 = 0.85$, $n = 7$, $P = 0.003$), suggestive of genome-wide effects. As an additional test for associative overdominance, we conducted a series of separate generalized linear models for each identified disease including each marker in turn, heterozygosity calculated excluding the marker, and the interaction between these two terms. General heterozygosity remained significant throughout all models and there were no significant effects of any particular marker(s) for infectious diseases or domoic-acid intoxication. However, individuals diagnosed with carcinoma showed significant effects at one locus, suggesting linkage with regions under balancing selection. Preliminary *in-silico* alignments of the marker's flanking sequence revealed highest homology to human diacylglycerol kinase 3 (DAGK3) ($E = 2e^{-6}$), a gene previously associated with oncogenic transformation. At this stage, it is not possible to determine whether the linkage is genuine, although recent studies have revealed associations of functional genes with cancer susceptibility in sea lions. Future research should aim to characterize the putative gene and investigate gene expression to determine potential causality for carcinoma in sea lions.

Extremely Lightweight Equipment for Tagging Unrestrained, Hauled Out Walrus

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The attachment of tags to walrus typically requires chemical immobilization of the candidate animals, the transportation of bulky equipment and dangerous chemicals both through customs and to remote areas and, most seriously, a high risk to the lives of the animals. A system allowing the attachment of tags without anesthesia, with simple lightweight equipment would represent a significant improvement. We developed a hand-harpoon tagging system and employed it on four, unrestrained hauled out Atlantic walrus in NE Greenland. The tags were attached to the mid dorsal region of the animals by a small, transcutaneous, titanium harpoon arrowheads provided with barbs to counter traction and expulsion from the body. A four meter long, conventional 3/4 inch plumbing pipe in two pieces served as detachable harpoon handle. The equipment weighed less than 15 kg and could be packed to a maximum length of 2 m. The attachment sites were monitored visually and showed clear but localized signs of infection. The tags remained attached for respectively 29, 19, 10 and 5 days. It is our opinion that minor improvements of the harpoon barbs and of the tag shape could considerably improve the performance of this system.

Extraterrestrial Influence on Cetacean Strandings

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Previous studies have established patterns underlying cetacean strandings, including marked seasonality and increasing stranding rates in recent years (generally attributed to anthropogenic factors). Attempts to link stranding events and lunar cycles (and changing tides) have been anecdotal or have suffered due to insufficient data. I examined 7 independent data sets of cetacean strandings from Australia ($n=586$ stranding events), Italy ($n=725$), Japan ($n=2,200$), New Zealand ($n=3,065$), eastern North America ($n=2,261$), western North America ($n=1,062$), and the British Isles ($n=1,588$) to establish potential correlations between strandings and lunar phases. As Roman calendar dates do not transcribe easily into lunar cycles (1 synodic lunar month = 29.8 days), stranding event dates were converted to lunar cycles (new moon = day 1). Lunar cycles varied 29-30 days in length, and these were converted to 28-day cycles by random deletion of 1-2 days/cycle. Four 7-day periods (centered on major moon phases) were then established, and numbers of strandings per period were tallied. In order to account for mass strandings, no strandings of

conspecifics within 7 days of an initial stranding event were scored for each of the 7 data sets. A chi-squared test indicates that stranding frequency is not equal for all moon phases, with increased occurrence of stranding events during full and new moons when tidal oscillations are maximal as compared with first and third quarter moon phases when tidal oscillations are minimal. These trends were also apparent when independent data sets were examined alone, when live and fresh strands were considered in isolation, and for numerous species for which >50 stranding records were known. Analyses of jellyfish stranding events and recovery dates of inanimate human-produced flotsam failed to reveal similar correlations. Taken together, these lines of evidence suggest an underlying and biologically significant pattern in cetacean strandings linked to extraterrestrial influence.

Facilitating the Visualization of Marine Mammal Health Data

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Health assessments of coastal bottlenose dolphin (*Tursiops truncatus*) populations are being conducted at multiple sites along the southeast US coast in order to investigate trends in health status, as well as chemical and biological toxicant exposure. For such studies, information on the spatial distribution of the dolphins is imperative to understanding the relationships between environmental factors and dolphin health. A health assessment study being conducted near Charleston, SC has been ongoing for 3 years and is complemented by 11 years of dolphin sighting information from prior and concurrent photo-identification and radio-tracking studies. The data generated during the first three years of this health assessment are currently stored in a Microsoft Access database and include an extensive collection of parameters associated with morphometrics, hematology and blood chemistry, hormones, serology, immunology, microbiology, cytology, and contaminant concentrations. Because of the quantity and character of the data, the structure of the database is unavoidably complex and creating queries and reports to explore research questions can be challenging. These tasks are more challenging when the research question involves a spatial component. To facilitate the visualization of the health data, an ArcGIS™ extension was developed. This extension bridges the gaps between the health database, associated photo-identification data, and ArcGIS to allow users with little to no background in GIS or relational database systems to rapidly query, display and explore the spatial distribution of a variety of health parameters within a GIS environment using simple, point-and-click controls.

The Release of a Long-Term Captive Manatee

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The Manatee Rescue, Rehabilitation and Release Program (Program) began 1973 under the guidance of the U.S. Fish and Wildlife Service. Program goals include assisting injured or distressed manatees, providing medical treatment, implementing pre-release conditioning, and releasing manatees into the wild as soon as feasible. To date, the Program has rescued over 725 manatees and released over 205 from captivity. Captive release criteria are based on manatee age, origin, medical status, and time in captivity. Post-release monitoring is conducted on animals considered "high risk" (e.g., naïve animals with little or no wild experience), that would increase our understanding of wild manatees, or those which may increase our understanding of the adaptability of released manatees. To date, the longest held captive manatee to be released was "Stormy". Born in captivity in 1985, he was released after 17 years into Blue Spring, a primary warm water/aggregation site for wintering manatees. Stormy spent approximately three weeks in the spring with other wild manatees until he was taken back to captivity, as a conservative approach to his reintroduction process. Stormy was fed wild vegetation and exposed to colder water

temperatures to acclimate him to the natural life cycle of wild animals. The following winter Stormy was released and monitored for 386 days. Observations in the wild included socializing with conspecifics, utilizing habitat, foraging on local vegetation, avoiding human interaction and returning to Blue Spring the following winter. Stormy's one year health assessment was indicative of wild manatees after a winter season. Deemed a success, Stormy made a significant contribution to advancing our understanding of the ability of manatees to adapt to the wild. Further releases of long-term manatees may indicate, unlike cetaceans and pinnipeds, that sirenians have a greater ability to adjust to conditions in the wild, even after extended periods of time in captivity.

Does Intense Ship Noise Disrupt Foraging in Deep-Diving Cuvier's Beaked Whales (*Ziphius cavirostris*)?

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This paper reports data from an acoustic digital tag (DTAG) attached to a Cuvier's beaked whale (Zc), showing that elevated received noise levels (RL) with ultrasonic components from a passing large ship coincided with a curtailed foraging dive (dive 4). The tag recorded click and foraging buzz sounds from the whale at the base of each of 8 deep dives 1,005 to 1,265 m depth, together with environmental and tag related noise. During dive 4 the maximum broad band (400 Hz to 44.8 kHz) RL from the ship was 136 dB rms re 1 μ Pa, recorded while the whale was at 700 m depth. Assuming spherical spreading this translates to a source level of 193dB rms re 1 μ Pa at 1m for the vessel at these frequencies. The mean RL in the frequency range of the echolocation clicks of Zc during the ship passage increased by 15 dB. This implies that the maximum sonar detection range and maximum communication range were reduced to 43% and 18% of their normal value respectively due to the masking noise of the ship during dive 4. In this dive the vocal phase lasted just 41% of the total dive length in comparison to the 60% (SD 7.6) in the other 7 dives. This resulted in a significantly lower number of buzzes (16) than in the other dives (mean of 33, SD 6). If we estimate foraging efficiency as the buzz rate divided by the total dive time, dive 4 showed a reduction of more than 50% as compared to the other dives. With the inherent limitations of a single observation, this case study suggests that Zc may react to intense motorized shipping noise by changing their dive and foraging behavior. It is of importance to evaluate whether this case reflects a general problem with implications for beaked whale conservation.

Holding Hands Acoustically: A Novel Use of Biosonar in a Pair of Free-Ranging Finless Porpoises

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The targets of echolocation in odontocetes in the wild are still not fully understood. Prey items, predators, environment, and conspecifics are all candidates. For the first time, group sonar behavior of free-ranging finless porpoises, including a mother-calf pair, was observed in an oxbow lake in China. Acoustic and behavior data loggers (A-tag and PD2GT, respectively; Little Leonardo, Tokyo) attached to fourteen animals recorded sonar pulse events, sound-source direction, swimming depth, speed, and two-dimensional body acceleration. Simultaneous sound recording in the group enabled measurement of inter-individual distances from the sound travel time of biosonar signals between animals. Synchronized swimming of arbitrary pairs was also determined by temporal matching of swimming depth and speed profiles. Temporal bonding pairs were frequently observed in

the group. During bonding, continuous production of sonar signals within the pair was commonly recorded. This phonation lasted throughout successive dive bouts. The biosonar range calculated from the inter-click interval continued seamlessly, even across respirations at the water surface. In the mother-calf pair, the mother phonated almost ceaselessly. In all pairs, the change in the inter-individual distance matched the change in the biosonar range well. The sonar range dropped when a pair swam within two meters of each other. These observations show that the seamless sonar targeted the other individual in a pair. When the two individuals separated and moved actively and independently, the seamless sonar disappeared. In this period, an "approach phase", characterized by linearly decreased inter-click intervals over a short time, was frequently observed. The approach phase was usually followed by rapid body angle changes thought to be prey capture behavior. The results suggest that the seamlessly continued inter-click intervals of sonar signals within a pair of finless porpoises help maintain bonding when visual connections are limited. In essence, porpoises hold hands acoustically using their sonar.

Modeling Logistic Curves of the Southeastern Pacific Humpback Whale (*Megaptera novaeangliae*) Stock

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The waters of the northwestern coast of South America are considered a major migration destiny and breeding area for the Southeastern Pacific humpback whale stock. No information regarding with carrying capacity, birth, survival and mortality trends exists to establish a baseline to promote conservation strategies for the recovery of this once overexploited stock. The objective of this study was to simulate population logistic curves and demographic rates based on population parameters (e.g., birth rate) and abundance estimations obtained off the coast of Ecuador. The program STELLA II was used for the modeling and simulation of curves. Because the lack of information on survival and mortality rates of this stock, data from other better studied populations as well as information on humpback whale photo-identification and strandings from Ecuador were used to estimate these vital rates. Available population estimates (1,922 and 2,917 individuals), based on the Petersen's model, were also incorporated into the simulation modeling. An average survival rate of 0.95 ± 0.03 for non-calves individuals, and a birth rate of 0.06 ± 0.1 were yielded. The dynamic steady state (carrying capacity) was predicted when the population was close to 6,000 individuals (95% CI=3,496-9,717) over a simulation period of 5-6 decades. The inflection point was obtained when the population reached a population of 5,600 individuals, and the steady state was reflected when the birth and mortality curves entered in balance with about 580 whales each other. The calf mortality curve was approximately 50% higher than those predicted for subadults and adults at steady state due to its lower survival. Population modeling of this whale stock might be a valuable tool for management purposes and the species action plan at regional level, but information on key aspects concerning to the population dynamics need to be locally generated to obtain a more reliable estimate.

Using Remotely-Sensed Satellite and Autonomous Underwater Vehicle Measurements to Characterize Northern Fur Seal Migratory Habitat

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This study combined remotely sensed (sea surface height and chlorophyll *a*) and *in-situ* data collected by two Seagliders (autonomous underwater vehicles), with northern fur seal migratory movement

patterns to characterize part of their foraging habitat. On four occasions, two satellite-tagged northern fur seals moved through areas where Seaglidors were profiling temperature, salinity, dissolved oxygen, fluorescence, and backscatter (surface to 1000 m) at horizontal resolutions of 5-10 km. A seal migrating through the Gulf of Alaska appeared to respond to variability associated with a cyclonic eddy (identified by remote sensing), by passing through its northern edge but lingering to forage for a week along the southern boundary. Seaglider profiles reveal elevated fluorescence and backscatter values within the upper 50 m along the southern edge, decreasing to the north. This suggests higher productivity along the eddy's southern side and possibly explains why the fur seal stopped to forage in that region. These results show that autonomous sampling technologies (e.g. Seaglidors and floats) can be employed to help explain northern fur seal migratory movement patterns and potentially identify foraging areas by characterizing vertical variations of their foraging habitat.

Beaked Whale Identification Reference on the Web: A Tool for Stranding Responders

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Identifications of stranded beaked whales are difficult due to morphological similarities between species. Most diagnostic characters are found in the skull, mandibles, and teeth, and many are ontogenetic and sexually dimorphic. Accurate species identifications are imperative for developing conservation and management strategies, as well as for understanding the overall biology of individual species. These identifications should ideally be made before biological samples and data from stranded specimens are distributed to various research labs. No comprehensive reference exists for making rapid, positive identifications of stranded ziphiid species. We have created a website to serve as a centralized resource for making morphological identifications of beaked whales. These pages include an introduction to the family Ziphiidae, historical information on beaked whale research, images of skulls and diagnostic characters, comparative morphology techniques, links to research collections, and bibliography. This project is an on-going collaborative effort with the marine mammal community, and will continue to draw from contributions from collaborators. We will present key diagnostic characters and comparative methods that are useful for identifying stranded beaked whales. We will also present some of the information resources that will be available from this website, including downloadable pdf files of field identification keys. With this website, we intend to enable more researchers and stranding responders to identify ziphiid species and become familiar with morphological variation within Ziphiidae by having access to reference materials available online. More rapid identification of stranded ziphiids enhances the life history data collected by stranding coordinators and subsequent researchers investigating these specimens and data. Ziphiids are potentially subject to human-related mortalities; therefore, it is imperative to develop more precise identification techniques for species. By increasing the level of knowledge about the basic biology of these whales, better conservation and management practices can be developed.

Behavior of Orphaned Bottlenose Dolphin Calves within a Long-term Resident Community in Sarasota Bay, Florida

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In Sarasota Bay, Florida, bottlenose dolphin (*Tursiops truncatus*) calves typically remain with their mothers for three to six years. During this time of dependence, calves develop social relationships and habitat use patterns. However, some mothers die before the calves reach independence (half-weight coefficient of association, hereafter COA, < 0.5 with mother) and, in some cases, the calves continue to survive

for months to years in the absence of a mother. Little is known about how these orphaned calves develop the skills and habits that allow them to mature to adulthood. The long-term, longitudinal study of the resident community in Sarasota Bay has provided us the unique opportunity to examine the social and ranging patterns of five calves orphaned between 1991 and 2004 at ages from 14 to 36 months. In each case, the mothers and calves were members of the multi-generation Sarasota Bay community, known since birth and identifiable from markings on their dorsal fins. COAs between mothers and calves one year prior to orphaning ranged from 0.92 to 1.00. We applied a procedure proposed by Syrjala (1996) to test for changes in geographic distribution. Of the three orphans that had enough sightings after their mother died, two had distributions significantly different from before orphaning. All five of the orphans, including those whose ranges changed significantly, appeared to use a subset of the range they used while with their mother. None of the orphans became closely associated with (COA > 0.5) any of the other adult females in the community, including close relatives. The orphans tended to associate with variable groups of mothers with calves and mixed-sex juvenile groups. The survivorship of these orphans in the absence of support from an adult female is somewhat surprising given the extended care and close mother-calf bonds typically exhibited in Sarasota Bay.

Pacific Walruses Acoustic Repertoires: Evidence for Ultra and Infrasonic Signals

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In previous research Pacific walruses (*Odobenus rosmarus divergens*) have been found to produce a rich variety of acoustic signals. However, they have not been well described in the literature. We recorded the acoustic signals and concurrent behavior of a social group of four walruses, a mature male, and three mature females in an aquarium setting. One hour of underwater recordings were collected twice a week over a two-month period. A Cetacean Research Technology C54 hydrophone mounted in a suction cup on the exterior of a window of the walrus pool enabled us to obtain recordings of the acoustic behavior of the animals without them damaging the transducer. Data was recorded directly into a laptop computer using Cool Edit Pro software. Acoustic signals were analyzed using Raven software and a database of spectrograms was categorized by visual inspection. Similar to behaviors reported in the wild, the male walrus made most of the acoustic signals. Past research has reported male walruses producing a metallic sounding 'gong' type vocalization. In this study we present spectrograms of different gong-like sounds that are either precursors of the previously described gong or another type of signal. Also, past studies reports walruses producing frequencies between 0.125-20 kHz. In this study the walruses produced a wider frequency range of 0.001-22 kHz (upper limit of the recording system). The male also produced acoustic-visual displays that often included movements of the fore-flippers from the mouth outward in arcing pattern concurrent with the behavior of forcing water through his mouth that had infrasonic components (0.001 Hz -22 kHz). Whether wild walruses exhibit this acoustic-visual display is unclear but it has been observed in other males in aquaria. We hypothesize that the infrasonic component of this display and other vocalizations could have potential value for long distance communication.

Fishery Characteristics and Cetacean Bycatch in Guarujá and Santos, São Paulo State, Southeastern Brazil

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Mortality in fishing gear is likely the most important threat to the conservation of small cetaceans worldwide. Fishery monitoring were carried out in Guarujá (23°59'S, 46°15'W) and Santos (23°57'S, 46°20'W) in central São Paulo State, southeastern Brazil with the purpose of describing the fishery and assess cetacean bycatch. Gillnets is the main gear used on both localities. The fishery in Guarujá is of smaller scale (artisanal). The fishing area is located within a ~60 nautical mile range (23°51'S to 24°01'S) near the landing port. The fleet is composed by 19 boats (length=3.5 to 7.5 m) some of which are equipped with outboard engines (4-18 hp). Gillnets are set on the bottom or at the surface and range from 240 to 1200m in length and 1.5 to 3.0m in height. In Santos, where a total of ten boats (13-25m in length) operate, the fishery is of a larger scale. Gillnets are usually set on the bottom and range from 6500 to 18520m in length and up to 3m in height and the fishing area range from Rio de Janeiro State (22°52'S, 42°01'W) to Santa Catarina State (27°17'S, 48°21'W). From January 2003 to June 2005 the capture of 13 franciscanas (*Pontoporia blainvillei*) was recorded in Guarujá. In Santos, monitoring took place from June 2004 to June 2005 and 17 individuals of three species were collected: Franciscanas (n=14), tucuxi *Sotalia guianensis* (n=2) and long-beaked common dolphins *Delphinus capensis* (n=1). All captures occurred in relatively shallow waters (depth < 22 m). Catch per unit of effort (CPUE) data indicate that mortality is higher in the summer in bottom set gillnets (mesh 7-14 cm). Results suggest that the Franciscana is possibly the most impacted species in this fishery due to its coastal habit. This study corresponds to the first systematic monitoring of the fishery in Guarujá and Santos. *Support: Project AWARE Foundation.*

Exploring the Population History of Eastern North Pacific Gray Whales Using Multi-Locus Genetic Data

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Estimating the historical abundance and ecology of marine mammals often has important implications for the management of today's populations. Under certain assumptions, the theoretical relationship between genetic diversity and effective population size allows inferences about historical population sizes from genetic data. Though past efforts to explore historical population sizes in baleen whales have focused on the mitochondrial control region, drawing demographic inferences from such data can be problematic since the control region represents only a tiny fraction of the genome and mutation rate has been shown to vary across its length in mammals. Thus, data from multiple, independently evolving regions of the genome are needed to estimate historical parameters. We are using the eastern North Pacific gray whale as a case study by sequencing 10 nuclear introns ranging from 600-1200 bp in size from approximately 40 individuals. This population is recovering after two centuries of whaling, and is thought by some biologists to have surpassed the historical population size estimated from whaling records. However, recent studies have shown that it is impossible to reconcile this historical size with recent population increases under density-dependent, age- and sex-structured models. Was the actual historical population size of gray whales significantly smaller or larger than today's population? Preliminary results from nuclear genetic data suggest long-term population estimates that are smaller than estimates derived from control region data, but larger than today's population of eastern North Pacific gray whales. A combination of multilocus genetics, historical records and population modeling will provide an enhanced view of the past history of whale populations.

Spatial Distribution of Steller Sea Lion (*Eumetopias jubatus*) Males on Non-Reproductive Section of Rookery

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At the end of the reproductive period, the spatial distribution of Steller sea lions on a rookery changes. Females with pups move from

reproductive area to the non-breeding sections of the rookery. A unique social environment develops in the post-reproductive period that consists of males and females with pups of different age. The study of these post-reproductive groupings provides a unique opportunity to study the interaction of animals of diverse ages. Observations were performed in 2001 on the non-reproductive section Steller sea lion rookery on Medny Island (Commander Islands). Spatial patterns of animal distribution on the rookery were reconstructed using photographs and behavioral observations of males. Males were separated into 3 age classes: bulls, *i.e.* males over 7 years in age; 6 - 7 year olds; and 4-5 year olds. Animals were distributed on the territory non-randomly, forming specific, identifiable clusters. The most bulls lay in groups. Only 5% of the mature bulls lay singly. Among males of 6 - 7 years old 25% lay singly while 4-5 year old males were always in groups of the same age-class only. When females began to arrive to non-reproductive section of the rookery (July 9) the social structure began to change. While the adult bulls' territorial behavior remained consistent, 6-7 year old males spent more time on average interacting with females than adult bulls and 4-5 year old males interacted more with males of the same age (Mann-Whitney U Test $P < 0.05$), splitting their time evenly between play and territorial behavior. In summary, behavior of males on non-reproductive areas of rookery varies with age and status. Young males interact with similar-aged animals mostly, 6-7 year olds interact with females and their territorial behavior is expressed primarily in the presence of females, while territorial behavior of adult bulls is independent of female presence.

Seasonal and Yearly Variations in Coda Repertoires of Sperm Whales in the Gulf of California, Mexico

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Sperm whales are present year round in the Gulf of California (GoC). However, in the Central GoC, our main study area, photo-identification and fatty acid studies suggested that different sperm whales frequent the area in spring and fall. To investigate whether different clans (groups of whales that share the same coda repertoire) are present in the GoC in spring and fall, we examined seasonal variations in coda repertoires among spring 2002, fall 2002, and spring 2003. Data were collected using standard techniques of photo-identification and recordings, and codas were extracted using Rainbow Click software. We compared coda repertoires among seasons and among different groups identified in different seasons using a multivariate similarity measure. We recorded 509 codas from 15 sperm whale's groups, 120 in spring 2002, 304 in fall 2002, and 85 in spring 2003. The highest similarity in repertoires was between groups recorded in spring 2002 and fall 2002 ($S=0.01$), and the lowest between spring 2002 and spring 2003 ($S=0.002$). The large difference in repertoire similarities between 2002 and 2003 suggested that two clans frequented the GoC, one in 2002 and one in 2003. However, the high proportion of individuals photographically matched between spring 2002 and 2003 suggested that both clans were present in 2003, although only one was recorded. It is possible that one clan was vocally dominant; or, as the 2003 sample size was low, that the second clan was missed. The likeness in similarity values ($S=0.01$) calculated between repertoires of a same clan ($S=0.01$, spring/fall 2002) in the GoC with those reported for clans in the South Pacific ($S=0.01$) may be an expression of sperm whale social organization on an ocean basin scale.

Group Structure and Stability of Killer Whales in Northern Norway

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The aim of the study was to describe the social organization of killer whales occurring in northern Norway based on a two-year photo-identification data set (2002-03), obtained mainly from whale-

watching vessels. A total of 698 different killer whale individuals and 30 pods were identified. Three hundred and fourteen (45%) of the identified individuals were considered to be well marked. The difference between 2002 mean group size (15.81 ± 6.83 S.D.) and 2003 (13.98 ± 5.27 S.D.) was not statistically significant (Mann-Whitney rank sum test, $P > 0.05$). These means were within the range of group sizes documented in a preliminary study for the same population, and for other fish-eating killer whale populations. Association patterns were analysed using a simple ratio index and 44 individuals sighted three times or more were included in the analysis. In addition, permutation tests were performed to test for non-random association as well as a temporal analysis of the association patterns. Although the results for association index indicate that the associations were predominantly weak (27 pairs with an association index $e^{\sim} 0.5$) both permutation tests and temporal analysis showed that individuals do not associate randomly and associations were stable over time. These results support the existent theory that killer whales of northern Norway do live in stable social units, consisting of both sexes and all ages.

Using Stable Isotope Ratios and Turnover Rates in the Skin of the West Indian Manatee (*Trichechus manatus*) to Interpret Feeding History

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The West Indian manatee is one of only two sirenian species (*T. manatus* and *T. senegalensis*) that utilize marine, brackish, and freshwater habitats. Relatively little is known about manatee feeding ecology and habitat use since they frequently occupy shallow, turbid water. Carbon and nitrogen stable isotope analyses were used to examine feeding history and isotope turnover rate in manatee skin. Skin biopsies from the paddle were collected from free ranging animals in Florida ($n=94$), Belize ($n=34$), and Puerto Rico, ($n=12$) and from captive animals in Florida ($n=9$). Isotopic turnover rates were determined by sampling skin from rescued animals in captivity that underwent a diet switch from natural forage to romaine lettuce. The total change in epidermal $\delta^{13}\text{C}$ values ranged from 11.5 to 15.0‰. Carbon turnover rates (half-life) ranged from 45 to 59 days. Low rates of metabolism in manatees may contribute to this slow turnover rate. Nitrogen turnover rates were inconclusive due to large variation in $\delta^{15}\text{N}$ values for romaine lettuce. For free ranging animals, isotope values (mean \pm SE) for manatees in Puerto Rico ($\delta^{13}\text{C}$ $-10.1 \pm 0.2\text{‰}$; $\delta^{15}\text{N}$ $5.7 \pm 0.3\text{‰}$) were indicative of a marine diet. Values for animals from Belize ($\delta^{13}\text{C}$ $-13.0 \pm 0.2\text{‰}$; $\delta^{15}\text{N}$ $1.7 \pm 0.4\text{‰}$) and coastal Florida ($\delta^{13}\text{C}$ $-14.5 \pm 0.6\text{‰}$; $\delta^{15}\text{N}$ $4.4 \pm 0.3\text{‰}$) were consistent with a diet of marine/brackish vegetation. Values for manatees sampled in Homosassa and Crystal Rivers, FL ($\delta^{13}\text{C}$ $-20.2 \pm 0.3\text{‰}$; $\delta^{15}\text{N}$ $7.0 \pm 0.2\text{‰}$) were indicative of a brackish/freshwater diet. Our data suggest regional differences in the proportion of freshwater, brackish, and marine vegetation contributing to the manatee diet. $\delta^{13}\text{C}$ values in epidermal tissue are better indicators of past diet rather than recent diet since turnover rate was slow.

Preliminary Results of Behavioral Responses of Humpback Whale (*Megaptera novaeangliae*) to Satellite Tag Deployment

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The use of satellite telemetry in whales is very recent due to difficulties in miniaturization and attaching the transmitters to the animals. Behavioral observations were conducted during tag deployment operations for humpback whales carried out off the Brazilian coast in 2003 and 2004. This study aimed to evaluate whale reactions to tag deployment. Observations were conducted from the flying bridge of a speed boat (5m above sea level) before and after inflatable boats approached the whales for tagging. Transmitters were deployed using 6-8m-long poles, when the inflatables were from 5-8m from the whales. Attachment systems were composed by a stainless steel spear, with barbs. Two types of transmitters/tips were used: implantable/triangular ($N=5$) and minican/needle ($N=7$). We registered submersion duration, respiratory frequency and behavior using focal animal sampling method. Comparisons between average respiratory rate and average submersion duration, before ($N=3$) and after ($N=3$) tagging, of the same animal, were calculated. Acute responses to tagging were compared across sexes and type of transmitters/tips. Average pursuing duration before tagging was 29.33min ($SD=13.76$) and 5.33min ($SD=2.05$) after. Respiratory rate was lower before (mean=0.63 blows/min, $SD=0.13$) than after (2.13 blows/min, $SD=0.48$) tagging. Submersions were longer before (mean=0.83min, $SD=0.06$) than after (0.44min, $SD=0.05$). We observed only tail slaps as acute responses, for 12 tagging attempts. No apparent behavioral responses were observed for seven whales tagged. Tail slaps were observed for 14.3% of whales tagged with minican/needle and 80% of those tagged with implantable/triangular. It suggests that the type of the attachment system tip has some behavioral responses. Behavioral responses for males and females were observed in two (50%) and three occasions (42.8%), respectively. Even with small sample sizes, preliminary results suggest it is important to monitor behavioral responses to tagging procedures as basis to assess animal welfare condition. Supported by Shell do Brasil S.A.

Rescue of Released Manatees (*Trichechus manatus*) in the Northeast Coast of Brazil

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The Aquatic Mammal Center/IBAMA (CMA) and Aquatic Mammal Foundation have released captive-held manatees to re-establish the species in areas of its historical range along the northeastern coast of Brazil. On December 2004, three animals were released in Patacho's Beach/AL (9.20021°S, 35.32115°W). Immediately after their release, two of them made long distance moves to the south to areas that jeopardized their survival. One of these individuals traveled away from foraging areas to deep offshore waters. "Tico" (3.7 years of age, 160 kilos) was monitored between 04 and 17 December as he traveled along 310 km of coast. He was initially tagged with a very high frequency (VHF) radio-transmitter. On 11 December he was re-tagged with a satellite-monitored Argos tag. On 17 December, "Tico" was observed 100 km offshore (11.61275°S; 36.70130°W) in water depths of 200 meters with visible signs of weight loss, and was captured. "Assú" (4.8 years of age, 190 kilos) in his second release was tagged using a VHF radio-transmitter and was monitored between 04 December and 07 January 2005. On 05 January, after he had traveled 550 km, "Assú" was observed in the urban center of Salvador/BA (12.94771°S; 38.50282°W) where illegal explosive fishing occurs and there are no food resources. He was captured and transferred to a temporally pool having lost 50 kilos. "Tico" and "Assu" were transported to the CMA facility and are being rehabilitated with plans to re-release them. These efforts allow for monitoring released manatee re-adaptation to the wild while enabling interventions and rescue when necessary.

Rescue criteria have been added to the captive manatee release protocol in Brazil. We suggest increasing the time of temporarily holding individuals in semi-captive seapens prior to release to prevent disorientation and possible wanderings away from shore. We also recommend use of satellite-monitored Argos tags to permit the remote monitoring of manatees that move offshore or long-distances after release.

Population Analysis of the Common Dolphin, *Delphinus delphis linnaeus*, from the Portuguese Coast by Mitochondrial Markers

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The common dolphin, *Delphinus delphis* Linnaeus, is one of the most widespread of the small cetaceans and is relatively abundant in the temperate to sub-tropical waters of the North East Atlantic. However, genetic information on the populations occurring in this region is deficient. We have examined the population structure of this species in the Portuguese coast comparing DNA sequences from two mitochondrial genes (cytochrome *b* and control-region). Samples from stranded animals collected between 1995 and 2005 along the entire Portuguese coast were analyzed. Contrasting patterns of genetic variation between the two mitochondrial fragments were observed, suggesting an ancient reduction of genetic variability in Portuguese waters, specially in the northern populations. A fine scale population structure was detected between the northern and southern populations indicating recent genetic differentiation with low levels of gene flow. Some individuals showed a high degree of genetic divergence when compared with common dolphins off the Pacific coast and with *D. capensis*, leading to the hypothesis that common dolphins off Portugal could be a different morphotype of *D. delphis*, somewhere in between the two actually recognized species. A shared haplotype between *D. delphis* and *Stenella coeruleoalba* was also found, suggesting a possible case of hybridization. These prior findings have important implications on a taxonomic level, although further investigations based on a larger geographical scale are needed.

Review of Finfish and Shellfish Trap Studies: Do These Traps Drown Sea Otters and if so What Can be Done About It?

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Previous studies have addressed the potential for sea otters to be drowning in fish traps (Hatfield *et al.*, 2001; Estes *et al.*, 2003). With those concerns in mind we began to view with some alarm the large number of sightings of sea otters, during rangewide survey overflights, in offshore habitat where significant numbers of crab trap buoys were also observed. In this study we tested both Dungeness crabs and sea otters to see what size openings each could transit. The fyke openings in several hundred commercial crab traps we examined were approximately 9 inches wide by 4 inches high. Previous work done by repeatedly pulling dead otters of all sizes through progressively smaller rigid rings and parallel bars that were moved closer and closer together, and the present work done where live otters were encouraged to transit smaller and smaller rigid rectangular openings (similar to crab trap openings), demonstrate that sizeable numbers of young independent sea otters (*i.e.*, foraging on their own) are vulnerable to the current 4-inch-high opening in commercial crab traps. Our tests on a few Dungeness crabs in a captive setting, as well as over 3,700 in the wild, suggest that the entrance to crab traps could be a full inch narrower (*i.e.*, 3 inches by 9 inches rather than 4 inches by 9 inches) without affecting the size of crabs caught and only minimally affecting

the overall catch. An opening of 3 inches by 9 inches would also result in the exclusion of virtually all independent sea otters. Studies on five captive adult sea otters presented with two different lobster pot opening designs suggest that only the largest adult sea otters would possibly be excluded from lobster pots. Live fish traps with unregulated entrances pose similar risks where they co-occur with sea otters.

Genetic Signals of Migration Between Sub-Population of Atlantic Walrus (*Odobenus rosmarus rosmarus*) from Eastern Hudson Strait (Canada) and West and Northwest Greenland

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A genetic analysis using 11 nuclear microsatellite markers was made of a total of 297 Atlantic walrus (*Odobenus rosmarus rosmarus*) sampled during 1988-2002 from E Hudson Bay across Greenland to Franz Josef Land. The aims of the study were to analyse the number of sub-populations represented in the entire sample, and the genetic relationships among groups of walrus in E Hudson Strait, W Greenland and NW Greenland. The study indicated that five sub-populations were represented: E Hudson Strait, W Greenland, NW Greenland, E Greenland and Svalbard-Franz Josef Land. The identification of the latter four confirms earlier studies whereas the identification of the first is novel. The genetic differences observed between walrus in the E Hudson Strait area and walrus in W Greenland were small, but significant, and population admixture analysis indicated that walrus in the E Hudson Strait, NW Greenland and W Greenland probably belonged to the same ancestral population. Furthermore, analysis of migration direction and rates indicated that walrus in eastern Canada could be the source of walrus wintering in W Greenland, where exploitation may exceed sustainability. The direction of migration could be a genetic signal of the large-scale counter-clockwise migration pattern in the Baffin Bay area.

Behavioural Responses of Polar Bears to Disturbance by Snowmobiles

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Snowmobile use in Svalbard, Norway, has increased significantly during the last 15 years. In the current study the distance at which polar bears detected and actively responded to approaching snowmobiles was measured. The responses were categorized according to the intensity and persistence of the reactions, and given numbers 1 to 4, where 4 was the strongest response. Polar bears were detected on the sea ice using telescopes and binoculars. Undisturbed bears were continuously observed and their behaviour recorded, while two snowmobiles approached it. Distances between the bear(s), the observer, and the snowmobiles were monitored while approaching the bear(s) using GPS positions. Wind direction at the time of the observation was recorded. Data on the behavioural response was collected for 20 encounters. Polar bears were detected at an average distance of 2475m (range 141 - 6260 m). On average the bears detected the snowmobiles at a distance of 1164 m (range 141 - 4903 m) and this distance varied between age and sex groups (adult males: 326 m (SD=249 m), adult females: 164 m (SD=16 m), females with cubs: 1,534 (SD=992 m), single medium sized bears (sex unknown): 1,313 m (SD=1,322 m). Also the responses to snowmobiles varied among age and sex groups (adult males: 2.4 (SD= 0.5), adult females: 3.0 (SD=1.4), females with cubs: 3.5 (SD=1.0), single medium sized bears (sex unknown): 3.5 (SD=0.6)). Weather conditions seemed to affect the results. Data collection for the current study is ongoing,

but preliminary results indicate that there is large variation in how polar bears respond to disturbance from snowmobiles, and that some bears are particularly vulnerable since they react at very long distances and show strong responses. Long term consequences of snowmobile disturbance on the population dynamics of polar bears are unknown.

Historic Stock Structure and Genetic Variation in Southern Hemisphere Area V Humpback Whales and the Impact of Whaling on Modern Stock Recovery

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Humpback whales (*Megaptera novaeangliae*) in the Southern Hemisphere IWC Management Area V (130°E - 170°W) numbered between 15,000 - 20,000 prior to the last commercial whaling period (pre-1945). When the species was declared protected in 1963, it was believed that only 200-500 individuals remained. Traditionally, these whales were considered to form a single panmictic population, however, recent genetic studies have suggested that a number of sub-populations may inhabit the region. As a result, the reduction in population size of each individual sub-population may have been far greater than previously recognised. Such dramatic reductions in population size can lead to loss of genetic variation and inbreeding, greatly reducing the chance of a population's recovery. Observations of Area V population recovery today suggest that each sub-population was independently impacted upon by commercial whaling, with recovery rates from Eastern Australia, Tonga, New Zealand and Norfolk Island varying substantially (range 0 - 10.9% pa). This study uses over 150 historic bone and baleen samples from humpback whales that were commercially harvested from sites throughout Area V prior to 1963. Results from 14 microsatellite loci as well as the mtDNA control region (d-loop, 447 bp) have been used to accurately determine the historic stock structure of Area V humpback whales. Additionally, genetic variation of each historic sub-population was compared to data from the modern sub-populations to determine whether reduced genetic variation may have contributed to the recoveries observed today. These results will be discussed and the implications that future whaling (such as the recently proposed JARPA II scientific whaling program) may have on Area V humpback whales will be examined.

Intraspecific Variability in Gene Flow Corresponds with Social System and Environment for the Hawaiian Spinner Dolphin (*Stenella longirostris*)

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Intraspecific variability in social system, dispersal, and environment are thought to be interrelated in many mammalian species. Environmental factors such as habitat quality and predator pressure can influence both social system and dispersal, and dispersal can influence social system by determining which individuals remain together in groups and which disaffiliate. In the spinner dolphin (*Stenella longirostris*), two different social systems exist at two ecologically different areas in Hawai'i, the far Northwestern atolls and the Main Islands. Patterns of gene flow within these two areas were investigated as an indirect measure of dispersal. Gene flow was measured using 429 bp of the mtDNA control region and 10 microsatellite markers for samples collected at all Hawaiian Islands that host spinner dolphins: Kure Atoll (n=34), Midway Atoll (57), Pearl & Hermes Reef (27), French Frigate Shoals (30), Ni'ihau (39), O'ahu (47), Maui Nui Complex (60), and the Big Island (74). The data indicate a correspondence between gene flow, social system, and

environmental conditions. Gene flow was higher within the far Northwestern atolls (Kure, Pearl & Hermes, and Midway), a region with limited habitat availability, small population sizes, and stable social groups (pairwise mtDNA and microsatellite F_{ST} between 0 and 0.02, $p > 0.05$), than within the Main Islands (pairwise mtDNA F_{ST} between 0.01 and 0.16, $p < 0.05$; pairwise microsatellite F_{ST} between 0.01 and 0.04, $p < 0.05$). These data indicate that differential dispersal pressures may be related to variability in social system and environment for the Hawaiian spinner dolphin. The possibility of inbreeding avoidance as a differential dispersal pressure is supported by lower diversity found at the mtDNA locus for spinner dolphins at the far Northwestern atolls than at the Main Islands. This low diversity is likely caused by geographic isolation of small populations that might experience some level of inbreeding.

Satellite Tags and Attachment Techniques for Killer Whales

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The purpose of this project was to develop remote tracking devices and attachment techniques to facilitate studies of the impact of killer whale predation on their marine mammal prey. The fish-eating residents based in the Kenai Fjords area of Alaska were chosen as our first tagging subjects because they are easier to approach and more likely to be resighted for post-tagging assessments. The initial prototype design of both VHF radio tracking beacons and Argos satellite tags was a small rectangular shape (4.0 cm long X 2.0 cm wide X 2.2 cm tall) attached to a thin (4.2 mm diam.) barbed titanium dart that was designed to penetrate approximately 3 cm into the blubber of the killer whale. The tags were deployed with a crossbow. In fall 2004, three southern Alaska resident killer whales were successfully tagged with VHF radio tags inside Resurrection Bay near Seward, Alaska. Inclement weather prevented us from tracking the whales after they left Resurrection Bay, but one of the whales was sighted approximately 3 weeks later. The VHF tag had fallen off the dorsal fin and a small (~1 cm diam.) wound was visible that was nearly healed. One Argos satellite transmitter was successfully attached to another resident killer whale, AJ21. The transmitter made frequent satellite uplinks (approximately 10/day) until ceasing transmissions 6 days later. The initial goals of minimal invasiveness and short-term attachment were met in this pilot project. None of the whales showed adverse responses to tag deployments, and the wound on the resighted whale suggested minimal tissue reaction and quick healing. We are working on a new design with reduced hydrodynamic drag and a more secure attachment mechanism for greater longevity, but with the same goal of the lowest possible impact on the whale.

Understanding Right Whale Body Fat Condition

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Investigation of biological and environmental factors contributing to high variability in reproductive performance of northwest Atlantic right whales is critical to the conservation of this endangered population. Blubber thickness and body shape (series of body widths) were measured on free-swimming right whales (*Eubalaena glacialis* and *Eubalaena australis*) using ultrasound and aerial photogrammetry to determine whether body fat condition varied with changes in reproductive status and in response to periods of reduced prey availability. Blubber thickness of females decreased during lactation,

increased after weaning, and was thickest in females measured a few months prior to the start of pregnancy, indicating that females draw on blubber for energetic support for reproduction. Moreover, body shape caudal to the blowholes of lactating females was significantly thinner than that of non-lactating females; most of this reduction occurred during the fasting portion of lactation. Juveniles and adult males measured during a year of low food abundance had significantly thinner blubber than those measured during years of greater food abundance. Taken together, these results suggest that blubber thickness and dorsal body shape are indicative of right whale energy balance; therefore, the marked fluctuations in northwest Atlantic right whale reproduction have a nutritional component. Additionally, in the absence of assessing the capacities of these indices to predict actual body fat condition, the relationships between the indices were explored and compared with subjective assessments of relative fatness. Maximum body width and blubber thickness were correlated in juveniles, but not in lactating females, suggesting different rates of lipid catabolism among various lipid reserves. The subjective assessments appeared to capture general trends in body fat condition but lacked the precision of the quantitative indices. Such comparisons indicate assessing body fat condition with a combination of indices is important to future monitoring of the condition of the northwest Atlantic right whale population.

Galapagos Sharks and Hawaiian Monk Seals: A Conservation Conundrum

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Predation by Galapagos sharks (*Carcharhinus galapagensis*) is the single greatest mortality source for pre-weaned monk seal (*Monachus schauinslandi*) pups at Trig Island, French Frigate Shoals. We hypothesized that the predation involved a small number of sharks that first adopted the behavior after being attracted by high numbers of pup carcasses associated with adult male aggression. This was tested using a combination of direct monitoring and the removal of limited numbers of active predators. At Trig Island, the number of mortalities peaked in 1997-1999 (18-28 mortalities each year, equal to 38-69% of the annual cohort) and declined thereafter (<10 mortalities each year, with 3-4 each of the last three years). Atoll-wide, the number of mortalities was relatively stable the last four years, with 10-12 losses each year, (15-21% of the annual cohort). During the four years of the project, the numbers of patrolling sharks exhibiting predatory behaviors declined during diurnal hours, and ten sharks were removed. As predation declined at Trig Island, it increased at other sites within the atoll. We attribute these results to shark displacement from Trig Island during diurnal hours. We discuss the decision framework for implementing the shark removal experiment in terms of the expected costs and benefits (to both the monk seal and shark populations), the uncertainties in the predation data, and concerns about the acceptability of the removal program within the management context of a refuge system. Given the current declining status of the monk seal and the probable minimal effect of the removals on the shark population, we concluded that available data were sufficient to proceed with the removal program.

Acoustic Length Measurement in Sperm Whales: Temporal Integration Improves Consistency of Inter Pulse Interval Measurement

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The pulsed nature of sperm whale clicks was noted in early sound recordings. It was later proposed that these pulses are intrinsic to the sound production mechanism in the spermaceti organ, and that the inter pulse interval (IPI) could provide an acoustic measure of body length. A number of papers generally support this mechanism and show IPIs can provide precise body length measurements. Standardization and automation of analysis techniques are required for this technique to be used reliably however. A good analysis method should provide consistent measurements of IPI from sequences of clicks from the same whale while providing a high degree of automation. In typical field recordings, "anomalous" pulses can occur temporarily within clicks and cause analysis problems. Temporal integration is a powerful signal processing technique for distinguishing a time-invariant signal from noise. In this application, a number of rectified click waveforms from a particular whale are integrated to allow measurement of the time-invariant true IPI. Field recordings made after a whale fluked up were analyzed using the Rainbow Click program. The clicks of the whale were identified and labeled, and their waveforms were then extracted and integrated using an algorithm implemented in Matlab. The program takes as input the waveforms of the sequence of clicks assigned to a whale, which are time-aligned and added to the sum of previous clicks. The IPI is measured between the first and second peak in the resulting waveform. This approach has performed well compared to alternative methods, providing consistent IPI measurements within and between recordings. Ongoing developments include filtering and windowing of click waveforms prior to integration, optimizing methods for temporal alignment of clicks, and evaluating peak detections. A reliable technique for IPI measurements will allow the precise measurement of body size in the field using acoustic methods.

Population Density and Threats Analysis of Marine Otters *Lontra felina* (Molina 1782) in the Central and Southern Coast of Peru

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Conservation status of marine otters in Peru is uncertain, only one reference from 1976 suggests its population could be between 200-300 individuals. However there is not any published study on population size nor in the threats it confronts. Since the species is listed as endangered by national legislation (DS 034-2004-AG) and in the Appendix I of CITES and CMS, we carried out five surveys between 2001 and 2004 along the central and southern coast of Peru (Lima 12°S - Tacna 18°S) to evaluate its actual conservation status. We aimed to locate the presence of *L. felina* in order to estimate population density and size, and qualitatively assess the threats it confronts. We surveyed the rocky littoral that was accessible from land and also some localities referred as marine otter habitat by personal communications. One hundred and sixty-nine individuals were reported in the 78 localities evaluated, which comprise a coastal perimeter of 141 km. To get an estimate of the size of the population, density was calculated with these data and then multiplied by the total perimeter of potential marine otter habitat determined for the Peruvian coast. Population density obtained was 1.48 ind/km and the estimate for the size of the population was 756 individuals. Threats to the species were identified by direct observation and interviews to some of the residents from the localities surveyed. Significance of

these threats was measured using a qualitative scale, results were as follows: artisanal fishery (explosive use, bycatch, hunting and mariculture) 57%, urban and industrial development 15%, mine tailings 10%, invasive species 10%, and tourism and recreation 8%. Explosive use by fisheries alone (25%) was the most significant threat, and population was found to be much bigger than suggested before, however the amount and magnitude of the threats identified place the species in risk.

Cetacean Biology, Conservation, and Management in the Southern Tañon Strait, Philippines

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The management of marine mammals, particularly cetaceans, in developing countries is often secondary to primary economic concerns. In the southern Tañon Strait, Visayas region, Philippines, we have combined a study of cetacean biology with the establishment of the foundations for a management plan featuring cetaceans. Our cetacean study includes a photographic identification catalogue of various species, which with the aid of GIS has allowed us to elucidate their distribution and abundance. In the span of two years we have documented the presence of spinner (*Stenella longirostris*), spotted (*Stenella attenuata*), Risso's (*Grampus griseus*), common bottlenose (*Tursiops truncatus*), and Indo-Pacific bottlenose (*Tursiops aduncus*) dolphins; melonheaded (*Peponocephala electra*), pilot (*Globicephala macrorhynchus*), dwarf and pygmy sperm (*Kogia* sp.) whales. Dolphin or whale watching in this area was initiated as an eco-tourism activity in Bais City in 1996. Recently, this activity has become popular and has emerged as a major economic activity for the entire region. However, with rising popularity comes increasing demand and consequently more operators and tour boats. Furthermore, guidelines for this particular activity, in their preliminary form, were previously adopted by only a few boat operators from Bais City. To address this and other related issues, we conducted a series of workshops for various stakeholders during which the participants drafted language for an ordinance on guidelines and regulations of dolphin watching which they hope will be adopted by the local governmental units in the area. Likewise, the tour operators adopted a series of guidelines and organized themselves into the "Tañon Strait Association of Cetacean Watchers". Their mission is to provide and promote ecologically friendly dolphin watching services and to elevate the standards of this eco-tourism activity. We believe Tañon Strait is a 'hotspot' for cetacean conservation and we have now established the foundations for a cetacean management plan in the area.

Novel "Gas Embolic Syndrome" in Beaked Whales Resembling Decompression Sickness

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Lesions consistent with in vivo bubble formation in beaked whales has been recently described in Nature by Fernández *et al.*, and Jepson *et al.* A Decompression Like Syndrome has been postulated to happen in whales in response to sonar exposure and might result from behavioral changes to normal dive profiles, causing excessive nitrogen supersaturation in the tissues (as occurs in decompression sickness); alternatively, bubble formation might result from a physical effect of sonar on in vivo bubble presursors (gas nuclei) in nitrogen

supersaturated tissues. As Gas Embolism "in vivo" is difficult to determine some time after death, fresh cases are certainly needed for this aim. One adult female and one old male Blainville's beaked whales (*Mesoplodon densirostris*) stranded on the coasts of Gran Canaria and Tenerife in 2003 and 2004 respectively. Both animals were necropsied around 4 to 8 hours after died. A routine necropsy for whales was carried out by pathologist. A routine histological study was also performed in all the sampled organs, as well as a microbiological study. Possible relationship with sonar exposure is, up to date, not known. Both animals showed massive gas bubbles in the portomesenteric system, involving changes in the liver. Gas bubbles were seen macro and microscopically in the venous system, including portomesenteric system, liver, lung, kidney, heart and brain. Although test of nitrogen content of the gas is now underway, the pathological picture is consistent with a severe acute systemic gas embolism in DCS in humans. No bacterial pathogens were found. The present results restate the occurrence of "systemic gas embolism" in beaked whales, a new pathology entity to be described in cetaceans, with special attention to deep, long time diving species. Triggering causes of this "embolic syndrome" should be further investigated.

Estimating Fishery Exposure of Dolphins in the Eastern Tropical Pacific

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We present a method for estimating the exposure of dolphins to tuna purse-seine sets in the eastern tropical Pacific (ETP). In the ETP, herds of dolphins, primarily spotted (*Stenella attenuata*) and spinner (*S. longirostris*), are regularly found with schools of yellowfin tuna (*Thunnus albacares*). For the past four decades, the ETP purse-seine fishery has exploited this association by chasing and encircling dolphins associated with tuna. The Inter-American Tropical Tuna Commission annually reports the number of purse-seine sets made on dolphins. However, the simple number of sets in an area does not accurately capture the experience of dolphins with the fishery, which is a function of both the historical spatial and temporal distribution of those sets relative to the dolphins. The method we have developed, based on a Bayesian model of spotted dolphin movement patterns derived from empirical tracking and mark/recapture data, estimates the relative recent set experience of any dolphin sighted at a particular location and time, such as from a research vessel or tuna purse-seiner. Because it is a relative measure of set experience, we refer to the estimate generated as an exposure "index." Using data on observed sets from 1973 to 1990, we present a GIS-based analysis of the spatial and temporal distribution and variability of this index across the ETP. Spatial patterns of this index are distinctly different from patterns based on the simple number of sets. This new index is promising for studies of the effect of the fishery on various aspects of dolphin population biology. As an example, we present preliminary examinations of correlations with measures of calf production, stress indices, and behavioral responses. The basic methodology should be applicable to studies of fisheries in other regions as well as other important interactions between cetaceans and ships, such as ship strikes resulting in mortality.

Foraging Areas of Female Australian Fur Seals: Implications for Interactions with Commercial Fisheries

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The Australian fur seal population is still recovering from the over-exploitation of the sealing era (1798-1825) and currently only ca30% of its pre-harvesting levels. Consequently, the fishing industry in southern Australia developed during a period of minimal competition with fur seals. Recent growth-rate estimates, however, suggest that the population could reach its pre-harvesting levels within 20-30

years. The species is known to consume commercially important prey, and there are concerns that interactions and competition between seals and fisheries could increase. Information on where Australian fur seals forage is crucial for developing appropriate management strategies. Satellite telemetry was used to determine the foraging areas of adult females ($n = 56$) from four colonies (>70% of the population) during winter and spring (2001-3). Individual females showed a high degree of foraging site-fidelity during winter but the areas utilised were more variable in spring following the weaning period. No individuals ventured beyond the continental shelf-edge supporting earlier findings that the species is an exclusively benthic forager. There were several foraging "hot spots", some of which were shared by animals from different colonies. The line and gill net fisheries did not appear to overlap with areas frequented by female Australian fur seals. The Danish Seine Fishery, a relatively small and localised fishery, overlaps entirely with foraging areas of some individuals from two colonies. While there was substantial overlap between the foraging areas of seals and the South East Trawl Fishery, it was not with areas of high fishing activity. The exception to this is in the eastern extent of the species range where the fishery is active over the continental shelf. Hence, the extent of overlap between female Australian fur seals and fisheries appears low at present due to their benthic foraging habits and the lack of major fisheries within Bass Strait.

GeoZui4D: A New Method for Viewing Multisensor Tag-Derived Data to Investigate the Underwater Behavior of Marine Mammals

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Direct, underwater observation of marine mammals for extended time periods is technically infeasible. As a result scientists have resorted to deploying a variety of devices on animals to measure and depict motor behavior. For example, the DTAG logs body pitch, roll, heading and depth, while simultaneously recording sounds emitted and received by the tagged animal. However, the dynamic nature of these data (and the animal) is usually depicted by static images or animations of simple data fields (e.g., time and location). In addition, key aspects of the environment, such as human activity that might influence whale behavior, are often difficult to incorporate into visualizations and analysis. GeoZui4D is a geo-referenced data visualization system that allows the integration of multiple data sources (e.g., pitch, roll, heading, and depth) to create a dynamic visualization of whale motor behavior that can be synchronized to sound or other files. The results allow virtual visualization of the underwater activities of the tagged animal, concurrent with sounds the animal makes and hears, shipping tracks or other measured aspects of the environment. For example, using GeoZui4D to combine DTAG data from a humpback whale with vessel tracks from boats in the vicinity allowed us to view the behavior of the virtual whale swimming along the seafloor and hear the vessel sounds received at the whale, while observing boat movements (including a continuous calculation of the distance between boat and whale). In addition, time in GeoZui4D can be sped up or slowed down, depending on the need of the investigator. Similarly, the system has a zooming user interface allowing for fine or large scale viewing from multiple perspectives. We will provide examples of GeoZui4D visualizations using DTAG data collected from humpback whales and describe the power of such visualizations in a policy setting.

Killer Whale Response to Experimental Approach by Many Boats is Opposite to that by Few Boats

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Vessel traffic has been implicated as a potential contributing factor to the at-risk status of two killer whale populations in western Canada and the US. Relevant guidelines can be informed by conducting experimental impact assessments that allow animal response to guide vessel management. Two published experimental studies document stereotyped avoidance responses. Opportunistic observations from these studies suggest an inflection point in avoidance behavior when approximately 3 boats approached within 1000 m. Our experiment was designed to test whether whales responded differently to approach by few (1-3) versus many (>3) vessels. Data were collected in summer 2004, in Johnstone Strait, British Columbia using a theodolite to track positions of boats and individually identifiable whales. Experimental trials included 20-minute "no boat" and 20-minute "boat" phases with local whalewatching vessels during which data were collected continuously on the focal whale. Responses of the 16 adult male killer whales tracked differed significantly between treatment levels (Wilcoxon's test $P = 0.0148$). Swimming path became less direct when approached by few boats, and whales increased directness when approached by many boats. Consistent with previous experiments, inter-breath interval, swimming speed, angle between successive dives, and surface behavior did not differ significantly. The apparent distinction between "few" and "many" boats was supported by opportunistic observations on 26 whales from the population of 216. Pooling both treatments would have masked these significant responses with strong statistical confidence (Wilcoxon's test $P > 0.999$), suggesting that boat presence had no effect on behavior. Generalized Additive Models were used to control for effects of potentially confounding variables, and confirmed a non-linear relationship between approach within 1000m and a whales' swimming path directness with an inflection point around 3 boats. Interpreting biological significance of null findings from impact assessments is problematic and therefore statistical power, study design, and appropriateness of response variables must be considered.

World Wide Marine Mammal Strandings – Is it Species Specific and a Cause for Concern?

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Strandings of cetaceans and pinnipeds are evidence of marine environmental stress and continues to occur despite efforts to improve this environment. This study examined the global incidence of strandings (one animal found either dead/alive on the beach and/or trapped in nets, lines, etc.) and whether certain species were more susceptible over a period of 4 decades. Available stranding reports for cetaceans and pinnipeds from the United Kingdom (14 years), California USA (12 years), Florida USA (26 years) and Queensland Australia (4 years) were analyzed over the complete time intervals of each report and showed a corresponding increase over time for stranded animals in that particular region. In the U.K., the number of stranded marine mammals had a 5 fold increase from 1990 (144 animals) to 2004 (776 animals), California had a nearly 2 fold increase from 1990 (1,321 animals) to 2002 (2,550 animals), Florida had a 5 fold increase from 1978 (67 animals) to 2004 (334 animals). Australia had no change over a 4 year period from 1999 (43 animals) to 2002 (45 animals). Based on geographical location, certain species had a greater number of strandings per year. For instance, in the U.K. harbour porpoises (*Phocoena phocoena*) comprised 31% of strandings in 1990 and rose to 41% in 2003 with a spike of 47% in 1999. However in California, sea lions (*Zalophus californianus*) comprised

93% of all strandings both in 1990 and 2002. Strandings of Florida bottlenose dolphins (*Tursiops truncatus*) rose from 52% in 1978 to 73% in 2004. Every geographical location had a dramatic rise in stranding numbers as well as a sharp increase in strandings of specific indigenous species. Despite current regulations to protect the marine environment, stranding numbers continue to grow and threaten marine mammal populations. Strandings could be viewed as a monitoring tool identifying species that are currently not "at risk" but who may become a species of concern.

SAVE Whales: A Pilot Program Which Developed Standby Assist Vessels for Entangled Whales as a Means to Increase the Likelihood of Disentangling Large Endangered Whales Coastal to Massachusetts

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One of the largest threats to endangered and protected whales in U.S. waters is entanglements in fishing gear. Since 1985, 57 confirmed large whale entanglements have been reported in the Massachusetts Bay area, including the Stellwagen Bank National Marine Sanctuary, with commercial whale watch vessels being the primary reporters (74%) of entangled whale sightings. However, commercial whale watch vessels are often restricted by tight schedules and are unlikely to be in a position to standby an animal for several hours until the disentanglement team arrives. According to the Provincetown Center for Coastal Studies Disentanglement Team, mobile whales have been lost within five minutes of an entanglement report, and once lost; the success rate of relocating an entangled free-swimming whale is less than 10%. As a result of the aforementioned statistics, the International Wildlife Coalition, in conjunction with the Provincetown Center for Coastal Studies, developed the Standby Assist Vessels for Entangled (SAVE) Whales project, a Massachusetts Environmental Trust funded program designed to use commercial assistance vessels (CAV), such as SeaTow, as rapid response standby vessels, when entangled whales are reported in the initial program area. CAVs are equipped, staffed and insured to provide timely on-the-water assistance to recreational boaters in need of towing or similar vessel services. The CAV season overlaps temporally and spatially with that of commercial whale watch operations, CAVs are on-call 24-hours per day, seven days a week, and operate out of a variety of ports in Massachusetts including Green Harbor, Boston, and Newburyport during the extended boating season (May through October). CAVs typically respond to calls for assistance within one hour. Success of this program was demonstrated in May of 2005 resulting in the disentanglement of a humpback whale.

Impact of Changing Diet Regimes on Steller Sea Lion Body Condition

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A leading theory for the cause of the decline of Steller sea lions was nutritional stress, which led to chronic high juvenile mortality and possibly episodic adult mortality. Nutritional stress may result from either poor quality or low abundance of prey. The objective of this study was to determine whether or not shifting diet (toward lower quality prey) could predict shifts in body condition (i.e., body mass or body fat content) over different seasons. Captive Steller sea lions (n=3) were fed 3 different diet regimes, where Diet 1 approximated the diet in the Kodiak area in the 1970's prior to the documented decline in that area, Diet 2 approximated the species composition in the Kodiak area after the decline had begun, and Diet 3 approximated

the diet in Southeast Alaska where the Steller sea lion population is stable to increasing. Although all of the Steller sea lions were still growing during the 3 year study, changes in body mass were not significantly different on the 3 diet regimes. Body fat (%) varied between 13 and 28%, but was not consistently high or low for any diet regime or season. Mean intake (in kg) of Diet 2 was significantly greater for all sea lions during all seasons. Mean weekly intake (in kcal) showed significant interactions between diet and season. Animals tended to lose body mass on Diets 2 and 3, as well as during the breeding and post-breeding seasons; they tended to gain mass during the winter and on Diet 1. We conclude that Steller sea lions are opportunistic predators that are capable of compensating for low quality prey. Changing seasonal physiology of Steller sea lions is likely to have more impact on body condition than quality of prey, provided sufficient quantity of prey is available.

Acoustic Basis for Fish Prey Discrimination and Recognition by Echolocating Odontocetes

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Echolocation signals of odontocetes have a high temporal-spatial resolution property that enables them to discriminate between fish prey species based on the information in the received echoes. To test the hypothesis that acoustic cues are present in the echoes for discrimination and recognition of prey species, acoustic backscatter data were obtained from four fish species, sea bass (*Dicentrarchus labrax*), pollack, (*Pollachius pollachius*), grey mullet (*Chelon labrosus*), and Atlantic cod (*Gadus morhua*) using broadband Atlantic bottlenose dolphin (*Tursiops truncatus*) and narrow-band harbor porpoise (*Phocoena phocoena*) signals. The fishes were anesthetized and attached to a monofilament net that was in turn attached to a rotor so echoes could be collected along the lateral axis of each fish. The echo waveforms were complex with many highlights and varied with the orientation of the fish. The highlight structure was determined by calculating the envelope of the cross-correlation function between the incident signal and the echoes. The strongest echo occurred when the incident angle was perpendicular to the longitudinal axis of the swim bladder, however, the number of highlights was the fewest at this orientation and increased as the fish was moved away from the perpendicular aspect. The echo structures were easily distinguishable between the different species and were generally consistent within species. The highlight structure of the echoes resulted in the frequency spectra being rippled, with local maxima and minima at different frequencies. Differences in species were more obvious with the broadband dolphin signal than with the narrower band porpoise signal which had a much lower spatial resolution. The acoustic backscatter data were also analyzed with a cochlea model consisting of a bank of bandpassed filters based on filter shape measurements on a *Tursiops truncatus*. Time-frequency representations of the processed echoes clearly show that cues are available for prey discrimination and recognition.

Cutaneous Wounds in Pups *Zalophus californianus*: Relationship with *Leptospira interrogans* Incident, Population Density, and Substrate Condition in the Gulf of California

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There are 13 sea lion rookeries in the Gulf of California located in islands that vary in size and ground conditions. A previous study indicated that presence of *Leptospira interrogans* serovars varied significantly among rookeries. In this work we present information

about the variability in the number of ventral wounds of unknown etiology and its correlation with population density, average number of positive reactions to *Leptospira* (APRL) and substrate. Ten pups were surveyed during the breeding seasons of 2002 at each of 11 sea lion rookeries. Number of wounds, weight, length and sex of pups was recorded and blood samples obtained to perform microagglutination tests for 27 serovars of *Leptospira*. Type of substrate in sampling areas was recorded and classified according to the Wentworth scale. We estimated population density from direct censuses and areas occupied by sea lions estimated by GPS and a program using island dimensions. Total population numbers among rookeries varied between 300 and 5000 individuals while average numbers of wounds (ANW) 2.1 and 23. ANW correlated positively with population density ($r = 0.78$, $p > 0.005$) and APRL ($r = 0.79$, $p > 0.005$). An increasing trend in ANW was also observed with a correspondent increase in grain of sediment, with the highest average in rock platform. Our results suggests that population density and type of terrain have an influence in the number of wounds of sea lion pups and their probability to acquire more *Leptospira* serovars. This is an evidence that smaller islands represent lower quality of terrestrial habitat, however more studies are needed to explain why most of the rookeries in the Gulf of California occur in small islands.

Consequences of Behaviour on Foraging Success: Linking Movement and Diving Behaviour to Feeding in a Large Marine Predator, the Grey Seal

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Establishing where and when predators forage is essential to understanding trophic interactions, yet remains poorly understood in marine mammals. We studied the spatial and temporal scales of foraging by grey seals using simultaneous deployments of satellite transmitters, time-depth recorders and stomach temperature loggers. Our goal was to establish characteristics of diving and movement that would predict foraging success. We linked diving behaviour to the foraging success of grey seals ($n=16$) at two temporal units relevant to the predator. At the scale of trips (d), trip duration (GLMM, $P<0.0001$) and accumulated bottom time/d (ABT) ($P=0.004$) were significant predictors of feeding. The best predictors of feeding at the scale of bouts (h) were mean depth (GLMM, $P<0.0001$) and mean bottom time/h ($P=0.0001$). Feeding occurred most often in bouts characterized by flat-bottomed dives, indicative of benthic foraging. We then investigated diving and feeding at 4 temporal scales (3h, 6h, 12h and 24h). The best predictors of feeding were ABT (GLMM, $P<0.0001$) and mean dive depth ($P=0.0001$) at the 3h and 12h scale. We also tested if characteristics of grey seal movement were predictive of feeding ($n=13$). Significant predictors of feeding within trips were angular variance (GLMM, $P=0.03$) and distance traveled per day ($P=0.009$). These findings suggest that foraging success can be predicted from diving and movement characteristics in these animals. Finally, we examined the relationship between diving and movement behaviour of grey seals ($n=30$), with individual movement type determined by fit to a correlated random walk model. Diving behaviour varied among individuals and differed between movement types (MANOVA, $F=2.6$, $P=0.02$), with resident seals having the longest bout duration ($F=4.7$, $P=0.02$), ABT ($F=5.8$, $P=0.008$) and shallowest dive depth ($F=4.2$, $P=0.03$) compared to wider ranging individuals. This behavioural variation has implications for the way we model predation in marine ecosystems.

Some Aspects of the Surface Behavior of Pods of Humpback Whales in Breeding Waters Off Colombian Pacific Coast, South America

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We examined five surface behaviors: displacement, resting, frisking, agitation and aerial display (flipping, lobtailing, chin-breaching, tail-breaching, spin-breaching), of humpback whales (*Megaptera novaeangliae*) in relation to pod types, season, sea state (Beaufort scale). The research was performed in the Málaga Bay (3°56'N, 77°25'W) in the breeding seasons (July – November) of the years 2000, 2001 and 2002. From a 15 meters high shore platform, during 688.5 diurnal hours, we followed 868 pods. Our results showed that the 55% of the pods were formed principally by the mother and her calf, following by pods formed by one adult (13%), by the mother, her calf and one escort (13%), by two adults (10%), by the mother, her calf and more than one escort (5%) and by more than two adults (4%). The most performed behavior was displacement, following by aerial display ($p<0.001$). Resting, frisking and aerial displays occurred more in pods formed by the mother and her calf ($p<0.001$); agitation was done more by pods formed by more than two adults ($p<0.001$), and displacement was done more by pods formed by the mother, her calf and more than one escort ($p<0.05$). At the end of the breeding season (October-November) the whales showed more resting ($p<0.001$), and the rest of the behaviors occurred at a similar rate across the breeding season. According with the sea state, the whales showed more resting and frisking at Beaufort 1 ($p<0.05$), and displacement and agitation were done more at Beaufort 4 ($p<0.05$). Our results indicate that humpback whales show more resting before their trip to their feeding area, that during the diurnal breeding season they do not stay still, and that their surface behavior (except displacement) is influenced principally by social dynamics and sea state.

Sperm Whale (*Physeter macrocephalus*) Distribution in the Western Ligurian Sea: Does a Correlation Exist with Sea Surface Temperature?

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Sperm whales are known to occur in the western Ligurian Sea and particularly along the continental slope of the shelf-edge area. However, very little is known about the environmental factors influencing their distribution. It is worldwide well known that sperm whales concentrate in areas with a specific bathymetry and occasionally along specific hydrographic features such as sea surface temperature patterns and fronts. Aim of this study was to investigate the relationship between sperm whale occurrence and hydrographic features in the Western Ligurian Sea. A total of 84 sighting data collected during opportunistic shipboard surveys conducted from 1991 to 2003 during the summer season were analysed. Surveys covered an area of about 20,000 km² in the western Ligurian Sea between the western Gulf of Genoa, the French Riviera and the Northern coast of Corsica. The study area was divided into 3,128 cells of 3x2 nautical miles and sperm whale presence was associated to remotely-sensed sea surface temperature data (SST-AVHRR). Mean and standard deviation were computed for SST in every cell. Sperm whale occurrence resulted significantly variable over the whole study period (Kruskal-Wallis: 32.37, df: 8, $P<0.01$), while it was rather stable in the 1996-2000 sub-period (Kruskal-Wallis: 4.009, df: 3, $P>0.20$). The relationship between sperm whale presence and SST was investigated by using 1996-2000 sighting data and the corresponding SST monthly images (June to September). Logistic Regression analysis was used to correlate sperm whale presence to SST features. Both SST mean and standard deviation were found significant predictors ($P>0.05$) for sperm whale presence; the resulting logistic models were able to predict 60-78% of presence(1)/absence(0) cells. The percentage of correct predictions was higher for presence(1) cells (up to 85%). These results suggest that thermal fronts and SST patterns play a role in explaining sperm whale occurrence and distribution in Ligurian Sea.

Phonetic Description of Six Delphinid Species Whistles Recorded in the Mediterranean Sea: Preliminary Results

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Acoustic observation can complement visual observation to provide more accurate estimates of marine mammal populations. For effective acoustic censuses, calibration methods must be determined by joint visual and acoustic studies. Research is still needed in acoustic species identification, particularly for smaller odontocetes, in order to allow their future passive monitoring. From 2001 to 2004, during visual-acoustic surveys, whistles of seven odontocetes species were recorded in the Mediterranean Sea, in order to determine how reliably these vocalizations can be classified to species, based on simple spectrographic measurements. For species-specific sounds categorization it is necessary to analyse recordings of the same species at different locations and over several years. The Mediterranean Region has been almost entirely acoustically and visually monitored for marine mammals. Recordings were attributed to species by simultaneous visual sighting. Different research groups and platforms contributed to the study by data collection: IFAW (UK), Alnitak (Spain), GREC (France), CNR (Italy). Western Mediterranean has been monitored by IFAW (2004) and Alnitak (1997-2001); Eastern Mediterranean by IFAW (2003); Central Mediterranean by IFAW (2003) and GREC (1998, 2000). Data for bottlenose dolphins were also collected in controlled environment by CNR researchers. The acoustically monitored species were: Common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), and rough-toothed dolphin (*Steno bredanensis*). After an analysis of sound quality the species that showed the best rate of recording quality results to be pilot whale, with a rate of 19.2% of good quality recordings over the total, followed by killer whale and striped dolphin, respectively with 11.2% and 5.8%; the last one results common dolphin, with 2.4%. After a selection of recordings of suitable quality, spectrographic analysis has been conducted. Descriptive statistic of temporal and spectrographic parameters of analysed sounds would be presented.

Mitochondrial DNA Variation in Historical Bowhead Whales (*Balaena mysticetus*) from Svalbard

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The current project focuses on temporal changes of the genetic structure of the Spitsbergen stock of Bowhead whales (*Balaena mysticetus*). Approximately 500bp of the control region of the mitochondrial DNA (mtDNA) were amplified and sequenced from template DNA extracted from bones. The bones were collected on raised beaches on Svalbard. According to ¹⁴C dating, most of the samples are 200-10,000 years old, only few bone samples were dated to ~40,000 and ~50,000 years BP. Overlapping fragments of the control region were successfully amplified from ~80 bone samples and sequenced. The vast majority of sequences were confirmed as authentic bowhead whale by means of GenBank searches. More than 40 different haplotypes were detected. The majority of haplotypes (80%) were unique (i.e. only obtained from one individual). The most common haplotype was shared by ~25% of all individuals. This particular haplotype was also the most common haplotype (10.3% of all individuals) of the present population of Bering-Chukchi-Beaufort bowhead whales, a population that is also characterized by a high proportion (76.5%) of unique haplotypes. So far, we have not detected any temporal haplotype structure in the historical material from Svalbard.

Quantitative Analysis of Dolphin Movement Paths and Their Relationship with Foraging

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Considerable field effort has been put into the tracking studies required to identify important habitats and foraging areas for marine mammals. However, analysis methods frequently require independent observations and the removal of sequential locations consequently reduces sample sizes. This may mask the underlying biological processes, for example an animals' movement path may be adjusted in response to prey distribution reflecting an individual's perception of food quality. Quantitative techniques that allow all recorded positions to be included in the analysis can therefore provide greater insight into the foraging locations and strategies employed. This study aims to assess the potential of these techniques for understanding fine-scale movement patterns of bottlenose dolphins (*Tursiops truncatus*) within a special area of conservation (SAC). Data were recorded from land using a theodolite and movements were modelled spatially as a correlated random walk (CRW) to test if the animals were moving randomly. Lack of fit to a CRW model indicates that they were moving non-randomly and may be responding to cues from the environment or conspecifics. A first-passage time approach was also used to examine the time allocation within different areas and to identify the location and spatial scale of intensively searched areas. Foraging behaviour mainly occurred within these areas indicating that they were feeding sites. These areas were generally less than 300 m in radius (0.6 km²) and a high degree of overlap of search effort indicated that there were small key sites within the study area (4 km²) that were regularly exploited. Foraging success may therefore greatly depend on a few critical areas within the SAC that the dolphins have specialised feeding on. This analysis approach provides a quantitative method of identifying important foraging areas and maximises the use of tracking data.

Effects of Vessels on Behavior of Southern Resident Killer Whales (*Orcinus* spp.)

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Vessel traffic may have contributed to Southern Resident Killer Whales becoming endangered. To determine the importance of this threat, we measured behavior of Southern Residents in the presence and absence of vessels in 2003-2005 at two different sites along San Juan Island. We then used the differences in behavior to estimate the change in energy balance of the population due to vessel traffic, and in turn the effect on population dynamics. Data collected include: theodolite tracks of focal individuals, along with observations of their behavior; scan sampling of activity states of subgroups, along with counts of vessels at various distances from each subgroup. Theodolite tracks were summarized in terms of directness and deviation indices, and travel speed. Rates of respiration and display behaviors were also determined for each focal sample. Vessel number and distance were used as candidate explanatory variables for differences in track indices and other behavior, along with natural factors such as sex, age, pod membership, time of day, time of year, geographic location, etc. As with Northern Residents, directness index decreased significantly in the presence of vessels, suggesting increased energy expenditure. Rates of display behavior changed significantly with vessel proximity, indicating potential for stress. Transitions between activity states were significantly affected by vessel traffic, indicating a reduction in time spent foraging as was observed in Northern Residents, and suggesting decreased energy acquisition. Each subgroup was within 400m of a vessel most of the time during daylight hours

from May through September. These results suggest that vessel traffic had sufficient detrimental effects on population growth rates to significantly reduce the probability that the population will recover. However, even if the effects of vessel traffic were to be eliminated completely, the population would not recover sufficiently to be downlisted, indicating other threats need to be addressed as well.

Diving Behavior of Cuvier's and Blainville's Beaked Whales: Implications for Mass-Strandings in Relation to High-Intensity Sonar

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Beaked whales are known to mass-strand in response to high-intensity sonar. What makes them susceptible to such impacts remains unclear, but received sound pressure levels are thought to be lower than levels that would cause direct physical harm. Theoretically, indirect physical harm could be caused by behavioral reactions in several ways, if whales: 1) surface excessively fast (causing gas bubble formation); 2) stay at the water's surface for too long (if tissues are supersaturated with nitrogen); 3) dive prematurely (if whales spend extended periods at the surface to eliminate nitrogen); or 4) stay at depth for too long, forcing an overly rapid ascent. Given the paucity of information on normal diving behavior of beaked whales, it is unknown which of these possibilities is most likely. We studied diving behavior of Cuvier's and Blainville's beaked whales in Hawaiian waters from 2002-2005, using suction-cup attached time-depth recorder/VHF tags. Six whales were tagged, two Cuvier's and four Blainville's, and 41 hours of dive data were collected. Several aspects of diving were similar between the species: 1) both dove for 48-68 minutes to depths greater than 800 m (maximum 1,408m for Blainville's, 1,450m for Cuvier's), on average every two hours; 2) ascent rates for long/deep dives were substantially slower than descent rates, while for shorter dives there were no consistent differences; and 3) both spent prolonged periods of time (66 – 155 minutes) in the upper 50 m of the water column. We suggest that the frequent extremely long dives push the animals' physiological limits, resulting in behavioral mechanisms (slow ascent rates and prolonged periods of time at the surface for outgassing) to compensate. Indirect physical harm from abnormally rapid ascents or premature dives seem most plausible as mechanisms for beaked whale mass-strandings in relation to high-intensity sonar.

Sex Differences in Diving Behaviour of Hooded Seals (*Cystophora cristata*) in the Gulf of St. Lawrence

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Reproduction represents a period of increased energy expenditure for animals. Many phocids have adopted a strategy of accumulating energy reserves throughout the year, then relying on these reserves to support the costs of lactation and mate defense during an abbreviated pupping/mating period. Although the rate of expenditure differs, total energy expenditures associated with reproduction are often similar between males and females. Post-breeding, animals replenish depleted energy reserves prior to the moult that often occurs 2-4 months later. Although males are often larger and have greater total energy requirements than females, they have until the next breeding season to replenish reserves. For females, energy buildup is expected to occur more rapidly to reach a minimum threshold for blastocyst implantation. Hooded seals are a large sexually dimorphic, pelagic, ice-breeding phocid found throughout the North Atlantic. Satellite linked time-depth recorders were deployed in 2004 and 2005 on 12

hooded seals (6M:6F) on the whelping patch in the Gulf of St. Lawrence. Using diving activity as a proxy for foraging activity, we predicted that females should show greater diving activity than males to favour rapid replenishment of energy reserves. For the period preceding migration to Greenland for moulting, the proportion of time spent diving for females was greater than for males. Significant differences were not observed between sexes for mean dive duration and mean dive depth. Our preliminary results support the hypothesis that females show greater diving activity than males.

Designing a Protected Area for Korea's Threatened and Endangered Coastal Whales

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Populations of great whales in Korean waters are among the most depleted in the world having shown little or no recovery from past commercial exploitation. The blue whale is apparently extinct, the gray and right whales are critically endangered, fin and humpback whales are endangered, and the coastal population of minke whales is depleted. The main threat to Korean cetaceans today is incidental entanglement in fisheries nets and gear, highlighted by the high levels of reported mortality for minke whales. Although Korean regulations prohibit killing whales deliberately, the sale of whales taken as 'bycatch' sustains a thriving commercial market in the southeast region of the Korean peninsula. Annual reported bycatch peaked at 160 for minke whales in 2001 and has included a small, but growing number of other endangered species of whales. Because even a small minke whale is reportedly worth US\$30-40,000 on the wholesale market, there is no incentive for fishermen to reduce bycatch and considerable incentive to engage in directed illegal hunting or intentional 'net whaling'. The Government of Korea has confirmed a number of illegal catches in recent years and independent estimates based on DNA profiling of whale meat in commercial markets suggest that the true magnitude of unregulated takes is much larger than officially reported. Here we present an overview of the status of whales in Korean coastal waters with particular consideration of the Western Pacific gray whale and minke whales in the East Sea/Sea of Japan. We also report on the recommendations of an international workshop held in June 2005 to consider the design and implementation of a Marine Protected Area (MPA) to mitigate the threats of bycatch and illegal exploitation and promote recovery of these populations.

Apparent Link Between Survival of Juvenile Hawaiian Monk Seals and Ocean Productivity

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The Hawaiian monk seal population is in decline and low juvenile survival due to prey limitation is believed to be a primary cause. Drivers and mechanisms of variable monk seal survival are unclear; a circumstance which hinders conservation efforts. The transition zone chlorophyll front (TZCF) is a large-scale oceanographic feature separating the vertically stratified, low surface chlorophyll subtropical waters and the vertically mixed cool, high chlorophyll Transition Zone waters. The TZCF migrates over 1000 km latitudinally during the year and its southern extent in winter varies. We hypothesize

that when the front migrates southward, it brings colder, more productive waters into monk seal foraging habitat, thereby enhancing the prey base and consequently survival. We expect that this effect will be strongest at seal populations situated furthest north and nearest the TZCF. To test this hypothesis, we examined over 3000 monk seal sighting histories to estimate survival rates at six sites during 1984-2004 using Program MARK, controlling for age, sex and subpopulation. Generalized Additive Models were then used to explore relationships between survival and the southern-most latitude of the 18°C isotherm (a proxy for the TZCF). We found a statistically significant nonlinear relationship between the winter position of the TZCF and survival of monk seals through age four years at the most northerly atolls. When the front remained further north, survival was poorer. The relationship was strongest following a two-year lag, perhaps indicating the time required for enhanced productivity to influence the food web and improve the seals' prey base. No such relationship was found at subpopulations located further south nor among adult animals at any site. Variation in ocean productivity may mediate prey availability in monk seal foraging habitat and consequently influence juvenile survival in the northern portion of their range.

A Multidimensional Behavioral Analysis of Pacific Coast Bottlenose Dolphins (*Tursiops truncatus*)

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An 18-month study (1998 to 1999) on the behavior of bottlenose dolphins (*Tursiops truncatus*) off San Diego, California, was completed to determine if pre-defined behavioral dimensions could be used to predict behavioral states. A total of 290 hours of direct observation was carried out, resulting in 50.2 hours of recorded data. Behavioral dimensions of group formation, dispersion, orientation, tempo, and synchrony were defined and Multinomial Logistic Regression (MLR) was used to classify and predict behavioral states (travel, feed, social, and mill) based on behavioral dimensions (formation, dispersion, orientation, tempo, and synchrony). Of 1506 behavioral state cases collected, over 95% were correctly classified by behavioral dimensions. In addition, MLR provided equations used to predict the probability of a behavioral state given a composite of behavioral dimensions. For example, there was a 99% chance that wide formation, less than one body-length dispersion, same orientation, slow tempo, and synchronous movements indicated travel behavior, while there was a 93% chance that feeding behavior was characterized by "other" formation, 1-2 body-lengths dispersion, variable orientation, fast tempo, and no synchrony. Similarly, there was a 92% chance that social behavior was characterized by "other" formation, less than one body-length dispersion, variable orientation, medium tempo, and no synchrony, while there was a 98% chance that mill behavior was characterized by "other" formation, 1-2 body-lengths dispersion, variable orientation, slow tempo, and no synchrony. The current research demonstrates that behavioral dimensions were useful in predicting behavioral states and suggests they can function as an important tool in refining future studies of dolphin behavior.

Inshore Cetacean Sightings in the Eastern Venezuelan Coast

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Dolphins and whale populations are commonly registered on inshore inlets of the eastern coast of Venezuela. In order to register a more trustable information regarding species, seasonality, population estimates, and behavior; a study since 2004 in two transects of the western coast in the Sucre State are sailed monthly using small boats and registering all the cetaceans sighted with the help of camera and video recording. The first results revealed a predominant presence of the long beaked common dolphin *Delphinus capensis* which numbers

range between 5 and 80 individual pods, another species sighted is the Bryde's whale *Balenoptera edeni*. The number and species presence in the area depend mainly with the food abundance (sardine) which are April and May according fisheries data and sea surface temperature satellite images. Both areas shown sightings year round but Araya transect in higher quantities than Mochima National Park. An additional goal within the project deals with the possibility to produce a cetacean watching conduct code with this results and the behavior pattern of the animals in the presence of boats is underway between local tourist entrepreneurs.

Short-Term Ranging Patterns of Bottlenose Dolphins (*Tursiops truncatus*) in and Around St. Joseph Bay, Florida, USA.

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In 1999 and 2004, bottlenose dolphins along the Florida panhandle experienced two unusual mortality events in which over 227 dolphins died. The majority of these strandings were located near St. Joseph Bay, but it is not known which stock(s) were impacted. This project represents the first effort to identify dolphin ranging patterns in this region. We used two methods to determine these patterns: photo-identification surveys and radio-tracking of individuals. Photo-identification surveys were undertaken during April – May 2004 and February – June 2005. Over 130 individuals have been identified, and over one-third of these have been identified in multiple seasons. In April 2005, NOAA sponsored a capture-release health assessment of dolphins in the region; nine individuals were tagged with VHF radio transmitters. These dolphins were monitored daily through boat, aerial, and/or vehicle tracking for over 50 days. Seven radio-tagged animals have been located more than 10 times with five being located more than 30 times. The tracking region covered by boat and/or truck included approximately 65 km of coastline. To ensure that tagged animals were not leaving this area, extended aerial tracking was conducted five times during May and June, ranging approximately 125 km to the east and to the west of St. Joseph Bay. Individual animal's known maximum distance from capture location ranged from 15-100 km. Two animals, which were not heard for 20 or more days, reappeared within 50 km of their capture locations, suggesting that these individuals had ranged greater than 100 km. In contrast, two animals had a typical daily ranging pattern of less than 10 km. These data, along with ongoing photo-identification surveys and biopsy dart sampling for genetic analyses will help in determining the movement patterns of bottlenose dolphins in the St. Joseph Bay region of the Florida panhandle, leading to improved definitions of stock designations.

Terrestrial Characteristics of Steller Sea Lion Haulouts and Rookeries

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Steller sea lions range across the Pacific rim from Southern California in the east to northern Japan in the west, where they have continuously occupied terrestrial resting sites (haulouts) and breeding sites (rookeries) for hundreds of years, if not longer. Anecdotal accounts describe Steller sea lions as predominantly occupying exposed, rocky shorelines, but this habitat preference has never been quantified. We compared locations of haulouts and rookeries against a coastline type database to identify and quantify the shoreline preferences of Steller sea lions and to look for other spatial trends in site characteristics. Steller sea lions were found to preferentially locate haulouts and rookeries on exposed rocky shorelines and wave-cut platforms. Shoreline types that were used in lower proportion than their

availability included fine-to-medium-grained sand beaches, mixed sand and gravel beaches, gravel beaches, and sheltered rocky shores). No relationship was found between either latitude or longitude of a site and its average non-pup count.

First Dietary Study of New Zealand Common Dolphins (*Delphinus* sp.)

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Despite the worldwide distribution of common dolphins, this is the first account of their diet in New Zealand waters. Stomach contents were analyzed from 33 common dolphins stranded (n=23) and by-caught (n=10) between 1997 and 2005 around New Zealand. Over 25 prey items were identified primarily by fish otoliths and cephalopod beaks. Arrow squid (*Nototodarus* spp) was the most frequently occurring prey item in both stranded (69.6% occurrence) and by-caught (60%) animals. The next most frequent prey of stranded dolphins were mullet (*Mugilidae*) (32%) and false trevallies (*Lactariidae*) (23%), both coastal species. In contrast, jack mackerel (*Trachurus* spp), cuttlefish (*Sepiolidae*), and anchovy (*Engraulis australis*), a mixture of pelagic and coastal species, were the next most common prey of by-caught dolphins (50%O, 40%O, and 40%O respectively). Large numbers (>150) of myctophids were found within the stomachs of two dolphins by-caught in oceanic waters beyond the continental shelf, consistent with myctophid distributions. Preliminary results from this study reveal a diversity of prey items that vary in frequency of occurrence between areas, complementing literature that suggest common dolphins are opportunistic predators. More importantly, arrow squid and jack mackerel are two commercially important fish species in addition to being common prey of common dolphins, highlighting the potential for competition between common dolphins and fisheries in New Zealand waters.

A Mass-Stranding Event of Rough-Toothed Dolphins (*Steno bredanensis*) in the Florida Keys (Florida, USA): II. Release and Tracking

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There are very few data on the life history and biology of *Steno bredanensis*. This species is typically thought to inhabit deep tropical and subtropical waters. Contact and observations by humans have been reported on a limited basis. On 2 March 2005, a minimum of 70 rough-toothed dolphins stranded along a 3 km stretch of the Florida Keys. Of the 26 dolphins transported to the Marine Mammal Conservancy (Key Largo, FL) for rehabilitation, 15 expired, 4 are still receiving care, and 7 were successfully rehabilitated and released. Various conditions were required for release and included: measured blood values within predetermined "normal" physiologic ranges, negative results for all infectious and non-infectious diseases, discontinued use of antibiotics for at least 10 days prior to release, and demonstration of behavioral stability and competence. SPOT4 and SPLASH model satellite tags and VHF trackers were mounted on 2 of the individuals to enable post-release monitoring of release success and to acquire information on species migration, distribution, diving capacity, and habitat utilization. On 3 May 2005, 7 dolphins were transported to the release site 14 miles east of Key Largo, Florida and were simultaneously released into waters 150 meters in depth. The satellite and VHF tracking devices indicated that the animals maintained pod structure and were successfully navigating shallow water habitats off of Andros Island in the Bahamas. This supports prior unpublished observations of *S. bredanensis* in shallow areas and may indicate utilization of benthic food sources. Time-depth recorders in the SPLASH tag indicated dives of up to 300 m depth, which has been previously undocumented for this species. This event was the largest release of cetaceans in documented history, and this study

exemplifies the potential for research inherent in rehabilitation and release efforts.

Aggregative Response of Harbor Seals to Prey Density at Small Spatial Scales within a Candidate Marine Reserve

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Marine reserves manage fisheries and conserve biodiversity by increasing abundance and average size of exploited species within their boundaries as well as in adjoining, non-protected sites. However, the effectiveness of marine reserves might be compromised if predators increase their numbers and foraging frequency in the reserve rather than in adjacent sites. The previous scenario assumes that predators respond to increased fish density at small spatial scales. We present preliminary results of an on-going project that tests the prediction that harbor seals (*Phoca vitulina*) will forage more frequently in sites where fish density is higher than in neighboring sites. The study was conducted from June through August 2004 in Burrow's Channel, a candidate marine reserve in Skagit County, Washington. Seals were observed from land with a theodolite ± 2 h from slack tide (n=187 h). Bottomfish density was estimated once a month with SCUBA surveys at two sites (A and B) separated by 700m, each survey followed a 200m transect line. Monthly fish density was higher at site A ($425.0 \pm \text{SD } 108.25$ fish/ha) than at site B ($241.7 \pm \text{SD } 40.18$ fish/ha); however, the difference was not significant due to small sample size given the monthly variability (paired $t_2=3.49$, $p=0.073$, $\text{Power}_{0.05}=0.48$; data were ln-transformed for analysis). Throughout the study period, the numbers of seals in site A were higher than those in site B (67.5% vs. 32.5%; $\chi^2=4.90$, $p=0.027$, $n=40$). Tracking of 22 focal seals revealed that individuals remained in the candidate marine reserve for $1:42 \pm \text{SD } 1:06$ h and engaged in possible foraging — defined as erratic swimming and frequent diving in a localized area — in 82 % of the tracking sessions. Preliminary results indicate that seals use the candidate marine reserve to forage and suggest that they respond to variations in prey density at small spatial scales. Their potential impact on bottomfish populations is currently unknown.

Physiological and Behavioral Mechanisms of Thermoregulation in Bottlenose Dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida, U.S.A.

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The temperature differential (ΔT) between a body surface and the environment is one factor that influences heat loss. Organisms can affect ΔT physiologically, by controlling body surface temperature, and behaviorally, by choosing the ambient temperature to which they are exposed. These thermoregulatory mechanisms were investigated across seasons in a resident community of bottlenose dolphins in Sarasota Bay, Florida, where water temperatures (T_w) range annually from 11 to 33°C. Dorsal fin surface temperatures (T_{dfin}) were measured on wild, free-swimming dolphins using infrared thermography (FLIR Agema 570) in fall, summer, and winter (2002-2004) (n=555 images). ΔT was calculated by subtracting T_w , measured during dolphin sightings, from T_{dfin} . There was a positive, linear relationship between T_{dfin} and T_w ($r^2=0.978$, $p<0.001$) and, on average, T_{dfin} was 0.9°C warmer than T_w across all seasons. Changes in integumentary and vascular insulation likely account for the protection of core temperature and the stability of ΔT across a 22°C annual range in T_w . To investigate whether dolphins were located in relatively warmer water in winter or cooler water in summer, photographically identified individuals were categorized based on age, sex, and reproductive status. T_w , matched to each identified dolphin, was compared across dolphin classes, within

and across seasons (repeated measures ANOVA). Only adult males in summer were found in significantly different water temperatures (0.2°C cooler) than all other dolphin classes. Thus, when T_w approaches core temperature, it may be an important factor to which these large dolphins, with relatively small surface area to volume ratios, may respond. These combined results suggest that dolphins primarily respond to seasonal changes in T_w by maintaining a relatively stable ΔT . For the largest dolphins, during the summer, even small reductions in the T_w to which they are exposed may be important.

Diversity, Occurrence and Distribution of Odontocetes in the Bahía de los Ángeles Region, Gulf of California, México

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The Gulf of California has an extremely dynamic oceanography with a relatively high primary productivity. Within the Gulf, the Bahía de los Ángeles region, including Ballenas Channel, is the most productive area throughout the year. Since prey abundance is one of the main factors affecting species' distribution, this region seems to be important for predators such as cetaceans. The results of this work will contribute as baseline data to the "Bahía de los Ángeles" Biosphere Reserve that will be created by the Mexican government. The main objective of this investigation was to analyze diversity, occurrence, and distribution of odontocetes in Ballenas Channel and Bahía de los Ángeles during 2003 and 2004. We visited the study area eight times (four each year). Surveys were carried out in a small boat (24 ft) to systematically cover the study area by applying line-transect methods. We searched during 145 days and 827.35 hours. We report *G. griseus* in this area for the first time. The diversity has seasonal and yearly differences, 2003 was less diverse than 2004, when all species reported here were sighted. The relative abundance (number of animals/hour of search effort) in the two years was: *Delphinus capensis* (56.03), *Tursiops truncatus* (0.71), *Globicephala macrorhynchus* (0.50), *Grampus griseus* (0.11), *Pseudorca crassidens* (0.10), *Physeter macrocephalus* (0.07), and *Orcinus orca* (0.02). The species (except for *G. griseus*) are comparable to the only previous study in this area during the 1980's. Relative abundance of odontocetes was higher in summer and fall than in winter and spring during 2003 and 2004, although yearly abundances differed between the two years. Sightings were concentrated in the middle of Ballenas Channel and close to the western (Baja California) coast.

Does Heavy Equal Healthy? Using Weight and Girth as Basic Measures of Health for Stranded Bottlenose Dolphins in Virginia, USA

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Quickly determining the health status of a dead stranded cetacean is difficult. We investigated whether basic measurements of weight and maximum girth could provide information about the health of stranded bottlenose dolphins with evidence of human interaction (HI) compared with those that showed no evidence. Our data set included 158 stranded dolphins from 1994-2003 in Virginia for which we recorded both length and weight. Of these, we recorded max girth for 101. In Virginia most HI cases are fishery interaction. There was no statistical difference in the relationship of length to girth or weight between fresh and slightly decomposed dolphins; therefore, we combined the two for all other analyses. Females were slightly heavier than, but not significantly different from males. Dolphins with evidence of HI were significantly heavier for their length than those without (ANOVA $F=15.824$; $P<0.001$). This relationship also occurred when we examined maximum girth (ANOVA $F=7.109$; $P<0.001$). To avoid

skewing the data toward smaller animals, we repeated our analysis using only those strandings greater than 160cm to approximate dolphins older than 1 year. The HI animals were still significantly heavier and had a larger girth than those with no HI. Higher weight and larger girth may indicate better health status. Future analyses will be used to validate these procedures.

Group Characteristics and Social Affiliation of Bottlenose Dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida

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A long-term investigation of the social structure of Atlantic coast bottlenose dolphins was carried out in the Indian River Lagoon (IRL), Florida. Dolphin group characteristics and photo-identification data were collected during 477 boat-based surveys conducted in the IRL from 1996 to 2004. Group size was higher a) between 1996 – 1998 (mean = 5.9) than between 1999 – 2004 (mean = 4.0), and b) for sightings in the afternoon (mean = 4.4) than in the morning (mean = 3.7). Unlike other inshore populations, which have larger groups in the fall and winter months, the size of IRL dolphin groups did not vary by season. Group size overall (mean = 4.1) was small, even compared to other inshore bottlenose dolphin populations. Together, these group effects may indicate that prey characteristics vary diurnally as well as annually but are relatively uniform within years. Further, the size of groups containing at least one calf (mean = 5.5) was larger than groups without calves (mean = 2.4) suggesting that mothers often rely on the assistance of conspecifics in calf-rearing. Dolphins with nine or more sightings showed a high degree of site fidelity. Overall, half-weight Coefficients of Association (COA) indices for these frequently sighted dolphins ranged from 0.09 to 0.83 (maximum values), showed that they preferentially associate and that associations were higher within sex class than between sex class. The larger range in maximum COA values that males (0.10 – 0.83) exhibit over females (0.00 – 0.33) may indicate that some males form longer-lasting bonds while females have several casual associates. Mothers and identified calves exhibited the strongest associations, with some associations lasting over three years. In general, these results reflect similar patterns of social structure to those observed in other residential inshore populations, including individuals who show a frequent change in group membership but maintain some long-term stable companionships.

Estimates of the Percentage of Sperm Whales Missed on Combined Visual and Acoustic Surveys in the Eastern Pacific Ocean

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Abundance estimation from line-transect surveys commonly assumes that all animals on the trackline are detected. For long-diving species, such as sperm whales, this assumption is commonly violated. Marine mammal surveys were conducted in the eastern Pacific in 2000-2002, with visual observers searching by 25X binoculars and acousticians aurally monitoring two elements of a towed hydrophone array. Visual and acoustic teams were independent and did not learn of detections made by the other team until after the animals had passed abeam. Data from the 90 visual and acoustic detections that were within 3 nmi of the trackline were used to estimate the fraction of whales missed by each method. Many other acoustic detections were at greater distances than could be seen by the visual observers. Based on Palka's direct-duplicate method, the percentages of missed trackline groups were 38% and 21%, respectively, for visual and acoustic methods. Assuming these two detection methods are independent, the percentage missed by both groups is 8%. Acoustic detections greatly reduce the fraction of missed animals, but by itself, this method

cannot reliably estimate group sizes and still misses some groups. A combination of acoustic and visual methods is recommended for sperm whale surveys.

Dense-Boned Late Miocene and Pliocene Fossil Walruses of Baja California and California: Apparent Buoyancy-Control Adaptations for Feeding on Benthic Marine Invertebrates

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In California and Baja California, fossils of strange and aberrant late Miocene and Pliocene (approximately 8 to 3 million years ago) walruses have been discovered that are characterized by having unusually dense (osteosclerotic) and volumetrically enlarged (pachyostotic) limb bones. Some of these fossils are identifiable as belonging to the genus *Valenictus*. Fossils of this genus have been found in the Imperial Valley of extreme southern California where they were deposited in the ancestral Gulf of California, in the San Diego area where they were deposited in a shallow bay on the Pacific coast, and in the San Joaquin Valley of central California where they were deposited in an inland sea. At a site in central Baja California Sur, México, bones of *Valenictus* have been discovered in Pliocene coastal marine deposits in association with those of a large sea lion which may have resembled the living northern (Steller) sea lion, a typical walrus which resembles the living Arctic species, and very strange walrus that is even more highly evolved than *Valenictus*. This southerly assemblage of fossil pinnipeds is the most diverse of its age to be documented in Baja California Sur, and it is unusual by being dominated, both taxonomically and numerically, by walruses. The phenomena of pachyostosis and osteosclerosis in *Valenictus* and in related extinct walruses might have been specializations that developed to facilitate bottom-feeding on invertebrates via a passive diving mechanism; the dense bones could have essentially anchored the animals, allowing them to remain close to the substrate while feeding. This feeding method is different from that of modern walruses, and its only parallel among living mammals is perhaps the sirenians, which have instead pachyostotic and osteosclerotic ribs.

Gray Whales (*Eschrichtius robustus*) in Magdalena Bay Complex During 2003 and 2004 Breeding Seasons

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The goal of this study was to determine the gray whale habitat use at Magdalena complex during 2003-2004 breeding seasons. The lagoon complex is formed by tree zones, north (Santo Domingo Channel), central (Magdalena Bay) and south (Almejas Bay). Eighteen surveys were conducted in the zone where we identified 306 whales (117 in 2003 and 189 in 2004). During the surveys we also conducted counts in the northern (2003 and 2004) and central areas (2004). The highest counts in the north zone were recorded during late January in 2003 with 74 whales (21 cow calf pairs and 53 single whales) and mid-February in 2004 with 159 whales (118 cow calf pairs and 41 single whales). The highest count in the central zone was recorded in early March with 11 whales (4 cow calf pairs and 7 single whales). The distribution in the complex was similar in both seasons. The Santo Domingo Channel was the zone with more cow calf pairs and Almejas Bay accounted for more single whales. The longest permanence in the complex was 53 days in 2003 and 63 days in 2004. In both cases cow calf pairs were involved. Based on recaptures we also recorded movements of whales in both seasons, one marked in 2003 at the northern zone was recaptured in the central zone. The other one was marked in the southern zone and recaptured at the central zone of the lagoon complex. The present study is the first one systematically using photoidentification methodologies in the area. Resulting pictures are in the process of being included in the digital catalog of Magdalena Bay Complex.

Black and White Versus Gray: Estimating Kill Rates, Consumption Rates, and Population-Level Impacts of Transient Killer Whales Feeding on Gray Whales

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The impact of killer whales on prey populations and their role in the structuring of marine communities has attracted much scientific interest in recent years. A general approach to quantifying such effects uses models that combine estimates of killer whale nutritional requirements with field data on their demography, abundance, seasonal distribution and feeding habits. One key parameter such models require is the proportion of killed prey that is consumed, especially for species such as baleen whales that usually sink after death. Here we report evidence of killer whales caching gray whale carcasses in shallow water and feeding on them for extended periods. On 18 occasions over three month-long annual surveys in the eastern Aleutian Islands we observed groups of 4-40 transient killer whales that for several days remained at, or frequently returned to, locations marked by oil slicks in 10-17 fathoms of water. We retrieved blubber fragments at 12 of the slicks and used mitochondrial DNA analysis to determine that all were from gray whales. On six occasions we obtained evidence that the carcasses were young-of-the-year calves, and in no cases did we find evidence of adult kills. Based on attendance periods and the number of killer whales present at kill sites, we estimated that 25-50% of the blubber of each calf was consumed. No kills of other species were observed. The number of transients documented in the area (at least 118) and the fact that many remained for a week or more is in striking contrast to other surveyed areas where much lower densities and higher transit rates have been reported. Our calculations indicate that predation on gray whales provides a minimum of 10% of the annual caloric requirement of transient killer whales and accounts for 15-35% of the average annual calf production of the eastern gray whale population.

Digestion and Recovery Rates of Otoliths, Bones and Beaks: Assessing Biases in Using Fecal Samples to Determine the Diet of the Steller Sea Lion (*Eumetopias jubatus*)

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Reliable estimates of diets of marine mammals are vital for understanding their role in the ecosystem, and the analysis of prey remains is the most widely used technique. We compared the digestion and passage of 14,616 fish otoliths and 240 squid beaks with that of other hard parts recovered from the scats of four captive Steller sea lions (*Eumetopias jubatus*) subjected to standardized activity levels. Prey species included walleye pollock, herring, coho salmon, capelin, eulachon, Atka mackerel, Pacific cod, sand lance and Californian squid. Enumerating other bones in addition to otoliths increased estimated prey recovery by twofold on average, but there were significant differences between species (range=14-400%). Bones were distributed over more scats per meal (mean=2.9, range=1-5) than otoliths (mean=1.9, range=1-4). Pollock remains occurred over more scats than salmon and capelin; while pollock otolith recovery was higher than herring, salmon, capelin, Atka mackerel and sand lance. Prey recovery was significantly correlated with otolith robustness (otolith weight/length) ($r^2=0.88$), but varied between individual sea lions. Squid beak recovery exceeded otolith recovery. One experiment fed sea lions four prey species (size range 24-412g) in three 15-day trials that differed only in the mass of different species fed. Biomass reconstruction (BR) indices performed better than frequency of

occurrence indices in reconstructing the proportion of prey actually consumed. The application of numerical correction factors (NCFs), which aim to account for lack of recovery due to complete digestion of otoliths and bones, improved BR diet estimates, especially those based on otoliths alone. The application of NCFs to otolith counts provided correct estimates (within 5% of that fed) in 11/12 (92%) cases, while all bone counts (with appropriate NCFs applied) predicted diets correctly in only 7/12 (58%) cases. New methods to enumerate prey from bones, particularly when otoliths are absent, are needed to improve BR estimates further.

The Influence of Habitat Features on Manatees' Selection and Use of a Winter Refuge in Charlotte Harbor, FL

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Investigating alternate winter refugia for Florida manatees (*Trichechus manatus latirostris*) is increasingly important as the long-term stability of industrial and some natural warm-water sites becomes more uncertain. This study examined habitat features of possible importance to manatees by comparing a winter refuge in Charlotte Harbor, FL (the Matlacha Isles canal system) to two nearby, seemingly similar sites that are not frequented by manatees during winter. Water temperature, salinity, tidal flushing, canal depth, and boat traffic were examined at all three sites. Additionally, movements and habitat use by manatees were documented during the winters of 1999/2000 through 2001/2002 at and near the refuge. Counts of manatees using Matlacha Isles during the winter sometimes exceed 100, although this site has no apparent warm-water input. However, Matlacha Isles is characterized by warmer, more stable water temperatures than those in either of the comparison sites. Matlacha Isles experienced fewer days than either comparison site when water temperature dropped below 16°C, a potentially lethal temperature for manatees. Heat retention within Matlacha Isles may be associated with greater water depth and lower tidal flushing. When manatees occupy Matlacha Isles in moderately cold weather, they leave at night to forage in Matlacha Pass and return early in the morning. No correlation exists between tidal state or boat traffic levels and manatee travel patterns into or out of Matlacha Isles. During extreme or prolonged cold weather, Matlacha Isles may provide inadequate warmth for manatees; during such times, most of them travel to a power plant on the Orange River, approximately 50 kilometers (31 miles) away. Findings from this study may inform resource managers as they consider attributes manatees find desirable or necessary in winter; such information will help managers create winter sanctuaries or refuges to protect manatees into the future.

Bottlenose Dolphin Abundance, Distribution, Seasonal and Long-Term Site Fidelity in the Charlotte Harbor Ecosystem on the West Coast of Florida

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Long-term studies documenting abundance trends and site fidelity of bottlenose dolphins in coastal estuaries can provide clues to the health of the ecosystem and stocks for management decisions. Dolphin distribution within these estuaries can be indicative of environmental features and prey distribution. We completed multi-week photographic identification surveys during September 2001, 2002, and 2003 and February 2002, 2003, and 2004 to determine dolphin abundance and distribution within Charlotte Harbor, as a continuation of NMFS sponsored surveys conducted in 1990-1994 and 1996. Smaller scale opportunistic surveys were done on occasion in some spring and summer months, for example, after Category 4 Hurricane Charley passed through the study area. Two types of search effort were used: (1) a 1 km randomized grid transect which included cross-harbor, edge, and contour transects and (2) opportunistic transects both within the defined study area and in surrounding waters. We attempted to

collect dorsal fin identification photographs of all dolphins in each sighting, with information on location, group size, numbers of calves, activities, and environmental parameters. Preliminary mark-recapture analyses indicate comparable numbers of dolphins in the region during the 1990's summer surveys and the more recent summer surveys, with a potential increase in numbers in winter. Preliminary examination of the distribution of sightings show relatively low numbers of dolphins near the river mouths during the summer rainy season when hypoxia was recorded and larger numbers in these areas during the drier winter months when waters had higher salinities and were well mixed. Repeated sightings of at least 471 marked individuals show they are present year-round and at least 390 dolphins show long-term site fidelity of five years or longer. Though most of the identified dolphins demonstrated strong site fidelity as reported for other Gulf of Mexico estuaries, a few individuals were documented traveling between estuaries.

Tactile Discrimination by Florida Manatees, *Trichechus manatus latirostris*

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Knowledge of the sensory abilities of the endangered Florida manatee is important for management and conservation of the species. As part of a program to broadly survey the manatee's sensory abilities, we studied discrimination of textures by two males in a two-choice discrimination task, using a modified staircase method. Stimuli were acrylic plates with vertical gratings of ridges and grooves. The standard stimulus, present on every trial, had 2 mm gratings and the comparison stimuli had wider gratings. The blindfolded subjects were trained to demonstrate discrimination by pressing the target with wider gratings. Discrimination thresholds (75% correct) for the subjects were 2.05 mm and 2.15 mm, corresponding to Weber fractions of .025 and .075, respectively. These results indicate thresholds comparable to humans (index finger tasks) and somewhat better than harbor seals and the closely related Antillean manatee, *Trichechus manatus manatus*. Perceptual learning, suggested by a plateau in performance followed by a lower threshold, may account for the difference in threshold between the manatee subspecies. Perceptual learning is commonly found in humans discriminating fine gratings. Video analysis of responses suggests that bristle-like hairs on the oral disk were used for making the discrimination. In a separate two-choice discrimination study of vibratory stimuli, subjects were required to touch the stimulus source, one of two speakers perpendicular to their heads. Preliminary testing indicated that the subjects demonstrated discrimination of various broad band frequencies between 5 Hz and 200 Hz, including a band between 5 Hz and 20 Hz. The manatee audiogram suggests that the response was not mediated by hearing, but further testing will be necessary to verify tactile vs. auditory discrimination.

Advancing Marine Mammal Ecology Research with Simultaneous Oceanographic and Acoustic Observations from Autonomous Underwater Vehicles

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A central goal of marine mammal ecology research is to understand the environmental factors that influence animal distribution. Standard

methods use ship-based human observers and in-situ instrumentation to simultaneously characterize marine mammal distribution and oceanographic conditions. Unfortunately, this approach is expensive, labor intensive and inefficient, since observers can only detect marine mammals in daylight, good visibility, and low sea state. In contrast, autonomous underwater vehicles are capable of continuous operation, even in adverse conditions, while measuring many of the same oceanographic properties observed during ship-based studies. Autonomous gliders, in particular, have characteristics that make them ideal for ecology studies: high endurance (> 60 days at sea), fine horizontal and vertical measurement resolution, and relatively silent operation that permits passive acoustic measurements. We deployed an array of gliders off Cape Cod, Massachusetts to characterize the physical and biological environment near baleen whales. Each of the four gliders continuously measured temperature, conductivity, depth, chlorophyll fluorescence, and optical backscatter while profiling from the surface to 100 m once every 20 minutes. In addition, three gliders were outfitted with custom-built acoustic recorders, and the fourth carried an acoustic Doppler current profiler (ADCP). The gliders were deployed on May 6, 2005, operated flawlessly through a gale during which seas reached 5.2 m (17 ft), and were recovered on May 11. Downsweep whale calls in the 16-160 Hz frequency band exhibited a diel pattern (fewer calls by night, more by day) that corresponded strongly to the diel vertical migration of zooplankton observed in the ADCP acoustic backscatter measurements. The number of calls in this frequency band did not diminish during the gale. Acoustic events were accurately time-stamped, thus the moving glider array was used to determine the position of vocalizing whales. Our novel observations demonstrate the utility of autonomous platforms in marine mammal ecology studies.

A National Marine Mammal Stranding Response Network: The Philippine Experience

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The Philippine National Marine Mammal Stranding Response Network is a rescue group formed through the Inter-Agency Task Force for Marine Mammal Conservation. It is currently composed of (8) eight rescue teams from the provinces of Cagayan, Batangas, Palawan, Bohol, Negros Oriental, Negros Occidental and Misamis Oriental, monitoring a total of 59 known cetacean sites throughout the Philippine archipelago. To date, the network consists of 296 individuals trained to provide the proper response for stranded marine mammals, as well as handle the dissemination of information regarding the importance and conservation of these animals. In its six years of existence, the network has received and responded to 127 stranding reports with 45 cases of successful release, 48 cases of mortalities and disposed carcasses and 34 cases lacking information as to the fate of the animal. Aside from presenting stranding data, this paper also documents the gradual growth of the network and identifies the teams' location, area of responsibility, legislative support, availability of funds and logistic support, efficiency of coordinating center and regular meetings as factors instrumental to the success and efficiency in stranding response and maintenance of the volunteer group. It is hoped that this paper will serve as a guide for future expansion of the network.

Factors Affecting the Reproductive Behavior of Sea Lions in Peru

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Over the past decades, sea-lions face environmental and anthropogenic factors that have affected both population dynamics and behavior, reflected in different survival strategies worldwide. This study focuses on the effects of these factors in the reproductive behavior of sea-lions living in Peru. Monitoring of exposed sea-lion rockeries were made within Paracas National Reserve in the south, central and

northern points and islands of Peru from January 2002 to March 2005. Data was collected from cliffs and boats during breeding and nursing season. Year to year statistics confronting cause of stranding to incidence of gender and location were also reviewed. Results demonstrated that also anthropogenic effects such as tourism interaction, illegal fishing techniques and over exploitation of resources in certain areas affects males and females moving them from regular breeding and nursing grounds. Killing of dominant adult males have the highest incidence and impact in sea-lion colonies leaving recessive and sub-adult individuals to become sexually active and with access to big number of females. Lack of competition due to little number of males translate to reduced genetic pool and leads to weaker pups easier to succumb to diseases or natural phenomena. Harems are not selecting males, nor locations, as males are not being sexually active by dominance but opportunity, different as reported in other populations of South America. When compared our results to prior studies developed in protected areas during "El Niño" years, it is evident that strategies for reproduction of sea-lions in Peru are being directed to sustain numbers rather than genetic quality. In order to understand the changes in reproductive behavior of sea-lions in Peru, it is necessary to understand the reality they face in an area where lack of awareness increases the effects over the species and its survival in the country. to the public indifference to sea-lion existence and killing.

The Hippocampus of the Bottlenose Dolphin

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Marine biotoxins have been shown to be lethal to dolphins that have ingested contaminated fish. Toxins from harmful algal blooms such as brevetoxin and domoic acid may contaminate the food chain resulting in significant lesions in the brain. Of special importance for finding signs of toxin damage is the hippocampus. Lesions with degeneration and necrosis of the hippocampus are often critical for making a definitive diagnosis. On average, the adult human brain weighs about 1400 g, while the adult brain of the bottlenose dolphin weighs around 1500 g. Previous neuroanatomical research on the dolphin brain has shown it to be enormously complex, even surpassing humans in surface area in addition to weight. However, one striking difference between humans and bottlenose dolphins is the difference in the relative sizes of the hippocampus. In bottlenose dolphins the hippocampus is quite small and appears reduced when compared to the hippocampus in humans. On a relative basis the dolphin hippocampus is smaller and more difficult to locate than that of humans, dogs or sea lions. We have identified the hippocampus proper in the bottlenose dolphin *Tursiops truncatus*. Our purpose was to illustrate the hippocampus in its entirety, rather than just in isolation or in cross section. Our dissections have revealed the location of the entire undamaged hippocampus in relation to the amygdala, parahippocampal gyrus, uncus, fornix, thalamus, and corpus callosum. Further dissections were made to focus in on specific anatomy of the hippocampus and to show its detailed relationship to specific structures such as the uncus. We believe that precise visualization and location of the dolphin hippocampus will make it easier for others to locate the hippocampus for future examination, especially in regard to diagnosis of stranded dolphins.

Silent or Echolocating Bottlenose Dolphins (*Tursiops truncatus*): Does Water Visibility Determine Their Acoustic Repertoire?

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Bottlenose dolphins are coastal and oceanic animals that live in a variety of habitats of the world's oceans using their acoustic sense to communicate and inspect their environment. One of these

environments is a coastal lagoon in the southern Gulf of Mexico, the Laguna de Términos, Campeche, México. This work investigates the acoustic repertoire of bottlenose dolphins that were found in Laguna de Términos during 2004 and 2005, and how it may relate to the dolphin's general behavioral state, herd size, presence/absence of calves, dolphin's distance to the boat, and to the general characteristics of the habitat, such as visibility and depth. Acoustic recordings were made using narrow (24 kHz) and broadband (180 kHz) systems with omnidirectional hydrophones (-194 ± 2 dB and -198 ± 3 dB re 1V/ μ Pa, respectively) when animals were within 400-500m of the boat. Preliminary results from the 110 herds sighted during 2004 show that bottlenose dolphins are silent during all behavioral states (feeding, resting, socializing, and traveling), but more often while traveling. When acoustically active, they produce by far more click trains (0.22 click trains/min/dolphin) than whistles (0.06 whistles/min/dolphin) or burst-pulses (0.06 burst-pulses/min/dolphin), generating more phonations during resting and feeding. There is a slight negative relationship between the number of click trains and visibility while no relationship with depth was found, suggesting that bottlenose dolphins are actively inspecting their environment acoustically, choosing when and where to produce their phonations. Detailed studies are needed to further understand how these animals are using their acoustic sense in the wild, in the large variety of habitats of the world's oceans. *Work supported by CONACyT-Gobierno Edo. de Campeche, PAPIIT, UNAM, and ICMYL, UNAM.*

Removal Rates of Epizootic Barnacles Due to the Surface Activity of Humpback Whales in a Low-Latitude Ground

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On 13 August 2004 a solitary humpback whale (*Megaptera novaeangliae*) exhibiting a high level of surface activity, was approached and observed for 65 minutes off the coast of Salinas, Ecuador ($2^{\circ}10'S$, $81^{\circ}00'W$). In this time the animal breached 80 times and flipper-slapped the waters surface 78 times. Although there are a number of possible reasons for this surface activity, dislodging epizoots and ectoparasites has been proposed to explain such active behavior in this whale species. During the observation a total of 63 digital photos were taken and later used to determine the removal rate of the epizootic barnacle *Coronula* sp. caused by the whale activity. The removal rate of barnacles from the whale's head was estimated to be 0.0145 or 1 barnacle removed after 69 breaches (17 backward and 52 forward breaches). The removal rate from the inner side of the right flipper and the outer side of the left flipper taken together was estimated to be 0.0484 this is 3 barnacles removed after 62 flipper-slaps, and 0.0968 or 6 barnacles removed when it was extrapolated to both sides of each flipper. These results indicate that surface activity may indeed remove barnacles, however the low removal rates estimated in this study suggest that dislodging barnacles may not be the main reason for carrying out such highly active surface behavior.

California Sea Lions Use Dolphins to Locate Food

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Aggregations by three species of dolphins (the common bottlenose dolphin, *Tursiops truncatus*, the short-beaked common dolphin, *Delphinus delphis*, and the long-beaked common dolphin, *Delphinus capensis*) and California sea lions (*Zalophus californianus*) were investigated in Santa Monica Bay, California. Over 200 surveys conducted during 1997-2001 documented that California sea lions were seen 18.6% of the sightings aggregated with common bottlenose dolphins (n bottlenose dolphin sightings = 150) and 45.9% of the sightings aggregated with the two species of common dolphins (n common dolphin sightings = 98). Aggregations of common bottlenose dolphins and sea lions were seen both in inshore and offshore waters, whereas common dolphins and sea lions were observed only in offshore waters. These aggregations were often recorded feeding near

escarpments and submarine canyons, showing a striking preference for these bathymetric features as opposed to flat areas, plateau and inshore waters of the continental shelf (< 500 m from shore). Observations for Santa Monica Bay show that: (1) sea lions initiate aggregation and departure from dolphin schools, (2) sea lions imitate dolphin behavior, and (3) no aggressive behavior between sea lions and dolphins was ever recorded. I argue that sea lions may take advantage of the superior food-locating abilities of dolphins. This study provides the first detailed description of mixed-species aggregations and habitat usage by three dolphin species and sea lions.

Abundance of the Irrawaddy Dolphin Population Inhabiting the Mekong River: Status and Conservation Implications

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The Irrawaddy dolphin *Orcaella brevirostris* population inhabiting the Mekong River of southern Lao, Cambodia and Vietnam was thought to be small and probably declining based on anecdotal information. We conducted surveys from 2001-2005 to estimate abundance, establish critical habitats and assess the conservation status of this population. The methodology consisted of boat surveys (modified direct count and distance sampling techniques) in combination with land-based surveys and photo-identification. Fieldwork consisted of 14,108 km of boat surveys undertaken over 1,715 hours and 46 hours of land-based observations. In addition, a total of 146 hours were spent conducting photo-identification. Photo-identification using appropriate mark-recapture models provided more precise estimates of abundance than either direct counts or distance sampling techniques. Photo-identification abundance estimates indicated that the population was very small: we estimate that less than 130 individuals remain in the entire Mekong River basin. Numerous anthropogenic impacts threaten the survival of the Mekong dolphin population; including accidental entanglement in gillnet fisheries, tourism boat harassment, potential water pollution from gold mining operations and direct catch. Given the very small population size and unsustainable mortality rate (14 dolphin carcasses were recovered in 2004 alone), conservation strategies to reduce threats, undertaken with local community involvement, are the highest priority for the long-term conservation and management of this critically endangered dolphin population.

Individual Reproductive Quality in Subantarctic Fur Seal (*Arctocephalus tropicalis*) Females Breeding at Amsterdam Island

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Life history theory commonly hypothesises that breeding events induce reproductive costs that may vary among individuals. While some evolutionary ecology studies have aimed to quantify and understand the sources and consequences of individual variation in fitness, few have focussed on marine mammal populations. The present study investigated breeding performances in subantarctic fur seal (*Arctocephalus tropicalis*) females from Amsterdam Island, Southern Indian Ocean. Using multistate capture-recapture models on data obtained from known-age tagged females over 10 consecutive years, we tested for evidence of individual quality and reproductive costs in terms of future survival and fecundity. Non-breeders exhibited a lower survival than that of breeders, and female breeding performances showed consistency from one year to the next, providing evidence for female individual quality. Moreover, the lower survival in younger breeders and the higher breeding success in females investing less time in reproduction during the previous year also suggested the existence of reproductive costs. Maximum individual lifetime reproductive period was found to be 10 years in this population of females. We thus calculated an index of reproductive quality using 127 tagged females, whose breeding history was known during at least

5 breeding seasons over the 1995-2004 period. This index allowed to determine 3 distinct groups of different reproductive quality. It showed that the higher quality group (28% of the female population) produced 60% of the viable next generation, while the lower quality group (44% of the female population) contributed to only 8% of the next generation. Interestingly, no difference was detected between classes in terms of breeding frequency (0.672 ± 0.239). Phenotypic (*i.e.*, morphological, ecological and physiological) characters were tested in order to investigate the correlates of female reproductive quality. This consequently led to consider female reproductive quality as a major issue in terms of evolutionary processes occurring in a marine mammal population.

Estimating Diets of Young Steller Sea Lions (SSL) Using Quantitative Fatty Acid Signature Analysis (QFASA)

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When weaning occurs and what prey species young SSL depend on are important questions in investigating the decline of SSL populations in Alaska. We employed QFASA to investigate these questions in young (2.5-42.0 month old) SSL in Prince William Sound (PWS). We used 155 blubber biopsy samples, 16 undigested milk samples, and a previously published fatty acid (FA) prey database from PWS (26 species) to estimate diet. QFASA requires that prey species be differentiated based on their FA signature. While this has previously been determined for PWS prey, we sought to determine whether milk samples could be differentiated from prey species. Milk samples were clearly distinguished from all other prey items using discriminate function analysis with 93% accuracy. To further investigate the differentiation of milk, we constructed 4 mixed-prey diets, each differing in the proportion of milk (range: 0-100%), and analyzed the ability of QFASA to estimate diet. Milk was underestimated by 18, 8 and 3% in simulation diets containing 100, 50 and 10% milk, respectively. Other components of the simulated diet (herring, pollock, salmon, and sand lance) were generally well-estimated and no milk was estimated for the simulation diet containing 0% milk. QFASA also requires calibration factors to account for FA metabolism within the predator. We used two sets of calibration factors: 1) those generated from captive SSL fed herring and 2) those generated from grey seals pups fed milk. Using SSL calibration factors, estimated diets of young SSL were dominated by herring, milk, sand lance, and invertebrates. However, contribution of milk was approximately 22% across all age groups. When modeled using grey seal pup calibrations, herring, milk, and squid dominated, with milk showing a significant negative correlation (Pearson coefficient = -0.410, $p < 0.01$) with age. The results suggest that QFASA can be used to determine the importance of milk with age in SSL.

Hookworms in Steller sea lions (*Eumetopias jubatus*) in Alaska

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Recent disease surveys in Steller sea lions (SSLs) in Alaska have detected the presence of a hookworm similar to *Uncinaria* spp. described in

other otariids. Our objectives were to determine hookworm prevalence and loads, pathologic effects and to identify the hookworm species in SSLs. Fecal sedimentations were performed on animals 2-35 months old ($n=197$). Hookworm eggs were not seen after 5 months and 2-3 month olds had a prevalence of 69% overall. Fecal egg counts were done in 2-4 week old ($n=77$) and 2 months old ($n=21$) pups in Southeast Alaska. Counts ranged from 0 to 4950 eggs/gm in 2-4 week olds and 53 – 889 eggs/gm of formalin-fixed feces in 2 month olds. Percent patent infections were 55% and 76% respectively in the 2-4 week olds and 2 month olds. Eggs counts and hematocrit were negatively correlated in 2-4 wk old pups while there was no correlation in the 2 month olds. All of 14 dead 2-4 week old pups were positive for hookworm adults. Total intestinal worm burdens ranged from 18 to 3477. Presumptive hookworm related lesions included gastrointestinal hemorrhage, organ pallor, and migration tracts in the liver. These parasites are morphologically identified as an *Uncinaria* sp. Molecular studies on 20 worms have indicated the sequenced products are identical to *U. lucasi*. Preliminary work has been done to study the life cycle of this parasite. Development to the free-living L3 occurs within the egg, similar to what occurs in northern fur seal (*Callorhinus ursinus*) and California sea lion (*Zalophus californianus*) hookworms. Parasitic L3 have been recovered from the ventral abdominal blubber from pups. Further studies on hookworm-associated pathology are critical considering that parasite loads encountered are well above those associated with significant mortalities in other pinniped species, and that we are missing comparative data from the declining western stock.

Shift in Habitat Use by Bottlenose Dolphins (*Tursiops* sp.) Exposed to Long-Term Anthropogenic Disturbance

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Studies evaluating effects of human activity on wildlife typically emphasize short-term behavioral responses, from which it is difficult to infer biological significance or formulate plans to mitigate harmful impacts. Based on decades of detailed behavioral records, we evaluated long-term impacts of tourist and research vessel activity on bottlenose dolphins in Shark Bay, Australia. We compared habitat use within adjacent 36 km² sites (impact: tourism + intensive research; control: periodic research), over three consecutive 4.5-year periods wherein research activity was relatively constant but tourism levels increased from zero, to one, to two dolphin watch operators. A non-linear logistic model demonstrated that, when comparing periods of no-tourism and one-operator within the impact site, there was no change in dolphin numbers per km²; however, as tour operators increased to two, there was a significant average decline of 14.9% (95% CI = -20.8 to -8.23) in the number of individual dolphins using any 1km², approximating a decline of one per seven individuals. Concurrently, within the control site, there was a nonsignificant average increase of 8.5% (95% CI = -4.0 to +16.7) in dolphins per km². Given the greater presence, size and noise of tour vessels, tour vessel activity was likely to be the more significant contributor to the decline in numbers of individual dolphins within the impact site. Although this trend may not jeopardize the large and genetically diverse Shark Bay dolphin population, the decline is unlikely to be sustainable for local dolphin tourism. A similar decline would be devastating for small, closed, resident and/or endangered cetacean populations. Given the substantial effect of tour vessels on dolphin numbers in a region of low-level

tourism, and the overall scarcity of studies with adequate controls or longevity to evaluate this human activity, we urge managers to draw strong inference from the best-studied populations wherein long-term, individually-specific information is available.

The Changing Threat to the Conservation of the Florida Manatee (*Trichechus manatus latirostris*)

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The Florida manatee (*Trichechus manatus latirostris*) has long been subjected to human (e.g., watercraft) and environmental (e.g., red-tide) threats, the former resulting in legislation and the implementation of watercraft speed limits. Whether this has had an impact on Florida manatee populations and their causes of death since 1995 was examined using data obtained from the Florida Fish and Wildlife Conservation Commission. Data pertaining to causes of death, synoptic survey data, and annual numbers of carcasses were charted over the period from 1995-2004. Interestingly, periodic spikes in various causes of deaths occur which can be at least partially attributed to climactic effects. Flood gate/canal lock deaths decreased significantly such that only 1% of deaths are now attributable to this. The proportion of deaths attributed to watercraft increased 4%. When comparing years with similar death totals, 272 in 2000 and 276 in 2004, the absolute and percentage values of watercraft-related incidents decreased; as did watercraft mortalities/registered vessel, despite yearly increases in number of registered vessels. The contribution of cold stress mortality has increased by 18% and showed a more than 50-fold increase in absolute numbers. Perinatal deaths increased in absolute values almost 50%. Synoptic surveys showed significant yearly variability in population counts –overall however no significant changes in population are occurring. These population figures are limited by the technique which cannot control for events that might alter their locations at the time of survey. From these results, it is clear that Florida manatee still face both human and environmental stressors whose relative impact has changed over time. Watercraft-related mortalities have recently been replaced by perinatal mortality followed closely by a significant rise in cold stress-related deaths. Further research should focus on the specific causes of perinatal deaths and cold stress if we are to significantly and favorably impact on their conservation.

Ribbon Seal Habitat Selection and Seasonal Movements

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The distribution of ribbon seals (*Histiophoca fasciata*) during the breeding season appears largely confined to habitats in the marginal sea ice zones of the Bering Sea and the Sea of Okhotsk. However, until recently, very little has been known of ribbon seals' whereabouts and behavior during the non-breeding season, particularly during summer and autumn in ice-free areas; the little information that has been available on this topic comes from incidental catches in fishing gear near Japan and in the central North Pacific and occasional sightings in the Bering and Chukchi Seas. This paper presents the first information on ribbon seal habitat selection and seasonal movements made available by satellite tracking. Ten ribbon seals were captured on ice in late spring along the central coast of the eastern Kamchatka Peninsula, Russia. Satellite-linked radio transmitters were attached to the seals to document their movements

during the post-molting and breeding period. Most seals dispersed southeast into ice-free areas soon after they were tagged. Several seals traveled into the North Pacific and foraged south of the western and central Aleutian Islands. Most dives were less than 150 m (perhaps to the seafloor) when over the continental shelf, but deepened as seals moved into offshore waters, where they evidently foraged in mesopelagic communities. These data indicate that these "pagophilic seals" spend a substantial part of their lives in ice-free ocean habitats notwithstanding their seasonal dependence on sea ice habitats for breeding and molting. Nevertheless, given rapidly-changing sea ice patterns, ribbon seals may be particularly vulnerable to climatic change. Evaluating ribbon seals' habitat selection and seasonal movements with respect to physical and biological environmental variables provides insight into the seals' potential responses to climate change such as redistribution of populations, diminished vital rates, and altered ecological interactions due to shifting mesopelagic communities.

Sea Otters and Recreational Activities: Managing People to Protect Sea Otters from Chronic Disturbance

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Wildlife tourism (WT) is a fast growing industry often relying on fragile habitats and species. WT can facilitate environmental education and conservation of natural resources but can also cause environmental impacts such as wildlife disturbance. This research is the first to focus on sea otters as a marine mammal subject to disturbance from tourism activities. The data collection was conducted in the Monterey National Marine Sanctuary, a busy tourist destination. This sea otter population has been slow to recover and suffers from high mortality rates. Interactions with recreational vessels may be causing chronic stress to sea otters, potentially causing behavioural and physiological changes with implications on the health and recovery of this population. Four years of data collection have shown that sea otters in areas with heavy recreational boat traffic suffer from high rates of disturbance, changes in behavioural time-budgeting (e.g., decreased resting), and changes in distribution along the coastline. This could have implications for future habitat use and recovery of the species. This research emphasises the importance of multidisciplinary research techniques to investigate and manage wildlife disturbance. This has been accomplished using a combination of standard behavioural observation techniques and sociology methodology (stakeholder questionnaires, interviews and workshops). It is suggested that managing wildlife disturbance has to be placed within a larger framework of stakeholder analysis and participation. Recent data analysis has shown that lack of communication and conflicts between stakeholders, together with poor dissemination of educational material to tourists, plays a large part in the ongoing problem of sea otter disturbance. Improved management of wildlife disturbance requires that differing perceptions and conflicts between stakeholders are addressed and resolved. Some recent studies in wildlife tourism and disturbance emphasise the need for stakeholder inclusion. We suggest that structured stakeholder analysis and management is necessary with the addition of environmental psychology methodologies to actively resolve conflicts, change attitudes and encourage environmentally responsible behavior. We believe that the findings of this study could facilitate improved management in the wider wildlife tourism and disturbance fields (e.g., whale watching and swim-with-dolphins). In association with University of California, Santa Cruz, Monterey Bay Aquarium, Friends of the Sea Otter and Pacific Cetacean Group.

Current and Historic Bycatch of Small Cetaceans and Other Megafauna in Newfoundland Gillnet Fisheries

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Bycatch of small cetaceans, notably harbour porpoise (*Phocoena phocoena*), and other marine animals occurs regularly in gillnet fisheries in Newfoundland and Labrador, Canada, but dependable estimates have been difficult to obtain. We estimated incidental catches in nearshore gillnet fisheries targeting Atlantic cod (*Gadus morhua*), lumpfish (*Cyclopterus lumpus*), and Atlantic herring (*Clupea harengus*), and the offshore monkfish (*Lophius americanus*) gillnet fishery, from 2001–03 based on logbooks. We also compare these estimates to those obtained for the nearshore cod fishery in 1989, prior to the commercial cod moratorium. Bycatch estimates were obtained at three geographic scales using landed catch and the number of net-days as fishing effort measures, with individual fishing trips as sampling units. Confidence intervals were generated using resampling techniques. Generally, bycatch estimates based on net days were lower than those obtained based on landed catch. Given its lower data variability and fewer assumptions required during analysis, we have greater confidence in estimates based on net days as a measure of effort, during fishing trips (rather than effort per fisher). Most porpoise catches occurred in the nearshore cod fishery, with average annual bycatches of 701 (95% CI=183-1,439), 1,127 (279-2,305), and 1,148 (206-2,580) small cetaceans in 2001, 2002, and 2003, respectively. Probably as a result of greater fishing effort, bycatch estimates for 1989 were 11,259 (2,231-25,041; based on landed catch). Fisheries for lumpfish and herring caught 126 (25-281) and 42 (10-85) porpoises, respectively. Average annual small cetacean bycatch, primarily *Lagenorhynchus* sp., in the monkfish fishery was 40 animals (10-92). Population estimates are required before determining if these mortality rates are sustainable. By comparison, approximately 1,470 (0-3,732) alcid seabirds, 255 (0-638) large sharks (mainly blue, *Prionace glauca*), 41 (0-124) sturgeons (*Acipenser oxyrinchus*) and 5,281 (966-12,193) seals (mainly harp, *Pagophilus groenlandicus*; based on landed catch) were bycaught in these fisheries during 2003.

Taking the Plunge: Diving Capabilities of Grey Seal Pups Increase with Postweaning Fast Duration, Body Size and Time Spent at Sea

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Grey seal pups must rapidly develop diving and foraging skills before their endogenous energy reserves become critically depleted. They undertake a land-based postweaning fast before going to sea for the first time, to undergo physiological development and training important for oxygen storage capacity and cardiovascular control. However, the decrease in body size and condition during fasting may limit their ability to survive until they find food, or influence diving capabilities through effects on metabolic rate and oxygen storage capacity. There is thus a trade-off between developmental requirements ashore and the need to begin to forage. We investigated the impact of body size, composition and fast duration on the ontogeny of maximum diving capabilities (5th percentile surface interval (SI), 95th percentile dive duration (DD) and percentage time spent underwater (%dive)) in free-ranging first-year grey seal pups, using satellite telemetry. DD in the first few days at sea was positively correlated with postweaning fast duration (DD (s) = 2.67 (fast duration) + 68.66; $F_{(1,18)} = 8.41$; $p = 0.0095$; $r^2 = 0.28$). Maximum diving capabilities during the first three months at sea improved with time since departure, possibly due to diving-induced development of oxygen stores and cardiovascular control. Greater mass conferred increased maximum diving capabilities (higher DD and %dive; lower SI) and was associated with longer track duration. Small animals should therefore leave the colony earlier, at the expense of developing diving abilities whilst ashore, to maximise their chance of survival, but may suffer when foraging requires longer underwater because prey is scarce or hard to catch. Larger pups have a double advantage because they can leave the colony with better maximum diving capabilities and greater energy reserves. This study provides direct behavioural evidence for one mechanism that may lead to the increased survivorship commonly

seen in larger and fatter seal pups.

Testing the Acoustic Prey Debilitation Hypothesis: No Stunning Results

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We examined the hypothesis that sounds produced by odontocetes can debilitate fish. We tested the effects of odontocete-like pulsed signals on three species of fish commonly preyed on by odontocetes: sea bass, cod, and herring. It has been proposed that the acoustic signal interacts with air filled cavities, primarily the swimbladder to cause loss of buoyancy control, abdominal hemorrhage, and even death. These species were chosen to represent a variety of swimbladder types, allowing us to examine the proposed mechanism of stunning. We exposed three individuals of each species as well as groups of four fish to a bottlenose-dolphin-like high-frequency click with a center frequency of 120 kHz (212 dB exposure level), a mid-frequency click modeled after a killer whale's signal with a center frequency of 70 kHz (208 dB exposure level), and a low-frequency click most like a beaked whale click with a center frequency of 40 kHz (193 dB exposure level). Fish were placed in a 0.3-m diameter net enclosure immediately in front of a transducer. Fish were observed for 15 minutes prior to exposure to the clicks which were presented at a rate of 100 pulses/sec grading to 700 pulses/sec in 1.1, 2.2, and 3.3 s, simulating a foraging dolphin's 'terminal buzz'. Sea bass were also exposed to a constant pulse rate of 700 pulses/sec for exposures of up to 30 s. We observed the swimming behavior, orientation, and balance of the subjects using 2 video cameras. No measurable change in behavior was observed in any of the fish for any signal type or pulse modulation rate despite the fact that clicks were at or near the maximums recorded for odontocetes. Based on our results, the hypothesis that acoustic signals of odontocetes alone can disorient or 'stun' prey cannot be supported.

Morphological and Behavioral Correlates of Population Status in the Southern Sea Otter: A Comparative Study Between Central California and San Nicolas Island

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We examined the relationship between population density and patterns of behavior and morphology in the Southern sea otter (*Enhydra lutris nereis*) by contrasting the recently established low-density population at San Nicolas Island (SNI) with the long established high-density population in central California (CC). One hundred and forty southern sea otters were translocated from CC to SNI in 1988-1990. After declining to near extinction, the surviving animals at SNI began to increase in 1993 and the population has since grown at 8.7% yr⁻¹. Currently, the population density at SNI is about 0.33 otters km⁻² whereas the density in central California is about 2.56 otters km⁻². A comparison of these populations and their prey resources thus affords the unique opportunity to examine the effect of intraspecific competition and density-dependence on the behavior and morphology of a large, mobile predator. The mean densities of high quality invertebrate prey were 10³ X higher at SNI than at CC, and we found that the mean rate of energy gain by foraging otters also was significantly higher at SNI. As a likely consequence, body condition was better and foraging activity was reduced in sea otters at SNI compared with CC. Distinct patterns of individuality in diet and foraging behavior, which characterized sea otters at CC, were absent at SNI. Dietary niche width was narrower overall at SNI than at CC and at SNI we found considerably greater overlap between the individual and population level diets. These data support the hypothesis that food limitation is an important factor in shaping and maintaining

behavioral polymorphisms, and lend support to the idea that competition for prey resources is a likely factor contributing to the stalled recovery of the threatened Southern sea otter.

Multi-Decadal Analysis of Cetacean Strandings in Central California

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The Department of Vertebrate Zoology at the Santa Barbara Museum of Natural History has been documenting cetacean mortality for the past 30 years. Cetacean strandings are reported from a tri-county region (San Luis Obispo, Santa Barbara, and Ventura Counties). From 1975-2004, a total of 406 animals have been reported consisting of 24 species from 7 families. Common dolphins (*Delphinus* spp.) were the most abundant animal accounting for 41% of the cetaceans. Strandings were not evenly distributed temporally with 37% occurring in the spring and only 18% occurring in the fall. Additionally, they were not evenly distributed spatially with 52% occurring in Santa Barbara County. Fishery related mortality decreased over the decades from 7% to 1%. Although, it appears that biotoxin related mortality has increased. Harmful algal blooms were not investigated as a cause of mortality early in our stranding program however, stranding "events" with large numbers of cetaceans in a concentrated period of time, were not as common over the first two decades as in recent years. Nevertheless, clusters of strandings occurring in concentrated time period have occurred throughout our history and may have been induced by biotoxins. During our history, this data set has been utilized for management decisions as well as to document native species. Consistent data collection of this type is an invaluable resource for baseline population analysis as well as long-term conservation goals.

Cetaceans Strandings in Nueva Esparta State, Venezuela, period 2000-2004

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During period 2000-2004, stranding data of Nueva Esparta State coasts were systematically registered by the Cetaceans Research Center CIC (by initials in Spanish) and Environment State Government DEA (by initials in Spanish) Nueva Esparta, aiming to determine an incidence pattern and the characterization of the strandings events. The research area was divided in 9 zones, according to geopolitical and logistic criteria. 111 events were registered to sum 137 stranded animals, corresponding to 9 species (8 odontoceti: *Delphinus capensis*, *Stenella frontalis*, *Stenella attenuata*, *Stenella coeruleoalba*, *Tursiops truncatus*, *Grampus griseus*, *Kogia sima*, *Feresa attenuata*; and one mysticete: *Balaenoptera edeni*) and two non identified species (*Delphinus* spp. and *Stenella* spp.). Seven of these events alone were massive (6.30%) and ten were living strandings (9%) from which 5 animals were successfully rescued. The largest number of events belonged to the species *D. capensis* with 61 (54 %) followed by the *Delphinus* spp. (23%) and the *B. edeni* (5%). Zone 1, to the east of Margarita Island, showed a larger number of events with 36 (32.43%), followed by Zones 7 and 2, with 27 (24.32%) and 26 (23.42%) respectively. "Reception beaches" with greater incidence were La Caracola (Zone 1) and El Silguero (Zone 7), with 18 events each. Both of them have coast lines that are perpendicular to the east-west current. During the analyzed period, a distinct pattern of incidence concerning months is shown, being the stranding data concentrated in the first quarter of each year. 24 events in January and 21 in February, amassed most of the events. Reports of: *Kogia sima*, *Stenella coeruleoalba*, *Grampus griseus* and *Feresa attenuata*, constitute the firsts for Nueva Esparta State coasts. Nevertheless, 52.25% of deaths causes are unknown or not reported; deaths causes of anthropic origin, related with 18 of the events, represent the first known causes.

Vocal Behaviour of Marine Tucuxi Dolphins (*Sotalia*

fluvialis) in the Gulf of Morrosquillo, Colombia (Caribbean Sea)

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Marine Tucuxi dolphin is one of the top predator in the Caribbean coast of Colombia and sss till one of the lesser-known delphinids. Very few studies have been conducted on its vocal behaviour, and many aspects of this species ethology remain unknown. Included in the Appendix I of CITES (Conservation on International Trade in Endangered Species of Wild Fauna and Flora) as "Data Deficient" (CITES Red List 2002), in Colombia this species has been catalogued as "vulnerable" due to many different anthropogenic causes. In this study we describe for the first time the vocal repertoire of the marine Tucuxi dolphin of the Caribbean Sea (Gulf of Morrosquillo, Colombia). Underwater acoustic recordings were conducted with an omnidirectional hydrophone connected to a DAT recorder (sampling rate @ 48 kHz). All vocalisations between 1 Hz and 24 kHz (± 3 dB) were recorded and low-frequency noises were cut off using filters. For each whistle we measured the following acoustic parameters: start frequency (kHz), end frequency (kHz), minimum frequency (kHz), maximum frequency (kHz), frequency range (kHz), duration (ms), and number of inflection points. The acoustic recordings were related to simultaneous visual observations of the individuals present at the surface. The association of vocalisations to different behavioural contexts and group composition was explored, and the results were compared to those of a Brazilian population leaving in a similar habitat. As part of future research we want to compare the vocal repertoire of both, the marine and the riverine, ecotype of this species in Colombia.

Assessing Heart Rate and Respiratory Rate in Free-Ranging Atlantic Walrus (*Odobenus rosmarus rosmarus*)

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Little is known about physiological parameters of free-ranging walruses. Basic physiological data such as baseline heart and respiratory rate is essential for meaningful monitoring of anesthesia, and may contribute to estimation of energy consumption/metabolic rate. Observations were made on 10 free-ranging adult male walruses (*Odobenus r. rosmarus*) at Young Sound in Northeast Greenland (74°18'N; 20°15'W) in August 2004. Animals that had been out of the water for at least one hour were examined. A battery operated electrocardiograph (Cardiovit AT-4 vet, Schiller AG, CH-6341, Switzerland) was equipped with custom made 10 m cords for bipolar recording. These cords ended in an insulated metal Luer-lock connector for easy attachment of aluminium 18G, 1.5" hypodermic needles. Each subject animal was slowly approached and the two electrodes were simultaneously applied with the aid of two light-weight metal rods with a distal "cup" using a gentle, stabbing motion. The electrodes were placed in the dorsal midline approximately 100 cm apart. The electrocardiogram was recorded for 3 minutes, and the heart rate was subsequently calculated as the mean for this period. Respiratory rate was determined visually, by observing the nostrils and respiratory movements of the animal in question. Mean heart rate \pm SD was 36 ± 3.7 (29 to 43) beats/min. The respiratory rate ranged from 2.67 to 3.67 with a mean of 3.27 ± 0.31 breaths/min. A pronounced sinus

arrhythmia was observed. The present study provides novel data on resting free-ranging animals. The technique is simple and affordable, and may be applicable to other marine mammals. *Acknowledgments:* The Commission for Scientific Research in Greenland is acknowledged for funding this research. The authors wish to thank the Danish Polar Center, the Sirius Sledge Patrol, E-Vet Denmark, and Simonsen & Weel.

Influence of Oceanographic Variables on Movements of Harbor Seal Pups (*Phoca vitulina concolor*) in the Gulf of Maine

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Movements and home ranges of newly weaned Western Atlantic Harbor Seal pups (*Phoca vitulina concolor*) in the Gulf of Maine were monitored during the summer and early fall of 2004. Five harbor seal pups, all approximately 1 month old, were captured, fitted with satellite-linked SDR-T16 tags from Wildlife Computers, and released from Blue Hill, Maine on 6/18/2004. Seal locations were monitored until all tags stopped transmitting by October 2004. Nearly all locations were < 75 km offshore and in water < 200 m deep. Mean transit speed between locations was 1.8 km/hour. Monthly home ranges varied from < 50 km² to > 10,000 km². Two seals traveled north to Nova Scotia, two seals traveled along the Maine coast between Blue Hill and Jeffreys Bank, and the remaining pup traveled south to Stellwagen Bank near the tip of Cape Cod. The wide-ranging movements of the seal pups is consistent with prior observations in other regions that young harbor seals tend to disperse and travel long distances after weaning, which typically occurs 4-6 weeks after birth. We are interested in the environmental cues that might influence the movements of inexperienced weaned pups. The influence of oceanographic variables, including sea surface temperature and bathymetry, on movements of seal pups was examined using available satellite data. Although sample size was small, this was one of the first studies to tag and monitor harbor seals in this age group within the Gulf of Maine. Additional seal pups are to be tagged in the future as a continuation of this research.

OBIS-SEAMAP: Developing a Spatial Information and Analysis System for Global Marine Mammal Distributions

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Our ability to answer fundamental questions concerning the spatial ecology of marine mammals and their environments is central to the resolution of a wide range of marine science and management problems. Relatively little is known about the spatial mechanisms that restrict large marine vertebrates to specific ocean domains, and the extent to which species distributions are influenced by seasonal, inter-annual and longer-term oceanographic variability. A thorough understanding of the patterns of marine biodiversity and species abundance are necessary foundations for effective management and conservation of marine systems. For marine mammals, these data may be particularly useful to guide fishery closures and marine protected areas designed to set aside important habitats (e.g., foraging areas, migration corridors) and to mitigate anthropogenic impacts (e.g., ship strikes, noise pollution). As part of the Ocean Biogeographic Information System (OBIS), the SEAMAP (Spatial Ecological Analysis of Megavertebrate Populations) initiative is compiling geo-referenced data on marine mammal at-sea surveys, movements, strandings, and population counts at haul out sites into a coherent and standardized format. To facilitate the research applications of this global database, SEAMAP is also developing a web-based system equipped with data analysis and visualization tools. This publicly-available database will allow users to display, query, subset, and summarize data on marine vertebrate distributions in conjunction with environmental information. This presentation will showcase the SEAMAP database

within the context of a novel data model designed to depict species distributions and animal movements in a fluid oceanic system. This dynamic global database of marine vertebrate distribution and abundance will enhance the understanding of the biogeography and the ecology of marine mammals by: (1) facilitating the study of potential impacts on threatened species; (2) enhancing our ability to test hypothesis about biogeographic and biodiversity models, and (3) supporting modeling efforts to predict distributional changes in response to environmental change.

Philopatry of Southern Elephant Seals at Marion Island

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Fidelity to terrestrial haulout site has been noted in a number of species of pinnipeds. Few of these studies, however, have considered philopatry, that is, fidelity to the natal site. Extensive mark-recapture records of southern elephant seals *Mirounga leonina* from the population at Marion Island (46°54'S, 37°45'E) have allowed us to investigate this. Almost all southern elephant seals of this population have been marked at their site of birth since 1983, and the location of their terrestrial haulout sites recorded every 7 – 10 days subsequently. Using 12 years of this data we investigated dispersal to terrestrial haulout sites at Marion Island. Expected dispersal distances were determined via random walk theory, from a probability matrix that considered both all possible distances of movement between sites, and the relative popularity of different sites. We found that southern elephant seals of the Marion Island population returned significantly closer to their natal site than expected for all types of haulouts. However, seals dispersed significantly shorter distances to breeding haulouts than either moult or winter haulouts. Furthermore, seals hauled out closer to their first breeding site when returning to breed in subsequent seasons, than to their natal site. They also hauled out a greater distance from their natal site on their first breeding haulout than from their first breeding haulout site on subsequent breeding haulouts.

Remote Viewing Systems: Using Video Cameras to Observe River Otter (*Lontra canadensis*) Behavior in Western New York and British Columbia.

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The North American river otter can be extremely elusive, and therefore little is currently known about its behavior. River otters were extirpated from much of their range during the 19th century. Between 1995 and 2000, the New York River Otter Project returned river otters to western New York. In order to track and monitor this otter population, we placed self-contained digital- and video-recording camera systems at latrine sites on several tributaries of the Genesee River. The digital-recording system consists of a weatherproof plastic box containing a small camera, which sends information via a wireless signal to a computer or onboard memory card. The video-recording system consists of a camera that communicates with a VCR to record information onto videotape. The cameras in both systems are motion-sensing, and have infrared sensors to provide night vision. The systems can be left unattended in remote areas because they are powered by a battery or solar panels. This allows us to view animals' behaviors without human disturbance, and to gather information from areas that are difficult for us to visit often. During field tests we have recorded the behaviors of several different species. Behavioral observations can be statistically analyzed to determine what times of day otters are most active, calculate an energy budget, and describe social interactions. These systems will be used to compare the behaviors of western NY river otters with those of a coastal otter population in British Columbia, Canada. This population in BC is not as shy of humans, but most of the behaviors observed are in response to a

human presence. These camera systems will be critical for observing their undisturbed behavior, and will be very useful for studying other marine mammals, especially in remote locations.

Counter-Calling in North Atlantic Right Whales (*Eubalaena glacialis*)

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North Atlantic right whales (*Eubalaena glacialis*) produce vocalizations in social contexts and to communicate over large areas. Counter-calling is a coordinated vocalization pattern used by both right whales and bowhead whales (*Balaena mysticetus*). Bowheads counter-call while migrating. Counter-calling has been observed in right whales during feeding and social activities. We hypothesize that right whales counter-call to coordinate their movements, advertise food resources, attract mates, and maintain acoustic contact. To test the hypothesis that right whales counter-call to coordinate their movements and behavior, data from six autonomous underwater recording devices deployed in Great South Channel during the spring months of 2004 and 2005 were analyzed. Data demonstrating that counter-calling occurs between pairs or groups of right whales, in which one animal locates the food and the other(s) moves toward the resource, support the prediction that right whales counter-call to advertise food. Ocean noise has increased considerably during the last fifty years. Therefore, if right whales counter-call to coordinate movements, increases in noise will decrease the area over which they can advertise food resources and socially interact. To determine the extent to which counter-calling is masked by noise, the Acoustic Integration Model (AIM) will be used to calculate the sound exposure level of whales by accounting for factors including shipping, substrate, and water depth. Theoretical calculations from the AIM will be verified using data from underwater recording devices. (Work sponsored by NDSEG Fellowship)

Polycyclic Aromatic Hydrocarbons in Subcutaneous Blubber of the Florida Manatee (*Trichechus manatus latirostris*)

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The Environmental Protection Agency has listed 16 polycyclic aromatic hydrocarbons (PAHs) as priority pollutants because of their carcinogenic and deleterious effects on aquatic organisms. PAHs may be found in the waters around electricity generating plants and in ports in Florida due to contaminated effluents. The characteristic high turbidity of Florida waters also causes the carcinogenic PAHs to become more bioavailable. Florida manatees (*Trichechus manatus latirostris*) frequent both power plants and ports and therefore are highly susceptible to PAH accumulation. Recently manatees have shown symptoms characteristic of PAH accumulation, e.g. impaired immune response, prolonged umbilical healing, and eye pathology. To date no studies have been published on PAH accumulation in manatees. The purpose of this study was to conduct an investigation of the levels of PAHs in the Florida manatee. Twenty-eight subcutaneous manatee blubber samples were obtained from the Florida Fish and Wildlife Conservation Commission Marine Mammal Pathobiology Laboratory archive. PAHs were extracted using an ASE 100 Accelerated Solvent Extraction System (Dionex Corporation, Sunnyvale, CA), and the 16 primary pollutant PAHs were quantified using high pressure liquid chromatography (Perkin-Elmer Corporation, Boston, MA) with a Vydac 201TP5415 reverse-phase (C18, 5 µm, 4.6 mm ID x 150 mm) HPLC column (Grace Vydac, Hesperia, CA), and calibrated by comparison to a standard priority pollutant PAH mixture. PAHs were found in the concentration range of 0.001-23.565 g/g. PAH concentrations showed a mean of 1.15 mg/g for total PAHs, and a mean of 1.25 mg/g of carcinogenic PAHs. These values compare respectively to literature mean values

of 9.05 mg/g and 0.31 mg/g in a planktophagus whale and 36.21 mg/g and 0.938 mg/g in a teuthophagus dolphin, both of which live offshore. These preliminary results indicate that Florida manatees are accumulating PAHs and that this accumulation may result in deleterious effects on their health, reproduction, and survival.

Sticking with Your Neighbours: A Comparative Analysis of Population Genetic Structure of Bottlenose and Common Dolphins in South Australian Waters

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Bottlenose dolphins (*Tursiops* sp.) and short-beaked common dolphins (*Delphinus delphis*) are distributed parapatrically in coastal waters of South Australia (SA). Several individuals from both species die each year in fisheries interactions in Spencer Gulf, one of the two Gulf systems in SA. There is a concern that this mortality may negatively impact on the viability of local dolphin populations. We are conducting a comparative analysis of the genetic variability and population structure of these species, using 467bp of the mitochondrial DNA (mtDNA) control region and seven microsatellite markers. Tissue samples (*Tursiops* sp.=160, *D. delphis*=148) were collected from free-ranging dolphins by biopsy sampling and from carcasses by the South Australian Museum. Genetic variability was lower for bottlenose than for common dolphins at both nuclear and mtDNA markers. In addition, microsatellite and mtDNA analyses indicated stronger population structure for bottlenose than for common dolphins. For bottlenose dolphins marked structure was detected among all sampling sites, especially between gulf and open water populations. The genetic differentiation in bottlenose dolphins seems to follow a pattern of isolation by distance, whereas common dolphins do not show this pattern on a similar scale. The contrasting levels of genetic variability and structure between the two dolphin species may be related to differences in habitat use, distribution and size of social groups. A similar pattern of contrasting population genetic structure is expected to be found for parapatrically distributed inshore bottlenose dolphins and common dolphins in other regions.

Measuring the Economic Benefits of Right Whale Protection

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The cost of protecting right whales is increasing. The northern right whale (*Eubalaena glacialis*) is currently protected under the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA). Under these acts, NMFS must provide protection to right whales through regulatory actions. Fishing gear entanglements and ship strikes are two sources of right whale mortality. Historically, the regulatory alternative that provides protection and minimizes the cost to the industry is chosen as the preferred alternative to implement. As an alternative approach, we can measure the benefits of protection, compare it to the cost and choose the alternative that maximizes net benefit. NMFS is currently developing a stated preference survey to estimate the public's willingness-to-pay for right whale protection. Willingness-to-pay is a benefit measure. Because right whales are not traded in the market, people cannot reveal what they are willing to pay for them through their market purchases or actions. The stated preference survey will ask people to state their willingness-to-pay for a service such as right whale protection, contingent on a specific hypothetical scenario and description of the service. The objective of this presentation is to discuss stated preference choice models, the framework of the economic analysis, the specific research being conducted with right whales and how these results can assist management decisions.

Down to Detail: The Movement and Diving Behaviour of Southern Elephant Seals in a Physical Context Revealed

by New Oceanographic Instruments

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The survival of marine mammals depends largely on their ability to locate and catch prey in the dynamic and unpredictable marine environment. Physical oceanographic characteristics may influence the migration routes and foraging behaviour of animals during feeding trips. While many studies have tried to characterise habitats using a variety of remotely sensed data on water surface properties and bottom topography, newly developed oceanographic instruments deployed on Southern elephant seals (*Mirounga leonina*) allowed us to measure the water properties in situ, throughout the vertical water column visited. These unique data were used to characterise the environment in more detail during the extended foraging migrations of elephant seals in the Southern Ocean. By monitoring changes in drift rate (related to density, a proxy for % body fat), we could distinguish changes in body composition and relate these to travel rate and location. By correlating these changes to the in situ oceanographic parameters along the tracks, we could also characterise important feeding "hotspots" oceanographically. We identified three distinct strategies: 1) Frontal Pelagic Foragers (FP) spent most of their time travelling along the frontal zones within the Antarctic Circumpolar Circulation (ACC); 2) Coastal Benthic (CB) foragers spent most of their time diving to the seafloor along the Antarctic continental shelf edge; 3) Ice-edge pelagic foragers (IP) spend most of their time in the vicinity of the pack-ice edge. Oceanography strongly influenced diving behaviour, but not in all regions. For instance, night-time travelling dives in the ACC were often associated with the temperature minimum layer at 150-200 m, while dives on the Antarctic shelf were benthic in areas of strong vertical mixing with little or no stratification. These new instruments can provide an unprecedented amount of detail about the links between movement and feeding strategies of marine vertebrates and their physical environment.

Killer Whale Predation on Gray Whales in Monterey Bay, California

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Popular literature has characterized the dramatic nature of killer whale attacks on marine mammals. Off central California, the numbers of predation events witnessed are higher than those reported for other regions. During the spring migration of gray whale mother/calf pairs past Monterey, gray whale calves are frequently killed by transient killer whales. To determine if killer whales selected calves in proportion to their relative abundance, we compared the number of kills/year to the number and occurrence of available prey. From 1997-2005, killer whale occurrence, number of individuals and re-sightings, group size, and predation events were recorded. Daily vessel surveys were conducted each spring. Concurrent with vessel studies, gray whale calves were counted from a shore station, 64 km south of Monterey. The number of gray whale calves counted and the number of killer whales sighted per week were compared. Gray whale migration varied each year by number (lowest in 2001 - 87 calves; highest in 2004 - 650 calves) as did the pattern of migration (compressed versus spread out). During spring 2004, killer whale occurrence (26 sightings, 76 individuals) and predation events (16) on gray whale calves was extremely high, corresponding to the largest number of calves ever estimated (1,527 whales). We observed multiple attacks by the same individual killer whales. During three seasons of relatively low calf counts (1999-2001), there were few attacks, although killer whale

occurrence was still higher than non-spring seasons. Attacks on the calf lasted up to 6 hrs, involving the temporary associations of core killer whale groups, with reproductively active females mostly involved. Feeding events lasted up to two days. Knowledge of temporal and spatial patterns, and hunting strategies must be culturally transmitted through this population of killer whales allowing the whales to take advantage of a seasonally abundant, large and rich food source.

Influence of Sediment Type and Other Abiotic Factors on the Distribution of Bottlenose Dolphins, *Tursiops truncatus*, in a South Carolina Estuary, USA

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Previous studies have investigated bottlenose dolphin feeding and foraging behavior relative to vegetated versus unvegetated benthic habitats, but to our knowledge, no one has examined habitat usage patterns relative to subtle differences in sedimentary bottom types. The purpose of this study is to determine if there is a correlation between areas of dolphin feeding behavior and sedimentary bottom types in an unvegetated, soft sediment environment. The study area, Winyah Bay, South Carolina (USA), is a 65 km² partially mixed estuary and has a heterogeneous bottom substrate profile, including the presence of five main sediment types: sand/ silt, sand, mud, shell, and clay (as determined through SideScan Sonar and sediment grabs). These bottom types are associated with different current regimes and with different benthic communities. Transect surveys were conducted approximately biweekly from May through October in 2004 and 2005. Dolphin location, group size, and behavior were recorded and correlated with bottom type, depth, and salinity. Preliminary results indicate the majority of bottlenose dolphin feeding behavior occurs in shallow areas (under 2.5 m.) that exhibit sediment features such as sand ridges and sand waves. Groups that were sighted over these areas ranged from 1 to 28 individuals, with a mean group size of 8. Out of the total range of salinities sampled (0-33 ppt), dolphins occur most frequently in the middle of the available salinity range (10-19 ppt). Chi-square tests will determine if feeding is more likely over specific substrates, or if other abiotic factors exert more of an influence.

MamVisAD: 3D, Interactive Visualization of Marine Mammal Movements in Time and Space on a Desktop Computer

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MamVisAD is a software package primarily designed to facilitate the interactive visualization of data collected about the movements of larger marine animals via attached telemetry tags that record location and diving behaviour, such as the satellite relayed data loggers (SRDL's) developed by the Sea Mammal Research Unit (SMRU). This data contains locations, from the ARGOS network and/or the new FASTLOC GPS, but may also include other information such as dive profiles, swim speeds and temperature and salinity profiles of the water column visited by the animals. SMRU's previous visualization system, MAMVIS (Fedak *et al.* 1996), demonstrated how visualizing such data in conjunction with environmental information could provide new insights into animal behaviour. MamVisAD builds on that approach, offering a more powerful investigative visualization tool. Developed using Java, Jython, and VisAD it supplies a cross platform solution, capable of leveraging modern PC hardware, which is not dependent on any commercial visualization package. Several different ways to explore the data are provided including an interactive 3D "ocean", a flexible time series view (zoomable/scrollable strip charts), and spreadsheets to show the actual values. All of these are linked. This allows data to be zoomed, filtered or selected on the basis of time, location or value using whichever "view" is most appropriate. The results of any such operation are then propagated to all the other "views". The display of other information about the dynamic oceanic environment is also supported (*e.g.*, bathymetry, satellite imagery,

sea ice extents, SST's, SSH's, and outputs of oceanographic models). MamVisAD provides researchers with a desktop tool that can help identify interesting events in an animal's life, even along tracks that last for years and cross ocean basins, and then zoom in to study them and the local environment in which they took place in more detail.

Kinematic Analysis of Suction and Ram Feeding in *Kogia* and *Tursiops* (Odontoceti: Cetacea)

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Although a wealth of anatomical and anecdotal evidence supports a wide range of feeding strategies among odontocetes, their feeding biomechanics have been inadequately studied. The feeding performances of one pygmy sperm whale (*Kogia breviceps*), one dwarf sperm whale (*K. sima*), and two bottlenose dolphins (*Tursiops truncatus*) were compared during controlled feeding trials. Feeding kinematics were characterized and a ram-suction index (RSI) measured. The feeding behavior of both genera was composed of four phases: preparatory (Phase I), jaw opening (Phase II), gular depression (Phase III) and jaw closing (Phase IV). The mean *Kogia* feeding cycle duration was 470 ms (S.D. ± 139), which was shorter ($p < 0.05$) than the mean for *Tursiops* (863 ms; S.D. ± 337). The mean maximum gape angle was also significantly greater ($p < 0.05$) for *Kogia* (39.8°; S.D. ± 18.9) than for *Tursiops* (24.8°; S.D. ± 6.6). The mean *Kogia* RSI (-0.67; S.D. ± 0.29) was significantly less ($p < 0.05$) than the mean *Tursiops* RSI (0.94; S.D. ± 0.11), indicating a suction and ram-based strategy for *Kogia* and *Tursiops*, respectively. *Tursiops* displayed two feeding behaviors, a closed gape approach in which the mandibles opened within centimeters of food item and an open gape approach in which gape was near maximum while the subject first entered the camera's field of view. The feeding cycle duration of *Tursiops* closed gape approach feeding (662 ms; S.D. ± 207) were significantly less than ($p < 0.05$) *Tursiops* open gape approach feeding (1211 ms; S.D. ± 207). Significant differences in RSI ($p < 0.05$) also existed between *Kogia* (-0.67; S.D. ± 0.29), *Tursiops* closed gape approach (0.93; S.D. ± 0.12) and *Tursiops* open gape approach (0.95; S.D. ± 0.08) feeding behaviors. The results suggest that odontocetes demonstrate a wide range of feeding strategies along the ram-suction continuum not previously characterized. Variability among individuals can be high and multiple feeding behaviors are possible even within a single genus (i.e., *Tursiops*).

Remote Monitoring of Vital Rates in Harbor Seals (*Phoca vitulina*)

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Harbor seals (*Phoca vitulina*) have declined in parts of Alaska since the mid 1970s, while seal populations in other areas of the state remained stable or increased. Genetic data indicate that movements of individuals between areas cannot explain the declines. Fluctuations in population abundance can be evaluated by estimating survival and reproduction, and quantifying effects of proximate factors on those vital rates. In 2003 we initiated long-term vital rates studies in two areas of Alaska where seal numbers have declined by >65%: in Prince William Sound (PWS) where the rate of decline has slowed to -3.1%/yr (1990-2004), and in Glacier Bay National Park (GBNP) where seals are declining at -15.5%/yr (1992-2004). Thus far 81 seals in PWS and 80 seals in GBNP have received subcutaneous VHF transmitters (Telonics IMP-300-L) duty-cycled for 5 years of battery life. At the time of capture we collect samples to assess body and reproductive condition, health, diet, immunocompetency, disease and contaminant exposure, age, and genetics. Long-term vital rates data from 5-yr VHF implants, paired with data on diet and health of individuals, permits an assessment of what variables may differentiate between seals that survive and reproduce and those that do not, potentially elucidating factors contributing to declines of seals in those areas. Initially our resight rate of tagged individuals was high (91.5%), however as the number of tagged individuals increased and

the study was expanded to two sites our ability to relocate radio-tagged seals to assess survival was reduced. In summer 2005 we established year-round land-based dataloggers (Advanced Telemetry Systems 4500S) at multiple haulout sites to continuously monitor presence/absence of radiotagged individuals and transmit those data via a geostationary operational environmental satellite (GOES). Herein we present information on field techniques, remotely obtained resight rates, confidence intervals and sample sizes for survival estimates, and data-analysis designs.

Underwater Auditory Localization by a Swimming Harbor Seal (*Phoca vitulina*)

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The underwater sound localization acuity of a swimming harbor seal (*Phoca vitulina*) was measured in the horizontal plane at anterior, posterior and lateral positions. The stimulus was a 6 kHz pure tone lasting either 1 s with a break of 0.2 s in between or a continuous tone of 1.2 s. Testing was conducted in an immersed experimental device forming a half circle (radius 5m) on which underwater speakers were placed. Speakers were hidden in a tube, so that the acoustic signal could not be localized by visual cues. The animal was trained to swim along the diameter of the half circle and to change its course in direction to the sound source as soon as the signal was given. The seal was required to indicate the sound source by touching its assumed position at the half circle. The mean error of the animal sound localisation performance was measured at 13 different positions by means of video analysis. Furthermore, the minimum audible angle (MAA) of the experimental animal was determined using a left/right forced choice procedure in order to compare it with data from the literature. MAA was defined as half the angular separation of two sound sources bisected by a subject's midline that correspond to 75% correct discrimination. The results show that the swimming seal was able to localize easily the sound sources with a mean error of 2.8° in the first case and 4.5° in the second case. The MAA of the subject with the same frequency was 10.2°. These results strongly suggest that harbor seals are able to detect, localize and reach the origin of underwater sounds and that self-motion or head movements seem to increase their precision.

Predicting the Spatial Distribution of Steller Sea Lion Prey Based on Modeled Physical Oceanography

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Characterizing the ocean habitat of marine mammals and their prey is complicated by high variance in water column properties – both spatially and temporally. While many studies have tried to link features of the marine environment (e.g., fronts, eddies, gyres) to aggregations of organisms from plankton to marine mammals, finding an appropriate scale of analysis has hindered some. To quantify the effect of scale on the predictive power of habitat models, we built and tested a predictive habitat distribution model for walleye pollock (*Theragra chalcogramma*), the pelagic prey of Steller sea lions (SSL) (*Eumetopias jubatus*) in the Gulf of Alaska using various temporal and spatial scales (i.e., 15, 30 days, and three months — and nine, 36, 144, and 1056 km²). After hypothesizing that pollock would be more prevalent in areas where converging water masses act to concentrate pollock prey, we analyzed the output of a coastal Gulf of Alaska ocean circulation model to locate areas of high oceanographic variability and abrupt change. We built a model relating these features to georeferenced pollock stock assessment data and evaluated the predictive ability of the model using commercial catch data. We found fewer areas of abrupt physical change and decreased predictive power of the models as we moved from fine to coarse temporal and spatial resolution. While

pollock assessment data were spatially autocorrelated only at the finest scale, environmental data was highly autocorrelated. Accounting for this in the models improved predictive performance. The results are being used to refine our SSL habitat model and estimate potential overlap between sea lion foraging arenas and commercial pollock fisheries. This study is one of the first to use output from an ocean circulation model to build spatially explicit predictions of marine habitat. These methods are applicable to many marine mammal species, especially those that consume pelagic prey.

Erysipelas in Cetaceans: A Coordinated Research Program

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Erysipelas has been the cause of significant morbidity and mortality in captive cetaceans for decades. The acute, septicemic form of the disease can lead to fatalities within hours, following a disease course that manifests with few clinical signs. Presumably, the same disease occurs in the wild as in controlled and monitored populations, however, the significance of this disease in wild populations of cetaceans has thus far been unknown. Although the causative organism of the disease, *Erysipelothrix* sp., is a well-characterized pathogen in domestic animals, the pathogenesis of erysipelas is poorly understood in cetaceans. Domestic animal research has led to effective preventive measures in swine and poultry industries, but research into the epidemiology of erysipelas and the associated immunology in cetaceans – captive or wild – remains limited. At present, little is understood of the disease process or its control in cetaceans. What is known, has been learned from animals in public display and other managed collections. In 2000, a workshop at Shedd Aquarium (Chicago, USA) brought together clinicians and research scientists to share information and develop strategies for advancing the study of erysipelas and its control in cetaceans. The objectives of this workshop were: (1) to share knowledge about erysipelas as it affects cetaceans, (2) to develop and prioritize an agenda of research to advance knowledge of the disease, and provide clinicians and collection managers with greater resources to control and prevent it, and (3) to identify funding and support strategies for this research. A NOAA-funded research program has been under way since 2003 to further this agenda. The program is yielding information that will advance the state of knowledge relative to this disease, with focused study on its epidemiology, associated immunology and diagnostic tools. Results will support important management decisions for cetaceans in public display populations and their wild counterparts.

Diagnosis and Spatio-Temporal Distribution of Mortalities in Stranded Marine Mammals on Cape Cod and Southeast Massachusetts: 2000-2005

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The diagnostic examination of stranded marine mammals provides a window into the health status of individuals, populations, and the marine environment. From 2000-2005, the Cape Cod Stranding Network necropsied 275 marine mammals (26% of all animals accessioned). Cause of death was determined through behavioral observation, histological evaluation, microbial pathogen identification, blood chemistry, imaging diagnostics and gross pathology evaluation. Diagnosis was categorized by type: disease (bacterial, viral, fungal, protozoan, parasitic), human interaction, mass stranding event, gastro-intestinal impaction, or predation. A summary of results and case studies is presented with a discussion of the spatio-temporal distribution of these findings. Pathology results and blood work indicate disease was the leading cause of strandings (30 %). Most notable is the presence of parasites in the pterygoid

sinuses and ears, brain lesions, and abnormal behavior observed in many common dolphin (*Delphinus delphis*) strandings. Other notable cetacean findings included lymphosarcoma, systemic fungal infection, the isolation of two human pathogens, and the presence of domoic acid. Diseases observed in pinnipeds included peritonitis, gastritis, bacterial sepsis, and viral infection. Several harbor seals exhibited oral and/or skin lesions with coinciding heavy acanthocephalan and nematode loads. Human interaction, including entanglement, vessel collision and harassment, affected 7% of cetaceans and pinnipeds. Twenty-two mass stranding events, involving 283 individuals and 5 species, occurred within this time frame. Obvious gross pathologies were not evident in most of these individuals; however, pulmonary edema, congestion of most tissues, gastric erosion, pancreatitis, and hypertrophic adrenals indicating shock and stress were observed. Ingestion of extraordinary amounts of rocks, resulting in impaction, led to death in 8% of harp seal strandings. Predation led to death in 5% of pinniped strandings. These findings and their spatio-temporal distribution indicate that marine mammal mortalities on Cape Cod and southeastern Massachusetts are generally due to a variety of “natural” causes.

The Effect of Boat Presence on the Behavior of Bottlenose Dolphins (*Tursiops truncatus*) in the Mississippi Sound

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The effect of boat presence on the behavior of bottlenose dolphins (*Tursiops truncatus*) in the Mississippi Sound was studied through both written and video recorded behavioral observations. Over 300 individual dolphins have been identified in the study area, which has a large number of shrimp boats, container ships, barges, and recreational boaters. When the research boat approached a group of dolphins, the dolphins were significantly more likely not to change their behavior than to be evasive or to approach the boat, perhaps because of the cautious nature of the research boat approaches. However, when controlling for group size and environmental factors, the presence of boats other than the research boat had significant effects on over-all group behavior. Dolphin feeding behaviors increased in the presence of shrimp boats and small fishing and recreational boats, but decreased around other types of boats. Traveling and aerial behaviors were seen less often when boats other than the research boat were present. Dolphins in larger groups were significantly more likely to approach other boats than were those in smaller groups. Dolphins were also more likely to approach and follow working shrimp boats than other types of boats. These results suggest that the presence of boats affects the behavior of the Mississippi Sound dolphin population, but that the nature of these effects depends on the boat's activity and the composition of a dolphin group.

Scientific Knowledge as the Basis for the Sustainability of Dolphinwatching in the Mochima National Park, Northeastern Venezuela

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Dolphin-watching and swim-with-the-dolphin programs at the Mochima National Park started in the early 1990s as opportunistic encounters associated with tourism to several islands and beaches inside the park. Although a protected area, these activities have neither been scientifically researched nor had any specific legal authorization by the relevant authorities. Since early 2004, a strategic alliance was signed between a local tour operator (Aventura Marina) and our NGO (SEA VIDA) with support from the regional Agency for Promotion of Tourism (CORANZTUR). The purpose of the alliance is to promote responsible dolphin-watching activities. Data is currently being collected in order to study the interactions and possible impacts.

From January through June 2005, trained observers collected data on dolphin sightings aboard 16 commercial trips. On the basis of 39 sightings, we determined that dolphins were encountered at least once during each trip; the average duration of a trip was a little over 6 hours. Overall, 95% of sightings were of the long-snouted common dolphin (*Delphinus capensis*). A stenellid, most probably a spinner dolphin (*Stenella longirostris*), was once sighted. The average number of sightings per trip was 2.64 (SD=+1.22; range=1-5), with an average duration of interactions with dolphins being 25.14 min (SD=+26.81; range=3-131). The mean group size was 32.55 individuals (SD=+41.78; range=2-200), calves and juveniles making up 37% of the groups' composition. Dolphin groups approached the boat to bowride on 59% of the time and showed no reaction to the presence of the boat on 23% of encounters. On the basis of these and other findings, guidelines for the regulation of dolphin watching inside this park were presented to INPARQUES (The Venezuela National Parks Institute) and have already been considered in a proposal for modifying the park's management plan.

Epibionts Identified on Manatees (*Trichechus manatus manatus*) in Belize

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This is the first reported evidence of epibiont fauna on the skin of West Indian manatees (*Trichechus manatus*) outside of Florida and Cuba. Published records exist only for the identity of two copepods (*Harpacticus pulex*) observed on a manatee from southern Florida (Humes 1964) and (*Harpactichecus manatorum*) reported on manatees in Cuba (Ortiz *et al.* 1992). In both these cases the copepods were observed on the skin with no tissue reaction. Other than occasional barnacles on the epidermis of manatees in marine environments throughout their range, there is little documentation of true ecto-parasitic associations with manatees. This study identifies and details one new ecto-parasitic association involving the amphipod crustacean (*Sinelobus stanfordi*) that readily attaches itself firmly into the epidermis. Additionally, these cases document several additional, as yet unidentified, epibionts (at least one other crustacean, a bryozoan, a diatom, and a nematode) obtained from the dorsal skin surface scrapings of four manatees examined off the Drowned Cayes in coastal Belize during May and November 2004 and April 2005. Specimens were preserved and examined using both light dissection and scanning electron microscopy. All specimens were collected in the course of radio-tagging studies that have been conducted in Belize since 1997. To date, these epibionts have been observed on only 4 of 84 manatees thoroughly examined as part of on-going manatee health assessment evaluations in this region of Central America.

Temporal Analysis of a Beluga Whale Population, *Delphinapterus leucas*, in Relation to Climate Change as Revealed by Molecular Genetic Analysis

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Sea ice thickness and extent has declined dramatically in the Arctic in the past several decades as a result of global warming. This change, along with others, has led to widespread concern about the effects of global warming on the world's oceans and marine ecosystems, including

the behavior and ecology of marine mammals. Beluga whales occur in many places of the Arctic and sub-Arctic and in some cases undertake extensive migrations between traditional summering and wintering areas. We postulated that changes in sea ice-cover may directly affect movement patterns and indirectly influence beluga ecology by altering access to important resources. We used a novel molecular genetic approach to monitor the composition and migratory behavior of beluga whales in the northeast Chukchi Sea in relation to changing environmental conditions. Tissue samples (n = 467) were collected from beluga whales during the summer on Alaska's Chukchi Sea coast in most years between 1979 and 2004. Standard and 'ancient DNA' methods were used to extract DNA. Each individual was analyzed for variation within 410bp of the mtDNA control region and at 8 independent microsatellite loci. The gender of each individual was also determined, and in many cases, the age and reproductive status was estimated. Seasonal sea ice cover in the Chukchi Sea was mapped annually for the same period. Ice conditions varied greatly among years; by contrast, mtDNA haplotypic frequencies did not vary substantially ($F_{ST} = 0.0098$, $p = 0.111$) during the 25 year period. Related whales were sampled in different years and in one instance an individual animal was sampled in subsequent years, indicating strong philopatry over multiple generations to a specific coastal region despite large inter-annual variation in ice conditions. These findings demonstrate the capacity of beluga whales to accommodate a certain level of environmental change over ecological time scales.

Radiotracking of Franciscana Dolphins (*Pontoporia blainvillei*) in Bahia Samborombon, Buenos Aires, Argentina

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The Franciscana dolphin is an endemic species to the coastal waters of Brazil, Uruguay and Argentina. It is currently perhaps the most threatened cetacean species in the Southwestern Atlantic. The primary threat throughout most of its range is incidental mortality in gillnets. The main goals of this study were to determine if capture-release and radio-tagging of this species is feasible, and if so, to begin to obtain information regarding movement patterns to aid in development of an effective management plan in Argentina. Three female Franciscana dolphins were radio tagged with small VHF transmitters and released in Bahia Samborombon in March 2005. The tags were attached to the dorsal fins by a single delrin plastic pin with corrosible nuts. The dolphins were tracked for 6 weeks from a lighthouse, the roof of a hotel, a boat, and from the shore. The maximum range from the highest receiving stations was about 20 km. Signals were received from at least one of the tagged dolphins daily, from two individuals on 71% of days, and from all three individuals on 40% of the tracking days. Preliminary analyses by unit effort revealed fairly localized movements by the dolphins, which were mainly recorded in the same area where they were caught. Preliminary analyses suggest a movement pattern associated with the tidal flow, with dolphins coming into the bay during high tide. Though the pilot data set is small, the consistency of findings across the animals suggests that the current designation of a single management stock in Argentina should be re-evaluated. The suggestion of small ranges in areas of heavy artisanal fishing pressure increases the urgency with which protective measures need to be implemented for this species. This study represents the first time that radio tracking has been accomplished with Franciscana dolphins.

A Mass-Stranding Event of Rough-Toothed Dolphins (*Steno bredanensis*) in the Florida Keys (Florida, USA): I. Rescue and Rehabilitation

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A mass-stranding event of rough-toothed dolphins (*Steno bredanensis*) occurred off of the Florida Keys on 2 March 2005. A total of 26

dolphins were transported to the Marine Mammal Conservancy (Key Largo, Florida) for rehabilitation. Upon arrival, all animals were individually captured for photo identification, blood extraction, physical measurements, blowhole, fecal, and mouth cultures, and feeding/hydration. Most of the animals were confined in natural habitat enclosures or artificial holding tanks, the latter used as critical care and quarantine areas. Their diets consisted of herring, mackerel, capelin, smelt, sardines, silversides, and squid, which were supplemented with vitamins. Many individuals also received physical therapy (electronic muscle stimulation and massage) and were trained for recall purposes only. Blood values, cultures, necropsies, and physical and behavioral observations indicated that many of the animals exhibited a wide range of infectious and non-infectious diseases, including dehydration, muscular atrophy, stenosis, pancreatitis, pneumonia, Fascioliasis, a protozoan parasitic infection, bacterial infections, spinal deformations, stomach and intestinal tract erosions, morbillivirus, peritonitis, cardiomyopathy, and various immune deficiencies. Animals were administered different combinations of broad-spectrum antibiotics, antifungal, antiparasite, and antinausea agents, antiulcer/GI protectants, and a histamine receptor antagonist. All diseases were successfully eradicated, and the response to each medication differed between individuals. There were no apparent allergic reactions to any of the medications and side effects were minimal. In addition, quarantines were effective in preventing the transmission of pathogens between hosts. Weight and length data indicated that the majority of animals increased in size and weight. The electrostimulation therapy was not as effective as manual manipulation and massage in the treatment of atrophy and deformation. On 3 May 2005, 7 dolphins were successfully released. This event was the largest, successful rehabilitation and release of cetaceans to date, and the data collected has contributed to our knowledge of a relatively cryptic cetacean species.

Walrus in West Greenland: Where Do They Belong?

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Historically, Atlantic walrus (*Odobenus rosmarus rosmarus*) were heavily exploited on their wintering grounds in Central West Greenland (CWG; 67°-71°30'N). Walrus in this area are still exploited and the group is thought to be much below historical population size. However, the demographic identity of walrus in CWG remains undetermined. Genetic studies indicate that CWG-walrus have only little exchange with walrus in Northwest and East Greenland. However, a comparison between walrus from Hudson Strait (HS) in Canada and CWG indicated a source (HS)-sink (CWG) relationship between these areas. During March 2005, satellite tags were deployed on three walrus in CWG. The tags were applied from a distance by use of a CO₂-powered gun. Two of the animals remained at the wintering grounds during the life of their transmitters (< 1 month), whereas the third (adult female with calf) transmitted for more than 3 months during which time she moved from CWG west to SE Baffin Island (SE BI). Hence, the studies supported a suspected connection between walrus in CWG and the HS-SE BI area. Future studies include a genetic comparison of biopsies from SE BI and CWG, and deployment of satellite tags on walrus at SE Baffin Island.

Does Pile-Driving Noise Withdraw Fin Whales from Their Habitat?

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During a long-term acoustic study within the Pelagos Sanctuary-area in the Ligurian Sea, rhythmic low-frequency sounds were detected. They were attributed to pile-driving activities. The objective of this study is a) to describe physical characteristics and temporal occurrence of pile-driving sounds and, b) to assess their potential impacts on fin whale communication. Sounds were recorded with autonomous pop-up recorders from 31 August 1999 to 6 September 2002 for a total of 655 days. Continuous recordings were for up to 51 days, in the frequency band from 7 to 1000 Hz. Pile-driving noise considered started on 27 May 2002 and ended on 25 June 2002. Daily distribution of percussive sounds was stable, encompassing most of the day (up to 23 hrs). Further similar activities were observed from 27 June to mid July, but not considered in this sample. Pulses (n=8430) were consistent with pile-driving. The inter-pulse-interval (IPI) ranged from 6.9 to 15.2 s (mean: 10.648 s). The duration was up to 2 s. Two frequency groups could be discriminated: one group of pulses (n=6,640) had an energy peak around 40 Hz (range: 21.48 to 70.3 Hz), a second group (n=1,790) had its energy peak at around 9 Hz (range: 5.86-19.53 Hz). Received levels were above ambient noise levels by up to 33dB. Ambient noise levels in the Ligurian Sea are characterised by high shipping noise and are among the highest throughout the world. Fin whale sounds occurring in the area match a generic 19-24 Hz frequency range with two call types and IPIs around 14s as described in literature and reiterated here. The question how anthropogenic noise affects habitat use in cetaceans is poorly understood. We can nevertheless describe which features of anthropogenic noise may mask fin whale communication. Both the low-frequency energy peak and the higher-frequency energy peak group of pile-driving noises fall within the usual band of fin whale vocalisations. The IPI observed from pile-driving activities may cancel 1 out of 6 fin whale calls, provided that both sources had a synchronous start. The relative received levels of pile-driving were up to 26 dB higher than those measured for fin whales. The pile-driving sounds recorded have thus high potential to disrupt fin whale vocal behavior and to inhibit communication. At appropriate distances the RLs have potential for TTS. It was striking to reveal that fin whales were heard during the same season in previous years as well as immediately before pile-driving started. No sounds from fin whales at all could be heard during and immediately after the activities described here.

Orogenital Neoplasia in Atlantic Bottlenose Dolphins (*Tursiops truncatus*)

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This report describes lingual papillomas and squamous cell carcinomas (n=11) and genital papillomas (n=4) in Atlantic bottlenose dolphins (*Tursiops truncatus*) evaluated in our laboratory from January 2000 to January 2005. Tumors were found primarily in adult dolphins of both sexes living in free-ranging and captive conditions. Three dolphins

had multiple mixed lingual tumors, consisting of transitions of papillomas to squamous cell carcinomas, suggesting malignant transformation of the benign papillomatous lesions. To our knowledge, this is the first report of oral papillomas in bottlenose dolphins and concurrent oral neoplasia that included both sessile papilloma and squamous cell carcinoma in the same dolphin. Additionally, it is the first report of genital papillomas in free-ranging bottlenose dolphins from Atlantic coastal waters. The unusually high occurrence of related benign and malignant epithelial orogenital neoplastic lesions in a short time period suggests that the lesions may represent one or more progressive emerging diseases. Preliminary evidence also suggests that these tumors may be infectious, most likely having an orogenital route of transmission.

Abundance and Ecological Distribution of Antarctic Pack Ice Seals in the Pacific Sector of the Southern Ocean

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Crabeater, Weddell, leopard, and Ross seals compose a large portion of the world's population of seals. However, these seals' abundance, distribution, and the magnitude of their ecological role in the Southern Ocean remain poorly understood. As part of the Antarctic Pack Ice Seals (APIS) Program, an international collaboration to improve this understanding, we conducted line transect surveys between 150°E and 100°W longitude in December, 1999 - March, 2000. The helicopter and ship survey transects comprised 25,561 km in pack ice and 2,080 km in shore-fast ice. We used satellite-linked dive recorders to estimate the proportion of seals hauled out and available to be counted. Crabeater seals were the most abundant (1,730,000), with highest densities on the shelf/slope (1.12 seals/km²) and along the ice edge (0.89 seals/km²), and lowest densities in the interior pack ice (0.22 seals/km²). Weddell seals were less abundant (330,000) with densities that were higher on fast ice than over the shelf/slope and over deep water (0.46, 0.14, and <0.04 seals/km², respectively). Ross seals (22,600) were estimated only from 180° - 130° W because they rarely hauled-out after mid-February when other regions were surveyed. Their density was highest in interior pack ice (0.04 seals/km²). Leopard seals were the least abundant (15,100) with highest densities along the ice edge (0.03 seals/km²). These abundance estimates should be more accurate and precise than previous estimates due to use of line, rather than strip transects; coverage of a large area in a single year; and more direct estimation of the proportion of seals hauled out. The clear differences in distribution and abundance of these species were consistent with differences in their life history adaptations and ecological interactions with their biological and physical environments.

Dietary Niche Breadth in Grey Seals: Sex-Season Interactions Based on Quantitative Fatty Acid Signature Analysis

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In many size-dimorphic species, males and females forage differently and are thus expected to meet their energy requirements by consuming different diets. We estimated dietary niche breadth from blubber biopsies taken from 496 adult and 91 young (6 month old) grey seals (*Halichoerus grypus*) between 1993 and 2000 using quantitative fatty acid signature analysis (QFASA) to estimate the proportions of prey species in the diet. Niche breadth and niche overlap were estimated using the Shannon-Weaver diversity index (H2) and the Morisita-Horn index (C_H), respectively. Sand lance (*Ammodytes dubius*) and

redfish (*Sebastes* sp.) were the dominant prey in both sexes, but the diets of adult males were significantly more diverse (H2: 226 males 0.39±0.008 vs. 270 females 0.30±0.008) and less energy dense (male 5.3±0.04 vs. females 5.5±0.04 kJ/g) than those of adult females. Season and sex explained most of the observed variation in adults, but there was a significant sex-season interaction. These differences were most evident during the post-breeding (spring) foraging period when energy acquisition may be critical to female reproductive success. Thus, relative to males, females seasonally selected fewer and higher quality prey species. There were no sex differences in the diet of juveniles grey seals. Although many of the species overlapped those eaten by adults, juvenile diets differed significantly from those of adults. Juvenile niche breadth was similar to adult males but significantly broader than in adult females (H2 91 juveniles 0.43±0.015 vs. 58 males 0.39±0.013 and 57 females 0.26±0.013). Juveniles diets were also of lower energy density than adult diets (juveniles 5.3±0.05 vs adults 5.5±0.08 kJ/g), suggesting less selectivity in these relatively naïve predators. Our results support the influence body size dimorphism and seasonal sex-specific reproductive costs as underlying the observed variation in dietary niche breadth of adults in this marine predator.

Genetic Profiling of Fecal Samples from the North Atlantic Right Whale (*Eubalaena glacialis*)

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The North Atlantic right whale (*Eubalaena glacialis*) has shown little signs of recovery since its international protection. This has been attributed to their high rate of anthropogenic mortality and reduced reproductive rate. Several indicators of reproductive dysfunction and signs of poor health have been noted including a high percentage of nulliparous females, reduced performance in reproductive females, poor body condition, high parasite prevalence and presence of skin lesions. Fecal-based techniques have been developed to assess health and reproduction. However, results are limited unless samples are linked to specific individuals. Only 40% of collected samples have been associated to known individuals through photo-identification during collection. Molecular identification of the remaining 60% is needed. Over a decade of long-term collaborations between photo-identification and genetic researchers, have yielded genetic information for over 56% of all whales ever identified and 66% of all whales alive today. Having genetic information available for most of the population gives us the unique opportunity to link samples of unknown origin to specific individuals. A fecal extraction method has been developed and DNA has been extracted from 141 samples. DNA from the samples is being profiled at the mitochondrial control region to confirm species and DNA quality, and genotyped at a portion of the 35 microsatellites used to profile the extant population. These profiles are then compared to the genetic database using exclusionary methods to associate the sample to a known individual. The probability of identity is calculated to provide a level of confidence in the association. Successful amplification at the mitochondrial control region was possible for all samples. Associations of samples to known individuals have been successfully made using the mitochondrial haplotype and as few as 3 microsatellite loci. In this way the genetic, photo-identification and fecal data have been integrated to maximize information gained from these samples.

How the Olympic Coast National Marine Sanctuary Supports Research, Monitoring, and Conservation of Marine Mammals in Washington State

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The Olympic Coast National Marine Sanctuary (sanctuary) was designated in 1994 as part of NOAA's National Marine Sanctuary Program. The sanctuary has promoted scientific research and monitoring programs that protect marine resources through education and research, complementing other marine resource trustees on the outer Washington coast. Sanctuary boundaries run from intertidal to shelf break, including 3 submarine canyons, thereby encompassing shallow nearshore habitats and offshore/deepwater communities. Examples of sanctuary supported and/or assisted research and long-term monitoring projects that directly or indirectly benefit marine mammals and habitats include: 1) sponsorship of annual ship-based surveys to document trends in offshore distribution/abundance of marine mammals and seabirds with oceanographic conditions; 2) support for humpback and orca photo identifications; 3) participation in annual sea otter census surveys; 4) support for annual kelp surveys and periodic subtidal community surveys; 5) acoustic surveys to map benthic habitat types; 7) assessment of contaminants and disease vectors in sea otters and prey; and 8) participant in marine mammal stranding network. The sanctuary also supports several protective measures that contribute to overall conservation of marine mammals and/or habitats: 1) prohibitions against oil and gas drilling and illegal discharges in the sanctuary; 2) promoting/monitoring the International Maritime Organization's designation of an 'Area To Be Avoided' for tankers/commercial vessels transporting hazardous materials; 3) prohibitions against low-altitude flights to minimize wildlife disturbance; and 4) continuing education and public outreach campaigns to promote better understanding of sensitive marine resources and key species. New areas of sanctuary interest include: 1) ongoing partnerships with SPLASH and CSCAPE programs; 2) assessment of background sound levels; and 3) trophic relationships of marine mammals with zooplankton and forage fish. The sanctuary is dedicated to long-term monitoring and conservation efforts and seeks partnership for these and other research activities linked to management issues.

Injuries Associated with Infanticide in Bottlenose Dolphins

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We have documented traumatic injuries in stranded *Tursiops* calves associated with infanticide each year since 1996, in Virginia, USA. To date, there have been a total of 32 dolphin calves (<160cm in length) whose injuries fit our criteria for infanticide. For this project, we examined and compared the number and types of injuries caused by infanticidal attacks. Muscle hemorrhage and skeletal fractures were seen in all cases. Skeletal fractures were prominent in the thoracic region (n=30) but fractures to the skull (n=3), vertebral column (n=4), bulla (n=1), and scapula (n=2) were also noted. The violence and intent of these attacks is evident in a number of cases where the dolphin calf suffered repeated attacks. Four specific case studies will be presented detailing ante-, peri-, and post-mortem fractures with compelling radiographic evidence. Case 1 presented with ante-, peri- and post-mortem rib fractures, vertebral luxation and concomitant epiphysis fracture, as well as lacerations to the liver and diaphragm. Case 2 presented with pre-mortem rib fractures and hemorrhage to the cranial aspect of the epaxial muscle and surrounding brain stem. Case 3 presented with ante- and post-mortem rib fractures and lung embolism and laceration. Case 4 presented with a depressed skull fracture to the left temporal region with associated hemorrhage. In these, and most cases, external evidence of attack ranges from none to deep tooth rakes and bite marks. The cases discussed here exhibit the variety of traumatic injuries sustained by dolphin calves that have been victims of infanticidal attacks and provides a guide to stranding network personnel who may encounter similar cases.

Using Photographs to Quantify Killer Whale and Anthropogenic Scarring of Western Gray Whales

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The western population of gray whales (*Eschrichtius robustus*) was significantly reduced by commercial whaling during the 19th and 20th centuries and currently numbers approximately 100 individuals. This population is struggling to survive and is listed as 'Critically Endangered' by the IUCN. The critically endangered status of western gray whales, in combination with low calf survival, male-biased sex ratio, and genetic isolation from the eastern gray whale population, could potentially compound the impacts of natural and anthropogenic threats, such as interactions with killer whales, entanglement in fishing gear, and collisions with vessels, ultimately resulting in extinction of the population. Examining the magnitude of these threats would be a valuable contribution to ongoing western gray whale conservation efforts. A multi-year (1994-2003) photo-identification study of western gray whales on their feeding ground off the northeastern coast of Sakhalin Island, Russia, has resulted in a large dataset of digital and film images of 131 identified individuals. These images were reviewed and scored for killer whale and anthropogenic scarring, as a means of assessing threats to survival of western gray whales. Scarring was examined by recording the presence of visible scars resulting from killer whale teeth, fishing gear entanglement, and vessel propellers in 20 defined body regions. Killer whale scarring was frequently observed, although a few instances of entanglement and vessel scarring were also detected. An inter-rater agreement study was used to validate the protocol. This presentation focuses on detailing the quantification protocol, but specific findings, limitations, and implications of the analysis are also discussed.

Are Pregnancy Rates Affected by Density Dependence in Eastern North Pacific Gray Whales (*Eschrichtius robustus*)?

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The eastern North Pacific population of gray whales (*Eschrichtius robustus*) is believed to have been severely depleted by 19th century whalers off the coast of the Californias. Over the past five decades the population has been increasing and may now be approaching carrying capacity. A proportion of this population migrates annually to feeding grounds off the coast of the Chukotka Peninsula, Russia, where an aboriginal hunt has operated since ancient times. We obtained previously unavailable, detailed biological data from the Soviet aboriginal hunt during 1980-91. Ear plug growth layer and corpora albicantia counts are analyzed to investigate changes in pregnancies-at-age through time. There does not appear to be an obvious pattern of decreasing pregnancy rates, as might be expected if the population growth rate was slowing due to a density-dependent response to increased population size during the 1980's. These results are not consistent with a previous analysis that showed an apparent decline over time in the proportion of pregnant females taken in this hunt during 1966-90. The pregnancy rate estimated from the data in this study is consistent with fluctuations observed in recent calf counts on the northbound migration off the coast of California and abundance estimates during the same time period. The lack of evidence for a decrease in fecundity is consistent with the hypothesis that environmental variability, as opposed to density dependence, is regulating calf production over short time periods.

Distribution of Gray Whales (*Eschrichtius robustus*) and

Human Activities in Bahía Magdalena, México

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Due to increasing contact and conflict between human activities and cetaceans, interdisciplinary studies of the relationship between the two are becoming essential for conservation and development strategies. This investigation focused on the distribution of both the California gray whale, *Eschrichtius robustus*, and human activities in Bahía Magdalena, B.C.S., México. Three transects were situated in the central Bahía Magdalena complex: in a shallow portion known locally as “El Bajo”; parallel to Isla Magdalena, and parallel to Isla Margarita. These transects furnished spatial and temporal relative distribution of gray whales between February 21 and April 21, 2005. Data from similar distribution studies done in 2004 were also included. Global Positioning System (GPS) data were taken to map distribution of human activities throughout the bay. Disproving the null hypothesis, there appeared to be a higher concentration of whales per effort hour in February (6.56 whales/hr) compared to April (0.0 whales/hr). Additionally, a significant difference was shown in the spatial distribution of *E. robustus*. There were 8.58 whales/hr found in El Bajo region, compared to the 0.61 whales/hr found in the Isla Margarita region. Past data suggests a possible shift in the spatial distribution away from the mouth to shallower areas of the bay. A preliminary census of human activities was taken and mapped using ArcView software, to be built upon in future studies. Human activities, like shipping and aquaculture, introduce acoustic pollution amongst others forms of degradation into a habitat. Future studies should expand on this acoustic data in determining gray whale distribution in Bahía Magdalena and contribute to management strategies.

Biomimetic Dolphin Echolocation Model Determines Target Location and Identity

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Dolphins foraging in a visually restricted environment must simultaneously locate and identify prey via echolocation. A biomimetic model was developed to simulate this ability incorporating anatomical, physiological, behavioral, and cognitive properties of a bottlenose dolphin's sonar system. The model was divided into two main components: (1) a hardware component that mimics acoustic processing from signal production to reception prior to the cochlea, and (2) a software component that mimics auditory signal processing beyond the cochlea. The hardware component of the model included a directional hydrophone that emitted a broadband transient signal with a similar beam pattern and time-frequency characteristics of a *Tursiops truncatus* sonar signal. Echoes were recorded with two directional, hydrophones at a sampling rate of 1 MHz. Asymmetric, reflective structures were positioned around the receivers to provide a gross approximation to the position dependent spectral filtration of the dolphin's auditory anatomy (i.e., low jaw fats, air sacs, skull). Digitized echoes were processed by a three stage model of the dolphin auditory periphery: (1) a bank of constant-Q, gamma-tone filters spaced between 11 kHz and 156 kHz, (2) half-wave rectification, and (3) low-pass filtering with a 264 μ sec exponential decay window. The output of the auditory model was presented to a series of parallel artificial neural networks that (1) learned to localize the spatial location of targets and (2) classify the targets. The output space of the localization network was a 3D Euclidean matrix representing a spatio-topic map of auditory space. The output space of the classification network were object categories. This model provides an objective way of testing hypotheses about the mechanisms dolphins use to locate and identify targets based on their echoes.

Using State-Space Models to Discriminate Behavioural

State from ARGOS Satellite Telemetry Data

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ARGOS satellite tags have been extensively used to monitor movements of free-living marine animals, greatly adding to the understanding of distribution and foraging ecology of many species. However, locations generated from these tags are prone to high error rates, especially in diving animals, and the multidimensional nature of the data are typically intractable to most conventional statistical techniques. The rich behavioral record resulting from satellite tags has, until recently, remained out of reach of robust quantitative analyses. State-space model (SSM) approaches allow flexibility in model fitting by explicitly modelling measurement error and stochastic behavioral processes separately. In this case, we have employed a 2-state correlated random walk model, one state representing highly correlated directed motion and another representing area limited search with low correlation. SSMs were fit using a Markov Chain Monte Carlo routine in the freely available software package WinBUGS. Models were fit to ARGOS tracks collected from 13 grey seals (*Halichoerus grypus*) deployed in 2003 from Sable Island, Nova Scotia. These seals were also fit with stomach temperature data loggers. 330 successful foraging bouts were inferred from stomach temperature data. Coincident to 248 of these successful bouts, visual inspection of the satellite track suggested area limited search behaviour. In 233 of these cases, SSM results inferred area limited search behaviour during successful foraging bouts. In the remaining 82 successful foraging bouts, neither visual inspection nor SSM results suggested area limited search behaviour. The validation of SSM-discriminated behavioural state with foraging success data from stomach temperature loggers suggests that implementation of SSMs for behavioural analysis of ARGOS data may prove to be a powerful analysis tool. We anticipate that employing additional behavioural variables, such as diving, will further improve our ability to discriminate among behavioural states in free-ranging marine animals.

Habitat Associations and Diving Activity of Subadult Steller Sea Lions (*Eumetopias jubatus*) During the Winter and Spring in the North-Central Gulf of Alaska

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In accordance with a 1997 status classification of the Western Steller sea lion (SSL) stock as endangered, the “critical habitat” for the species needs to be defined. This habitat has now been designated to include 10-20 nautical mile buffer zones around most rookeries and haulouts in the Gulf of Alaska and Aleutian Islands. However, these zones were based on limited, summer data. The primary objective of this study was to characterize subadult SSL diving patterns and habitat use along the Kenai Peninsula and in Prince William Sound (PWS) from winter to spring. Fifteen juvenile Steller sea lions (9M, 6F) were captured and equipped with satellite telemeters at five haulout sites in Prince William Sound and Resurrection Bay, Alaska. Telemeters transmitted for an average of 122 da (range 38-181 da). A total of 11,692 locations were received and 217,419 dives recorded. All sea lions exhibited localized movements near shore. Most dives were short (mean duration = 1 min) and shallow (mean depth = 11 m), with animals diving to an average maximum depth of 193 m. Season appeared to have a significant effect on diving behavior. During winter (January and February), most dives (> 40%) occurred during the daytime (0900-1500 LT). However, by April and May this pattern changed and the animals made most of their dives (> 40%) during night (2100-0300 LT). This relationship was more pronounced for dives deeper than 20 m and coincided with the seasonal increase in photoperiod. Such patterns may also reflect responses to diel

distributions of prey. Shallow, near-coastal waters may provide important habitat for juvenile sea lions during the transition to nutritional independence.

Mercury Concentrations in the Pacific Harbor Seal, *Phoca vitulina richardii*, in Central California: How "Hot" are They?

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To determine total mercury (THg) and monomethyl mercury (MeHg) concentrations in the Pacific harbor seal (*Phoca vitulina richardii*), live capture and dead seals (n=186 and n=40, respectively) were sampled throughout central California from March 2003-January 2005. Blood and hair of live harbor seals were analyzed for THg concentrations; whereas, hair and liver of dead harbor seals were analyzed for THg with an additional analysis of MeHg in the liver. THg concentrations were analyzed with Atomic Absorption Spectroscopy using a Flow-Injection Mercury System (AAS/FIMS) and/or Inductive Coupled Plasma-Mass Spectroscopy (ICPMS). MeHg concentrations were determined by isothermal Gas Chromatography (GC) separation of ethyl analogs and Cold Vapor Atomic Fluorescence Spectrometry (CVAFS). Age class assignments of live harbor seals were based on morphometrics, and ages of dead harbor seals were determined by cementum annuli in teeth. Significant differences were found in THg concentrations in blood and hair based on age ($P < 0.0001$). THg concentrations in blood, hair, and liver increased linearly with age ($P < 0.0001$); whereas, MeHg concentrations in liver increased with age exponentially with an asymptote at approximately 2 ppm wet weight. MeHg expressed as a percentage of THg (%MeHg) is best described by a decay function ($r^2 = 0.8348$, $P < 0.001$). As harbor seals age, %MeHg decreases to a minimum and remains constant. Significant differences in THg concentrations in blood, hair, or liver, however, were not detected for gender or location. Gender differences likely did not occur because the sampled population was skewed towards females. Assessing the possible affect of location of sampling on mercury concentrations, however, is confounded and limited by lack of equal sample sizes for basic age and sex cohorts.

Worldwide Mass Stranding of Sperm Whales: Locations, Numbers, Composition and Causes

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The mass stranding of sperm whales (three or more whales) is well documented worldwide because of the size and numbers of these whales. The first recorded mass stranding event (MSE) occurred in July 1577 on the coast of the Netherlands in the North Sea. We documented 74 MSEs for sperm whales between 1577 and 31 December 2004. The number of animals involved in these MSEs ranged from 3 to 72. Possible explanations for these MSEs include: receiving misleading echolocation information, panic in shallow water, and strong social cohesion when a single individual gets stranded. The major regions where MSEs occurred are, Tasmania, New Zealand, and the North Sea. These three regions comprise approximately 60% of the total number of mass strandings. During the past 15 years the number of sperm whale MSEs is ca. 35 % of the total. Since 1990, anthropogenic events (acoustic disturbances and contaminants) have been suggested for the increase in these MSEs. Possible causes of these MSEs and their recent increase will be discussed, including the above possible reasons along with natural environmental effects.

Effects of Bottlenose Dolphin Sounds on the Acoustic

Behavior of Spotted Sea Trout

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Acoustic communication is common among animals in low-visibility environments (e.g., darkness, cluttered forests, or turbid water). Many predators in these environments use passive listening to find prey. Therefore, sound-producing animals tradeoff their need for conspecific communication with their need to avoid predation. Acoustic communication is widespread among fishes; they produce sounds under a variety of contexts, such as when courting potential mates, defending territory, competing for food, or responding to threats. Bottlenose dolphins, *Tursiops truncatus*, appear to use both passive listening and echolocation to detect prey. Initial prey detection appears to occur often via passive listening and then echolocation is used to facilitate pursuit and capture. One soniferous species eaten by bottlenose dolphins is the spotted seatrout (*Cynoscion nebulosus*). We performed acoustic playback experiments in the field to examine the effects of dolphin whistles and echolocation clicks on spotted seatrout spawning choruses. Playbacks of dolphin clicks caused a significant decrease in the received level of spotted seatrout chorus sounds (t test, $P = 0.04$), whereas neither dolphin whistles nor snapping shrimp (*Alpheus* sp.) sounds caused a change in received sound levels ($P = 0.93$ and $P = 0.20$, respectively). These data suggest that spotted seatrout can detect and respond to sounds associated with foraging dolphins. The lack of response to the whistles may have been due to these stimuli being inaudible to the sea trout or to the sea trout not perceiving whistling dolphins as a threat. The lack of response to the snapping shrimp control sounds indicates that spotted seatrout do not simply respond in a generalized fashion to any broadband pulsed sound stimulus. These data illustrate the co-evolution of an acoustically mediated predator-prey system in which sound production incurs ecological costs for both predator and prey.

Establishing Baseline Trace Element and Methylmercury Concentrations for Bottlenose Dolphins in Sarasota Bay, Florida as an Indicator of Health Status

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Several major unusual mortality events have occurred in recent years, increasing the level of concern for the health of bottlenose dolphin (*Tursiops truncatus*) populations along the east coast of the United States and in the Gulf of Mexico. The resident community of bottlenose dolphins in Sarasota Bay, Florida has been studied for more than 35 years and presents unique opportunities to investigate relationships between life history, health, and trace element concentration data. Whole blood and skin samples collected from November 2002-June 2004 through health assessment live capture/release events in Sarasota Bay have been analyzed for Al, V, Cr, Mn, Cu, Zn, As, Se, Rb, Sr, Mo, Cd, Pb, total Hg (THg), and methylmercury (MeHg) by ICPMS, gas chromatography ICPMS, and CV-AFS. Trace element concentrations in the skin were 2 to 45 times higher than the blood with the exception of Cu which was 1.4 times higher in blood. Statistically strong correlations ($p < 0.05$) were found for V, As, Se, Rb, Sr, and THg between blood and skin. The strongest correlation was established for THg ($R^2 = 0.94$) and levels in both blood and skin were above the threshold at which detrimental effects are observed in other vertebrate species. THg concentrations were related to age class and sex. Males and females accumulate mercury through the calf and juvenile stages. Once females begin reproducing, their THg concentrations were significantly higher than adult males and younger age classes of both sexes. Methylmercury, examined in individuals and mother/calf pairs,

comprised greater than 90% and approximately 50% of the total mercury in blood and milk respectively. Trace element concentrations established in this study will serve as an index for comparison for future monitoring of this population and as a benchmark for comparison of other coastal bottlenose dolphin populations.

FASTLOC – Fast Acquisition GPS Technology for Marine Mammal Research

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It is well known that traditional Global Positioning System (GPS) receivers are ineffective for the majority of marine animal tracking studies. This is due to the animal's brief surfacing periods, which preclude the acquisition of ephemeris data. Fastloc, a new development in GPS receiver technology, avoids this constraint by collecting raw satellite data and computing pseudo-range information on board. The records from a typical detection of 8 satellites can be compressed into 23 bytes and are therefore suited to re-transmission to the user through low bandwidth telemetry links such as System Argos. When these pseudo-ranges are recovered, they are used in conjunction with publicly available archived ephemeris information to compute locations. The advantage of this system is that a tagged animal only has to be at the surface for 16 milliseconds to obtain the data (termed "snapshots") to provide an accurate location. In tests 4000 snapshots were collected over 24 hours of which 99% resulted in location estimates. These had 2D & 3D RMS accuracies of 18m & 27m respectively. As part of the NOPP program and a NERC Connect B grant, the Sea Mammal Research Unit integrated Fastloc receivers with Argos Satellite Relay Data Logger (SRDL) and GSM Phonetag technology. Two SRDLs and one GSM Phonetag were successfully deployed on grey seals around the coast of Scotland. SRDLs were programmed to take hourly snapshots while the GSM Phonetag took snapshots every 15 minutes; in all cases approximately 50% of the snapshots were successful. The Argos SRDL relayed about 10 Fastloc locations per day; the GSM phone tag relayed about 50 per day. Each provided numerous high-resolution locations that identified haulout, foraging and travelling behaviour in unprecedented spatial and temporal detail.

Bowhead Whale (*Balaena mysticetus*) Blubber Fatty Acids Provide Insights into Foraging Ecology and Climate Variability

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There is considerable interest in determining the importance of the Beaufort Sea as a summer feeding ground of the Pacific population of bowhead whales (*Balaena mysticetus*). Conflicting conclusions have been reached from several recent studies employing stable isotopes and analysis of stomach contents. We assessed diets and foraging by examining the fatty acids (FA) of the inner layer of blubber of 64 bowheads taken in the spring and fall subsistent hunts in 1997, 1998, 2000, 2001 and 2002 at Barrow and Kaktovik, Alaska. Principal component analysis (PCA), followed by analysis of variance (ANOVA) on the FA showing the greatest variation in levels in bowhead whale prey, revealed significant age ($P<0.005$) and season ($P<0.05$) effects. These results indicate that both adults and sub-adults foraged to some extent on different prey, and that both age classes of bowheads consumed copepod prey in the Beaufort Sea in summer at sufficient levels to significantly alter their blubber FA profiles. Both of these findings support conclusions reached from stomach content analyses. Furthermore, a separate PCA of FA expected to vary in phytoplankton with variation in ocean conditions yielded three significant components. Multivariate ANOVA on these components revealed

significant differences in age ($P<0.005$) and year ($P<0.05$), providing further evidence of dietary differences between age classes and indicating that changes in FA composition of species at the base of the food web in response to climate variation were being reflected in the blubber FA profiles. Exceptionally low values of the third PC corresponded to anomalously low values for both the Arctic Oscillation and North Pacific Index. This raises the possibility of employing FA in bowhead whale blubber to monitor the effects of climate change on lower trophic levels and production processes in the western Arctic.

The Relationship Between Polychlorinated Biphenyls in Blubber and Levels of Nematode Infestations in Harbour Porpoises, *Phocoena phocoena*

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Post mortem examinations of harbour porpoises, *Phocoena phocoena*, regularly reveal heavy parasitic worm burdens. These same post mortem records show varying levels of polychlorinated biphenyls (PCBs) accumulating in the blubber of porpoises. Although a number of papers have documented geospatial and temporal changes of PCBs and their detrimental effects on marine mammal health, as yet none have examined their role in determining nematode burdens in wild marine mammal populations. Using a data set consisting of harbour porpoises stranded in the UK between 1989 and 2002, we found a significant association between PCB levels and nematode burdens, although the nature of the relationship was confounded with porpoise sex, age and cause of death. It was also apparent that individuals with the heaviest infestations of nematodes did not have the highest PCB levels suggesting that whereas PCBs are important, they may not be sole determinants of nematode burdens in wild populations of the harbour porpoise around the UK.

Quantifying Cetacean Wound Healing Rates Using GIS Techniques

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To date, much of the literature available on cetacean wound healing has involved qualitative assessments. Quantitative analyses of wound healing in previous studies have been limited by insufficient sightings of healing animals, as well as difficulties in comparing images from field observations. A method utilizing tools provided by ArcGIS™ has been developed to quantitatively assess the rate of cetacean wound healing. Georeferencing tools commonly used in GIS analyses provide the ability to calculate wound healing rates from a time series of digital pictures taken during field observations. This is made possible through image-to-image registration, a process in which digital images of varying extent, scale, and camera angle are transformed into the same geographic space. The registration process requires the presence of control points, which are easily identifiable features found on each image in the time series. The method was developed using a time series of digital pictures depicting a healing wound on a captive bottlenose dolphin (*Tursiops truncatus*). For the captive animal, distinct skin markings were used as control points. These features are rarely visible in digital images of free-ranging bottlenose dolphins acquired during field observations. However, digital pictures taken during a Charleston, SC radio-tracking project in 2003 revealed that the surgical biopsy injection sites made during a health assessment project persisted throughout the healing process, and have great potential to serve as control points for image-to-image registration. Digital pictures from a health assessment and subsequent radio-tracking project in August 2005 will be used to examine the utility of this method for assessing and eventually modeling the healing rate of surgical biopsy wounds on free-ranging bottlenose dolphins.

Breeding performance of marked Steller sea lions (*Eumetopias jubatus*) in Russian waters.

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Steller sea lions in Russia have undergone population declines over the last few decades. Reproductive performance of marked (branded and tagged) females was monitored on five major rookeries in the Russian Far East in May - July of 2002 to 2004 in order to examine the hypothesis that reduced birth rates may be responsible for the population changes. A total of 646 marked females aged 1 to 15 years were resighted. No females < 4 years old were observed with pups. The birth rate among 191 four year olds was only 2.9 %. Three hundred and eighty-two mature females (age 5 to 15 years) were seen at rookeries, 217 of which had pupped 1 to 3 times. Of the 95 females that were seen at least once in the 3 years and that were 5 or more years old in the first season of observation (2002), 22 (23.2%) had no pups at all; 25 (26.3%) pupped in only one year; 34 (35.8%) pupped in two years; and 14 (14.7%) had pups in all 3 years. Sixty-three of these mature females were resighted in at least 2 of the 3 years, and 4 (6.3%) did not give birth, 13 (20.6%) had pupped in only one year, 32 (50.8%) had two pups, and 14 (22.2%) had pups in all 3 years. Forty-one females => 5 years old were sighted in all 3 years and 3 (7.3%) did not pup, 5 (12.2%) pupped only once, 19 (46.3%) pupped in two years, and 14 (34.1%) pupped all 3 years. These results demonstrate the importance of monitoring animals for multiple consecutive years. Birth rates on Medny Island, where the population was decreasing over the observation period were significantly lower than on the Kuril Islands rookeries, where sea lions numbers had stabilized between 2002 and 2004.

Use of Satellite Imagery to Estimate Walrus Abundance at Round Island, Alaska

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Until recently, the use of satellite imagery in marine mammal studies has largely been limited to habitat characterization, such as sea surface temperature and primary productivity. Advances in commercial satellite imaging technology have reached a point where studies of the animals themselves are now possible. Commercial satellite imagery with sub-meter resolution became a reality with the successful launch of the QuickBird platform in October 2001. We ordered the collection of QuickBird satellite imagery of Round Island, Alaska to evaluate the suitability of commercial satellite imagery to monitor Pacific walrus haulouts. The QuickBird satellite is equipped with 0.6 m panchromatic and 2.4 m multispectral sensors. During the period when collections were scheduled, ground observers counted the number of walrus present and collected digital photographs at each beach to verify the number of walrus present at each location. A total of 4 images were collected in 2002, and another 5 images in 2003. Walrus were present on Round Island during each collection, and walrus groups were clearly visible in each image. We performed a supervised classification of 0.6 m pan-sharpened imagery to determine the spatial footprint of walrus groups at multiple beaches on Round Island. Based on their spectral signatures, walrus groups as small as 2 animals were detectable at least some of the time, and walrus groups of 12 or more were always visible. We calculated the number of walrus present at each beach using an estimate of walrus density from aerial photography collected at Round Island in 1998 and 1999. Estimates of total walrus numbers were comparable to total counts from ground photos. The use of satellite imagery to estimate walrus abundance will likely improve as commercial satellites with finer spatial resolution and more spectral bands are deployed.

Migratory Movements of Humpback Whales (*Megaptera novaeangliae*) Photographed off the East Coast of Australia

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Three-hundred fifty-two individual humpback whales (*Megaptera novaeangliae*) were identified by fluke photograph during vessel surveys conducted off the coast of Ballina, northern New South Wales, during the seasonal southern migration of whales back to Antarctica (September to November) in 2003 and 2004. Of the 352 identified individuals, eight were photographed on two days within a season. Intervals between sightings for these whales ranged from 1 to 47 days. Resighted whales included individuals seen travelling south on both sightings, north on both sightings, north on first sighting and south on the second, and south on first sighting and north on the second. These observations suggest not all whales travel continuously south; instead some individuals may circle north before resuming their southern migration. Within season movements of humpback whales were also documented by comparing fluke photographs taken in Hervey Bay, Queensland (387 in 2003 and 329 in 2004), with those taken at Ballina (212 in 2003 and 152 in 2004). The closest swimming distance between these two survey sites is approximately 550 km. Nineteen whales photographed in Hervey Bay were later photographed at Ballina between 5 and 26 days later. Minimum travel speeds for these whales ranged from 4.6 km/h to 0.9 km/h. Two whales resighted at Ballina were also photographed in Hervey Bay in the same season. One whale seen travelling northwest at Ballina in September was photographed in Hervey Bay 22 days later, then at Ballina another 8 days later. Another whale seen in Hervey Bay was photographed travelling southwest at Ballina eight days later, then travelling south at Ballina another eight days later. Seven whales were photographed at Ballina in both 2003 and 2004. Each of these whales was seen in 2004 within nine days of the date of sighting in 2003, indicating some consistency of timing of migration for these individuals.

Temporal Patterns in Crabeater Seal (*Lobodon carcinophagus*) Diving Behavior

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Previous studies within the Marguerite Bay Region of the Antarctic Peninsula (~67° S, ~67° W) demonstrated that crabeater seals were not randomly distributed across available habitat, but instead were more likely to be located in nearshore waters where bathymetric gradients and ice concentrations were high. Here we investigate the temporal pattern of diving activity of crabeater seals by examining dive shape profiles and bout structure, and interpret dive patterns in light of optimal foraging theory (OFT) and information on the distribution of their primary prey, Antarctic krill (*Euphausia superba*). Diving and movement patterns were obtained from 34 seals (16M 18F) outfitted with Satellite-Relay Data Loggers (SRDLs), and dive metrics, shapes, and bout structure were determined. We identified 5 basic dive shapes: U, V, Square, Slow Ascent, and Slow Descent. Overall, Random Effects Mixed Linear Models indicated that during the day, dives were deeper (158 vs 73 m), longer (7.2 vs 6.0 min), and closer to the bottom (50.2 vs 26.3%) than those during the night. During the day, the most common dives were V shaped with little bottom time, while square dives were three times more common at night. Dive bouts were longer during the day (135 vs 78 min), and consisted primarily of long, deep, V shape dives. These bouts were often bracketed by shorter bouts of shallow dives, or by a few single dives. In combination these findings suggest that seals concentrated their diving activity, not when they could maximize bottom time, as predicted by some OFT models, but when they could they could most efficiently exploit zooplankton schools which become compressed close to the bottom, even though this reduced bottom time and

increased post-dive recovery periods.

Can Protecting Fish Reduce Bycatch of Bottlenose Dolphins in North Carolina, USA?

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In the early 1990s, high numbers of bottlenose dolphins stranded on NC beaches were thought to be indicative of incidental mortality in coastal gillnets. Observed mortality between 1996-2000 confirmed this hypothesis; an estimated 146 animals were killed annually in gillnets off NC during the winter (November-April) (Palka and Rossman 2001). The majority of takes occurred in nets targeting spiny dogfish, but a federal FMP implemented in 2000 essentially eliminated this fishery off NC. As a result, we expected a reduction in bycatch to occur, which would be reflected in a reduction of strandings. We used stranding data of dolphins and effort data of spiny dogfish during winter in NC for 1997-2004. Of the animals that stranded (n=503), 22% showed evidence of fishery (FI) or other human interaction (HI). Presence or absence of evidence could not be determined (CBD) for the majority of strandings (59%) due primarily to decomposition. There was a significant positive relationship between the number of dolphin strandings (FI/HI/CBD) and spiny dogfish trips ($P=0.0003$), and pounds ($P=0.001$). In addition, the average number of strandings (FI/HI/CBD) per month was significantly less after the FMP (0=4.4) than before (0=8.0; $P=0.003$). The observed reduction in strandings was also supported by a new annual bycatch estimate of 19 for years 2001-2002 (Rossman and Palka 2005). Although FMPs that limit fishing can concomitantly reduce bycatch of marine mammals, the opposite is also true. As some fish species off the mid-Atlantic rebound, increased quotas may increase bycatch rates. Bycatch estimates take years of data to calculate and depend on representative coverage of all fisheries where entanglement occurs. Monitoring stranding patterns in real time can detect changes indicative of decreased or, more importantly, increased fishing mortality. This can decrease response times to mitigate increases in bycatch, important for depleted stocks like the Mid-Atlantic bottlenose dolphin.

Molecular Systematics of the South American Dolphin *Sotalia* sp.: Sister Taxa Determination and Phylogenetic Relationships

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The South American dolphin or tucuxi, genus *Sotalia*, is currently considered a member of the Stenoninae subfamily, along with members of the genera *Steno* and *Sousa*. In recent years, a revision of this classification was proposed and the inclusion of *Sousa* in the subfamily Delphininae was suggested. Here we evaluate *Sotalia*'s phylogenetic relationships, using twelve gene fragments: the mitochondrial Control Region, a portion of the Cytochrome *b*, six autosomal introns (CAT, IFN, GBA, CHRNA1, the first intron of the Actin gene and the first intron and exon of the Lactalbumin gene) and four Y chromosome introns (DBY7, DBY8, SMY7 and UBE1Y7). A total of 970 bps of mitochondrial DNA and 4213 bps of nuclear DNA were analyzed.

Sequences of these genes were obtained for seventeen delphinid species, including four *Sotalia*, one *Sousa* and four *Steno* individuals and at least one species from each recognized subfamily plus one member of the Monodontidae family (*Delphinapterus leucas*), two of the Phocoenidae family (*Phocoenoides dalli* and *Phocoena phocoena*) and two of the Iniidae family (*Inia geoffrensis* and *Inia boliviensis*) as outgroups. Parsimony, maximum likelihood and neighbor-joining phylogenetic reconstructions were analyzed and compared for the whole combined data set and for independent gene fragments. Results show that *Sotalia* falls within a clade containing other members of the delphininae subfamily that include *Sousa*, yet separate from *Steno*. *Sousa* appears to be *Sotalia*'s sister taxa. These results are not consistent with current subfamily classification but help explain some life history and morphological similarities between *Sotalia* and *Sousa*. Our data suggest *Sotalia* should be placed into the Delphininae subfamily and maintain *Steno* as the sole member of the Stenoninae subfamily.

A Pygmy Right Whale (*Caperea marginata*) from Chiloe Island, Chile

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Few records of pygmy right whales exist for the temperate waters of the Southern Hemisphere. The species has been reported mainly for waters off Australia and Tasmania, with only two records for the South American Atlantic region. For Chilean waters, the species has been included in earlier national marine mammal guides and later publications but without positive identification. Here we report on the stranding of a pygmy right whale in the Northwestern coast of Chiloe Island, the first documented record of this species in Chilean waters and the third documented record of the species in the South American region. The whale stranded on 6 December 2004 at the Pullihue estuary (41° 49' 09" S / 73° 58' 47" W). Members of the National Marine Mammal Sighting Network established by CCC reported that the specimen was approximately 3m to 3.5m long and that it had been butchered almost entirely, with flesh remaining on the head. No wounds or scratches were observed and the whale was not bloated, supporting the report that the whale beached fresh. Local people collected the skeleton and some baleen plates. Several measurements of the skull, bulla, mandible and vertebrae were taken and compared to the best predictors for estimating the body size of the specimen. The results suggest that the pygmy right whale from Chiloe Island was close to the average size at weaning or 3.5m. This specimen confirms the presence of pygmy right whales in the Southeast Pacific Ocean and highlights the lack of knowledge about this species in the region.

Abundance and Home Range of Indo-Pacific Humpback Dolphins *Sousa chinensis* in the Great Sandy Strait and Hervey Bay, Queensland, Australia

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The distribution and abundance patterns of coastal Indo-Pacific humpback dolphins (*Sousa chinensis*) were examined in the Great Sandy Strait and Hervey Bay region, Australia. 112 surveys were completed from April 2004 to May 2005, and individual dolphins were identified by distinctive fin characteristics. A total of 127 individuals were identified, of which 103 were found in two geographically distinct populations: the Mary River population or Northern population (NP) and the Southern population (SP). A further 24 individuals were recorded only once, beyond the northern limit of the NP population range. The ranges of the two populations did not overlap and cluster analysis showed the presence of two distinct groups

with a very low Association Index. The population size estimated by mark-recapture was $N = 56$ (95% CI = 54-65) for the NP, and $N = 51$ (95% CI = 49-60) for the SP. The NP home range area calculated using the Kernel Estimator at 95%UD was 599.7 km², whereas the core habitat was 105 km². The core area includes the Mary River estuary and surrounding waters where dolphins can be sighted on a daily basis feeding on the outgoing tide. The SP habitat calculated using the Kernel Estimator was 354.2 km² and the core habitat was 15.9 km². Indo-Pacific humpback dolphins were sighted in a wide range of water conditions, and remained mostly within 50 m of the shore, sandbanks or islands, in water less than 8 m deep. The high number of females and calves (17 pairs) recorded in the northern section indicates strongly that these shallow and sheltered waters are used as a nursery area for the Indo-Pacific humpback dolphin and require an higher level of habitat protection.

Changes in Abundance of Humpback Whales off the West Coast of the U.S.

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Photographic identification studies of humpback whales have been conducted annually off the U.S. West Coast from 1986 through 2004 and have been the primary means of determining abundance of this distinct feeding aggregation. Starting in 1991, small-boat effort surveyed multiple locations to obtain a broadly representative sample of the entire region and photo-identified 200-400 different individuals each year. Mark-recapture estimates were conducted using annual samples with the closed Petersen estimate or with the open Jolly-Seber model. Abundance estimates prior to 1991 were biased downward by heterogeneity of capture probabilities created by the limited geographic coverage. Abundance estimates since 1991 have ranged from a low of 569 for 1991-92 (CV=0.03) to a high of 1,454 in 2003-04 (CV=0.09). While the overall trend in humpback abundance has been upward, the trend shows three phases, a steady and consistent increase of about 9% per year from 1991 through 1998, a sharp decline immediately after 1998, and then an escalating rate of increase in recent years. The increase through the 1990s was the result of the population recovering from commercial whaling that ended in 1966 in this area. The decline in 1998 coincides with a severe El Nino in that year that resulted in some of the lowest zooplankton abundances that have been observed in this region. The dramatic increases in abundance in recent years have been more puzzling and coincide with an increase in the proportion of whales that have not been seen previously in the region; in 2004 35% of whales identified had not been previously compared to <10% for 1991-98. One hypothesis is that immigration is occurring from other feeding areas; this would be a departure from previous findings of limited interchange based on genetic and photo-identification data. Despite the increase we document, the population remains below that prior to whaling.

Does Consuming Pollock Truly Have Negative Impacts on Free Ranging Steller Sea Lions?

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Listing western stock Steller sea lions (*Eumetopias jubatus*) as endangered in the US generated much attention and concern because an important prey of sea lions, walleye pollock (*Theragra chalcogramma*) is also the single most important commercial groundfish species in Alaska. Some speculation and some experimental data from permanent captive sea lions have supported a theory that consuming pollock results in negative impacts on juvenile sea lions. The primary objective of this work was to test the hypothesis that

free-ranging Steller sea lions suffer negative consequences from a diet of pollock. Seven free ranging juveniles (1 to 2 yrs old) were temporarily held captive and fed an exclusive pollock diet for an average of 54 (± 0.9) days. Eight additional animals were fed a mixed diet consisting of several species of fish and cephalopods, but averaged 92.4% (± 5.7) herring for an average of 54.1 (± 21.1) days. Morphometric measurements were recorded, blood chemistry was monitored and body condition using ultrasound and deuterium oxide dilution was measured periodically. The treatment group (fed pollock) was comprised of two groups of animals, 3 animals in fall during molt and 4 in spring prior to breeding season. All animals increased mass on both diets. There was a significant increase in mean body fat (8.2%) between capture and release for the 7 animals in the treatment group ($t_{0.05,12} = -2.606$, $p = 0.023$). There was no significant difference in mass change between diet types ($F=1.231$; $p=0.287$). No negative consequences to free ranging Steller sea lions were detected from consuming an exclusive pollock diet. It seems likely that negative health effects that may have been detected in previous studies were artifacts of permanent captivity.

Biogeography of Whale Lice (Amphipoda: Cyamidae) Living on Gray Whale Islands

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A variety of "island" systems, including oceanic islands, mountaintops, lakes and nature reserves, have served as testing grounds for biogeographic theory. Because hosts are discrete habitats or 'living islands' for parasites, host-parasite systems can also be studied from a biogeographic perspective. For example, Gray whales (*Eschrichtius robustus*) are living islands to a diverse but little known assemblage of ectoparasites that includes at least three species of whale lice (*Cyamus* sp.). These species of louse differ greatly in terms of their host-specificity and spatial distribution on host individuals, and, unlike other crustacean ectoparasites, such as barnacles, they lack a free-living aquatic life-stage. As a result, transfer of whale lice is largely dependent on direct physical contact, such as mating or nursing, among host individuals. It has been suggested that the distribution of these lice is non-random, with each species selectively occupying a different region of the host's body following colonization. However, the biogeography of this entire host-parasite system remains poorly understood. Here we describe the colonization of whale lice onto a new host, a neonatal gray whale that washed ashore in Humboldt County, CA. All three species of whale lice were present. We collected 316 lice, of which 180 were identified to species based on morphology. Most lice (95%) were located near the head region, suggesting that colonization occurred via nursing. We are currently examining these samples with molecular data to verify species identification and to infer the phylogeographic structure of lice on this host. Extending this study to future strandings will provide valuable insights into the colonization dynamics and biogeography of ectoparasites on whale "islands."

Assessment of Dugong Habitat in Central Philippines

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In light of two recent dugong strandings in the south Visayan Sea, a study was funded by Ocean Park Conservation Foundation to survey these waters for the presence of dugongs and determine the distribution, composition and productivity of seagrass beds. Seagrass beds were marked using GPS and mapped with Map Info. Seagrass cover was determined using five 1 m x 1 m quadrats; seagrass biomass and density by harvesting 0.25 m². Water parameters were measured. Sources of destruction to seagrass ecosystem were noted. Seagrass

beds fringed the shoreline and islands of northern Negros. Total area at 0-10m isobath, from Sagay Manapla, was estimated at 179.3141 km². Seagrass zones were distinct. *Halophila minor* occupied the deepest zone, to 18 m in clear waters; *H. spinulosa*- *H. minor* zone at 7-15 m; *H. spinulosa* pure zone at 5-12 m; *H. spinulosa*-dominated mixed zone starting at 9 m; *H. ovalis* pure zone between 3-6m. Between 4-8 m, the bed was mixed, consisting of *Halodule uninervis*-dominated mixed zone with or without *Halophila* spp., *Cymodocea* and *Syringodium*. In 3 m to intertidal, *H. spinulosa* and *H. minor* may be replaced by *Enhalus* and/or *Thalassia/Cymodocea rotundata*. The most extensive bed lined Manapla, growing in the intertidal to about 7 m. It was a mixed bed of *Halophila spinulosa*, *H. ovalis*, *H. minor*, *Halodule uninervis*, *Cymodocea rotundata* and *Syringodium isoetofolium*, species generally preferred by dugongs. This was where a dugong was sighted and fresh grazing tracks seen. The most diverse bed was in Maca Reef with nine species.

Pulsed Call Structure in South Atlantic Spinner Dolphins (*Stenella longirostris*)

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Pulse-based vocalizations are known to be produced by every odontocete species over which some description of sound repertoire has been investigated. Dolphins of the genus *Cephalorhynchus*, for instance, produce only pulsive-structured sounds, using them for social and food-related signaling. However, very few studies have been done on the descriptive characteristics of pulsed sounds in other delphinoid species. The vocal repertoire of a spinner dolphin population from Fernando de Noronha Archipelago, Northeastern Brazil is being studied since 2002. Acoustic recordings have been done while diving amongst dolphins in a protected bay. Sounds have been sampled from a DV camcorder (frequency response 20 Hz - 20 kHz \pm 1dB, sampling rate at 48 kHz) placed inside an Amphibico case equipped with a mono element hydrophone. Sound analysis has been conducted using Canary 1.2.4. Due to equipment limitations, only sounds within human audio range (up to 20 kHz) were categorized. An amount of 454-pulsed sounds were evaluated from the inspection of their aural and spectrographic properties and three classes of pulses (single, repeat and click bursts) were recognized from the samples. The repertoire of pulsed sounds was analyzed and classified using multivariate techniques. Duration ranged from 22 to 2400 ms and the frequency, from 800 Hz to 18 kHz. Most energy was concentrated in low and medium frequencies (around 12 kHz). Highly variable pulsed sequences in terms of repeatability, where each individual pulse sounded like a *quack*, were found associated with behaviors occurring inside groups we call "mating groups".

Is the Catfish (*Calophysus macropterus*) Fishery a New Threat to the Amazon River Dolphin (*Inia geoffrensis*)

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The Amazon River dolphin, called boto in Brazil is an endemic species of the Amazon River basin and traditionally protected by legends. However, in the last five years, this dolphin is being threatened by direct human action in the Central Amazon region. The local fishermen are using boto as bait to catch a catfish (*Calophysus macropterus*). This fish is not consumed in Brazil, however it is exported to Colombia. Information collected during 2003-2004 indicates that about 200 botos are being killed per year to support this fishery. In 2004, a study to quantify the number of botos being killed, to identify the area of this activity and to elaborate an action plan to mitigate it was established. The study area covered the upper and middle Solimões River. A total of 30 communities and 2 towns

were visited and the information was collected using formal interviews applied to boto hunters, fishermen, fish seller and frigorific managers. A total of 53 interviews were carried out: 32 in communities in the middle Solimões River and 21 in the upper part. Among those interviewed, 2% were dolphin hunters, 58% fishermen, 16% fish seller and 24% frigorific managers. According to the interviews, a total of 105 botos were killed to be used as bait for catfish fishing: 72 from the upper and 33 from the middle Solimões River. Of this total, 77.3% of botos were captured directly by fishermen, 13.6% were incidentally killed in nets but also used as bait and 9.1% were bought from boto hunters to be used as bait. These previous results indicate that the catfish fishing in the Brazilian Amazon can be an economic activity dangerous to the conservation of the Amazon river dolphin. More information is necessary to evaluate the effect of this fishing of the boto population.

Site-fidelity of Weddell Seals: The Effects of Sex and Age

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Weddell seals (*Leptonychotes weddellii*) are known to return to traditional pupping and breeding colonies each spring. Site fidelity is an important life history strategy for Weddell seals, yet it could have severe consequences for their long-term survival in a physical environment altered by global warming. We examined four hypotheses concerning fidelity to these colonies: (1) Females tend to return to specific sites more often than males. (2) Male and female fidelity is stronger to natal sites (natal fidelity) than to other sites. (3) The degree of fidelity to a site increases with age. (4) The occurrence of mature males occupying the same site as their mother is relatively unusual, indicating that the potential for inbreeding is limited. Analysis of a long-term tagging database from McMurdo Sound did not support hypotheses (1) and (2). While animals did express fidelity to chosen colonies over their lifetime, natal fidelity estimates were no different than those from a null model where every site was equally desirable. Further, there were no differences between males and females with regard to estimates of natal fidelity ($P > 0.05$) or fidelity to other sites ($P > 0.05$). Hypothesis (3) was supported. The probability of a returning seal occupying the same colony as the previous year increased with age among both sexes. Finally, out of 120 sexually-mature male offspring observed in Erebus Bay on the same day as their mothers, only 19 were found to be in the same colony as their mothers, generally supporting hypothesis (4).

Interpretation of the Timing and Pathology of Mandibular Fractures in Right Whales Hit by Ships

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Necropsy findings of two mature female North Atlantic right whales (*Eubalaena glacialis*) indicated that the cause of death in both cases was blunt trauma most likely associated with a vessel-whale collision. Right whale Eg1014, had fractures in the right mandible and right transverse processes of five vertebrae, superficial and deep discoloration overlying the sternum, as well as substantial edema and hemorrhage in the right axillary and hypaxial muscles. Right whale Eg2150 had a fractured right mandible, a meter-long longitudinal fracture through the posterior surface of the skull (including the brain case), disarticulated ribs with associated hemorrhages, and a copious amount of dark red 'putty-like' material, compatible with clotted blood, in the thoracic cavity. Histological analyses of the mandibular

fracture margins of Eg1014 revealed cartilaginous growth and that of Eg2150 revealed both cartilage and woven bone, thus providing evidence of ante-mortem healing in the fracture plane in both animals. Neither the fractured vertebrae of Eg1014 nor the fractured skull of Eg2150 displayed evidence of healing, leaving a question of whether one or two ship strikes were involved in each case. Computed tomography (CT) was used to determine the variation in apparent density and the extent of abnormal bone surrounding the fracture plane. The fractured mandibles of Eg1014 and Eg2150 were compared, via CT, with the unbroken right mandible of Eg1004, a mature female right whale. Subsequent analyses will be used to determine whether the abnormal bone was evidence of 1) a healing process indicative of post-fracture survival or 2) pre-existing bone disease that pre-disposed the pathological region to fracture when the animal was hit by a ship. Post-cranial bones will be analyzed to determine if abnormal bone was polyostotic. Observed lesions will be compared to bone disease processes seen in other animals in an attempt to determine etiology.

Ecology of the Short-Beaked Common Dolphin (*Delphinus delphis*) off Southern Spain

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The short-beaked common dolphin is believed to have suffered a steep decline in the Mediterranean in recent years. ACCOBAMS (Agreement for the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic waters) is therefore developing a Conservation Plan for this species. Effective conservation will depend critically on our understanding and ability to predict the relationship between the population and its habitats. The Alboran Sea is believed to be the most important remaining habitat for this species in the basin and constitutes, therefore, a vital source of information on its ecology, essential for the development of conservation measures. Spatial modelling using GAMs was used to provide information on distribution and abundance of common dolphins in the area. In total, 37,385 km of non-systematic line transects conducted from 1992 to 2004, generating 738 sightings in a 19,189 km² study area, were analyzed. Analyses examined differences among sub-areas, years, seasons and behavioural categories. Seasonal variation in abundance was detected, with higher average density in summer (1.01 animals/km²) than in winter (0.5 animals/km²). Geographical differences were also found, with higher density in the west (1.5 animals/km²) than in the east (0.4 animals/km²) during summer. No overall trend in abundance was observed in the whole area but a decline was observed in the eastern portion (Gulf of Vera) with a summer density of 0.5 in 1992-1995 and 0.2 in 1996-2004. With respect to depth, a bimodal distribution was predicted, with higher densities around the continental slope (100-400m) and in deeper waters (800-1200m). This can partially be explained by the difference in predicted habitat use depending on behavioural factors: groups with calves, feeding groups and single species groups preferred shallower waters; socialising groups, groups with no calves and multi-species groups preferred deeper waters. These results will inform conservation efforts in the Mediterranean.

Analysis of Movements and Home Ranges of Bottlenose Dolphins in the Sado Estuary, Portugal, Using a Geographical Information System

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Geographical Information Systems are a tool of growing usefulness in marine species conservation and protected areas management. In the Sado estuary, Portugal, a small and apparently declining resident bottlenose dolphin population has been studied since the 1980's, but systematic information concerning home ranges and distribution is still lacking. In this study we performed an individual analysis of data

related to movement and distribution of seven bottlenose dolphins in the Sado estuary and adjacent coastal waters using a GIS. All analysis were performed with Animal Movement 2.0 beta extension for ArcView 3.1. Daylight movements ranged from 5.6 km to 20.8 km. The maximum instantaneous travel speed was calculated as being 32.4 km/h, but the mean individual speeds rarely go beyond 3.6 km/h. We estimated 105 as the minimum sample size needed to reliably estimate home ranges for this population, based on the home range versus sequential locations curve. A female and a male, both adult dolphins, had the largest estimated home range areas using two methods (Minimum Convex Polygon, MCP, and fixed Kernel, K, 95% Utilization Distribution, UD): MCP 37.1 km², K 47.8 km² and MCP 44.1 km², K 50.8 km², respectively. The mean home range area calculated by the MCP method is 32.0 km² and by the K method is 41.9 km². Mean core area is 6.9 km². Core areas (K 50% UD) seem to overlap with areas previously known to be of importance as a result of higher prey availability and lower levels of pollutants, in the lower South Channel of the estuary. Such areas clearly require more protection from deleterious human activities, and these results further stress the need to include them in the Sado Estuary Natural Reserve.

Population Density, Heat Stress and Habitat Availability as Determinants of Pupping Site Selection in the S.

American Fur Seal at Punta San Juan, Peru

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Female otariids breeding on land, tend to choose sites where they can give birth and nurse their young undisturbed, and where the probability of survival for their newborn pup is maximized. For fur coated seals living near the Tropics, heat stress strongly limits the range of places where they can breed. At Punta San Juan (PSJ), Peru (15°22' Lat. S), female S. American fur seals (*Arctocephalus australis* – SAFS hereafter) breeding at high population densities usually pupped in dry places, away from the water, but had to make daily movements to the intertidal areas to thermoregulate during the hottest times of the day. These movements and aggressive competition for nursing spots within the intertidal resulted in high early pup mortality (up to 40% at peak densities) and constant disturbances to lactating mother pup pairs. Recent changes in population density and beach topography resulting from two major natural events (the 1997-98 ENSO and the 1996 earthquake, respectively) allowed us to quantify changes in breeding habitat selection patterns of SAFS at PSJ. We compared the spatial distribution and habitat types used by females to give birth during the 2004 breeding season (low density after population collapse in 1998) with similar data collected in 1990-1994 (high density, small intertidal area) and 1997 (low density and larger intertidal). Our results show that at low densities and with unlimited access to intertidal areas, no females pupped in dry areas away from the water, thus suggesting wet intertidal areas are the preferred and perhaps optimal pupping sites for female SAFS at PSJ. Only when population density and competition for these wet spots are high, female fur seals will be forced to pup in dry areas where they suffer heat stress and are forced to make thermoregulatory movements that endanger their pups' lives.

A Beaked Whale Hotspot? Preliminary Results on the Abundance and Distribution of Beaked Whales in the Southwest Gulf of California

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Beaked whales are present in every ocean of the world, yet they are

the least known of all cetacean families. This is due to the difficulty of observing and identifying them, and because they generally inhabit deep ocean waters. Few areas have been identified where beaked whales can be easily studied. In the southwest Gulf of California, the conditions are suitable for sighting beaked whales, since this area is characterized by a narrow continental shelf and is protected from the conditions of the open ocean. We undertook surveys for beaked whales in the southwestern Gulf of California during March 2004 and from December 2004 to May 2005. We covered 2,220 km of trackline during 198 hours of search effort. In addition, opportunistic sightings were made in the winters 2004 and 2005 incidentals to humpback whale research in the area. Twenty-two sightings of beaked whales were recorded, indicating a density of beaked whales as much as five times higher than in some other deep-water areas. However, six sightings were opportunistic. *Ziphius* group sizes ranged from 1 to 4 individuals (mean = 2.4; SD = 0.9) with depths ranging from 550 m to 2,200m (mean = 1123 m; SD = 565 m). We photographically identified 6 *Z. cavirostris*. While *M. peruvianus* ranged from 1 to 4 individuals (mean = 2.3; SD = 1.5) with depths from 1,050m to 1,625m (mean = 1,250 m; SD = 325 m). Beaked whales were found to distances from coastline ranging between 4.9 km and 63.6 km (mean = 18.3; SD = 14.7). *Ziphius* represented 68% of the sightings, *M. peruvianus* 13.6%, *B. bairdii* 4.5%, and unknown beaked whales 13.6%. *Ziphius* relative abundance was greatest in December 2004 (0,375 individuals/hour) and lowest in May 2005 (0,11), while *M. peruvianus* were recorded only in May of 2005 (0,038) and *Berardius bairdii* only in March 2004.

Cooperative Echoic Matching by Two Bottlenose Dolphins

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Two captive-born, male, blindfolded dolphins learned to perform an echoic 3-alternative matching-to-sample task (*i.e.*, a dolphin echolocated a sample object and was reinforced for choosing an object identical to the sample from among three objects presented in a choice array) with high accuracy (>95%). Then we investigated the ability of the pair to perform the task cooperatively. At the start of a cooperative session, each dolphin was positioned on opposite sides of the choice array. When a trial began, the Sampler dolphin submerged and echolocated the sample while the Chooser dolphin hauled out of the water and did not experience the sample. Then the Chooser returned to the water and chose an array object while the Sampler continued to face the array 3 meters away. All reinforcement was contingent upon a correct choice as identified by an observer naïve to sample identity. Each dolphin performed both roles. In the most recent ten 18-trial sessions balanced for sample identity and alternative position, choice accuracy was 69% and 84% (chance = 33%) depending upon the dolphin roles. To date, various manipulations have revealed that the Chooser's accuracy drops to chance levels whenever the Sampler is not in the water facing the choice array (when the Sampler is out of the water, M = 42%; when the Sampler is in the water but facing away from the array, M = 35%; when the task is all visual in air, M = 30%). Acoustic analyses indicate that two stereotypic whistles occur in most trials, and echolocation clicks occur in all. Based on the current findings, it appears likely that the dolphins are performing the task via some combination of four mechanisms: (1) echoic points, (2) body orientation, (3) object ensonification, &/or (4) guiding.

Weaning Mass and Fasting Duration in Southern Elephant Seals at the South Shetland Islands

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Pup weaning mass and fast duration were measured in the elephant

seal population at King George Island, Antarctica, during three consecutive seasons (2001-2003). There was no significant difference in the weaning mass among years ($P < 0.05$). When data for the three years were combined, male pups were significantly heavier than female pups (158.6 ± 27.3 , $N = 213$ vs. 146.8 ± 25.4 , $N = 207$; $P < 0.0001$) but when years were considered separately, the sex difference was significant only in 2002. Pups fast for a mean of 39.6 ± 7.7 d, $n = 386$, losing $30.7 \pm 5.0\%$ of their weaning mass. For each year, postweaning duration was positively related to weaning mass and negatively related to the daily percentage of mass loss. During postweaning, mean temperature affected the daily percentage of mass loss, accounting for 9 - 31% of its variation depending on the season. The negative relationship between weaning mass and daily percentage of mass loss allows greater pups to spend more time on the beach making the necessary adjustments for diving, ending the postweaning fast with a proportionally similar weight and thus presumably greater reserves in absolute terms than lighter pups at weaning. These facts, *a priori*, would give heavier pups an advantage over lighter ones in future survival.

Compliance with Voluntary Speed Guidelines by the Commercial Whale Watching Industry in and around Stellwagen Bank National Marine Sanctuary

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Voluntary operational procedures (guidelines) have been established by the whale watching industry in the northeast region of the United States, in cooperation with government agencies and non-profit conservation organizations. Their intent is to avoid harassment and possible injury to large whales by both commercial and recreational vessels. One important aspect of these guidelines is a series of recommended speeds within various distances of the whales. To measure compliance with this aspect of the guidelines, we placed inconspicuous observers onboard thirty-five (35) commercial whale watching trips that occurred in and around Stellwagen Bank National Marine Sanctuary. Observations were made from August to October 2003. Vessel speed and position was measured using a WAAS-enabled GPS receiver with an accuracy of approximately 3-meters. Data were collected at five (5) seconds intervals from the time of departure from port until the vessel's return. Military-grade binoculars with internal laser rangefinder and digital compass were used to record the range and bearing to sighted whales, allowing their location to be calculated. Both data sources were processed and mapped using ArcView GIS. Compliance was evaluated by creating guideline specified speed zone buffers around the sighted whales and overlaying them with the vessel track and speed data. Speeds in excess of those prescribed by the guidelines were considered non-compliant. Result indicated that whale watching vessels often ignored speed zone guidelines and that the degree of non-compliance increased as distance from the whale(s) increased. Using *time* as the metric (*i.e.*, how much time was spent in or out of compliance), non-compliance was 25% in Zone 1, 71% in Zone 2 and 79% in Zone 3. Using *distance* as the metric (*i.e.*, distance traveled in or out of compliance), non-compliance was 63% in Zone 1, 92% in Zone 2, and 94% in Zone 3.

Mitogenomics of Coastal and Oceanic Dolphins in the Southern Hemisphere

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The genus *Cephalorhynchus* consists of four small dolphin species endemic to coastal waters of Chile, Argentina, South Africa, and New Zealand. The origins of this widely discontinuous distribution can be explained by two alternate hypotheses; 'coastal convergence', where each species arose independently from widely distributed oceanic dolphins and their similar morphology is a result of convergent

evolution; or 'hopeful migrants', where these species arose from a common coastal ancestor, and radiated around the Southern Hemisphere. To discriminate between these hypotheses we sequenced the entire protein coding region of the mitochondrial DNA (>11,000 bp) from all members of the *Cephalorhynchus* genus and from six closely related species of the genus *Lagenorhynchus*, *Delphinus*, *Globicephala* and *Tursiops*. To these 13 dolphin mitogenomes, we added seventeen other cetartiodactyl species from Genbank, to give a final dataset of >300,000 bp. In our phylogenetic analysis, species of the genus *Cephalorhynchus* consistently comprised a strongly supported (100% bootstrap) monophyletic clade, regardless of phylogenetic method, and species of the genus *Lagenorhynchus* were consistently placed as the sister group. This confirms the 'hopeful migrants' hypothesis with a likely origin off the coast of South Africa followed by large-scale migration events to colonise New Zealand and South America. Using accepted fossil dates for calibration, the origin of this genus was estimated at 3 Ma, however the clock was not sufficient to resolve dates for each species. Our results confirm the utility of mitogenomics for resolving close sister taxa relationships and their potential for investigating radiation events in widely dispersed taxonomic groups.

Tracing Maternal Lineages Through a Recent Bottleneck: The Minimum Number of Females in the New Zealand Population of Southern Right Whale *Eubalaena australis*

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Modern whaling led to the consecutive collapse of most large cetacean populations during the twentieth century. Many species underwent a demographic bottleneck, declining to less than ten percent of their original population size. One such species is the southern right whale, *Eubalaena australis*. Despite 70 years of ostensive protection the population around the mainland of New Zealand is severely depleted, and likely numbers less than 20 reproductive females, while the remnant population recovering in the sub-Antarctic Islands numbers less than 1,000. Previous demographic modeling of the population suggested that numbers declined from 17,000 to less than 60 individuals as a result of 19th century commercial hunting and 20th century illegal catches. This extensive decline in abundance is concordant with a low current estimate of mitochondrial (mt) haplotype diversity ($h=0.65$) and the previous identification of only six maternal lineages in the New Zealand population. Here we attempt to improve estimates of genetic diversity and the minimum number of maternal lineages surviving the bottleneck by analyzing more than 500 bp of the mt control region from 350 samples collected from the sub-Antarctic Islands between 1995 and 1998. Sequencing to date has resolved two additional haplotypes for a total of eight mitochondrial lineages. An additional 1100 bp of the cytochrome *b* gene was sequenced for selected individuals with different control region haplotypes but this resolved no further lineages. Our findings are concordant with the known demographic bottleneck, perhaps survived by as few as eight unrelated females.

Management Recommendations for Humpback Whale Nursery Regions

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A five year study of the behavior and dynamics of mother and calf humpback whale (*Megaptera novaeangliae*) pairs in Hawaiian waters has revealed several aspects of the behavior of these pairs that warrant targeted management strategies. In reviewing distribution of mother and calf pairs, we established that critical habitat is delineated by depth of water, not distance from shore; boundaries of management regions should therefore reflect this and ensure that the extent of shallow water regions are fully protected. Quantitative behavioral

data was collected during focal follows of mother and calf pairs and this data provided details of calf surface persistence, frequency of intermittent calf breaths and documentation of potentially adaptive changes in behavior with increased levels of vessel traffic. These aspects of behavior explain calf susceptibility to vessel strikes and reinforce the need for speed limits within critical mother and calf habitat. When calves in the behavioral sample were categorized by relative age, based on the degree of unfurling of their dorsal fins, results indicated that calf behavior changes as the calves mature, transitioning from an early 'travel' stage to a later 'resting' stage. Calf groups were also categorized according to group composition; frequency of multiple male associations was not related to the relative age of the calf however behavior varied significantly; mother and calf pairs associated with multiple males spent more time traveling, travel was faster and changes in direction more frequent. Habitat preference also varied with behavior. These variations in behavior speak to variations in potential impact of vessels according to relative calf age group composition and location. A decision tree, designed for use by those operating vessels within critical mother and calf habitat, summarizes these results, allowing vessel operators to make informed decisions when maneuvering around mother and calf pairs.

The Importance of the West African Archipelago of São Tomé and Príncipe for Humpback Whale Mother-Calf Pairs

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In the Southern Hemisphere humpback whales (*Megaptera novaeangliae*) feed in the Antarctic waters during the austral summer and migrate to the breeding and calving grounds in subtropical and tropical waters during the winter months. The Archipelago of São Tomé and Príncipe, located in the Gulf of Guinea has been described as a possible breeding ground since the time of commercial whaling. Annual surveys have been conducted between August and November since 2002, to investigate the occurrence, composition and distribution of humpback whales around the Island of São Tomé. To date, a total of 147 boat-based surveys have been conducted. When animals were encountered, photographic methods were used to identify individuals. Additional data were collected for each sighting that included geographic positions, group size, group composition and behaviour classifications. In 2004, the first attempt was made to collect genetic samples. During 2002 and 2003, effort was concentrated in the waters south of São Tomé where sightings occurred mostly around the smaller Island of Rolas. A total of 20 individuals have been successfully identified using photographic methods, but none have been resighted in different years. Of the 52 groups encountered, mother-calf pairs made up a large proportion (56.3%), followed by solitary individuals (32%). Mother-calf pairs have been seen in the region as late as November, showing extended periods of occupancy in the region lasting over a three week. Very few behaviours associated with mating activity (competitive groups and singing) have been observed. Given the high percentage of mother-calf pairs, sometimes with very young calves, and the low frequency of mating activity, the waters of this archipelago may primarily serve as a calving and nursing or resting area for humpback whales.

The Visible Sea Lion: An Introduction to Sea Lion Anatomy, Necropsy and Pathology

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The University of California Santa Cruz Long Marine Lab (LML) in conjunction with the California Department of Fish and Game (CDFG) Marine Wildlife Veterinary Care and Research Center (MWVRCR), using NMFS Prescott funds, has created a web site of sea lion images reflecting normal anatomy during dissection as well as an atlas of pathologic lesions. The intended audience for this web site includes marine mammal researchers and stranding network personnel. For instance, marine mammal researchers from LML visit coastal rookeries on a regular basis. There is significant natural mortality at these rookeries. Our researchers are frequently willing to examine carcasses in situ and collect specimens for the stranding network pathologists at the Prescott funded CDFG pathology program. This association has resulted in interesting interchanges between CDFG pathologists and field researchers. The researchers are often observant of unusual conditions surrounding the deaths of animals at these rookeries. The interchange often takes the form of researchers retrieving specimens from carcasses during field necropsies and returning to the pathologist to ask about the significance of various lesions. These individuals are a special kind of observer. They are much more sophisticated than a usual stranding network volunteer, but they are not board certified pathologists. This web site is designed as an educational aid to this relationship between the pathologists and the field biologists. It consists of a visual resource which the field researchers can access in order to help identify pathologic lesions. Beyond being useful to sea lion researchers, we hope that this website can be expanded to include sections devoted to other species. We hope that the picture intensive visual format will be useful to all individuals curious about gross pathologic lesions in marine mammals. The web address is <<http://shutterbug.ucsc.edu/sealion>>

Lipid, Protein and Carbohydrate Metabolism During Diving, Resting and Meal Digestion in Wild Weddell Seals, Antarctica

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For the first time, an *in vivo* and *in situ* metabolic profile of lipid, protein and carbohydrate turnover and metabolism in a naturally feeding pinniped has been attempted. We used stable isotope tracers and clinical chemistry analytical techniques to follow glycerol (lipid), glucose (carbohydrate) and glycine (protein) turnover and concentrations in Weddell seals. Measurements were taken during fasting, feeding, rest, diving and surface periods in non-pregnant females. We placed catheters into the seals and allowed them to go through natural periods of the above activities in various combinations. We then injected stable isotope tracers into the seals to follow the disappearance of the labels, the concentration of relevant plasma chemistries and the appearance of labeled nitrogen in urine. The specific enrichment samples (similar to specific activity for

radioisotope studies) for glucose and glycerol turnover have been fully analyzed and all experiments were successful. The protein turnover samples are still in process. Protein turnover has both a short term (48 hr) and long term (weeks) component while lipid and carbohydrate are focused on periods of less than an hour. While not all animals fit into each matrix square, the results to date (1) were consistent with the predicted rapid turnover of lipid as compared to carbohydrate; (2) appear to follow single-pool exponential decay models; (3) quantify plasma lipemia clearance rates; (4) can be used to distinguish metabolic differences between digesting, resting and exercise conditions in Weddell seals; (5) demonstrate the movement of carbon between the carbohydrate and lipid metabolic pathways; and (6) may be the first data of their type for large, naturally feeding mammalian carnivores, either marine or terrestrial. In this presentation, a full matrix of exercise vs rest vs feeding vs fasting for lipid and carbohydrate will be presented along with preliminary data on protein turnover

The Acoustic Behavior of L'Oceanogràfic Beluga Whales

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Despite the fact that beluga whales are known for their ability to produce a wide range of sounds, their acoustic behaviour is still largely unstudied. The few quantitative reports available in the literature show non-standardized subjective classification methods obtaining diverse vocalization repertoires of graded nature. Behavioural contexts have been included in very few of these studies and are scarce to achieve conclusive results. L'Oceanogràfic, a new marine park in Spain, has started a long-term study of the acoustic behaviour of two beluga whales. Acoustic and behaviour activity of an adult male and a juvenile female are being analysed since March 2003, before their transportation to new facilities. Acoustical observations proved to be an effective technique for the monitoring of the whale's adaptation to the new environment, as well as the adaptation to changes in their facilities. Adaptation periods were identified by a drastic decrease in their vocalization rate (ANOVA, $p < 0.01$). Based in available literature, a standardized categorization scheme has been designed allowing the classification of 97 % of all acoustic activity recorded. More than 43,000 vocalizations have been identified obtaining a vocal repertoire of 29 types distributed in 7 categories (pure tonal, mixed tonal, pulses, pulse trains, click trains, mixed and noisy). Behavioural contexts have been associated to the acoustic activity through focal sampling methods. To date, 7 context-specific vocalizations have been identified (Chi-square, $p < 0.05$). Detailed knowledge of the acoustic behaviour of these 2 whales and the evolution over a 2-years period has been obtained in the first phase of this study and is presented in this report.

Klebsiella pneumoniae Epidemics in New Zealand Sea Lion Pups on the Auckland Islands in 2002 and 2003

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The breeding colonies of New Zealand sea lions (*Phocarctos hookeri*) on the Auckland Islands were impacted by two infectious disease epidemics in 2002 and 2003. The events were characterised by a sharp rise in the pup mortality rate approximately three weeks after the start of the pupping season. In both 2002 and 2003, bacterial infection contributed to over 50% of neonatal mortality contrasting with the previous years (11%). Necropsies were conducted on all the pups that died at the Sandy Bay rookery and samples collected for bacteriology and histology. Gross examination of affected pups consisted of one or more of the following lesions: acute suppurative arthritis or polyarthritis, cellulitis, peritonitis, pleuritis, or meningitis. Histology confirmed acute suppurative inflammation with necrosis and thrombosis. The pathogen implicated in both events was the gram negative bacterium *Klebsiella pneumoniae*. Isolates from both seasons

were genetically and phenotypically indistinguishable suggesting that the events were caused by a single introduction of an epidemic strain of the pathogen. *Klebsiella pneumoniae* was consistently isolated from all pups diagnosed with a bacterial infection (83% in 2002 and 76% in 2003) but it was not found from pups that died during the 2000 and 2001 seasons. Although mortality had returned to normal levels in 2004 and 2005, some pups died from the *Klebsiella*-like disease indicating that the pathogen was still circulating in the population. Whereas adults and yearlings did not show any signs of bacterial infection at necropsy, *Klebsiella* sp. was cultured from various internal organs and fecal samples. *K. pneumoniae* is primarily a human pathogen and has only rarely been isolated from pinnipeds: this is the first example of a marine mammal epidemic caused by this pathogen.

Current Knowledge of Orca (*Orcinus orca*) Attacks on Humpback Whales (*Megaptera novaeangliae*) in the Machalilla National Park, Ecuador

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Humpback whales use the Machalilla National Park (MNP) in Ecuador as a breeding ground during the austral winter months. At the same time orcas have been observed in this area. To determine the occurrence and behavior of orcas in the MNP, interviews with local fishermen, vessel captains and tourist guides were conducted. They provided information on 27 sightings from 1991 to 1999. From 1996 to 2004 an additional 23 orca sightings were recorded directly by guides, captains and scientists, in total 49 sightings. The behavior of the orcas was described for 42 sightings. In six cases (14%) orcas were following a group of humpbacks or were seen in their close vicinity. In 9 cases (22%) orcas were observed feeding on fish or were associated with marine birds. For 19 orca sightings (45%) orcas were travelling or porpoising. In eight cases (19%) orcas were observed following one or more humpbacks and charging them while the humpbacks were showing defensive behavior, such as fluke slashes towards the attackers. In one of the attacks a pod of 6 orcas attacked a pod of three humpbacks including a calf. After about 20 min. the calf disappeared and several minutes later pieces of flesh, oil and oil mixed with blood was floating on the water surface. The flesh had a blubber layer about 6cm thick. Attacks of orcas on humpbacks in their breeding grounds around the world have only been documented in few cases. It has been suggested that orca predation on baleen whale calves was the primary selective force for the evolution of migration away from high latitudes to low-latitude wintering areas. The observations from Ecuadorian waters suggest that orcas occur regularly in this area and that attacks on humpbacks might have a higher influence on the breeding humpback population than previously thought.

Molecular Characterization of Vaquita's (*Phocoena sinus*) Major Histocompatibility Class I Genes

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The vaquita represents an outstanding model to study how selection and historical demography have shaped *Mhc* polymorphism in reduced cetacean populations displaying low genetic diversity. Neutral loci

polymorphism do not provide precise information on issues of particular relevance for conservation like how selection operates as individuals interact with environmental factors, or on their capacity to adapt to future environmental change. In such instances, the analysis of genes subject to selection like those of the major histocompatibility complex (*Mhc*) might turn profitable. MHC-I proteins are responsible for eliciting immune responses, by presenting self and non self antigen peptides to T-cells. These proteins are composed by a light b chain adjacent to the cell surface and a distal heavy chain, that forms the peptide binding region (PBR) integrated by $\alpha 1$ and $\alpha 2$ domains. The latter are encoded respectively by the hypervariable second and third exons of *Mhc* genes. To assess *Mhc*-I polymorphism in the species, we first aimed to isolate and characterize class I sequences encoding the PBR. Thus, total DNA was extracted from two individuals and used to amplify sequences from exons encoding the PBR of MHC class I molecules using the PCR technology. A product of 570 base pairs (bp) was amplified from one individual, corresponding to: 171 exon 2 nucleotides, encoding 57 amino acids, an intron 2 sequence of 202 bp and 197 exon 3 nucleotides encoding 65 amino. Its deduced amino acid sequence corresponds to amino acid positions 33-90, and 91-155 of human MHC-I genes, and includes the PBR where most of the functional polymorphism resides. Homology analysis showed that these *P. sinus* *Mhc*-I sequences share greatest homology to like *Mhc*-I from other cetartiodactyls and gray whales among cetaceans. Such results would make feasible to further assess class-I polymorphism in the species.

Demography and Population Growth of the North Atlantic Right Whale

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The North Atlantic right whale (*Eubalaena glacialis*) is critically endangered; for such populations, rigorous estimates of the vital rates (survival, reproduction, maturation, etc.) and population growth rate are critical for evaluating population status and management options. We applied multi-stage mark-recapture analysis to the photo-ID catalog curated by the New England Aquarium, to obtain maximum likelihood estimates of a 2-sex stage-structured matrix population model under a variety of statistical hypotheses (time-invariant parameters, time-varying parameters, temporal trends, and dependence on the NAO index). Resighting probability was time-varying to compensate for changes in sampling effort. The model most supported by the data (as measured by Akaike's Information Criterion) included temporal trends and NAO-dependence. A decline in survival of reproducing females and in the birth rate has driven a corresponding downward trend in population growth rate, to values below replacement. Elasticity analysis shows that population growth would be most improved by increases in survival probability; increases in calf production (such as have been recorded in recent years) are insufficient to reverse the decline of this population. We include an overview of the methods used in this study, which can be applied to other long-term photographic identification studies.

First Account of the UCCR - Urinary Cortisol:Creatinine Ratio - in a Fur Seal Colony: A New Tool for Estimating Stress in Wild Pinnipeds

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Human impact (disturbance) is particularly difficult to monitor in

marine mammals, as access to these species is limited while they are at sea. In this study, we have tested the potential to use the measurement of cortisol (stress hormone) levels in natural pinniped populations while they gather on land. Blood sampling (traditional for endocrinology) provides a punctual measure of mammals physiological stress; on the other hand, urine and faecal samples provide an average measure of stress, representative of longer periods (several hours) over which cortisol accumulated in excretas. Also, as opposed to blood sampling, the collection of fresh urine in a rocky substrate is minimally-invasive and is therefore ideal for a study of the average stress in free-ranging groups of mammals. In 2002, 03 and 04, we collected a total of 134 fresh urine samples from individual New Zealand fur seals *Arctocephalus forsteri* of known age class/gender. [Cortisol] was quantified using standard radio-immunoassays after a dichloromethane extraction of urine. The Jaffé reaction was used to measure [Creatinine], so that cortisol values could be expressed relatively to the creatinine, correcting for dilution/evaporation of samples before collection and for individual variations in gross muscle mass. We have showed that the UCCR – the urinary cortisol:creatinine ratio – can be measured in a rocky-substrate colony of pinnipeds. We present a simple and low cost protocol for processing the samples and a first series of reference values for UCCR (0.26-27.37 μ moles/moles, $n = 134$) in a fur seal colony post breeding. We also show that UCCR is a stable value in samples stored for 1 year at -20°C, even after having been thawed up to five times.

Reproduction of Female Humpback Whales off the Revillagigedo Archipelago During a Severe El Niño Event

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A particularly severe El Niño occurred in the North Pacific in 1997, resulting in well-documented effects on productivity, fish stocks and several marine mammal populations. We hypothesize that El Niño related effects on high latitude food resources would have a negative impact on individual condition and reproduction for migratory humpback whale populations. Specifically, due to females being in generally poor condition after the 1997 summer feeding season, we predict (1) a low birth rate in winter 1998, (2) reduced reproductive success for females conceiving in 1998, and (3) a calf sex ratio skewed towards females for calves conceived in 1998. Evidence gathered from the Revillagigedo Archipelago population during 1997 to 2001 generally supports these predictions. In 1998 birth rate was low: 30 different mothers were identified resulting in a rate of 4.2 mothers/100 hours survey effort, as compared to 6.5 and 10.0 for the 1999 and 2000 seasons respectively. Between 1998 and 1999 there was low reproductive success among females: of 13 females sighted without a calf in 1998 and sighted again in 1999, only 4 (31%) returned with a calf, as compared to 50% and 53% for the 1997-1998 and 1999-2000 gestation years, respectively. In 1999, calf sex ratio was skewed slightly towards females at 56% of 36 calves, as compared to 25%, 41%, 53% and 50% for 1997, 1998, 2000 and 2001, respectively. Sample sizes were small and power was low for any individual test, however the combined probability of all three effects was statistically significant. We therefore believe that subtle and difficult to detect impacts likely occur on large whale populations as a result of perturbations of global climate, and must be considered in the management of recovering populations, particularly when considering the synergistic effects of multiple environmental and anthropogenic stressors.

Does Handling and Attaching Tracking Devices on Lactating Antarctic Fur Seals Affect Maternal Performances?

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We investigated pup growth and maternal attendance pattern in Antarctic fur seals (*Arctocephalus gazella*) on Heard Island, south Indian Ocean, during the summer 2000-2001. Adult females were captured (manipulated) to attach tracking devices or to monitor milk transfer to the pup (handled), and pups were weighed regularly. We compared pup growth rates from 1) females that were and weren't handled and 2) females with and without tracking devices attached. In both cases, male pups grew significantly faster than females. Pup growth rate was not affected by manipulation of their mother. Half of the manipulated females changed the duration of the foraging trip immediately following manipulation, with mothers carrying tracking devices doing longer trips and mothers weighed to monitor milk transfer doing shorter trips. Although, mean duration of foraging trips before and after the manipulation did not change. Our results suggest that manipulating lactating Antarctic fur seals could induce short-term changes in the maternal attendance behaviour, with no detectable long-term effect on the growth of their pup.

Glucose Flux in a Fasting Lactating Animal, The Northern Elephant Seal

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In the fasting state glucose must be provided to glucose dependent tissues via gluconeogenesis, requiring some catabolism of amino acids for gluconeogenic substrates. Lactation is characterized by mobilization of nutrient reserves, an elevated metabolic rate, and has been shown to be the most energetically expensive component of reproduction in mammalian species. Most phocid seals combine lactation with fasting; resulting in the conflicting demands of protecting maternal tissues from degradation while provisioning offspring with milk. To explore the physiological adaptations that presumably optimize maternal investment in offspring relative to maternal metabolic costs, we utilized a differentially labeled glucose isotopic tracer to investigate glucose metabolism in fasting while lactating northern elephant seals (*Mirounga angustirostris*). To our knowledge this study is the first to measure glucose cycle activity in a lactating animal. Glucose production and glucose cycle activity were measured in lactating seals early (5 days) and late (21 days post-partum) in the lactation period and after the completion of molting (~3 weeks fasting) as a non-lactating control. Glucose cycle activity was highly variable throughout the study period and did not change over fasting duration. We found no evidence of the glucose cycle regulating glucose flux in lactating or molting elephant seals. Glucose production decreased across lactation ($t = -3.41$, $p = 0.008$) and mass specific glucose production rates were lower during lactation than in molted animals ($t = -4.4$, -3.1 , $p < 0.01$; early and late lactation, respectively, vs. molted animals). It is likely that the energetic constraints of lactation play a role in the reduced gluconeogenesis observed. The glucose production values measured in this study were very high when compared to glucose utilization requirements and gluconeogenic substrate availability. These data suggest extensive glucose recycling via Cori cycle activity occurs in northern elephant seals.

Calories of Neonatal Milk Formula Leads to Increase Growth and Nutritional Independence of Harbor Seals

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In the developmental stages of phocid seals, abandonment by females leaves pups to obtain food independently. The independence shift has pups stranded with malnutrition conditions, which disrupts the growth and development. It was hypothesized that substituting the female's milk with a set amount of calories of neonatal milk formula would increase the growth in stranded harbor seal pups and lead to a successful nutritional independence. Nursing of pups was practiced in a similar fashion to that of the mother. Pups were given milk and fish, and were weaned. Neonatal milk formula was used to substitute for the female's milk. The milk formula was analyzed for content of moisture, protein, fat, ash, carbohydrates, and calories. The formula's nutritional value was similar to the female's milk. In the first few days of nursing, stranded harbor seal pups were given formula similar to dam's milk. The amount of calories given was based on the seal's weight. The seals were weighed each day to determine growth from the milk formula. The data from ten harbor seals who survived and were released showed acceptable growth over 30 days. The data of the seals was combined to give an average growth curve, which showed an increase of weight. The average weight gain from the milk formula was 1.67 kg during an average of 8.5 days; the highest weight gain was 4.68 kg. The average weight gain in 30 days was 2.48 kg; the highest was 10.36 kg. The seals were weaned after they were removed from the milk formula. During the weaning process, the caloric intake and individual pup's weights tended to increase, but because of competition factors, there was fluctuation among individuals. After 30 days, the weights of seals increased as they were feeding independently. The growth of the seals allowed them to be released, demonstrating nutritional independence.

Three-dimensional Reconstructions of a Florida Manatee (*Trichechus manatus latirostris*) Head and Isolated Ear Bone: The Search for Sound Pathways

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The Florida manatee is an obligate aquatic mammal that has developed an auditory apparatus adapted for hearing under water. Anatomical studies have described the gross structure of the manatee ear, and behavioral and auditory evoked potential research has documented their hearing capabilities. However, the sound pathway(s) from the external environment to the inner ear remain unclear. Computerized tomography (CT) is used to visualize the in situ arrangement of soft tissues of the head and bones of the skull and ears. Scans were made of severed manatee heads and an isolated tympanoperiotic complex. One millimeter contiguous slices were obtained. The DICOM data were used to create 3-dimensional reconstructions with Amira 3.1 software.[†] This method for analyzing the structure of the auditory apparatus is superior to gross dissection because multiple "slices" (horizontal, sagittal, coronal) can be made through structures (hard and soft) without destroying the tissues. The middle ear, including the tympanoperiotic complex, tympanic membrane, ossicles, and associated muscles and membranes are visualized and described. Measurements of middle-ear structures from collected specimens (n = 50) were made for comparison with the 3-D reconstruction and for modeling impedance matching (presented as an electrical analog circuit). Additionally, the DICOM data contains information regarding the densities (reported as Hounsfield Units) of small volumes (voxels) within the scans. Previous research has established a positive linear relationship between density and sound velocity within tissues. A density map of the head and potential sound pathways are presented.[†] Mercury Computer Systems Incorporated, San Diego, CA

Bottlenose Dolphins from Coastal Waters of Southern Australia have Unique Mitochondrial DNA

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Bottlenose dolphins have a global distribution throughout tropical and temperate waters, both inshore and offshore and they exhibit morphological and genetic variation that is often regionally associated. Uncertainty regarding the taxonomy of the bottlenose dolphin worldwide has prompted its listing as a 'priority topic' for the IWC Scientific Committee's Sub-committee on Small Cetaceans. The dolphins residing in coastal Victoria population of southern Australia are a prime example of such uncertainty about taxonomic status and about local population structure. A population of 80-100 animals that are resident in the southern end of Victoria's Port Phillip Bay is considered to be vulnerable to extinction due to its small size, female natal philopatry, restricted home range, and to the large degree of human activity in the Bay. While bottlenose dolphins are also known from one other Victorian coastal site, the Gippsland Lakes around 320 km east of Port Phillip Bay, the geographical range of these dolphins is unknown. To clarify the affinities of these groups, we sequenced a 346bp region of the mitochondrial DNA control region from 12 individuals, and incorporated them into phylogenetic analyses involving published sequences of other *Tursiops* sp., *Stenella* sp. and *Delphinus* sp., found worldwide. Both neighbour-joining and maximum parsimony trees placed all these Victorian coastal haplotypes in a highly-supported group separate to those from all other dolphins, including those of similar morphology from the southern part of the Australian eastern coast. Victorian haplotypes are least divergent from *T. truncatus* (5.5%) and most divergent from *T. aduncus* (9.1%) suggesting that these populations are genetically unique, long isolated and possibly locally adapted. This is in agreement with the emerging world-wide picture that coastal bottlenose dolphins often have local fine scale population structure with unique regional patterns of genetic differentiation and morphology.

Acoustic Communication in Australian Sea Lion, *Neophoca cinerea*: A Descriptive Analysis of the Mother-Pup Recognition System

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Pinnipeds are known to be highly vocal, and use their vocalisations in different social contexts. The Australian sea lion *Neophoca cinerea* has a breeding cycle that is unique amongst the pinnipeds. They breed asynchronously between neighbouring colonies and non-seasonally with a reproductive cycle averaging 17.2 months. Like all otariids, female sea lions alternate foraging sea-trips with periods ashore to feed their pup. At each return, they have to find each other among all the individuals of the colony. The need for a finely tuned mechanism of recognition is exacerbated by their habit of changing the location where they suckle over the course of lactation. This is in sharp contrast to fur seals showing a very high degree of site fidelity. Given that female sea lions are particularly aggressive to non-kin, selection pressures for a very reliable mechanism of recognition are even more likely to be high. Here, we exhaustively investigated the potential acoustic features used in mother-pup recognition process in Australian sea lions. By recording 290 calls from 14 females and 15 pups at Seal Bay (Kangaroo Island, Australia) and by analysing 11 acoustic features from these vocalizations, we found that several features are likely to be used in the individual identification process since they show low intra- and high inter-individual variability (e.g., f_0 , energy spectrum, AM and FM). DFA correctly assigned calls to individual females or pups with an average classification rate of 65% and of 77%

respectively. Parameters relative to fo, energy spectrum and FM are the most important features to distinguish individuals. Lastly, PCA showed that pups' and females' calls are easily distinguishable by using features relative to timbre and FM. Based on this analysis, future investigations will determine the acoustic features used in the individual recognition process by using playback experiments with synthesised and modified signals.

Where Do We Miss? Establishing Global Distribution of Cetacean by Meta-Analysis and GIS

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Meta-analysis is an effective method for synthesizing studies from many scattered investigation. In this research, we combined the distribution information from 40+ published studies and Ocean Biogeographic Information System (OBIS) database to establish global distribution of cetacean. Our goals are to answer the following questions: (1) What is the distribution pattern of cetacean in the world? (2) What are the critical environmental factors affecting the distribution? (3) Where are the current gaps in distribution data and cetacean protection? We used a geographic information system (GIS) to compile all available data of cetacean distribution. We also compiled environmental data, e.g., sea surface temperature (SST), chlorophyll concentration, depth and depth gradient from various sources. The data were in 1° x 1° square of latitude and longitude. Our initial results indicate that there are at least 20 species in the dataset. Of these, 18 species are toothed whales and 2 are Baleen whales. The dominant species include bottlenose dolphin (*Tursiops truncatus*), sperm whale (*Physeter macrocephalus*) and common dolphin (*Delphinus delphis*). The distribution data were scattered and most of them concentrated on certain regions, such as northern Gulf of Mexico. The distribution data in the pelagic region are few. We haven't finished the analysis of habitat preference of cetacean species as we continue compiling the distribution data. Finally, we expect to investigate the missing piece of the current cetacean research in terms of distribution, and identify gaps in the protection area.

The Experience of Using the Thermovision During Spring Aerial Survey of the Pacific Walrus Census in the Northwestern Part of the Bering Sea

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Since 2000 American and Russian researchers have been working on a joint spring walrus survey, based on a standard method, using new technologies. Within this project on April 4-11, we have conducted 5 experimental flights in an AN-26 "Arctic" aircraft-lab in the northwestern part of the Bering Sea, mostly within the Anadyr Gulf. The majority of the flights were conducted at the altitude range of 800-1200 meters, where the aircraft engines didn't bother walruses. The accounted segments were determined by the thermovision scanning area's borders and equaled to the doubled flight altitude. The infrared scanning of the ice surface was continuously conducted during all the flights, when the walruses were observed. We photographed the ice haulouts with 2 digital cameras with 35 and 210 mm lenses. Several observed groups were up to 70 individuals. The largest aggregation of walrus haulouts was found in the central part of the Anadyr Gulf. In this region we conducted a survey on a model area (80 by 40 kilometers). We made 10 transects with 10 kilometers in between. The survey embraced 30% of the model area. To choose the best survey altitude we conducted an experiment: simultaneous thermovision and photo surveys of the haulouts were conducted on the altitude ranged between 800 and 2000 meters. Based on the

quality of photo and thermo images' results we chose the best survey altitude – 1500 meters. Now we are developing the standard model of compliance of thermo spots produced by walrus' haulouts to the quantity of individuals in each haulout, counted in the digital photographs. The developed method will be used in the joint American-Russian walrus census to be conducted in 2006. *This project was carried out within the frame of US FWS 701815G329 grant.*

Diving to Extremes: Are New Zealand Sea Lions Pushing Their Limits in a Marginal Habitat?

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When studying diving behaviour, it is important to know whether a species is operating at or close to its maximum physiological capacity, because if it is, it will be less capable of compensating for normal environmental or human-induced fluctuations in its environment. New Zealand sea lion (*Phocartos hookeri*) are among the world's rarest and most highly localized pinnipeds. Due to past exploitation they have been restricted in both abundance and distribution to the most southerly limit of their known range, New Zealand's sub-Antarctic. In this study, the diving behaviours of 18 female NZ sea lions from Enderby Island, Auckland Islands, were recorded during early lactation over two austral summers, 2003 and 2004. While at sea, sea lions dived almost continuously spending on average 52.7% of their time submerged (>6 m). The mean dive depth (\pm s.e.) for all dives was 129.5 ± 5.3 m (range 94.6 ± 1.1 to 178.9 ± 1.6 m). The mean duration of dives was 4.0 ± 0.1 min with an average of 40 ± 2.9 % of all dive times spent in the deepest 85% of the dive. While there was high variation in diving behaviour among individuals, overall, animals were found to be diving beyond their estimated aerobic dive limits on 68 % of all dives. Given that female NZ sea lions have a high percentage of dives that are beyond their theoretical aerobic limits we ask if this represents a miscalculation in aerobic limits, is it a species highly adapted to carry an anaerobic load, or a species that is physically stretched to their limits? A species that is presumably under physiological stress just to maintain its current low static population numbers is also likely to be more susceptible to external impacts and this needs consideration for their management.

Genetic Analyses Reveal Multiple Populations of *Delphinus delphis* in the Eastern North Pacific

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Short-beaked common dolphin, *Delphinus delphis*, are the species most frequently killed in the gillnet fishery operating off the coast of California (CA). However, our ability to accurately assess the impact of this fishery is limited by recognition of a large, geo-politically defined management unit. *D. delphis* are not unique in having geo-political boundaries recognized for management, because they are the default when our knowledge about a species' distribution, ecology and natural history is insufficient to identify boundaries that correspond to demographically isolated groups of animals. The geo-political boundaries for the CA/OR/WA stock of *D. delphis* equate to those of the U.S.A.'s exclusive economic zone off the coasts of CA, Oregon and Washington. Available data on dorsal fin color patterns, contaminant concentrations, reproductive seasonality and genetics suggest there are multiple populations within the CA/OR/WA stock, but each data set was too limited by sample size and temporal/spatial coverage to identify potential population boundaries. In this geographic region, *D. delphis* are a particularly difficult species to study because they are abundant (i.e., N~446,595), continuously distributed and have high haplotypic diversity (i.e., 98%). We sequenced 400 base pairs of the mitochondrial DNA control region for 312 specimens, which were individually assigned to geographic strata for analyses. Our *a priori* geographic strata were defined using information about the species' biology and the oceanography of the region. We detected evidence of genetic distinctness among the

strata using both Φ_{ST} and c^2 ($P < 0.05$) and concluded that the strata likely represent demographically isolated populations with boundaries corresponding to the region's primary oceanographic water masses: the Inshore Countercurrent off southern CA, the California Current off central and northern CA, and the Central North Pacific waters ~200nm off central and northern CA.

Variation in Humpback Whale Song in Response to Neighboring Singing Males

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Many songbirds use song to mediate interactions between neighboring males. In species that have diverse repertoires, repetition and rate of song-type switching can be used to indicate level of aggression. Humpback whale songs have been studied for several decades, but we have yet to elucidate the function of song within this breeding system. We are investigating the hypothesis that male humpbacks use song to mediate interactions. We predict that males change their song and movement patterns in response to nearby singers, and these responses may vary depending on distance (or level of threat) to the nearby singer. We deployed a 6x4 km array of autonomous acoustic recording devices ("popups") from February 26th- April 7th, 2004 off Socorro Island in the Mexican Pacific. Three popups recorded continuously at a 2 kHz sampling rate for 41 days; a fourth and fifth unit sampling at 10 kHz were deployed sequentially for 21 days each. Upon popup retrieval, sound files were synchronized to create a 4-channel array. Four main themes, two of which had multiple variants, were categorized. Numbers of singers were quantified at 30-minute intervals and a clear diurnal trend in singing activity was documented. Potential "interaction" sessions were chosen based upon the following criterion: one singer was audible within the array for at least an hour, followed by an hour in which a second singer moved into the area. These were analyzed as "control" and "experimental" periods. Song variables included: thematic structure, phrase repetition, switching rate, proportion of phrases with high-frequency units. Songs appeared to be much more labile than in previous years, therefore variables were analyzed both within songs as well as over 1-hour time blocks. Preliminary results indicate a higher rate of phrase-type switching in the presence of another singer. Additionally, analyses will incorporate distance and movement patterns of singers.

Sighting Records of Killer Whales from Taiwan

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The status of all cetaceans in Taiwan has changed from fishing targets into protected wildlife since 1990. The types of cetacean records also shifted from whaling records to stranding and boat sighting records. The sighting of killer whales (*Orcinus orca*) in particular excited the Taiwanese over the past 9 years. The first sighting was reported by our research team in August 1996 off the coast of Hualien, in the eastern water of Taiwan, and this record was published as head line news. It provided great impetus to promote awareness of cetacean conservation in Taiwan and attract public attention to the whale watching tours being quickly launched the following year. We interviewed whale watching operators, fishermen, and fishery researchers whenever they reported sightings. Our boat surveys combined with those interview results gave a total of 20 sighting records during the period from 1996 to 2005 (5 from formal boat surveys, 12 from the reports by local whale-watching operators, 2 from fishermen and one from Taiwan Fishery Research Institute). Their pod size varied from 2-10 animals and calves were commonly sighted when they were close enough for observation. Regarding their

spatial distribution, 19 out 20 sightings were collected in the eastern water of Taiwan, in the area between Hualien and Orchid Island. The exceptional one was found in the southwestern water of Taiwan in May 2005. Since 1996, killer whales were sighted 1-4 times a year (except no record for the year 2000), and all sightings were reported during the months from April to August, with more sightings in May (8/20) and August (6/20). It appears that killer whales were sighted more often in the summer time before 2000, while more often in spring time after 2000. We plan to research on if there is some correlation between their occurrences with changes of marine environment in the eastern water of Taiwan.

A Stochastic Framework for Reconstructing Historical Marine Mammal Abundance from Catch Records and Sparse Abundance Information

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The perspective gained by estimating historical abundance prior to the onset of harvest is crucial to setting recovery goals, evaluating rebuilding policies, and determining optimal catch quotas for the future. To this end, the International Whaling Commission, regional and national governing bodies are assessing marine mammal abundance. Assessments to date, however, have been limited to a relatively small number of stocks and species, as the availability of historical time series information on removals and abundance information is limited. To address these concerns, we implement a Bayesian approach to Stock Reduction Analysis (SRA). Minimal data requirements consist of the historical catch information and at least one observation (preferably more) of absolute abundance, or a time series of relative abundance indices (e.g., catch rate or cpue information). A deterministic SRA was used to construct prior distributions for population parameters that were parsimonious with historical catch information. Using a stochastic framework to represent process errors, a sample distribution was then generated using Monte Carlo simulations. In cases where recent abundance information was available, we use Sampling Importance Resampling (SIR) to construct posterior distributions of historical abundance. For cases in which it is known that historical catch records are incomplete, the sample trajectories provide lower bound estimates of abundance. We tested the approach on simulated data sets generated from a reference model and found that results are sensitive to the assumed ratio of observation errors to process errors. We then apply the method to catch data and abundance estimates for selected great whale species in the Southern Hemisphere.

Year-Round Distribution and Occupancy Patterns of Chilean Dolphins at Isla Chiloé, Chile

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Protection of critical habitat for a species requires information on its spatial and temporal occupancy patterns. We conducted monthly boat-based sighting surveys in 2004 to investigate whether a small population of coastal Chilean dolphins (*Cephalorhynchus eutropia*) resided year-round in an area identified as important summer habitat at southern Isla Chiloé (43°S), Chile. Chilean dolphins were present in the study area throughout the year but small scale occupancy and relative abundance varied seasonally. Chilean dolphins showed a consistent year-round preference for parts of Coldita channel (~4.5 km²) compared to the remaining study area (absence-presence, $G=17.8$, $df=5$, $p=0.003$). Adjacent Yaldad bay (~11 km²), covered by large mussel farms, was mainly used during the summer. The number of dolphins sighted during surveys did not vary between locations but was lower in winter compared to summer ($F_{1,56}=9.22$, $p=0.004$). Group sizes also varied significantly between seasons ($F_{9,74}=2.9$, $p=0.006$) with the largest groups seen in late summer, early autumn (mean= 6.7

± 0.8 SE) and the smallest groups in late winter, early spring (mean = 2.3 ± 0.3 SE). Newborns and calves were observed throughout the study area from the beginning of summer until the autumn but none were seen in winter or spring. Regular sightings of photographically identified dolphins suggested year-round residency of some individuals (five out of 38 individuals photographed in summer). These observations confirm the presence of at least some Chilean dolphins in nearshore waters throughout the year and highlight the importance of selected sites. Coldita channel has been proposed as a 'conservation zone' under the coastal management plan for Chiloé. Given the extremely small size of this area, and the seasonal importance of adjacent bays for adult dolphins and calves, habitat protection plans need to be expanded for conservation measures to be effective in an already impacted habitat.

The Origin and Evolution of Right Whales (Balaenoidea)

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Balaenoid mysticetes include both the Balaenidae (bowhead and right whales) and the Neobalaenidae (pygmy right whale). Previous morphological analyses have strongly supported monophyly of this group, while molecular studies consistently place Neobalaenidae as sister to the Balaenopteroidea (rorquals and gray whales). However, prior analyses have often failed to include all relevant taxa, outgroups or fossil taxa. A cladistic analysis was performed using 60 cranial, postcranial, and soft anatomical characters and 21 fossil and extant taxa. Balaenoid monophyly was strongly supported. Neobalaenidae was recognized as the earliest diverging balaenoid lineage, and Balaenidae monophyly is confirmed. Distinct morphological differences separate the balaenids into two clades, one including *Balaena* (bowheads) and another comprised of *Eubalaena* (right whales) and the extinct *Balaenula*. The origin and biogeography of the Balaenoidea was also examined using this phylogenetic framework. Balaenids are the oldest extant lineage of mysticetes. The earliest balaenoids are, as yet, undescribed specimens from 28 Ma rocks in New Zealand. The slightly younger, *Morenocetus parvus*, is from 22 Ma rocks of Argentina. The fossil record and phylogeny of balaenoids and present day distribution of the pygmy right whale supports a southern origin for balaenoids. Balaenids occupied the North Pacific by the Mio-Pliocene, and the North Atlantic by the Pliocene. Subsequent reinvasion of the southern hemisphere by *Eubalaena* in the Pleistocene and isolation due to warmer postglacial temperatures accounts for their present anti-tropical distribution.

The Scrape Sampler – A Pole-mounted Biopsy Sampler for Small Cetaceans Assembled from Off-The-Shelf Components

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Genetic analysis is used in population structure studies, to investigate genetic diversity within populations, to document evolutionary relationships, parentage, and kin-group relatedness, and for species and individual identification. Tissue samples from cetaceans are obtained from bycaught and beach-cast individuals, museum specimens, fecal samples and sloughed skin, and increasingly from biopsy-sampling of free-swimming animals in the wild. Biopsy samples have been obtained using floating darts fired from a crossbow or air rifle, and with a pot-scrubber-type nylon pad mounted on a wooden pole. Studies indicate only minimal behavioral changes in reaction to biopsy sampling efforts, but less-injurious methods avoid puncturing the skin and the potential for blunt trauma from rapidly-propelled darts. The use of crossbows and rifles to obtain biopsies from small cetaceans in nearshore waters may also be viewed unfavorably by observers. We have developed a cheap, simple, and effective biopsy sampling system based on off-the-shelf components available from hardware stores and sporting goods shops. Tools used to construct and assemble the

components include only a drill, hacksaw, pliers, and vise. The system uses an extendable aluminum trekking pole equipped with a removable sampling head, to scrape a small skin sample from small cetaceans that bow-ride or closely approach the side of a boat within reach of the pole. The sampling head consists of a short section of a cylindrical rasp mounted on a nylon rod. Any part of the head can be used to contact the back of an animal on close approach, and the movement of the animal away is sufficient to scrape a thin strip of skin that is retained between the cutting head and the nylon rod. The entire biopsy head is placed into a sterile plastic tube with ethanol to preserve the sample, and another head can be fitted quickly for the next sample.

Pursuit of the Fat and Wet: Being A Brief and Peculiar History of Marine Mammal Science (and Scientists)

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We review the history of marine mammal research, which can be broadly divided into several epochs, beginning with Aristotle's observations of seals, dolphins and whales in the 4th century BCE. Subsequent work consisted largely of compiling rather than original observation until the 1550's when Gesner, Belon and Rondolet all produced well-illustrated volumes that included selected marine mammals. During the Enlightenment, Linnaeus' taxonomic revolution was supplemented for cetaceans by Lacépède; at the same time, Hunter and Cuvier introduced comparative anatomical approaches, while Bufon, Cuvier, Steller and others added greatly to existing knowledge. The 19th century was the age of the great Victorian-style naturalists (Eschricht, Van Beneden, Gervais, Gray, Andrews and Allen, among others), expanding museum collections and the first extensive hunt-based observations of whales and pinnipeds, notably by Scoresby, Scammon, Maury and True. During early modern whaling (circa 1900-1945), the importance of individual variation was recognized; also, the first multi-disciplinary investigations began with the *Discovery* expeditions, and the first journals devoted exclusively to whale biology were founded. The 1950's saw the first recordings of wild marine mammal sounds, while captive animals permitted previously impossible experimentation and observation. During this time careful and often large-scale studies of the life history and population dynamics of whales took advantage of the huge samples sizes arising from overexploitation. The modern era of marine mammal research can perhaps be said to have begun in August 1963, when Ken Norris convened the first comprehensive meeting of existing experts. In the 1970's, studies of free-ranging and individually identified marine mammals revolutionized the field. This was followed by major technological advances in areas such as telemetry and genetics, and by an increasing awareness of the importance of a comparative, multi-disciplinary and broad ecological approach to the study of marine mammal biology and behavior. Today, numerous academic and other institutions maintain marine mammal research and education programs, and the field has developed into a highly professional multi-disciplinary endeavor.

Age-class Segregation of Blainville's Beaked Whale (*Mesoplodon densirostris*) Groups in The Bahamas

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Mass strandings coincident with naval and seismic operations have demonstrated that beaked whales are particularly vulnerable to loud sources of anthropogenic sound. During these stranding events, sub-adult beaked whales have stranded more frequently than whales of other age classes, but our understanding of this discrepancy has been constrained by a lack of information about the distribution of different age classes of beaked whales at sea. To address this knowledge gap, I analysed beaked whale sightings data collected from 1997 to 2002 during small vessel surveys of Northwest Providence Channel, in the

northern Bahamas. The study site is within the area where the March 2000 mass stranding event occurred. When beaked whales were sighted, photographs of the dorsal fin, head, and thoracic regions were taken and used to identify individuals and to assign each whale to one of five age and sex classes. During the six-year study period, 111 sightings of Blainville's beaked whales (*Mesoplodon densirostris*) were made, and 60 adults and 16 sub-adults were identified from high quality photographs. Cluster analyses of pair-wise association indices showed evidence of social segregation between age classes. Adult whales were grouped into harem-like social units consisting of a single adult male with multiple adult females, while sub-adult whales of both sexes were assigned to separate clusters. Univariate analyses of sightings data showed habitat partitioning between these adult and sub-adult groups. The harem-like units occurred along the shelf waters of the canyon wall. In contrast, sub-adult groups were sighted both further offshore (ANOVAs, $p < 0.05$) and in deeper water (ANOVAs, $p < 0.01$). Subadult whales may be restricted to less productive offshore waters by a dominance hierarchy. This age-segregation may explain the discrepancy in the stranding record, with sub-adult animals being exposed to the greatest sound intensity in offshore waters closer to the source.

Spatial Modelling of Hector's Dolphin Habitat Relationships with Geographically Weighted Regression

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Cetacean habitat studies often explore relationships between species' distribution and features of their environment. Resulting predictive models usually present an average or 'global' statistic of these indirect relationships. This global assumption is not necessarily reasonable when the nature of a relationship may change over space. Instead, new spatial tools can identify the presence of 'spatial non-stationarity' as the local statistical approach emphasizes any underlying spatial aspects of the data contributing to spatial variability in habitat relationships. By using both global methods and a new spatial modelling technique known as geographical weighted regression (GWR), this study examined relationships between oceanographic features and aggregations of Hector's dolphin around Banks Peninsula, New Zealand. GWR is based on a basic linear model that allows all parameter estimates (intercept constant and parameter coefficients) to vary over space. By incorporating spatial variation, continuous locally-varying spatial models avoided averaging over potential differences in dolphin responses to their physical environment. GWR models out-performed corresponding global models, despite differences in degrees of freedom and increased model complexity. GWR results found relationships varied over a localized scale that was concealed by global methods. Monthly GWR models suggested the seasonal presence and strength of local oceanographic fronts were the main spatial mechanisms influencing dolphin distribution. Dolphin aggregations coincided with the steepest gradients between water masses and/or strong downwelling or upwelling events. The improved performance of GWR models suggest that spatially varying methods provide a more appropriate spatial complement or alternative to global regression analyses of habitat relationships. Instead of a "one-size-fits-all" global approach, this study suggests the use of global analyses as a coarse-scale filter to reveal any general, large-scale associations with fine-scale, local models used to characterize any spatial variations in these trends, specifying where management strategies could be fine-tuned or focused to be more effective.

Mortality and Serious Injury Determinations for Large Whales Stocks Along the Eastern Seaboard of the United States, 1999-2003

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As part of the 1994 amendments to the Marine Mammal Protection Act (MMPA), the NOAA National Marine Fisheries Service (NMFS) was mandated to establish monitoring programs to obtain statistically reliable estimates of incidental mortality and serious injury of marine mammals taken during commercial fishing operations. A serious injury has been defined as "any injury that will likely result in mortality". Using guidelines recommended by NMFS's 1997 Serious Injury Workshop, the Northeast Fisheries Science Center developed protocols for determining large whale serious injuries and human-caused mortalities. We describe the protocols used and report on the determinations made for right, humpback, fin, sei, blue, minke and Brydes whale events that occurred from 1999 through 2003 along the eastern seaboard of the United States. A total of 408 unique large whale events were reported during the period, including both strandings and sightings at sea. These included 174 entanglement reports and 37 reports of ship strikes. We were able to verify 147 entanglements, 25 ship strikes, and 267 mortalities. Entanglements were identified as the cause of death for 25 whales and ship strikes as the cause for an additional 15 mortalities. Entanglements were determined to have caused serious injury in 17 other events. Minke whales had the greatest number of entanglement mortalities (15), while humpback whales had the highest number of serious injury events resulting from entanglements (9). Right whales and fin whales each had five confirmed mortalities from ship strikes. No serious injuries resulting from ship strikes were confirmed for any species. These human-caused mortality and serious injury rates represent the minimum levels of impact to these stocks. Procedures and methods for estimating actual serious injury and mortality rates have yet to be developed.

Mother-Pup Vocalisations and Reunion Behaviour in Weddell Seals, *Leptonychotes weddellii*

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Mother-pup in-air vocal recognition has been studied extensively in colonial otariids and appears to be characteristic of this family. Studies of phocids suggest a diversity of recognition abilities that likely reflect their varied life histories. Weddell seals exhibit breeding behaviours akin to otariids and therefore mother-pup vocal recognition may have an important function in this species. Our study investigated the basis for vocal recognition by examining the: 1) individuality, 2) functionality, and 3) development of Weddell seal mother-pup 'contact' calls. Acoustic and behavioural data were recorded in the Vestfold Hills and McMurdo Sound, Antarctica. Results of cross-validated discriminant function analyses demonstrated that both mothers and pups produce individually distinct calls. However, the percentage of calls correctly classified indicated that pups are less vocally distinct than their mothers. Examination of mother-pup reunion behaviour confirmed the use of these distinct calls during the reunion process. Investigation of 'contact' call development indicated that pups are individually distinguishable by 14 days of age. This may be the result of increased stereotypy of the first half of pup calls and their level of frequency modulation. MANOVA revealed that there was ontogenetic change in six acoustic characteristics. Three of these developmental changes differ in relation to pup sex. The fact that Weddell seal mothers and pups produce individually distinct 'contact' calls, and that such calls are produced during the reunion process, suggests that a mother-pup vocal recognition system occurs in this species. It appears that this system is functional by two weeks post-partum, before mother-pup separations are likely to occur. Acoustic characteristic analysis suggests that given the change in pup voices with maturity, females may be required to continually adapt their

recognition template over the course of pup dependence.

Behavioral Analysis of Parturition in the Southern Elephant Seal (*Mirounga leonina*)

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In the present study, we analyzed the behavior of female Southern elephant seals (*Mirounga leonina*) during parturition. Eight gravid females, members of a small harem, were videotaped at Peninsula Valdez, Argentina during the months of September and October. During the study, weather conditions varied from overcast to warm and windy. In all tapes where births were captured, similar events were observed. During review of the videotapes, we encoded the frequency and duration of 11 different behavioral events. Prior to birth, we analyzed: 1) lying down, 2) ambulating, 3) visual scanning, 4) rolling (on the dorsum), 5) flipping sand, 6) vocalization, 7) rear flipper lifts, and 8) behavioral expressions of labor (contractions). During birth, we encoded the emergence of the pup birth and maternally-directed activities (visual interest and vocalization). Prior to birth, all females showed swelling near the rear flippers, lying with head down, rolling, flipping sand and contractions. As the time of birth approached, females spent less time ambulating and more time lying with their head down. An increase in side-to-side rear flipper movement and behavioral expressions of labor contractions were observed over time. In the ten minutes prior to birth, pregnant females showed an average of 39.3 (\pm 25.7) contractions characterized by head and body extensions (lordosis contractions) and an average of 114 (\pm 16) contractions characterized by abdominal lifts (vertical contractions). Consistent with the literature, approximately one-half of the births captured were of pups born in the breech position (flippers first). Following birth, females tended to bark at their pups possibly arousing their newborns with their vocalizations. Collectively, these observations suggest that Southern elephant seals display typical behaviors associated with pre- and postpartum events. Supported by NIH Grant MH 46485 and the MIRT/Fogarty Program

Differences in Harbor Seal Serum Chemistries in the Gulf of Alaska

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We initiated long-term monitoring studies to assess diet, health status and reproductive success in two declining populations of harbor seals (*Phoca vitulina*). Study areas included Prince William Sound (PWS) and Glacier Bay National Park (GB), where seal numbers have decreased by >65%. Current rates of decline differ, -3.1%/yr in PWS [1990-2004] and -15.5%/yr in GB [1992-2004]. We measured serum chemistry variables in free-ranging harbor seals in PWS (n=39) and GB (n=32) from 2003-2005 to compare population-specific values and differences among cohorts (adult, subadult, yearling/young of the year (YOY)). Within each age category, differences in serum chemistries were not apparent between locations. Samples combining both GB and PWS showed significant differences between yearling/ YOY (n=25) and the other age classes (subadult n=29, adult n=17) in the following variables: Alkaline phosphatase (ALKP), calcium (Ca) and total protein (TP). The higher levels of ALKP and Ca in yearling/ YOY were expected as they reflect skeletal growth. TP was lower in

yearling/YOY, suggesting lower dietary protein or lower protein assimilation. Higher levels of cholesterol (CHOL) in yearling/YOY than adults may reflect higher lipid intake from nursing and prey than consumed by other seals. Blood urea nitrogen (BUN) and creatinine (CREA) levels were significantly higher in the adults indicating differences in diet and hydration state. Seasonal and developmental differences within the yearling/YOY category were indicated for albumin (ALB), globulin (GLOB), chloride (Cl), sodium (Na), total bilirubin (TBIL), inorganic phosphate (PHOS), creatine kinase (CK), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and amylase (AMYL). Ongoing research and sampling effort may help to establish critical serum chemistry reference ranges, regionally and age classes.

Do Not Disturb: Creating Dolphin-Watching Exclusion Zones that Reflect Bottlenose Dolphin (*Tursiops truncatus*) Habitat Use

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The development of dolphin-watching tourism rarely considers the dolphins' spatial and temporal use of habitat. In the Bay of Islands, New Zealand managers created dolphin-watching tour-boat exclusion zones without knowledge of whether behaviours occur in preferred areas, or are influenced by season. The Bay forms an important part of the home-range of a population of 446 (95% CI 418-487) bottlenose dolphins. To provide managers with information on dolphin habitat use, we tested the hypotheses that dolphins do not have preferential habitat use within the Bay for different behavioural states, and that there is no seasonal effect on distribution within the Bay. Four zones were characterised by similar oceanographic features and divided spatially using the polygon tool in ArcView. Behavioural data were collected on independent focal groups with a predominant activity assigned after an instantaneous scan of individuals. Between December 1996 and February 2000, data on 138 groups were collected on 123 days. There were spatial differences in habitat use ($\chi^2=28.98$, d.f.=12, $P=0.004$) with rest occurring in the exposed outer-bay, traveling in the deeper middle-ground and foraging in the shallow inner-bay more than expected. The dolphins' distribution differed by season with groups found in deeper water in summer ($z=19.07$, $P<0.001$). The seasonal changes are probably related to prey distribution with a sub-tropical current arriving in summer. Bottlenose dolphins in the Bay decrease their resting behaviour in the presence of boats so the low levels of boat traffic in the outer-bay may explain the increase in resting. The dolphins generally do not cooperatively forage and the diversity of fishes and habitat types in the inner-bay may explain the higher than expected observations of foraging. Knowledge of these spatial and temporal differences was used by managers to create the first exclusion zones to protect the dolphins' preferred resting areas from boat disturbance.

Evaluation of a Robust Design Mark-Recapture Method for Monitoring Florida Manatees (*Trichechus manatus latirostris*) Using Warm-Water Outfalls

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Florida manatees (*Trichechus manatus latirostris*) are listed as endangered by federal and state governments, and a major threat to populations is the pending loss of warm-water habitat. A large portion of the Florida manatee population has come to depend on industrial warm-water sites whose availability is expected to decline in the future. We are in the process of developing predictive models designed for use in the adaptive management of thermal habitats for manatees. An important component of adaptive management is the implementation of a monitoring program to inform decision-making,

assess status, and facilitate learning. We implemented a novel method of manatee monitoring through the application of robust design capture-recapture, which allows for estimation of movement rates, survival, and abundance. Captures of manatees consist of photo-documentation of individuals with known scar patterns in the MIPS (Manatee Individual Photo-identification system) database, maintained jointly by the US Geological Survey and Florida Wildlife Research Institute. We have completed weekly abundance estimation at 4 industrial warm-water sites for 3 winters, using closed population models designed to correct for imperfect detection rates. We found that detection rates of manatees were negatively influenced by wind, turbidity, and ambient water temperatures. We suspect that we have not met all assumptions of closed population models: specifically, we believe manatees are moving into and out of study areas during sampling sessions and that manatees exhibit heterogeneity in capture probabilities. We discuss the implications of these assumption violations for abundance estimator performance and consider alternate sources of information and potential modifications to field methods to correct for these problems. Finally, we discuss the strengths and weaknesses of 3 primary monitoring methods – capture-recapture, aerial surveys, and telemetry – in the context of warm-water monitoring needs. Lessons from this analysis may be informative in the design of monitoring programs for other marine mammals.

Global Population Structure of Blue Whales, *Balaenoptera musculus* spp., Based on Nuclear Genetic Variation

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We investigated the population structure of blue whales (*Balaenoptera musculus* spp.) worldwide to describe patterns of genetic differentiation and delineate biological stocks for conservation management. We examined 204 individuals from 14 locations for sequence variation primarily within the intron regions of five structural genes: the alpha-L-iduronidase gene (10 alleles), the DNA polymerase beta gene (six alleles), the acetylcholine receptor gene (22 alleles), a gene in the serine-threonine kinase PIM-1 family (four alleles), and the actin gene (four alleles). A hierarchical analysis of molecular variance over all loci indicated a moderate level of substructure in the data set (weighted average $\hat{O}_{ST}=0.085$). Based on pairwise comparisons and factorial correspondence analyses, we found four major subdivisions that roughly correspond to different ocean basins: the eastern North and tropical Pacific Ocean, the southern Indian Ocean, the Southern Ocean, and the western North Atlantic Ocean. We were unable to determine whether the eastern South Pacific Ocean constituted a separate subdivision. In pairwise comparisons, it was not significantly different from either the eastern North and tropical Pacific Ocean or the southern Indian Ocean. This is one of the first studies to explore the global population structure of a cetacean species using nuclear intron/exon diversity.

Auditory Evoked Potential (AEP) Hearing Measurements in Free-ranging Bottlenose Dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida

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Bottlenose dolphins (*Tursiops truncatus*) rely on sound for communication, navigation, and foraging. Therefore hearing is one of their primary sensory and communication modalities. Both natural and anthropogenic noise in the marine environment could mask the ability of free-ranging dolphins to detect sounds, and chronic noise exposure could cause permanent hearing losses. The goal of this study is to investigate the hearing abilities of a population of free-ranging bottlenose dolphins in Sarasota Bay, Florida. Our study is the first to measure the hearing sensitivity of a population of free-ranging dolphins that are exposed to significant levels of environmental noise. The hearing abilities of 48 bottlenose dolphins (25 males and 23 females), ranging in age from 2 to 31, were measured in the field using non-invasive auditory evoked potential (AEP) techniques during brief capture-release sessions for health assessment. Amplitude-modulated tones were presented to each animal through a suction cup jawphone to determine individual hearing abilities between 5 and 120 kHz. The tones were modulated at 600 Hertz, which elicited a robust envelope following response. A rapid AEP procedure was employed so that an entire audiogram could be obtained in approximately 40 minutes. Signals were tested in 10 dB steps at levels up to 100-160 dB. Preliminary data analyses show considerable individual variation in hearing abilities. This study also provides baseline data for longitudinal hearing studies in known individuals.

Steller Sea Lion Haulouts: Breeding Locations for Nonpregnant Females?

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Steller sea lions (*Eumetopias jubatus*) are commonly thought to rest at haulout sites and breed at rookeries. To test the assumption that breeding does not occur at haulouts, we recorded reproductive behaviour (through direct observations of courtships and copulations of bulls) at two haulout sites in Alaska during the spring and summer seasons (1996-1998). We compared the timing and frequency of reproductive behaviours documented at the haulouts with those of bulls at a rookery. Mature males were noted to hold territories on the haulouts, and were seen to engage in courtships and copulations with nonpregnant females that were either unencumbered or nursing pups from the previous year. Breeding at these haulouts appeared to occur one to two weeks earlier than it did on the rookery, which may indicate that females giving birth on rookeries are generally not receptive to males until the end of the perinatal period (about 8-10 days after giving birth). Immature sea lions (ages 1-4 years) and adult females were the most abundant age classes observed. Births were only observed a few times at the haulouts, but none of the newborns survived. Subadult males (SAMs) were usually not tolerated on the haulout by mature bulls until after the 'breeding season'. Our observations suggest that summer haulouts are important breeding areas for nonpregnant females that are alone or encumbered with young, and consequently should not be thought of as strictly non-breeding sites. Across their range, Steller sea lions are known to use 88 rookeries and about 600 haulouts, however approximately 45% of the population does not return to rookeries during the summer. The reproductive behaviour that occurs at haulouts during summer may therefore be significant to the recovery of the western population of Steller sea lions, and should be considered when implementing management strategies.

Development of Cetacean Hyperphalangy

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Most mammals have two phalanges in the thumb and three within the remaining digits. The only mammals that increase the number of phalanges per digit (hyperphalangy) are cetaceans which have more than three phalanges in at least two digits. Among other vertebrates hyperphalangy also evolved within marine diapsid reptiles (i.e., ichthyosaurs and plesiosaurs) during the Mesozoic. Hyperphalangy therefore evolved at least twice as tetrapods adapted to an aquatic

lifestyle and is an example of convergence. It is possible that hyperphalangy functions to elongate and stabilize the manus. The developmental mechanisms generating hyperphalangy are mostly unknown as cetacean embryos have previously been unavailable for developmental studies. Recent descriptive embryological studies on odontocetes have shown that hyperphalangy is associated with limb heterochrony in which the apical ectodermal ridge thickens and becomes isolated to the terminal ends of digits II and III allowing for the addition of terminal phalanges. The genes that lead to hyperphalangy are unknown. This study describes forelimb morphology in embryos and fetuses and analyses the developmental mechanisms creating hyperphalangy in the embryonic forelimbs of *Stenella attenuata* via novel immunohistochemical protocols specific for cetaceans. Clear and stained fetuses were examined to elucidate the count and morphology of cartilage phalanges. Also, prenatal specimens of different ontogenetic stages were sectioned and stained to study the expression of proteins an indicator of genes expression during digital development.

Metabolism of Dietary Cetoleic Acid (22:1n-11) in Grey Seals (*Halichoerus grypus*) and Mink (*Mustela vison*) Studied Using Radiolabelled Fatty Acids

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Cetoleic acid (22:1n-11) is a good indicator of diet in marine predators and has proven to be an important fatty acid (FA) when using adipose tissue FA composition to study diet in marine mammals and seabirds. Feeding studies have shown that 22:1 isomers are predictably under-represented in adipose tissue relative to diet, implying that metabolism within the predator has a particularly strong influence on the relationship between the level of this FA in diet and adipose tissue. Fully understanding such metabolic processes for individual FA is important to the estimation of calibration coefficients used in quantitatively modeling predator diets. We employed a dual-label radioisotope-tracer technique to investigate the potential modification of 22:1n-11 and its recovery in the blubber of grey seals and in the liver and five adipose depots of mink, a smaller model carnivore also accustomed to fish-based diets. Individual variation in recovery of ³H-22:1n-11 relative to ¹⁴C-18:1n-9 was found in both seals and mink. In mink sampled 6h post-feeding, mesenteric adipose tissue showed the greatest relative recovery of 22:1n-11, consistent with the liver being the primary location for the chain-shortening of this FA. After 9h incubation, relative recoveries were more consistent across mink adipose depots implying a progression in the metabolism of labelled 22:1n-11. In both seals and mink, ³H radioactivity was found in the chain-shortened products of 22:1n-11, namely 20:1, 18:1 and 16:1, with 18:1 being the dominant product, consistent with its generally elevated level in blubber relative to diet. ³H radioactivity was also found in saturated FA, indicating that some radioactively-labelled acetyl groups released during α -oxidation were incorporated into *de novo* synthesized FA. The distribution patterns of ³H-radioactivity across the FA isolated from seal blubber and mink adipose tissue were comparable, indicating that mink are a good model for investigating lipid metabolism in marine carnivores.

Marine Mammals and "Ecosystem-Based Fishery Management": The Next Big Conservation Challenge?

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A recent exchange of letters in *Science* makes it clear that there are two competing views of what "Ecosystem-Based Fishery Management" (EBFM) means. The scientific consensus holds that EBFM entails revising the burden of proof in marine environmental management, so restoring and sustaining ecosystem function has priority over maximizing fisheries yields. Another view presents EBFM as ecosystem tinkering: culling marine mammals in the hopes of

enhancing fisheries production. The clash of these management cultures is already underway. Norway introduced a new policy on marine mammal management in 2004, aiming to operationalize the "EBFM as culling" approach. The policy is directly in opposition to substantive aspects of the consensus view of EBFM. This is clear in responses to: existing precautionary management (e.g. the IWC's Revised Management Procedure), current programmes seeking to implement ecosystem-based reference points, and in considering spatial zoning. At heart, the two approaches differ in their conceptualization of the oceans. Underpinning the consensus view of EBFM is that our knowledge of marine ecosystems, and capacity to manage our activities in them, remains inadequate. This needs confronting through precautionary and design-based approaches to using science in management. At its core, EBFM as culling contends that our knowledge is sufficient to construct models of ecosystems that provide management forecasts, and that fisheries extraction will be enhanced by reducing marine mammal populations. Some responses to the Johannesburg Summit's call for implementing an "Ecosystem Approach" to fisheries by 2010 indicate an intent to see "EBFM as culling" as the internationally accepted version of the "Ecosystem Approach". This bodes ill for marine mammal conservation.

Effects of Increased Swimming Costs on Foraging Behavior and Efficiency of Captive Steller Sea Lions

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A significant component of the cost of foraging is the cost of locomotion, which for marine animals, is the cost of swimming. Increases in the cost of swimming can have significant impacts on foraging efficiency. Minimizing the cost of swimming can contribute to the optimization of foraging strategies by reducing the energetic cost of foraging. Results of field studies suggest that an increase in the cost of locomotion may have comparable effects on foraging behavior and efficiency to a decrease in prey availability. We tested the hypothesis that increased cost of swimming, brought on by increased hydrodynamic drag, has the same effect on dive behavior and efficiency as reduced prey availability under standard locomotion. Experiments were performed using two adult female Steller sea lions at the Alaska SeaLife Center in Seward, AK, using the same animals and general experimental design previously used to test the effects of reduced prey encounter rate on dive behavior and efficiency. Animals were fitted with a drag-inducing harness for half of the 500 simulated foraging dives in order to increase the cost of swimming. Individual dive duration and foraging time were significantly reduced in all cost increased dives, comparable to the effects of reduced prey encounter rate. However, over a bout of dives, dive and foraging efficiency were only slightly reduced, which is likely due to an average 50% reduction in post-dive surface recovery duration during cost increased dives. Increased heat flux across the body surface confirmed a significant increase in work during cost increased dives. These results suggest that sea lions are able to compensate for changes in the cost of foraging and maintain their foraging efficiency by altering their dive strategy over an entire bout of dives when operating well within their aerobic scope.

Utilization of the North Pacific By Marine Mammals and Others Top Predators: Tagging of Pacific Pelagics: Using Electronic Tags to Discover Hotspots in the Pelagic Realm

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In an effort to understand and locate biological hotspots in the North Pacific Ocean, the Tagging of Pacific Pelagics program is using biologging technology to simultaneously map the location of marine vertebrates including sharks, tuna, albatrosses, seals and whales. Hot spots are regions of high biological activity where linkages occur between physical forcing, primary production, secondary consumers and top pelagic predators. Although it is generally accepted that these hotspots occur and are important, surprisingly little is known about these congregating spots for marine organisms in the open ocean. Our lack of understanding of the aggregating forces in the pelagic ocean ecosystem stems largely from limitations of available technology. Prior studies have focused on single species tracking and few have attempted to examine interactions among top pelagic species. TOPP is coupling electronic tagging data with satellite remote sensing technologies to simultaneously map the movements of diverse pelagic species and link their movements to oceanographic processes. To date we have tagged and tracked mako, salmon and white sharks, elephant seals, bluefin and yellowfin tuna, black-footed and Laysan albatross, California sea lions and leatherback sea turtles. To date our analysis indicates that frontal features associated with the North Pacific Transition zone and the California Current are the major regions of common habitat utilization for these species.

Anatomic Geometry of Sound Transmission and Reception in Cuvier's Beaked Whale (*Ziphius cavirostris*) and Baird's Beaked Whale (*Berardius bairdii*)

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Under some circumstances it is clear that stranding, physiologic collapse, and subsequent death in beaked whales (Family: Ziphiidae) are related to exposure to high-intensity sound. The particular set of environmental circumstances, behavioral responses, or physiologic mechanisms that lead to the failure of organs systems is unknown, enigmatic, and has become the subject of intense investigation. This study capitalizes on the availability of industrial CT scanning technology to collect the first CT scans from the heads of adult Cuvier's and Baird's beaked whales. The large sizes of these animals have previously prevented scanning by conventional means. Primary results reveal details of anatomic geometry with implications for acoustic function. Specifically, the juxtaposition of the large pterygoid sinuses, a fibrous venous plexus, and lipid-rich pathways that connect the acoustic environment to the bony ear complex provides a focus for research into potential mechanism(s) that might precipitate stranding under conditions of exposure to high-intensity sound. It is possible that the large pterygoid air sinuses are essential adaptations for maintaining auditory acuity at depth and may increase the potential for harm in the presence of high-intensity sound. In addition, an acoustic waveguide lined with pachyosteosclerotic bones is apparently part of a novel transmission path for outgoing biosonar signals in deep diving animals. These newly described transmission pathways are reminiscent of the configuration that would be seen in a sperm whale with its forehead turned upside-down.

Size Matters: Foraging Strategies of Rorquals in the California Current

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Humpback and blue whales are the most common species of large whale that occur in the Central California National Marine Sanctuaries (CCNMS). Previous studies have shown that both species forage on seasonally dense aggregations of krill found on the continental shelf break in late spring and summer. However, using allometry, we estimated that the daily prey requirements of blue whales (~1200 kg

day⁻¹) are twice that of humpback whales (~600 kg day⁻¹). This, combined with anecdotal observations of humpbacks additionally feeding upon schooling fishes suggests that the two species should have distinctly different foraging strategies in the Sanctuaries due to differences in prey requirements and diet. Using a combination of long-term surveys, digital echosounders, time-depth recorders, and satellite tagging we examined: 1) temporal differences in the arrival and departure of humpback and blue whales in the CCNMS, 2) temporal and spatial differences in the distribution of dense aggregations of krill and schooling fish, 3) differences in the foraging behavior of humpback and blue whales in relation to schooling prey, and 4) differences in the large scale movement patterns of humpback and blue whales along the California coast. Humpback whales arrived earlier and persisted longer than blue whales in the CCNMS. Humpbacks were found both on the continental shelf and in the vicinity of the shelf break feeding on both schooling fish and krill whereas blue whales were primarily found at the shelf break and offshore feeding on krill. Across longer time scales, humpbacks had more restricted movements than blue whales which undertook frequent long distance movements along the coast within the California Current.

A National Census of the Harbour Seal (*Phoca vitulina vitulina*) Population in the Republic of Ireland Using Thermal Imagery

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The status of Ireland's harbour seal population and its relationship with that of Britain and Western Europe are poorly understood. Until recently, the national harbour seal population estimate for Ireland dated to 1978 and resulted from a boat-based survey that did not cover the entire coastline. In order to provide comprehensive current information on Ireland's harbour seal population, a geographically extensive aerial survey was conducted along the coastline of the Republic of Ireland during the species' annual moult in August 2003. This complemented a similar survey of Northern Ireland, which was conducted in 2002. Haul-out habitat utilised by harbour seals on the Irish coastline is predominantly seaweed-dominated rocky shore. Thermal imaging technology overcame difficulties associated with the identification of seals on such a substrate from the air. Using a thermal imaging technique developed at the Sea Mammal Research Unit, St. Andrews, Scotland, haul-out groups of harbour seals and grey seals were identified from the air, aerial-counts were obtained and the data compared with simultaneous ground-count data from selected sites. Surveys were planned to occur within strict limits with respect to the state of tide, time of day and degree of precipitation. Harbour seal distribution recorded during the 2003 moult season was concentrated in the southwest, west and northwest of the country. This national survey yielded a minimum population estimate for the Republic of Ireland of 2,905 harbour seals, delivering an effective baseline for current and future population research. A ground truthing element in the survey provided a means of assessing aerial survey data being gathered for the first time in the Republic of Ireland and supported the accuracy of data acquired aerially. It did however highlight the potential for occasional observer errors in counting thermal images in real-time.

Building a Network to Evaluate Global Bycatch of Marine Mammals, Seabirds, and Sea Turtles

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Many marine mammals are inadvertently taken as bycatch in global fisheries. Some of the better known cases include the bycatch of dolphins in the Eastern Tropical Pacific tuna purse seine fishery and of harbor porpoise in coastal gill nets in the North Atlantic. In both cases, collaborative efforts of scientists and fishermen have led to dramatic reductions in bycatch within these regions. Some would like to consider these problems largely solved, while others consider that there is much more to do (e.g., marine mammals in the ETP have still shown limited signs of recovery). This issue has analogies to successes in reducing bycatch of seabirds and sea turtles, but there are still vexing problems to solve. Assessing and reducing bycatch impacts becomes particularly difficult when these species migrate through waters managed by a number of different countries, or through international waters, encountering a variety of fisheries along the way. Another common problem is that mandated changes in fishing gear or methods meant to resolve conflicts with one species may lead to increased bycatch of other protected species. It is time for a more comprehensive approach which considers the entire gauntlet of fisheries and their impact on all protected species. We are beginning to develop an international network of scientists, managers, and fishermen interested in assessing the global bycatch of marine mammals, seabirds, and sea turtles. The goal of the Global Bycatch Assessment Network is to collate data, quantify impacts, and suggest conservation measures for reversing the declines of seabirds, sea turtles and marine mammals due to incidental fisheries bycatch. Here we detail the goals of the project and seek to build partnerships with others interested in contributing to this larger, more integrative approach.

Vocal Productions of Rhythms by the Bottlenose Dolphin

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This study is an in-depth analysis of vocalizations produced by a dolphin participating in a rhythm production study. In the rhythm production study, the dolphin was shown one of six objects and reinforced for vocally producing a rhythm uniquely associated with that object. Each object was labeled with its own rhythm, consisting of a sequence of long and short tones. The dolphin learned to produce the appropriate rhythm to the appropriate object at 83% accuracy. An analysis of the dolphin's vocal responses across eight months of the study revealed that the dolphin varied frequencies and durations across the rhythms while maintaining the structure of each rhythm. The rhythms also changed in general ways. As the study progressed, the dolphin altered the long tones such that the dolphin produced fewer single-frequency (flat frequency contour) long elements and more upsweeps (low to high frequency). In addition, short elements became louder and more broadband. These results demonstrate that dolphins represent rhythms in terms of relative durations and frequencies versus absolute durations and frequencies. In addition, because the importance of contour in the dolphin's vocal repertoire was evident throughout this study, these data suggest that dolphins may categorize whistles by contour.

Sperm Whales Groups Identification in the Gulf of California by Using Fatty Acid Analysis

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The sperm whale, *Physeter macrocephalus* occurs during the whole year in the Gulf of California. The variation among the number of observed photo-recaptures among seasons vs. year suggest that exists at least two groups of sperm whales in the Gulf, one of them can come

from the zone of Galapagos of which we have photo-recaptures. The analysis of the Fatty Acids (FA) profile of tissues with great abundance of structural lipids has been used in the separation of groups or stocks in fish, pinnipeds and cetaceans. The histochemic analysis, with the black Sudan technique and using image analysis, in samples of distinct portions of the subcutaneous blubber of a stranded sperm whale, shows that the fat of the caudal fin contains a 78.6% of structural FA. We use biopsies of female and young sperm whales caudal fins from warm and cold seasons of the year (n=5 and n=5 respectively) to verify the presence of sperm whales groups in the Gulf of California. We extract the total lipids using chloroform: methanol (1:2) and were methylsterified with chlorhidric acid: methanol (5:95). The samples were analyzed using a GC-MS. The Principal Component Analysis of the FA profiles established two groups that match with the warm and the cold seasons. The monounsaturated FA 16:1n9, 16:1n7, 20:1n11, 20:1n9 y 22:1n11 were significantly distinct between both groups (P<0.05). The subcutaneous fat from the caudal fin with a high quantity of structural FA, support the hypothesis of the existence of at least two groups of sperm whales in the Gulf of California. Our results suggest that the analysis of FA in biopsies of the caudal fin can be used as an identification tool of groups of sperm whales.

Behavioral Reactions of Free-Ranging Harbor Porpoises (*Phocoena phocoena*) Encountering Standard Nylon and BaSO₄ Mesh Gillnets and Warning Sound

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Field tests suggest that high-density nets can reduce harbor porpoise by-catch in fisheries. However, it is not clear whether acoustic reflectivity or stiffness are responsible for this. Sonar tests in a tank (110 to 190 kHz) showed that target strength of the high-density BaSO₄ net was 7.2 dB higher at 150 kHz than in the standard nylon net. In a fjord on Vancouver Island, Canada we investigated porpoise surfacing and echolocation behavior with respect to two surface gillnets (45 x 9 m, 165 mm mesh size) made of (1) a mix of BaSO₄ and nylon and (2) standard 100% nylon. Distribution of click interval duration was shifted to longer intervals when the BaSO₄ net was used (median = 51 ms vs. 45.2 ms for standard net; Kolmogorov-Smirnov-Test, p < 0.001), suggesting a greater target distance. However, the percentage of echolocating porpoise groups near nets (BaSO₄ 19.3 %, standard 30.6 %) was generally low. A subsequent experiment showed that playing pure 2.5 kHz tones as warning sound increased biosonar use by a factor of four (16.7 % in controls vs. 71.4 % during ensonification; Chi²-Test, p < 0.001). The median surfacing distance increased from 21.3 m (n = 23, no sound) to 37.9 m (n = 43, sound). Below the surface, click-intervals (measured via POD), an indirect measure of target distance, were highest in the ensonified barium-sulphate net (64.7 ms, n=9) as opposed to the ensonified standard net (51.6 ms, n=23; KS-Test, p<0.05). The number of clicks per minute recorded within 80 m of the net increased from 54 (barium-sulphate net without sound, n=10) to 64 (standard net with sound, n=8) to 86 (barium-sulphate net with sound, n=5). The combination of reflective nets and warning sounds looks promising.

Bioaccumulation of Flame-Retardant Chemicals in Harbour Seal Food Webs in British Columbia, Canada

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The accumulation of Persistent Organic Pollutants (POPs) in marine mammal food webs is of significant concern, as they are typically fat-soluble compounds, not easily metabolized, and can often reach very high concentrations in high trophic level marine mammals. Exposure to these chemicals has been associated with immunotoxicity, endocrine disruption, reproductive impairment and developmental abnormalities in high trophic level wildlife, including harbour seals. We recently demonstrated that harbour seals inhabiting Puget Sound, Washington State, USA, were seven times more contaminated with polychlorinated biphenyls (PCBs) than their counterparts inhabiting the Strait of Georgia, British Columbia, Canada. In a subsequent study, we constructed harbour seal "food baskets", each consisting of over 200 individual prey items reflecting dietary preferences for seals in the two basins, finding PCB concentrations to be consistent with those detected in seals (*i.e.*, 7-fold higher in Puget Sound). Concentrations of the largely unregulated polybrominated diphenyl ethers (PBDEs) were approaching those of the PCBs, highlighting the emergence of a significant new chemical concern for marine mammals. We characterized the bioaccumulation and trophic transfer of PCBs and PBDEs in Strait of Georgia harbour seals. Total PCB concentrations in adult harbour seals from the Strait of Georgia were three times higher than seal pups, and increased with age, illustrating the bioaccumulative nature of PCBs. PCB concentrations in adult male harbour seals were twice that of adult females, reflecting the lactational transfer of PCBs from female to pup. Concentrations of the most prominent PCB congener (153) increased with stable $\delta^{15}\text{N}$ ratios in the Strait of Georgia seal food web ($r = 0.57$; $p = 0.01$). Dramatic changes in POP patterns from prey to predator (food basket to harbour seal; fish to harbour seal), exemplified by the loss of lower-chlorinated or "lighter" PCBs, provide evidence of metabolism by harbour seals. Only by characterizing the relative importance of factors such as age, sex, condition, prey selection, site, and metabolism, can we reliably interpret contaminant concentrations and patterns in marine mammals. In such a way, harbour seals can be used to identify regional contamination "hotspots", and provide integrated information on the ecological health of coastal food webs.

Using Photo-Identification to Monitor the Conservation Status of Harbour Seals

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The European Habitat's Directive protects harbour seals (*Phoca vitulina*) in Special Areas of Conservation (SAC). The Directive requires that populations within these SACs are monitored with a six yearly reporting cycle. The Sea Mammal Research Unit has carried out aerial surveys of harbour seals around the British coast since 1988. For consistency, these aerial counts are only carried out during a three-week period within the annual moult. Temporal and financial limitations restrict the frequency of aerial counts, such that each area of coast is surveyed on average once every four to five years. To understand more about the conservation status of harbour seals, photo-identification could be used as an additional or alternative monitoring technique. Harbour seals have unique pelage patterns that provide a potential for individual photo-identification from natural markings. As well as providing local abundance estimates, photo-identification could provide additional information on estimating adult and pup survival, distribution and on the general health status of individuals. This study tested the use of computer-assisted photo-identification for estimating harbour seal abundance. Around 700 photographs were taken each month between April and October, except during the August moult, from small tourist boats off the Isle of Skye, northwest Scotland. Each seal was photographed several times (mean = 6.46) from both sides and at different angles. Different pattern cells or combinations of pattern cells (ventral, flank, shoulder and side of head) were used for automatic selection of potential matching pairs and those pairs were then checked visually. Local abundance estimates from photo-identification data were compared with those obtained from five consecutive aerial surveys conducted in August the previous year.

Variability of Fatty Acids in Blood and Blubber of *Zalophus californianus* Pups in the Gulf of California, Related to Size, Age, Sex and Time of Fasting

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The analysis of fatty acids (FA) is a technique of increasing use to describe the diet in marine mammals, however sampling is sometimes a difficult task. For some pinnipeds samples from pups and relatively easier to obtain and could be used to track the feeding habits of their mothers, however is necessary to determine the similitude between pup and mother FA profiles and other sources of variability affecting the FA profiles in the pups. In this study we explored the relationship between FA profiles in blood and blubber of California sea lion pups and their size, sex and relative time of fasting and age. Thirty two pups were captured and anesthetized in the summer of 1999, to collect samples of blood and subcutaneous fat on the ventral side of the animal by micro liposuction with a syringe. The samples were analyzed by gas chromatography with flame ionization detection (FID). Half of the 24 FA analyzed, had significantly different abundance in plasma as opposed to blubber (Kruskal-Wallis Test $p < 0.05$). No differences were observed in plasma FA profiles with respect to size or age and sex of pups, but differences were observed with relative time of fasting. The FA 22:2n6 in blubber was significantly more abundant in female pups (K-W $p < 0.05$), while the FA 18:2n6c and 22:1n9 increased with pup weight and the FA 18:2n6t increased with age (K-W $p < 0.05$), however relative time of fasting had not influence in the FA profiles of the blubber. These results suggest that FA in blubber would be more appropriate to compare diet among sea lions pups, as its variability due to size and age was limited to a few FA but not affected by fasting time, a variable more difficult to control in field conditions.

Structure and Innervation of the Vibrissal Follicle Crypts in the Dolphin *Sotalia fluviatilis guianensis*

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Early morphological studies described vibrissal follicles of odontocetes as vestigial structures. But recent IR-thermographic studies on *Sotalia* demonstrated follicles as clearly defined spots of high heat radiation, suggesting that they are functional sensory units. Light microscopic techniques were used to examine the structure and innervation of these follicles obtained from a male *Sotalia*. Histological observations showed that they differ fundamentally from vibrissal follicle-sinus complexes seen in other mammals. Distinct morphological characteristics like a capsule, a hair shaft, a hair papilla and a blood sinus are missing. Therefore we use the term 'follicle crypt' for these special structures. A follicle crypt consists of an invagination of the epidermis, which expands into a papillary pear-shaped structure that varies in lengths from 4.1–7.1mm and from 1.2–4.3mm in width. It is surrounded by large blood vessels responsible for the increased temperature seen in thermograms. The lumen of the follicle crypt is filled with desquamated keratinocytes and varies in length from 1.2–6.6mm. Immunohistology (PGP 9.5) revealed dense innervation. Nerve bundles approach from below and branch underneath an adiposal fat body at the base of the follicle crypt. Numerous nerve fibers ascend along the subepidermal connective tissue and surround the follicle crypt like a net, but innervation is mainly located at its lower two-third. Small nerve fibres innervate numerous Merkel cells scattered in the epidermal basal layer. No other nerve terminals were identified. Also we could not identify any intraepithelial nerve fibers or any axons penetrating the follicle crypt, which might be a consequence of the autolytic stage of the tissue. Due to the high blood supply and the dense degree of innervation

these morphological data support the hypothesis that follicle crypts of *Sotalia* are functional sensory units.

Using GIS to Identify Mother-Pup Pairs in a Harbor Seal Population

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Identification of pups from aerial photographs is a challenge for estimating productivity of harbor seal populations, partly due to the presence of yearlings, which are similar to pups in size and appearance. To distinguish harbor seal pups from yearlings, researchers typically rely on visual assessments of relative size, proximity, and orientation to nearest neighbors, as well as pelage color. Since most of these criteria are spatial in nature, we used a geographic information system (GIS) to quantify our identifications of pups in aerial photographs from biweekly surveys of a harbor seal population in Disenchantment Bay, Alaska during the pupping season (May-June, 2004). Because the seals hauled out on relatively flat glacial icebergs and contrasted strongly with the ice, we were able to accurately measure body lengths and inter-seal distances on our georeferenced photographs. We calculated the relative size and proximity of each seal to its closest neighbor and plotted three-dimensional histograms of these variables for five surveys. As the pupping season neared its peak, three distinct modes developed in the length-proximity distribution. Two of these modes were observed among seals in close proximity: one represented seals much smaller than their nearest neighbors (likely pups) and the other, seals much larger than their nearest neighbors (likely mothers). The third mode represented nearest neighbors of similar lengths and various proximities. The length-proximity distributions of known mother-pup pairs (*i.e.*, pairs that were nursing) closely matched those of likely mothers and pups, though such a pattern could also include yearlings closely associating with adults. These results suggest that spatial measures are useful for identifying mother-pup pairs, and that refinements, such as including pelage color gradation to further discriminate between pups and yearlings, may aid in quantifying age-class structure of harbor seal populations.

Interannual and Small-Scale Spatial Variation in Humpback Whale Encounter Rates in the Gerlache Strait, Antarctic Peninsula

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Previous studies have indicated that the Gerlache Strait is an important feeding ground for humpback whales in the Antarctic Peninsula region and might represent a valuable site for long term ecological studies. During the austral summers of 1997/98 to 2004/05, the Projeto Baleias/Brazilian Antarctic Program conducted ship surveys for whale distribution and sighting frequencies in the Gerlache Strait, westward of the Antarctic Peninsula (edge between IWC Areas I and II). Between the summers 2001/02 and 2004/05, simultaneous whale and oceanographic data were collected as a multidisciplinary study by the "High Latitude Oceanographic Group" (GOAL). In order to explore the possible association between whale distribution pattern and chlorophyll-*a* concentration, a preliminary analysis to test small-scale spatial correlation of whale encounter rates with chlorophyll-*a* concentration was performed. Humpback whales showed the highest annual mean encounter rate (0.73 whale/nm), followed by minke

whales (0.11 whale/nm) and killer whales (0.11 whale/nm). Years of higher encounter rates of humpback whales were also years of higher chlorophyll-*a* concentration. Analysis of small-scale spatial whale distribution showed a significant correlation between whale encounter rates and chlorophyll-*a* concentration (Spearman's rank correlation). These preliminary results suggest that primary productivity might be a reasonable predictor for humpback whale distribution, at least in the area west of the Antarctic Peninsula. Additional analyses using chlorophyll data from remote sensing as well as other predictors and spatial scales are in progress to better understand the nature of the observed correlation.

Habitat-based Spatial and Temporal Variability in Life History Characteristics of Female Common Dolphins (*Delphinus delphis*) in the Eastern Tropical Pacific

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Spatial and temporal variability in total body length, mean age, and breeding season were examined using 878 central stock female short-beaked common dolphins (*Delphinus delphis*) incidentally killed in the eastern tropical Pacific (ETP) tuna purse-seine fishery between 1973 and 1993. A *k*-means cluster analysis was used to form *a priori* spatial groupings based on habitat differences reflected by a principle component analysis of oceanographic variables. Life history parameters were compared between *D. delphis* associated with the Costa Rica Dome (CRD), those that lived in the surrounding areas of the CRD, and between "early" and "later" time periods in the data set. Calving occurred throughout the year (Kuiper's test: $P > 0.10$) for both spatial groups. A two-way ANOVA demonstrated that the mean age of mature females did not vary over space and time. However, a two-way ANOVA followed by a Tukey Multiple Comparison test demonstrated that the mean total body length of *D. delphis* sampled "on" the CRD was 10 cm shorter than those sampled "off" the CRD during the years 1973-1974. Mean total body length did not vary between these two habitat groups in the "later" years of 1988-1989. The difference between spatial groups during the 1973-1974 time period is likely attributed to animals moving within the region in response to changes in their environment. That is, animal size and location is consistent with southern stock *D. delphis* moving into the higher quality habitat of the CRD area during the strong El Niño of 1972-1973 when preferred habitat was likely reduced in the area that the southern stock inhabits. Our evidence for animal movement suggests that animals cross stock boundaries during periods of significant environmental change. This result has implications for development and implementation of management plans and estimation of life history parameters for *D. delphis* inhabiting the ETP.

Annual Mortality of Franciscanas (*Pontoporia blainvillei*) by the Coastal Fishery in Northern Rio Grande do Sul, Brazil

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The Franciscana (*Pontoporia blainvillei*) is the small cetacean most threatened by incidental catches in the Southwestern Atlantic Ocean. In this study, we aimed to update the Franciscana mortality estimates in northern Rio Grande do Sul by the coastal fishery and identify periods, areas, and fishery gear that present more risk to the species in this region. The fishery communities of Torres and Tramandaí were surveyed from January 2002 to December 2004 during 350 days. The masters of 12 fishing boats (25% of the fleet) were interviewed and asked to collaborate with the project by filling a standard log-book with information on the fishery (date, local, effort) and Franciscana by-catches. In order to verify the fishery

characteristics and Franciscana by-catches *in situ*, 33 onboard surveys were carried out. Fishing boats were separated into five categories according to their characteristics (size, autonomy, fishery effort). In order to minimize biases from extrapolations, Franciscana mortality was estimated separately for each boat category. Annual mortality was calculated as (CPUE) \times (average daily fishery effort) \times (number of fishing days per year) \times (number of vessels). An annual mortality of 535 Franciscanas (95% CI: 357 – 747) was estimated for northern Rio Grande do Sul. Franciscana by-catches occurred in depths ranging from 9 to 45 m, and about 37% of CPUE values were from waters shallower than 20 m. Concerning the period of the year, two evident peaks of mortality were noticed: one in summer and another in winter. The fishing gear with the highest CPUEs have quite different mesh sizes (9-11 and 18 cm) and are probably more related to the period of the year when they are utilized than with its intrinsic characteristics. When this estimate is summed with the mortality caused in southern Rio Grande do Sul, the total Franciscana by-catch certainly outnumbers one thousand per year. *Financial support: FNMA/MMA – Brazilian Federal Government; Yagu Pacha Organization; Cetacean Society International.*

Sonar Beamwidth Control, Beam Steering, and Off-axis Target Detection by a Bottlenose Dolphin

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The reported mean beamwidth of the dolphin echolocation beam is nearly symmetrical with a 3-dB beamwidth of $\sim 10^\circ$. The receive beam is comparatively larger, suggesting detection capability for objects located peripheral to the maximum response axis (MRA) of the transmit beam. To determine object detection capability off of the MRA, a bottlenose dolphin (*Tursiops truncatus*) was trained to echo-detect metal, water-filled targets. Targets were placed 9 m from the dolphin, first aligned with the long-axis of the dolphin's body, and then progressively displaced laterally. The dolphin stationed on a biteplate to prevent head movement while echolocating. A curved array of 24 hydrophones (77° horizontal arc/33.2° vertical arc) was placed 1 m in front of the biteplate so that the echolocation beamwidth could be measured for each echolocation click. The dolphin detected an 18 cm diameter sphere up to 26° left and 21° to the right of the MRA and an 18 x 7.6 cm cylinder up to 19° left and 13° to the right of the MRA. Movement of the MRA, independent of head movement, indicated that the dolphin could nominally steer its echolocation beam $\sim 7^\circ$ horizontally and $\sim 4^\circ$ vertically. Horizontal beamwidths varied from 5 – 35° and vertical beamwidths varied from 3 – 22°. Lateral beam steering was coupled to an increase in horizontal beamwidth; mean beamwidth while the MRA was centered on the array was 13.4 – 5.9° but was 20.8 + 2.0° and 18.8 + 4.3° when nominally steered $\sim 7^\circ$ to the left or right, respectively. Vertical beamwidth increased from 11.8 + 3.8° to 16.2 + 3.0° when the MRA was nominally steered $\sim 4^\circ$ upward of the array center, but only slightly decreased when steered downward. Results indicate that dolphins have a limited echolocation beam steering capability and demonstrate considerable plasticity in and control over the echolocation beamwidth.

Are Humpback Whale Song Characteristics and Singer Behavior Consistent with Male Cooperation in Mating?

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Most speculation on the humpback whale song has been based on assumptions that male relations were fundamentally competitive within a polygynous breeding system. Non-agonistic and cooperative behavior among males broadens the context in which to consider song function. The behavior and interactions of 167 singers were studied from 1997-2002 in Hawaii. Singers typically: 1) were lone males (80%); 2) sang until joined by non-singing males (87%), at least some of which had been neighboring singers; 3) engaged in brief interactions (80% < 10 min), otherwise the pair stayed together until

a subsequent interaction; 4) were involved in non-agonistic (83%) interactions and; 5) were involved in sequences of such interactions across the breeding ground (documented in 25% of sample) which could lead to one or more of the males joining a group that included a female (documented in 13% of sample). A singer-joiner interaction proceeded directly to discernable cooperative behavior around a female in two obvious cases; this relationship was not ruled-out in other similar interactions. The two key elements of male behavior during the breeding season are: a song that unites males, but changes collectively throughout the breeding season; and a wide range of male-male relationships that range from aggressive to non-agonistic to cooperative. One hypothetical construct is: the song's characteristics of continuous change, and adoption of these changes by all singers, provide a real-time index of association of males; that is, the more time spent in acoustic range, the more similar the song. Constant, song-facilitated, male-male interactions make it likely that males in a specific area connect physically, and potentially engage in coordinated/cooperative behavior around females. The song provides an automatic means of recognition of recent associates and likely assistants, thereby a basis for selective, mutual male cooperation in accessing females. These features are consistent with reciprocal altruism theory.

Mercury, Polychlorobiphenyls and Stable Isotopes in the Blood of Harbour Seals (*Phoca vitulina*) from the Southern North Sea

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The harbor seal (*Phoca vitulina*) is one of the most widely distributed seal species and the North Sea contains around 10 % of the world population. The harbour seal population in the North Sea was estimated at 36 000 individuals between 1994 and 1996). However, recurrent Phocine Distemper Virus (PDV) epizootics have affected the North Sea seal population. Recently, 21 500 harbor seals were killed by PDV in the North Sea and adjacent waters in 2002. Some intriguing questions about the interaction between PDV and immunotoxic contaminants, such as mercury (Hg) and polychlorinated biphenyls (PCBs) remain unanswered. In this framework, circulating levels of Hg and PCBs (PCBs 28, 52, 101, 118, 138, 153, 180) were measured in the blood of 24 harbour seals captured on a sandbank between 2001 and 2004 (Schleswig-Holstein, Germany). As pollutant level may be linked to the trophic position in the food web, carbon and nitrogen isotopic ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) were measured in clotted blood cells. The average concentration of mercury in these living seals did not differ significantly from those observed previously in stranded harbour seals (94 ± 41 vs 146 ± 71 $\mu\text{g.l}^{-1}$ respectively). Mean blood concentrations of total PCBs ("PCBs") were 11 ng/ml. CB 153 clearly dominated the mix (45%) followed by PCB 138 (31%). The average isotopic composition measured in the blood cells was -15.6 ± 0.3 ‰ and 18.7 ± 0.6 ‰ for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ respectively, similar to that obtained previously in muscle of stranded individuals, confirming the high position of the harbour seal in the North Sea trophic chain. Further investigations are obviously needed on a larger sampling but our preliminary results suggest that blood is an interesting substrate for both trophic and pollutant long-term monitoring of the harbour seal in the North Sea.

Diving Behavior of Sperm Whales and Their Jumbo Squid Prey

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Sperm whales play an important role in pelagic ecosystems, but knowledge of their foraging behavior is limited due to deep, long dives for prey about which little is known. In the Gulf of California, Mexico, sperm whales are thought to feed largely on *Dosidicus gigas* (jumbo squid), a commercially-fished species that aggregates near shore, thus presenting a unique opportunity to concurrently investigate diving behavior of both sperm whales and squid. In November 2004, we attached satellite depth-recorders to five sperm whales in the central Gulf, and data were transmitted to the ARGOS satellite system when the whales surfaced. Pop-up satellite archival tags were deployed on three large *D. gigas* in roughly the same area. These tags monitored depth and temperature, detached after ~1 week, and transmitted data to ARGOS satellites after surfacing. Nearly all sperm whale dives (92%) ≥ 100 m ranged from 100-500m, representing 88% of time submerged. The deepest dives (1.9%) were 1,250-1,500 m. Most (71%) dives ≥ 5 min were between 15-35 min. During the day, whales made most of their dives to a depth range (200-500 m) where jumbo squid spent most of their time, thus foraging where the probability of encountering squid was highest. At night squid distribution was bimodal, with a major peak at 100-200m and a secondary component at 300-400 m due to squid making frequent recovery dives to the preferred daytime depth, however whales continued to make most dives to 300-400 m. This pattern of diving by whales during both day and night (200-500 m) suggests that they are foraging on squid in the upper region of the oxygen minimum layer. In this cold, hypoxic region squid are probably slower, less reactive and particularly susceptible to predation. Although exactly how sperm whales capture jumbo squid remains unknown, our data suggest that whales have adopted foraging strategies that may minimize the challenge.

Sexual Maturity and Annual Reproductive Cycle of the Male Australian Fur Seal (*Arctocephalus pusillus doriferus*)

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Studies on several otariid species, including the Cape fur seal (*Arctocephalus pusillus pusillus*), have indicated males undergo an annual cycle of testicular activity, with sperm production initiating just prior to the start of the breeding season and then regressing after the breeding season ends. Variability in the timing of breeding in some otariids has also been shown to be related to latitude and environmental conditions. Furthermore, sexual maturity in mammals is generally reached at a younger age when populations are of lower densities. The Australian fur seal (*A. p. doriferus*) is a sub-species of the Cape fur seal with a breeding distribution further south than its con-specific. It has also experienced slower population recovery rates, occurring in colonies of much lower densities than the Cape fur seal, which is thought to be related to differences in local marine productivity. The annual reproductive cycle and age of sexual maturity of male Australian fur seals was examined in 58 specimens collected from Seal Rocks (38°31'S, 145°06'E). Despite lower population densities and faster growth rates of male Australian fur seals, age at sexual maturity was the same as in Cape fur seals (3 yr) and peak testicular activity occurred at the same time (December). However, in contrast to that found in other otariids, sperm production and testicular enlargement appears to occur outside of the breeding season for a substantial proportion (70.58%) of individuals. Leydig cell nucleus diameter also indicated heightened testosterone production at these times. Some male Australian fur seals have been shown to return to the colonies, engaging in territorial activity outside of the breeding season which may be related to testicular activity. The significance of this behaviour is not known but may function to

develop territory familiarity and enhance tenure during the breeding season which could, in turn, increase reproductive success.

An International Neighborhood: A World-Wide Perspective on the Population Structure and Genetic Diversity of Bottlenose Dolphins (*Tursiops truncatus*) in New Zealand

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Bottlenose dolphins (*Tursiops truncatus*) inhabit a wide range of coastal, insular and pelagic habitats throughout tropical and temperate waters around the world. In some regions, coastal forms differ genetically and morphologically from pelagic forms despite no obvious boundaries to interchange. Around New Zealand, bottlenose dolphins have a discontinuous distribution, inhabiting three ecologically distinct areas: Northland, Marlborough Sounds and Fiordland. Previous demographic studies based on individual identification photographs show no interchange of individuals between populations. To describe the genetic isolation or interchange among these populations, skin samples were collected from dolphins using a small biopsy dart. Analysis of the molecular variance from mitochondrial DNA (mtDNA) control region sequences (n=99) showed considerable differentiation between populations ($F_{ST} = 0.20$ and $\hat{O}_{ST} = 0.50$, $p < 0.001$) suggesting little or no female gene flow. All three populations showed greater mtDNA diversity than expected given their small sizes (e.g. less than 70 individuals in Doubtful Sound, Fiordland) and isolation. To explain the source of this unexpected variation, 338 sequences of the mtDNA control region were obtained from collaborators and reconstructed from published surveys of 12 populations worldwide. Genetic differentiation among populations was also high ($F_{ST} = 0.20$ and $\hat{O}_{ST} = 0.50$); and haplotype differentiation was even greater when the populations were grouped into ocean basins ($F_{ST} = 0.35$). A nested clade analysis was performed to infer ancestral haplotypes and to test for associations of haplotype variation and geography in a phylogenetic framework. Results suggest an interesting pattern of repeated colonization and subsequent isolation, perhaps augmented by occasional gene flow from larger pelagic populations.

Molecular Scatology as a Tool to Study Diet: Analysis of Prey DNA in Scats from Captive Steller Sea Lions

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The DNA of prey present in animal scats may provide a valuable source of information for dietary studies. We conducted a captive feeding trial to test whether prey DNA could be reliably detected in scat samples from Steller sea lions (*Eumetopias jubatus*) that had been fed a diet of fish (five species) and squid (one species). Most of the DNA extracted from the collected scats came from the predator, but prey DNA could be amplified using prey-specific primers. The four prey species fed in consistent daily proportions throughout the trial were detected in more than 90% of the DNA extractions. Squid and sockeye salmon, which were fed as a small percentage of the daily diet, were detected as reliably as the more abundant diet items. Prey detection was erratic in scats collected when the daily diet was fed in two meals that differed in prey composition, suggesting that prey DNA is passed in meal specific pulses. Prey items that were removed

from the diet following one day of feeding were only detected in scats collected within 48 hours of ingestion. Quantitative estimates of diet composition could be obtained if the relative amounts of prey DNA in the scat are proportional to the relative mass of the prey items consumed. To investigate this possibility, we measured the proportions of DNA from the fish prey species in scat samples. Our results show that the proportions of fish DNA are roughly proportional to mass of the prey items consumed; however, some species specific bias due to differential digestion is apparent. Finally, we used a novel real-time PCR method to quantify the extent of DNA degradation in the scat samples.

The Context of Breaching Behavior Performed by Humpback Whales on the Hawaiian Wintering Grounds

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To better understand the context in which breaching occurs in humpback whales, we examined the relationship between breaching, social role, and group composition. Observations were made of 2,609 groups of humpbacks in Hawaiian waters over five winters (2000 through 2004). This amounted to 6,005 individuals for a total of 2,120 hours of observation. Ten percent of all whales observed performed breaches. The whales most likely to be seen breaching were immatures (calves, yearlings, and juveniles), of which 27% (67 of 177) breached compared with only 9% (145 of 1505) of adults, a significant finding. Adult males (45 of 824) and adult females (22 of 296) were not significantly different in breaching likelihood (5-7%). Adult males not in the presence of other adult males (*i.e.*, not in a competitive group) were significantly more likely to breach (11%, 29 of 241) than adult males accompanied by one or more adult males (3%, 16 of 583), suggesting that breaching is not a male dominance display. Adult females not in the presence of an adult male were significantly more likely to breach (24%, 8 of 26) than adult females accompanied by one or more adult males (5%, 14 of 271). An adult male was never observed to join a breaching, unescorted female. However, her calf was also surface active in 75% of the observations, suggesting social facilitation of breaching behavior in these mother/calf groups, and not likely an attempt to attract a male escort. Overall, a breaching whale (23%, 121 of 523) was significantly less likely to gain or lose a member of the group than a whale that was not breaching (58%, 1,806 of 3,139). These findings suggest that breaching is not sex specific, may not directly attract other whales, and may be an expression of playfulness or exuberance in young animals.

Mechanisms Involved in the Mobilisation of Polychlorinated Biphenyls from Blubber in Phocid Seals

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Phocid seals are characterized by extended fasting situations (lactation, post-weaning, *etc.*) during which they rely entirely on their own body reserves. During these periods, lipids are mobilised from blubber in order to match the energy requirements of the animal. This transfer induces the freeing of toxic fat-soluble pollutants such as polychlorinated biphenyls (PCBs) into the blood circulation, which may exert adverse health effects. We have investigated the dynamics of PCB mobilisation from blubber into the blood circulation in grey seal (*Halichoerus grypus*) adult females during lactation as well as in northern elephant seal (*Mirounga angustirostris*) pups during the post-weaning fast. Longitudinal samples of blubber and serum were collected

at the beginning and at the end of the fasting period. Blubber biopsies were separated into inner and outer blubber. In both physiological status (lactation and post-weaning fast), PCB concentrations in inner blubber increased at the end of the fast whereas they remained constant in outer blubber. A corresponding rise of PCB concentrations was observed in the serum. The increases of PCB concentrations in inner blubber and serum were more pronounced in leaner animals. These results suggest that the dynamics of PCB mobilisation from blubber are similar among different fasting situations (lactation or post-weaning). The pollutants tend to accumulate in the remaining amount of blubber until its retention capacity for PCBs is reached. Beyond this point, the chemicals cannot concentrate anymore and begin to be released in higher amounts in the circulation. The greater increase of PCBs observed in leaner animals suggests that the retention capacity of blubber for PCBs is reached more quickly, resulting in a sharper increase of concentrations in the serum. These animals may thus be more at risk for potential toxic effects.

DARWIN – Dolphin Photo-identification Software: Adaptations to Digital Camera Acquisition and Increased Matching Accuracy

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DARWIN is a computer program that allows users to manage archives of digital images, store and retrieve sighting data related to those images, and automate the photo-identification of dolphins from digital photographs of dorsal fins. The program allows researchers to query a database of previously identified dorsal fin images with a digital image of an unidentified dolphin's fin. With minimal user interaction it detects and characterizes the query fin's outline, adjusts its 3D pose and responds with a rank ordered list of the database fins it most closely resembles. This helps researchers to prioritize their search of database images, and potentially reduces the time required for identification. The system has no fixed limits on image size, quality, resolution or color representation. A basic suite of image enhancement tools exists and is being augmented. Original and modified versions of images will be equally accessible. As digital cameras rapidly replace film cameras in the field, the software is being adapted to the changing needs of the user community. Compatibility with appropriate image formats, efficient handling of higher resolution image data, and streamlined data entry are being incorporated to facilitate the processing of increasing quantities of field data. Automatic retrieval of relevant EXIF data and export of sighting data for external processing and analysis exemplify our efforts to reduce user workload, data entry requirements and transcription errors. In order to further increase the matching accuracy and utility of the DARWIN software, the most successful aspects of a quantitative dorsal fin matching process have been incorporated within a broad hierarchical approach using qualitative distinctions between fins. This enhanced software (1) facilitates subset searches of the database based on damage category (missing tip, etc), (2) selects more intuitive transformations for 3D pose realignment, and (3) more closely emulates the manual photo-identification process.

Studying Killer Whale Predation in the Field: A Sound Approach to Detecting Kills

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Killer whales are top predators in many coastal and oceanic ecosystems and are thus likely to play an important role in regulating marine mammal populations. Field studies investigating the energetic requirements and dietary preferences of mammal-eating killer whales have been compromised by our inability to consistently identify kills. In particular, attacks on smaller prey may be difficult to detect by

conventional visual observation techniques alone. This leads to underestimates in capture rates and to biases in the perceived diet spectrum towards larger species that are more difficult to subdue. We conducted a 5-year study of the vocal behaviour of mammal-eating killer whales in south-east Alaska and British Columbia to test whether acoustic monitoring can be used to detect killer whale attacks. Compared to fish-eating killer whales, we found that groups of mammal-hunters travelled in complete silence the great majority of the time. Vocal behaviour was limited to brief bouts while the animals were surface-active or were milling after a successful attack. The animals started vocalizing following 11 of the 12 confirmed kills of marine mammals. This shows that vocal behaviour is consistently associated with predation events and can be used to document their occurrence. Our findings indicate that acoustic monitoring should be incorporated into field studies attempting to assess the prey capture rates of mammal-eating killer whales and the impact of their predation on marine mammal populations.

A Temporal Perspective on Pinniped Foraging Ecology: Stable Isotope Variations in the Teeth and Bones of Steller Sea Lions (*Eumetopias jubatus*)

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Stable isotopic studies on north Pacific pinnipeds have previously been used to determine the impact of shifts in nutritional limitation on the survival of marine mammals, but have been spatially insufficient to decipher a trophic link with their population collapse. This study employs stable isotope analyses of Steller sea lions (SSL-*Eumetopias jubatus*) throughout their entire spatial range during their precipitous population decline. To investigate the impact of geography and feeding range on trophic inputs to SSL, bone and tooth collagen of SSL ranging from southeastern Russia to southern California ($n = 196$), were sampled and analyzed for stable carbon and nitrogen isotope ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) composition. Rather than a uniform isotopic composition, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the SSL samples analyzed vary greatly according to the location and year of each sample ($\delta^{13}\text{C} = -17$ to -11 ‰; $\delta^{15}\text{N} = 14$ to 22 ‰), with signatures indicative of their home range and feeding source. Lower $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in SSL from more western areas are likely the result of consuming lower trophic level fish species. Tooth collagen analyses assisted in filling temporal gaps and elucidating fine-scale life history changes. The range of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values over all samples is larger than normal population variation, suggesting differences in feeding behavior/area across both species' range and decline period. The signature differences and trends isolated from tooth samples suggest that there may have been a change in $\delta^{13}\text{C}$ around a regime shift period (~1976), and that this jump may be due to alterations in local primary production. Using stable isotope mixing models, this new dataset will help to isolate specific sources of isotopic depletion, highlight the importance of nutritional limitation, and ultimately further our understanding of natural population foraging and mammalian reactions to environmental changes.

How a Harbor Seal Sees the Night Sky

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One possible mechanism for offshore orientation in marine mammals could be astronavigation. The knowledge how to navigate by the stars without the help of technical instruments has been used by ancient seafarers and is still in use in some Polynesian navigators. Of course,

the first prerequisite for astronavigation is to see the stars. This has been particularly unclear for seals as it is assumed that due to adaptations of their dioptric apparatus to the optical properties of water, pinniped vision should be myopic and suffer from astigmatism when out of the water under low light conditions. Using a go/no-go response paradigm we therefore tested the capability of a harbor seal (*Phoca vitulina vitulina*) to see real and artificial stars of various brightness. The dark-adapted seal was trained to place its head into the opening of a traversable tube and to retreat its head only when a small light appeared at the opposite aperture. Correct responses were rewarded by pieces of cut herring. During the first block of experimental sessions, qualitative evidence was obtained by showing that the seal responded to some bright real stars (e.g., Sirius) becoming suddenly visible when the tube was slowly moved across the night sky. During the second experimental stage, absolute thresholds were determined using artificial stars consisting of small spots of parallel light of pre-defined brightness generated by an optical system installed in front of the tube. The seal was able to detect artificial stars down to a brightness of 4.4 star magnitudes. This sensitivity should allow a seal to see enough stars of the night sky to reliably perform astronavigation.

Prebottleneck Microsatellite Variation in the Northern Elephant Seal (*Mirounga angustirostris*)

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Northern elephant seals (*Mirounga angustirostris*) were hunted almost to extinction in the late nineteenth century, which resulted in a severe genetic bottleneck. Early genetics work on the species failed to find genetic variation. However, the advent of highly variable molecular markers, such as microsatellites, has the potential to reveal genetic variation in such bottlenecked species that may be useful for population studies. Microsatellites have proven useful in other bottlenecked species to elucidate population structure and dynamics. We surveyed 57 microsatellite loci in northern elephant seals, including seals from two of the three largest colonies. We compared genetic variation from 528 seals sampled throughout the entire range of the species, including rookeries throughout California. Of the 57 microsatellites genotyped, only 17 were polymorphic, with 2 to 6 alleles present and a mean of 2.8 alleles per locus. This is among the lowest recorded genetic diversity for a mammal at these normally highly variable genetic markers. Additionally, sequence analysis determined that some of this variation was present before the bottleneck. An evaluation of genetic population structure revealed no significant differences between geographically separated rookeries and no evidence of structure. Finally, northern elephant seals are an excellent natural model system for the estimation of mutation rates, because newly arising mutations are readily identified and the population has grown approximately exponentially. Microsatellite mutation rates so estimated are similar to those of other mammals. This work demonstrates that genetic tools are useful for evaluating population biology of northern elephant seals in spite of past reductions in population size which have removed most of the genetic variation. However, many markers may be necessary to identify individual- and family-level structure.

Incidental Captures of Franciscana (*Pontoporia blainvillei*) in Southeastern Brazil

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Information on Franciscana (*Pontoporia blainvillei*) incidental captures in fishery operations is still scarce along São Paulo state coast, Southeastern Brazil. In this study, the fishing fleet of Cananéia (25°00'S - 47°55'W) was monitored with the main objective of describing the fleet, fishing gear and operations, as well as to evaluate

the bycatch of the franciscana and other small cetaceans. From October 2004 to March 2005, logbooks were provided to 18 boats (78% of the fleet) with questions about fishing effort, characteristics, soak time, target species and cetacean incidental interactions. Net lengths and heights ranged from 2 – 9 km and 1.5 – 15 m, respectively. They were made of nylon monofilament thread, with mesh sizes varying from 7 to 13 cm. A total of 643 fishing trips were recorded during the monitoring period. The fishing effort was around 1,650 km and 6,700 km² of nets immersed along the six months. At least a total of 22 franciscanas out of 33 dolphins captures were recorded. Captures of this species occurred mainly between 3 and 28 nm from shore in waters ranging from 10 to 20m in depth. The Franciscana catch per unit of effort resulted in 0.0133 animals x (km of net x day)⁻¹ or 0.0032 animals x (km² of net x day)⁻¹. Although this study is preliminary, relatively high CPUE values were observed in comparison to other areas along the range of the species. A high fishing effort was recorded in the Franciscana preferred habitat. This shows the importance of conducting additional studies in the area in order to better evaluate the magnitude of the impact caused by the fishery on franciscanas in southeastern Brazil. *Acknowledgements: We thank the Parque Estadual da Ilha do Cardoso (PEIC) for logistical support. This work was supported by the Brazilian Government, PROBIO/ Ministério do Meio Ambiente/ Brasil, BIRD/GEF and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).*

Human Interaction Impact on Cetacean Recorded Along Peruvian Coast

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In the central coast of Peru, little is known about incidence of cetacean strandings due to human interaction. This study focuses on the impact of human activity in the local populations of cetaceans as main stranding cause. Stranding cases (n=117) were recorded from areas next to high fisheries activity and densely populated towns between January 2002 and May 2005. All cases were medically characterized through laboratory diagnosis and post-mortem examination. Findings were classified according to the cause of stranding: stabbing, fisheries entanglement, slaughtering/ harvesting for human consumption. These causes were statistically quantified according to species, age, gender, body area affected, and location. Results revealed that 75.21% (n=88) of total strandings registered had an anthropogenic origin related to effects of human activity in the environment of these marine mammals. Strandings revealed that Burmeister's porpoise (*Phocoena spinipinnis*) and bottle nose dolphins (*Tursiops truncatus*) were the most affected by human interaction (39.77% and 37.50% respectively). Locations with higher incidence of strandings caused by human activity were beaches in the northern coast of the country (S 4° 06.437' - W 81° 03.740' / S 7° 31.176' - W 79° 32.405') (n=44, 50%) and in the south next to Paracas National Reserve (S 13° 18.366' / W 76° 15.457' / S 13° 53.749' / W 76° 18.865') (n=24, 27.27%). Most of the animals stranded due to human interaction showed lesions over the thorax, muscle removal over the spinal column and/or were decapitated. We concluded that the impact of human interaction in local populations of cetaceans next to towns is significant enough to be considered a major cause of strandings, and the causalities are not incidental but intentional. Incidental by catch or fisheries direct effect is not as significant as intentional harvesting in small boats, involving direct contact between humans and cetaceans in the coastal waters.

Population Genetic Structure of the Northeastern Pacific Gray Whale (*Eschrichtius robustus*)

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Evidence from long-term photo-identification studies on the Northeastern Pacific gray whale suggests a strong maternal philopatry to the breeding grounds. In order to test the influence of this behavior on the population genetic structure of the species, skin biopsies from free-ranging individuals were collected at the most important breeding lagoons along Baja California Peninsula, Mexico: San Ignacio (n = 20), Ojo de Liebre (n = 28) and Bahía Magdalena (n = 33). Molecular identification of gender, mitochondrial (mt) control region sequencing and genotyping at 6 microsatellite loci were performed for each sample. Sex ratio was skewed to females for all lagoons (3 to 6 females per male). We found 14 haplotypes (489 bp, 28 variable sites), from which overall haplotype and nucleotide diversities were estimated to be relatively high ($h=0.88$ and $p=0.02$, respectively) and equivalent in all lagoons. Differentiation tests failed to detect significant mtDNA genetic structure among lagoons (AMOVA; $F_{st} = 0.0120$ and $\Phi_{st} = 0.0002$, $p>0.05$ for both). Our results are consistent with previously reported mitochondrial molecular data for this population, suggesting little loss of genetic variation due to historical whaling. Preliminary results from 3 microsatellite loci also shown high overall diversity (0.97) but, in contrast with the homogeneity revealed by the mitochondrial DNA, nuclear markers detected a slight but significant difference between lagoons (AMOVA, $F_{st} = 0.014$, $p<0.05$). Even when nuclear genetic diversity was similar for the three lagoons, pairwise comparisons pointed out Bahía Magdalena as the most genetically distinct. Historically, Bahía Magdalena was the most important whaling ground in Mexico, and it currently exhibits a lower abundance and calf production when compared to the other two lagoons. Ongoing analysis of additional samples and loci will help establish if this demographic history could have originated the observed genetic structure at Mexican breeding grounds.

Human Listening Studies Reveal Insights into Echo Features used by Bottlenose Dolphins to Discriminate Among Objects

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Echolocating dolphins extract object feature information from the acoustic parameters of object echoes. However, it is not clear which acoustic parameters of object echoes convey object features such as size, shape, and material to an echolocating dolphin. To gain insight into which acoustic parameters may be salient for dolphins, human listeners were presented with slowed-down echoes from objects used in dolphins' discrimination tasks. The advantage to using humans is that they can verbally report the echo parameters that allow them to discriminate among objects. In three experiments, participants listened to an echoic sample via headphones and then visually selected the correct object. In the first experiment, participants were able to discriminate between objects varying in size, shape, and material ($M = 88\%$ correct) and reported using acoustic parameters such as loudness, pitch, and timbre. In the second experiment, the results suggest that listening to echoes from various object orientations is effective for identifying shape, but not necessary for identifying object size or material. In the third experiment, participants reported using primarily pitch to discriminate between aluminum cylinders with different wall thicknesses (± 0.8 mm). In all experiments, participants performed as well or better than the dolphins and made many of the same types of errors as the dolphins. These data suggest that dolphins may use some of the same echo parameters reported by the human listeners to discriminate among objects. These human listening studies shed light on how dolphins could extract object feature information from echoes and can be used to generate hypotheses that can be tested using dolphin subjects.

Microflora of Steller Sea Lion Pups (*Eumetopias jubatus*) of the Kamchatka and Commander Islands

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Our study is concerned with the species composition of microbial associations of organism of wild Steller Sea Lion (*Eumetopias jubatus*). In addition, in a course of our studies, we investigated the biological properties of isolated microorganisms, including their pathogen factors. The material was taken from Steller sea lion pups (*Eumetopias jubatus*) at Kamchatka at the Medny Island and the Kozlov Cape in June-July of 2004. We examined 230 swabs from 46 pups. The swabs were taken from the skin surface, cavity of the mouth, nasal cavity, anus, genitals, conjunctiva of the eye, purulent exudation by the sterile tampon. Also we investigated the blood serum of animals with purpose the detection antibodies against *Leptospira interrogans* and *Brucella*. The blood serum were investigated from 17 pups. From all examined Steller sea lion pups, microorganisms belonging to various species were isolated. We found out more than 9 species of bacteria at every examined animal. The samples revealed members of the genera *Staphylococcus*, *Streptococcus*, *Escherichia*, *Serratia*, *Proteus*, *Hafnia*, *Bacillus*. In 71.74% cases *E.coli* were isolated, in 39.13% - *Staphylococcus* and in 43.48% - *Streptococcus*. *Staphylococcus* and *Streptococcus* were isolated from nasal cavity, genitals, conjunctiva of the eye, purulent exudation and *Enterobacteriaceae* were isolated from cavity of the mouth, nasal cavity, anus, genitals. Investigation of the pathogenic properties of the isolated microorganisms demonstrated that *E.coli*, *Staphylococcus*, *Streptococcus* exhibited α - and β -hemolysis in relation to sheep erythrocytes and *E.coli*, *Streptococcus* were virulent to mice. Antibody to *Leptospira interrogans* were found in 52.94% cases. That properties of isolating microorganisms can show the changes of health of animals. So it is important to investigate the quantitative, consist of microbial association of organism of Steller sea lion pups.

Using Ship-Mounted Radar to Detect and Track Cetaceans — Results of CEDAR Experiment

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There is a clear need for technology that can detect the presence of cetaceans at the ocean's surface at sufficient distance to permit evasive maneuvering on the part of fast-traveling vessels. During an earlier 2003 experiment ("Project Humpback") using a land-based radar system at 500 m altitude above Kauai's Pacific Missile Range Facility (PMRF), we were able to track humpback whales at distances up to 18 km. In this paper, we report on preliminary results of a recent NOPP-sponsored cetacean detection and tracking experiment conducted in the Mediterranean Sea during a 14 day period (May 20 – June 2, 2005). The primary objective of this experiment, CEDAR ("CEtacean Detection radarAR"), was to demonstrate a similar detection and tracking capability using a shipboard X-band radar system (Furuno FR2125). Radar detections were validated via visual observations through Big Eyes binoculars augmented with Electro-Optic video cameras. Additionally, a towed acoustic array was used to detect vocalizing cetaceans as possible candidates for radar tracking. The results of the CEDAR experiment demonstrated the feasibility of detecting and tracking fin whales (*Baleanoptera physalus*) and striped dolphins

(*Stenella coeruleoalba*) in real-time at distances up to 5.5 km or more. In one case, we were able to track a pod of three fin whales continuously for more than three hours. Separation of individual pod members was also demonstrated. Possible applications of this technology include cetacean-ship collision avoidance, large area clearance during Navy operations and a variety of cetacean research and population monitoring applications.

Quantification and Acoustic Propagation Modeling of Airgun Noise Recorded on DTAG-tagged Sperm Whales in the Gulf of Mexico

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Reliably estimating the sound levels received by exposed animals is a critical component of mitigation of underwater noise. In 2002 and 2003 in the Gulf of Mexico, eight DTAG-tagged sperm whales (*Physeter macrocephalus*) underwent controlled exposure to airgun pulses to test how range and depth affect sound exposure. Received levels of airgun pulses recorded on tags at source-whale distances of 1.4 - 12.6 km and depths of 0-658 m ranged from 111-164 dB re 1 μ Pa (p-p) with levels at 12 km sometimes equal to those at 2 km. Broadband acoustic PE models reproduced the observed variation in received levels with range, illustrating the influences of sound-speed profile, bathymetry, and bottom properties on propagation. Combining a theoretical airgun array beampattern with PE model output allowed good prediction of the relative levels of multipath arrivals. However, lack of array source signature data limited modeling of absolute, frequency specific received levels. Ray trace models accurately predicted time of arrival differences between multipath arrivals, allowing determination of the propagation path of each arrival. Airguns produce energy predominately at 50-200 Hz, but the direct arrivals of some pulses recorded on whales near the surface in 2002 had energy predominantly above 500 Hz. The presence of a surface duct in the 2002 sound-speed profiles, in which high frequency energy propagated with little transmission loss, helps explain this effect. In addition, the beampattern of the source array has grating lobes at high frequencies, further increasing the high-frequency content of sound propagating horizontally from the array. Our results demonstrate the influences of source and environmental characteristics on the level and frequency content of airgun pulses received by marine mammals. We conclude that airguns may expose animals to significant sound energy above 500Hz, and that on-axis source levels and spherical spreading assumptions alone inadequately describe airgun pulse propagation and the extent of exposure zones.

Central-Place Foraging by Manatees Overwintering at a Warm-water Refuge

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Florida manatees (*Trichechus manatus latirostris*) require access to warm-water refuges during winter because of their vulnerability to cold-related stress and mortality. We investigated manatee foraging movements and attendance patterns at industrial warm-water refuges in Tampa Bay, Florida, in relation to ambient temperature during

three winters (Dec. 2002 to Mar. 2005). We hypothesized that the distance and duration manatees spend away from the refuge should be positively correlated with ambient water temperature. Eighteen manatees were tagged (six in each winter) and tracked from December through February using state-of-the-art Global Positioning System (GPS) tags that relayed near-real-time and highly accurate movement data through the Argos system. The tags attempted GPS fixes every 15-20 minutes, with a success rate of about 80%; the full record of locations and temperatures was downloaded after tag recovery. Tagged manatees sought shelter from the cold in the heated discharge canal of a power plant, spending approximately half of the time there during the winter. They made regular foraging excursions to seagrass beds within 35 km of the plant. Time spent away from the refuge increased significantly as ambient water temperature increased. In unusually cold weather, manatees fasted in the refuge for up to 7 consecutive days. Manatees exhibited a pattern of nocturnal foraging activity, which may be due to the coincidence of winter high tides with night time hours. Study animals demonstrated remarkable consistency in their daily movements and fidelity to their foraging grounds. The maximum distance of foraging excursions from the refuge varied among individuals (medians of 5-33 km); preliminary analyses suggest that foraging distance was not correlated with ambient water temperature during the bout. Application of this new GPS technology is providing insights into the decisions manatees make to optimize the energetic tradeoffs between foraging in cold water and fasting in warm water.

Age at Maturity and Pregnancy Rates of Grey Seals (*Halichoerus grypus*) in the Baltic Sea

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The number of grey seals in the Baltic Sea was depleted during the 20th century. Hunting and a disease complex linked to organo-chlorines reduced the number of seals in the population from 80-100,000 to less than 4000 in the late 1970-s. However since then the numbers are increasing and in year 2000 the population size was estimated to 15,631 (95% confidence interval 9,592 to 19,005) using photo-id. The increasing population size has led to escalating seal-fisheries interactions. To mitigate the conflict, hunting has been reinstated in both Finland and Sweden. To manage the population without disturbing its recovery, information about vital population parameters is needed. To determine age of maturity and pregnancy rate, 214 female grey seals were autopsied between 1976 and 2004 at the Swedish Museum of Natural History. Age was determined using growth layers in tooth sections. Maturity was defined as a female that proved to have at least one corpus luteum in one of the ovaries. To specify pregnancy the female should show visible signs of implantation or carrying a foetus. Pregnancy were only determined in those months appropriate to secure implantation in the population. Results showed that maturity in the Baltic seals started in small scale at the age of two and increased to 100% in age-class six. In the Baltic, 44% of the specimens in age-class four were pregnant increasing to more than 95% (n=23) in animals aged 6-25 born after 1985. Animals aged 6-25, born before 1985 had a significantly lower pregnancy rate 35% (n=17) ($P < 0.001$). In animals older than 25, born before 1985 only 4% was pregnant (n=24). The observed increase in pregnancy rate is most likely an effect of increased gynaecological health and decreased levels of organo-chlorines in the seals prey.

Broadband Sound Production by Feeding Blue Whales (*Balaenoptera musculus*)

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Blue whale vocalizations have been described in many regions worldwide, and there is good evidence for geographic variation. However, most knowledge of blue whale acoustics is based on studies of their long, patterned, infrasonic call series, or "songs." The known vocal repertoire of this species also includes transient, frequency-modulated calls having a higher frequency range and shorter duration than song notes, and often sweeping down in frequency. In a few cases, the characteristics of transient calls have been briefly documented but very few studies have associated behavioral contexts with their occurrence. Consequently, the function of these sounds remains unknown. In this study, we describe a newly discovered transient sound produced by blue whales in the eastern North Pacific (Monterey Bay, California) and the western North Atlantic (Gulf of Saint Lawrence, Canada) during surface feeding. High-intensity, broadband (858 Hz \pm 148 Hz), short-duration (0.55 s \pm 0.1 s) pulses are documented in both regions. No statistical differences ($p > 0.05$) were found between broadband sounds from both regions when comparing frequency range, energy distribution and duration parameters. Bottom deployed autonomous recording units were used to locate the sound source locations in Monterey Bay on seven different occasions on three different days. The locations of the broadband sounds matched those of blue whale song notes and transient calls, supporting the conclusion that blue whales produced the broadband sounds. In the Gulf of Saint Lawrence, simultaneous vessel-based behavioral observations and sound recordings confirmed the production of these broadband sounds from surface feeding animals. The acoustic production mechanism that might create this sound and the function of the sound in relation to blue whale behavior are hypothesized. The benefit to distribution and abundance studies of an increased knowledge of blue whale acoustic repertoire and associated behavior is also discussed.

Strandings of Beaked Whales along the Western South Atlantic: Relative Frequency of Species, Seasonality and Zoogeography

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The Ziphiidae is one of the least known cetacean families and occurs predominantly in deep waters. In the western South Atlantic the continental shelf is generally wide and deep waters are far from coast. Therefore, sightings are rare and most of the information available comes from strandings. In this study we assembled published and unpublished records from Brazil, Uruguay, Argentina and the Falkland/Malvinas Islands. A total of 174 specimens representing 11 species were recorded. This diversity represents over half of the world's beaked whale species. *Ziphius cavirostris* was the most frequent species (35.6%), followed by *Mesoplodon grayi* and *M. layardii* (15.5%), *Hyperoodon planifrons* (14.4%), *M. hectori* (6.9%), *Tasmacetus shepherdi* (4.0%), *Berardius arnuxii* (2.9%), *M. densirostris* and *M. bowdoini* (1.7%). *Mesoplodon europaeus* (1.1%) and *M. mirus* (0.6%) were only recently recorded for this region. *Ziphius cavirostris* and *M. layardii* records ranged widely from tropical to cold waters. The northern limits of *M. grayi*, *M. hectori* and *H. planifrons* were restricted to temperate waters of southern Brazil (ca 30°S). Although a *B. arnuxii* was washed ashore in tropical waters of southeastern Brazil, most records were for colder waters. *M. bowdoini* and *T. shepherdi* stranded only in cold temperate regions of Argentina and the Falkland/Malvinas Islands, whereas the recent strandings of *M. europaeus* and *M. mirus* occurred in tropical regions of Brazil. The three strandings of *M. densirostris* occurred in a narrow stretch of coast in southern Brazil. Seasonality was considered only for species with a frequency of occurrence above 5% and when carcasses were

relatively fresh. *Ziphius cavirostris* stranded predominantly in spring and summer in southern Argentina. *M. grayi* stranded in all seasons except winter and *M. layardii* occurred during autumn and summer in Argentina and in winter in the tropical waters of Brazil. Strandings of *H. planifrons* occurred only in summer.

Sperm Whales and Short-finned Pilot Whales Interaction in the Gulf of California

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On 25 January 2005 a surface interaction between sperm whales (*Physeter macrocephalus*) and short-finned pilot whales (*Globicephala macrorhynchus*) was observed in the southwest Gulf of California (25° 17.05'N, 110° 53.20'W), a deep-water area (700 m) of frequent sightings of sperm whales. Here we report the harassment behavior of pilot whales and the avoiding behavior of sperm whales. A group of 13 adult sperm whales without calves neither large males and associated with offshore bottlenose dolphins (*Tursiops truncatus*), which was been tracked visually and acoustically, was traveling north-northwest and showing dives of 32 minutes on average and 9 minutes at surface. Suddenly, the sperm whales started to do codas, porpoise and shallow dive. A group of approximately 30 individuals of pilot whale involving males, females and calves approached the sperm whales from behind. Apparently excited, the pilot whales chased the sperm whales group and mixed with them. The threatened sperm whales displayed some behaviors as lobtailing, sidefluking, discharging feces and fast swimming, which were interpreted as a defense response to the aggression from pilot whales. Although pilot whales are not known as predators of sperm whales, this interaction can be interpreted as food competition, kleptoparasitism or social play due to the harassment behavior from pilot whales.

Population Size of Fin Whales in the Gulf of California, México

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Genetic studies have demonstrated that fin whales that inhabit the Gulf of California comprise a closed and isolated population. Previous studies on its abundance have estimated a total of 386 (282-488) and 820 (594-3,229) individuals with capture-recapture and line transect methods respectively, both based on surveys conducted in 1993. The purpose of this study was to obtain a more accurate and actual estimation of the population size based on 168 photographically identified whales sighted between summer of 2004 and winter of 2005 and using the Bailey's modification of the Petersen capture-recapture estimator. Natural marks on the dorsal fin and body were used to individually identify each whale. A selection of the photographs was made establishing a set of variables that should be graded from 1 to 5, being 1 the highest quality and 5 the lowest. The variables graded were: angle in which the dorsal fin was photographed, visible portion of the body, lighting and focus. 10% of the photographs were eliminated for poor quality, which means having 5 in at least one variable or more than 12 in the total score. Another 6% was rejected for being whales with non distinctive or identifiable marks, these gave us a total of 106 photo-identified whales in summer of 2004 and 76 in the winter of 2005. We estimated an abundance of 574 (± 129) fin whales, what let us assume that around 30% of the population is already photographed. The study of parameters such as the abundance is essential to conduct further demographic and ecological studies that would give us a better insight of the dynamic of the population and in consequence a more complete baseline for conservation issues.

Photographic Assessment of Trends in Body Condition of Juvenile Hawaiian Monk Seals

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Mortality of juvenile Hawaiian monk seals (*Monachus schauinslandi*) is a major factor hindering the recovery of this endangered species. As a method for gaining insight into body condition at last sighting and possible mortality sources, non-invasive observations were documented through standardized digital photographs of individual juvenile seals and compiled to create a comparative image catalog. Imaging was conducted over an eight month period and included all animals born within the previous four breeding seasons at French Frigate Shoals, Northwestern Hawaiian Islands. Each time an individual was sighted during the twice weekly islet patrols, photographs were taken using standardized angles/views and distances to document any changes in body morphology. Previous attempts at cataloging changes in seal body conditions had been attempted using photogrammetry. It was found that the many variables, including inconsistent haul-out substrate, prevented accurate measurement using this method. In contrast, these catalogs of comparative images rely on numerous re-sighting photographs of each individual seal (ideally once every week to 10 days) to obtain comparable overall body views at standardized angles and distances allowing comparisons of anatomical features to ascertain changes in body condition. After eight months, two individuals (permanent ID Y122 and Y146, both born in 2004) exhibited the most extreme changes in body condition. Over the eight month period there were 154 images taken of Y122, and 160 images taken of Y146, both revealing loss in body condition. Using these two individuals, a catalog for comparison of seal body conditions was created which can be used to determine body condition, thus adding insight to a possible mortality source.

Adding Admiralty Inlet to Our Narwhal Knowledge

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In 2003 and 2004 21 narwhals were tagged at their summering ground in Admiralty Inlet, Canada. These whales bring the total number of tagged narwhals up to 69 representing 4 distinct summering grounds. Tag longevity has improved going from a duration of 4 month (August to December) over first three tagging years, to 14 months in 2000-2001 and down to 11 months obtained in the last two years. The increase in longevity is due to smaller transmitter packages with less energy consumption and improved attachment methods. Collection of dive information has been sacrificed to reduce the transmitter size and battery consumption. One unit was still active at the end of June 2005 and has the potential for elucidating annual site fidelity, an important information for management decisions. Similar information has so far only been obtained from 2 out of 69 animals tagged to date. Their habitat selection will be described with reference to size and depth and seasonal changes based on the 393,659 km of tracking data obtained from 37,127 reliable positions. The formation of ice during the autumn in the Arctic forces the narwhals to leave their summering grounds in the Canadian and Greenlandic fiords and bays from where the narwhals migrate south to deep waters in central Baffin Bay and Northern Davis Strait. The variation in movement patterns and wintering grounds is described from the different areas and years. A more detailed insight to the summer habitat use was obtained through deployment of crittercams and DTAGs. Information from the first 6 hours of crittercam footage revealed upside-down swimming along the bottom for 61.2 to 93.5% of the time. The DTAG information is presented separately.

Rehabilitation and Post Release Monitoring of a Male Risso's Dolphin (*Grampus griseus*) Released in New York Waters

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On July 31, 2004, a team from the Marine Education Research and Rehabilitation Institute responded to a male Risso's dolphin, stranded in Cape Henlopen State Park, Delaware. The animal was transported to Riverhead Foundation for Marine Research and Preservation located in Riverhead, New York for rehabilitation. According to the National Marine Mammal Stranding Database 65 Risso's dolphins were recovered between 1995 and 2004, of which 60 have stranded along the east coast of the United States. Prior to 2003 the east coast averaged three or four animals per year. In 2003 and 2004 those numbers have risen to 15 and 17 respectively. Of these 60 animals 78% (n=46) stranded alive or fresh dead, 58% (n=34) and 20% (n=12) respectively. Until April 13, 2005 none of these animals were rehabilitated and released back to the wild. As little is known about the movement of Risso's dolphin in the New York Bight during the winter and spring, sighting data on pilot whales were used to identify a suitable release site. On April 13, 2005 at 11:30 AM local time the Riverhead Foundation released a Risso's dolphin 50 nm SSE of Shinnecock Inlet, New York. The animal was tracked using a wildlife computers splash fin mount tag in addition to a fin mounted radio tag. Post-release monitoring on the day of release showed the animal heading east through areas where pilot whales were sighted on previous aerial surveys. Subsequent aerial surveys observed Risso's dolphins in close proximity to position data obtained from the animal's satellite tag. During the 67 days of post-release monitoring the animal has spent most of its time along the shelf break between North Carolina and Hudson Canyon. Preliminary analysis of satellite tracking data revealed a maximum dive depth of 600 m and dive maximum duration of 15 minutes.

Distribution and Ecology of Dolphins Along the Mid-Atlantic Ridge Between Iceland and the Azores

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Dolphin observations were recorded as a part of the MAR-ECO project, aiming at studying life along the mid-Atlantic ridge, an open ocean ecosystem. Because being part of a large ecosystem cruise, observations of pilot whale (*Globicephala melas*), white-sided dolphin (*Lagenorhynchus actus*), striped dolphin (*Stenella coeruleoalba*) and common dolphin (*Delphinus delphis*), can be linked to several different hydrographical variables such as sea-surface temperature, thermocline depth, salinity, velocity and weather, which were recorded continuously. Multi-frequency acoustic data were used to calculate bottom depth and slope, and mapping feeding habits by studying the biological composition of the water column. Temperature and salinity analyses indicate separation into cold- and warm water species. Pilot whale and white-sided dolphin seems to prefer cold (5-16°C), less saline (34.6-35.8) water masses, while common and striped dolphin inhabit warmer (12-21°C), more saline (34.8-36.7) waters. All species were observed over broad depth ranges, with common dolphin having the deepest mean depth (2901m) and white-sided dolphin the shallowest (1357m). Results indicate bottom depth being of less importance for dolphin distribution in the open ocean than in continental shelf areas. The slope in the areas where the dolphins were observed, is significantly higher than slope of the overall cruise track (p=2.2e-16). This is probably related to upwelling or retention over ridges/sea mounts, and hence higher food abundance in such areas. Pilot whale and white-sided dolphin has the largest variability

in group size, CV= 123 and 139 respectively, varying from 2 to 100 individuals. Common and striped dolphins were observed in groups of 1 to 30 individuals, and hence had lower variability, CV= 88 and 92. There seems to be a trend towards increasing group sizes at night, when the dolphins are feeding. An important food source for dolphins in the open ocean is probably mesopelagic fish.

Rediscovery of a Dugong Population in the Southern Visayan Sea, Philippines

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Historically, dugongs were distributed throughout the Philippine archipelago and were fairly common until the 1970's, when populations started to decline rapidly. They are believed to be extirpated from most of the areas they used to occupy, including the coastal waters of south Visayan Sea. Two dugong strandings in northern Negros in 2003 and 2004 prompted a survey and habitat assessment of the area starting May, 2005. Twelve coastal villages on Negros and three on Panay were visited and 119 fisherfolk were interviewed to obtain information on occurrence of dugongs, location of recent sightings, strandings, incidental catches, fishing methods used and areas of extensive seagrass beds. Local government offices were visited to obtain reports/documentation of strandings and by-catch. Traditional knowledge on dugong abundance and distribution was also sought, including the reasons elders thought were the cause of the rapid decline of dugong populations in the area. Boat surveys were made to verify sites of reportedly recent and high sighting rates by fishermen. Seagrass species and extent were determined. The interviews yielded four locations where dugongs have been often sighted recently: (1) the waters between Chambery (Negros Island) and Ilacon Island, (2) the waters around Ilacon Island and (3) Macahulom reefs and (4) the waters off Lamintao, Barotac Nuevo on Panay Island. Dugong occurrence in site (1) was confirmed by a sighting on 8 May, 2005. Feeding trails were documented in all three sites on Negros (seagrass beds in site 4 have not been investigated yet). Seagrass species found include: *Halophila minor*, *H. ovalis*, *H. spinulosa*, *Halodule uninervis*, *H. pinifolia*, *Cymodocea rotundata*, *Syringodium isoetofolium*, *Enhalus acoroides* and *Thalassia hemprichii*. Incidental takes were reported for the following gears: fish corral, Danish seine net, set gill nets, and driftnets. Blast fishing has resulted in two recent dugong strandings, the last on May 30, 2005.

Multivariate Analysis of Habitat Selection by Rorqual Whales in the Gulf of St. Lawrence, Quebec, Canada

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A better understanding of the factors influencing habitat selection by large whales can contribute to improve management and conservation plans. Traditionally such studies have been hindered by the limitations of the oceanographic data, especially when the spatio-temporal scale does not match that of the whale dataset. In this case, we used a computer model of the Gulf of St. Lawrence with very precise resolution in time and space to analyze the fine-scale distribution of four rorqual whale species (blue, fin, humpback and minke whales). For each of 5,231 sightings collected from boat surveys between 1996 and 2002, and an equal number of random locations, we computed depth and slope of the seabed, distance to shore, temperature at the surface and at three other depths, salinity, current strength and turbulent kinetic energy. We used principal component analysis to simplify the multivariate dataset and investigate inter-correlation

between variables. The results were used to define habitat preferences in environmental space for each species and compare the overlap of their ecological niches. We then used logistic regression to compare the variables associated with random points (representing available habitat) and those associated with whale sightings (habitat used). Using Akaike's Information Criteria, we determined which models best fitted the data. These models all confirmed the influence of static factors like bathymetry but also emphasized the importance of dynamic variables such as temperature and currents. There were strong interactions between factors, underlining the complexity of the relationships linking orca whales to oceanographic processes. These findings allow us to better predict which areas constitute potentially important habitat requiring protection. They also encourage other studies of habitat selection to make greater use of dynamic variables and multivariate datasets.

Conservation in the Real World: Managing Aboriginal Subsistence Whaling Wisely

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Several communities in the world are reliant on whales for cultural and subsistence needs. These include peoples in northern Alaska (USA), Chukotka (Russian Federation), Greenland and St Vincent and The Grenadines. Management of such hunts must be scientifically based and take into account both the needs of the people involved and the status of the whale populations that they harvest. Until relatively recently, the management of such hunts by the International Whaling Commission (IWC) has been on an *ad hoc* basis. However, since the mid-1990s, the Scientific Committee of the IWC has been developing a 'management procedure' approach that removes the *ad hoc* nature of assessments and takes in to account objectives set by the IWC and the level of scientific knowledge concerning the stocks involved. In particular, this approach takes explicit account of scientific uncertainty in essential parameters, including the abundance estimates, biological parameters (especially with respect to mortality and productivity) and carrying capacity. The approach uses computer simulations to develop a wide and challenging range of scenarios to determine whether catch limits can safely be calculated using an algorithm (or algorithms) that is robust to such uncertainty. The author will explain the development of *catch limit algorithms* to manage hunt of bowhead whales (*Balaena mysticetus*) for the Bering-Chukchi-Beaufort Seas stock and gray whales (*Eschrichtius robustus*). The approaches tried and finally chosen encapsulate quite different theoretical backgrounds (both biological and engineering) but converge on similar conservation performance statistics. The development process and results are presented and compared, the general lessons for the management of conservation problems (including both direct and indirect kills) illustrated and the pragmatic requirements of the 'management procedure' approach stated. The value of this almost decade-long process and its relevance to wider cetacean (and beyond) conservation issues are highlighted.

A Comparison of Indices of Sea Otter Health and Condition Between the Declining Southwest Population in Alaska and the Stable Commander Islands Population in Russia in 2004-05

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Since the mid 1980's, sea otter (*Enhydra lutris kenyoni*) abundance has declined as much as 90% over major portions of southwest Alaska. Because of the significance of this region to the species as a whole,

the U. S. Fish and Wildlife Service has proposed listing the southwest distinct population segment of the northern sea otter as threatened under the Endangered Species Act. In the Aleutians the cause of the population decline has been hypothesized to be predation by killer whales (*Orcinus orca*), however, data on survival, health, condition, habitat use and behavior for other regions within the area of decline are lacking. In 2004 and 2005, we captured sea otters in the eastern Aleutians (n=4) and Kodiak archipelago (n=93) to assess indices of health and condition, and contrast these data with animals captured on Bering Island, Russia (n=58) where no population declines have been observed. Capture methods differed, but sample handling was consistent among study sites. We evaluated hematological values (RBC, complete WBC, Hgb, Hct, MCV, MCH, MCHC), serum biochemical values, exposure to marine and terrestrial pathogens (distemper, herpesvirus, leptospirosis, Toxoplasma gondii, Sarcocystis neurona, calicivirus) teeth for age determination and weight and length measures to assess condition relative to hematologic and serum biochemical values in these animals. Sample analysis to date suggests hematological values did not differ from published ranges, however, results are preliminary. A complete analysis of hematological and body condition values, fecal and oral fauna, and the exposure of sea otters to pathogens will be reported on in this study.

Behavior and Travel Direction of Whales and Dolphins off of San Clemente Island, California, as Observed from a Moored Observation Platform – FLIP

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Platforms typically used to study cetacean abundance or behavior include vessels and aircraft, although land-based studies are also undertaken with near-shore populations. Each of these methods has inherent biases. Moored observation platforms are less frequently used, but have the advantage (over land-based studies) of positioning observers closer to the population of interest, and compared to vessel platforms, they do not generate any propulsion noise and are less likely to influence behavior of animals. To examine marine mammal relative abundance and behavior around San Clemente Island, a military training area, the R/P FLIP (Floating Instrument Platform) was stationed 12.7km off the island from 27 August to 15 September 2004. Four observers 27m above sea level used 7x and 20x binoculars to identify species, estimate group sizes, and document behavior. Depending on the distance to animals, up to 20 position updates were made to establish speed and direction of travel. In conjunction with visual observations, acoustic monitoring was conducted with hydrophone arrays connected to FLIP, and with seafloor autonomous hydrophones. In 237 hours, we observed 335 groups (nine species) of cetaceans, including *Delphinus* (124 groups), Pacific white-sided dolphin (2 groups), and balaenopterids (118 groups, primarily blue and fin whales). Pacific white-sided dolphins were noteworthy since year-round aerial surveys in 1998 and 1999 found them only in the winter months. Both commercial and naval vessels were common within the study area (54 cargo or navy vessels), providing us with the opportunity to monitor marine mammal behavior in the presence of both shipping traffic and some of the major sources of anthropogenic noise in the ocean today. By carefully choosing a mooring site, FLIP can be a useful observation platform to monitor behavior and spatial distribution of cetaceans in response to various environmental parameters, as well as potential sources of anthropogenic disturbance.

Comparison of Harbor Seal, *Phoca vitulina*, Distribution and Haul-Out Site Use During Pupping and Molting Seasons in Maine.

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Many marine mammals respond to seasonal biological cycles and environmental variation by changing their patterns of habitat use. Understanding such changes is important both to the study of their ecology and to the design of effective conservation and management strategies. We used data from aerial surveys of harbor seals (*Phoca vitulina*) made during the pupping (May-June) and molting seasons (August) in 1993 and 1997 to explore seasonal patterns of habitat use in Maine. In 1993 harbor seals used 574 haul-out sites during the pupping season and 282 ledges during the molting season. In 1997 harbor seals used 541 haul-out sites during the pupping season and 212 during the molting season. The number of haul-out sites decreased from the pupping to the molting season by 51% in 1993 and 61% in 1997. In 1993 the number of seals was similar in both the May-June and August counts, but in 1997 the pupping count was 35% lower than the molting count. The average group size at haul-out sites was larger during the molting season. In 1993 the average group size was 51 during the pupping season and 94 during pupping season. In 1997 the average group size was 60 during the pupping season and 97 during the molting season. We used GIS analyses to describe the physical characteristics of haul-out sites during both seasons and found that harbor seals aggregate in smaller groups on near-shore ledges during the pupping season, and in larger groups on a smaller number of offshore ledges during the molting season. Knowledge of this seasonal change in habitat use is an important requisite for generating environmental plans, such as responses to oil spills, designing strategies to manage an increasing harbor seal population in the Northwest Atlantic and to better understand harbor seal ecology.

Quantifying Adjustments Due to Boat Noise in Signal Transmission Rates of Humpback Whales in Southeast Alaska

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The effects of boat noise on the underwater acoustic environment can be well characterized using the parameters appropriate for calculating the channel capacity of a given signaling medium,— *i.e.*, the channel in this case is the open sea. Simultaneous measurements can also be made of humpback whale (*Megaptera novaeangliae*) vocalizations with and without the presence of boat noise, so that information theoretic measures may then be applied to quantify any changes of the signal transmission rate in response to this noise. A quantitative comparison can then be made between the decreases in transmission rates of the humpback whale vocalizations and the decreased channel capacity of the transmitting medium to measure how well the humpback whales may be adjusting to the increase in background noise. We characterize the noisy and non-noisy environments in Icy Strait and Glacier Bay, Alaska and calculate the response, via decreased information entropy, in the feeding call frequencies and increased conditional probabilities of occurrence of signals from humpback whales. We also present plans to tighten the uncertainties of this study in the next field season.

Population Dynamics of UK Grey Seals; Evidence of Density Dependent Effects

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Approximately 40% of the world's grey seals (*Halichoerus grypus*) breed around the UK. The population has been increasing since the 1960s when modern surveys began. Accurate population status information is now required under both national and international

legislation. We used stochastic modelling of the birth and pup development processes to generate a 40-year time series of pup productions from aerial surveys of British grey seal colonies. Between 1984-2002 overall pup production increased by $5.5 \pm 0.30\%$ per year. The breeding sites fall naturally into four geographical sub-populations: Outer Hebrides, Inner Hebrides, Orkney and the North Sea. Simple exponential and logistic growth models were fitted to the pup production estimates for each subpopulation independently. Relative goodness of fit of exponential and logistic models was assessed using likelihood ratio (LR) tests. Pup production trajectories differ between areas. Older Outer Hebrides colonies have declined since 1984, at 1.2% per year. Logistic models provided significantly better descriptions of the growth patterns than exponential models in both the Inner Hebrides (LR=23.7, $p < 0.0001$) and the Monachs (LR=36.8, $p < 0.0001$) with populations levelling off in the mid 1990s in both areas. The Orkney trajectory was also described significantly better by a logistic growth model (LR=15.8, $p < 0.0004$), but the density dependent effect is less pronounced and more recent. The pup production attained 95% of its asymptotic level in 2001. The North Sea population shows no evidence of density dependent effects (LR=0.73, $p=0.70$), and is best described as simple exponential growth at 6.5% p.a.. The UK grey seal population is clearly approaching some form of asymptote while the West Atlantic population continues to grow exponentially. We do not know what mechanism is controlling the growth rates, but the close fit to logistic models suggests density dependence. We discuss the implications of these changes for population management.

Unraveling the Multi-Scale Mélange of Gray Whale Ecology on the Summer Foraging Area On the West Coast of Vancouver Island

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Gray whales offer a unique, but slightly complicated, experimental tool for inspecting the interplay between top-down and bottom-up forces in small spaces (1's to 10's kms.) at both within-foraging season and between-foraging season temporal scales. For the past 8 years we have been studying several aspects of the community ecology and the variations in prey and whales on a small discrete foraging area on the west coast of Vancouver Island. We have discovered most of the core linkages in the short food chains that determine gray whale's distribution and abundance in the study area and have devised methods to quantify the relationship. In the process we have also elucidated hierarchical prey preference, fine scale habitat use patterns, some aspects of population structure, a primer of major prey species ecology, long term community changes due to predation, and diving behaviour. Gray whales are easily the most tractable baleen whale with regards to ecological study. The past eight years worth of research has provided us the opportunity to build up a suite of tools and ideas borrowed from various research areas and test them in fine scale applications and in the inshore waters that gray whales utilize. In this paper I will report on the success and problems we have encountered in specific aspects of our ecological study and outline what we think are fruitful areas for future research. The crucial argument in this paper is that the themes of ecology and spatial scale coupled to expanding techniques in oceanography will open windows into explanation in smaller spaces and shorter times which is the type of information demanded in many emerging management arenas.

First Report of *Brucella* sp. in Hector's Dolphins (*Cephalorhynchus hectori hectori*) in New Zealand

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Hector's dolphin (*Cephalorhynchus hectori hectori*) is found only around the South Island of New Zealand and there are as few as 6000 to 7000 animals in three separate populations, off the east, west and south coasts. Maui's dolphin (*C. hectori maui*), is critically endangered with probably less than 100 individuals off the west coast of the North Island. In March 2004 a trial was conducted to evaluate satellite telemetry on Hector's dolphins in the waters surrounding the Banks Peninsula, South Island. This provided the opportunity to assess the health of three captured animals. One adult female was sero-positive for *Brucella abortus* in a cELISA test. This was the first evidence that *Brucella*, a potentially significant pathogen of dolphins, was present in New Zealand marine mammals. An investigation of all stranded Hector's and Maui's dolphins was initiated and since June 2004, post mortem examinations have been conducted on four specimens from the South Island. An adult female with a mascerated foetus, a pregnant female, and two subadult females. The following tissues were collected for culture on selective media for *Brucella* sp.: Mammary gland, spleen, lung, lymph nodes, liver, uterus, and fetus if present. The same tissues were also used for nested *Brucella* PCR (OMP25, 272 bp). PCR product of the expected size was amplified from all tissues of one subadult female dolphin. BLAST analysis confirmed its relationship to *B. suis*, *B. pinnipediae* and *B. cetacea*. Further characterization is underway. The prevalence of this infection in Hector's and Maui's dolphins is as yet unknown as is its potential effect on reproductive success. This could have significant consequences for both subspecies but in particular for the critically endangered Maui's dolphin.

Assessing Energetic Demands in Cetaceans: Interrelationships Between Metabolic Rate, Caloric Intake, and Body Condition

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The management of cetacean populations whether for the establishment of marine reserves, determination of critical habitats, or assessment of potential fisheries conflicts requires basic information concerning energetic requirements of the animal. Although a variety of techniques provide estimates of immediate energetic demands, the results are complicated by seasonal changes in the deposition and utilization of stored energy reserves in blubber. In view of this, we simultaneously measured metabolic rate, caloric intake, and two indices of body energy reserves (total body mass and blubber thickness) for summer and winter periods in trained, adult male Atlantic bottlenose dolphins (*Tursiops truncatus*). Resting metabolic rate determined from open-flow respirometry was correlated to monthly averages of caloric intake and blubber thickness. External (air and water temperatures) and internal (plasma testosterone concentration) cues that may influence energetic requirements were also measured. We found that mean resting metabolic rate was not significantly different between summer (5.27 ± 0.14 SE $\text{mlO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) and winter (5.64 ± 0.15 SE $\text{mlO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) ($p = 0.08$; $F = 3.22$). Conversely, caloric intake decreased 41 - 46% during the summer period; body mass increased by 7.9 - 8.6% during the same period. Mean blubber thickness was 10.2% greater in winter compared to summer. These changes in caloric intake, body mass, and blubber thickness were independent of air and water temperature (air: $p = 0.21$, $F = 1.59$; water: $p = 0.28$, $F = 1.16$). Testosterone concentration was positively correlated with body mass and negatively correlated with blubber thickness and caloric intake. These data indicate the importance of internal endocrine cues in driving seasonal changes in blubber deposition, and hence body energy reserves. As a result, the actual caloric intake of dolphins may vary widely from what would be predicted based on a single metric of an animal's energetic requirements. (Supported by Alaska SeaLife Center)

Widespread and Contextual Use of Social Communication in Migrating Humpback Whales

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Humpback whales are renowned for the complex structured songs produced by males. A second, previously neglected area of humpback acoustics concerns unstructured social vocalizations. This study describes a portion of the non-song vocal repertoire of humpbacks and explores the social relevance of these sounds. Vocalizations were recorded and analyzed from 50 pods that were tracked visually from land and acoustically using a static hydrophone array. Behaviors including surface activities, joining and splitting were noted. Non-song vocalizations were found to occur in all pod compositions; loners, adult pairs, mother/calf pairs, mother/calf/escorts and pods with more than two adults. A total of 43 different sound types were catalogued and measured ($n = 600$), of which 13 of the most common types were selected for further analysis ($n = 380$). Principal component analysis and discriminate function analysis generated nine discrete sound categories ($P < 0.0001$). Low-frequency upsweeps ("thwops" and "wops") were the most common sounds heard, occurring significantly more in stable pods compared to those undergoing a split or join ($P = 0.0321$). "Wops" were significantly more common in mother/calf pods ($P = 0.0005$) and may be a variation of the "thwop" call. Some sounds were heard significantly more in pods with more than two adults than other pod compositions. These included high frequency harmonic "trumpets", presumed underwater blows ($P = 0.038$), complex "screams" ($P = 0.0254$) and high frequency "shrieks" ($P < 0.0001$). "Barks" (brief mid-frequency harmonic upsweeps) and pulsative low-frequency broadband sounds ("grunts" and "croaks") were heard only in joining pods and "yaps" (brief mid-frequency harmonic downsweeps) only during pods splitting. These sounds may therefore have specific behavioral functions. This work opens up a new area of humpback acoustics, demonstrating that humpbacks are not only capable of complex song, but produce a great range of other communication signals, few of which have been previously described.

Association Patterns of Sperm Whales in the Great Bahama Canyon, Northern Bahamas

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Small vessel surveys were conducted between 1997 and 2005 off the southern coast of Great Abaco Island, northern Bahamas, providing the first information on sperm whale (*Physeter macrocephalus*) social organization in this region. During the 8.5-year study period, sperm whales were encountered on 90 different days, and observed for a total of 182.2 hours. Eighty-six sperm whale groups were observed and photographically identified. Groups ranged in size from one to 19 whales (mean = 6.0, sd = 4.1) and 71% of the groups included at least one mother-calf pair. High quality photographs of sperm whale flukes were used to identify individuals and determine patterns of association. From these photographs, 101 individual sperm whales were identified, of which 54 were sighted more than once (53.5% re-sighting rate). Forty-three whales were seen in more than one year, and four whales were encountered in five different years. The longest period between re-sightings was eight years. These results suggest long-term site fidelity for some individuals. Association analyses were performed using data from the 48 groups comprised of individuals ($n = 21$) that were photographically identified four or more times. Patterns of association between individuals were quantified on a scale of 0 - 1 using the Simple Ratio Index (0 = never photographed together, 1 = always photographed in the same group). The overall mean association index was 0.06 (sd = 0.03), and the highest pairwise association index was 0.60. Cluster analysis grouped individuals into four distinct clusters with low association between groups (maximum = 0.07, mean = 0.01, sd = 0.03). Our results suggest that the Great Bahama Canyon provides habitat primarily for nursery groups of sperm whales and that these groups exhibit relative stability in their social organization.

Dusky Dolphin Groups Targeted by Tourism in Kaikoura, New Zealand

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Dusky dolphin (*Lagenorhynchus obscurus*) groups targeted by a swim-with-dolphin enterprise, a boat and an air-based whale watching company, and private tourists near Kaikoura, New Zealand, were tracked from shore by theodolite. Between 25 January and 29 March, 2005, 34 large (>150) dolphin groups were tracked for 117.84 hrs. over 28 days, between the Kaikoura Peninsula and 19.8 km south to Haumuri Bluffs. Tracking times ranged from 1.0 to 8.8 hrs. (\bar{x} =3.47, SD=1.664, Median= 3.56). Dolphin groups had no boats within 400 m for 56.3 hrs. (47.8% of tracking time) and at least one boat within 400 m for 61.5 hrs. (52.2% of tracking time). The swim-with-dolphins and vessel-based whale watch operators have indicated that they follow a 2-hr. self-imposed down-time of no dolphin approaches between 11:30 and 13:30 local time, December-March. We compared vessel activity outside and during this rest period. Out-side the rest period, we observed an average of 3.28 visits/hr (SD=2.036, n=34, $T_{\text{non-rest}}$ =89.63 hrs.), and during the rest period, an average of 1.78 visits/hr (SD=1.584, n=17, T_{rest} =26.93 hrs.). The number of approaches per hour during the rest period was significantly lower than the number of approaches during non-rest periods (t =18.826, df =49, P <0.005), indicating that the voluntary down time was effective in lowering visits per hour. Private recreational vessels represented 27.9% and 36.0% of the traffic visiting dolphin groups for non-rest and rest periods, respectively. The swim-with-dolphin operator made no visits during the rest period. Whale watching tours made 58.3% of the total visits during the rest-period (37.5% boats, 20.8% aircraft). Previous research on interactions between boats and dusky dolphins in Kaikoura found midday to be an important resting time for the dolphins. To achieve a true rest time for dusky dolphins, a greater amount of participation is required from the public and tourism companies.

Mammal-Killers Around SW Alaska: Transient or Persistent?

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Recent attention has focused on the possible role of predation by killer whales (*Orcinus orca*) in the population declines of several marine mammal species in the far North Pacific. Evaluating predation requires empirical data on the number of mammal-eating killer whales in this area. We report on a collaborative project using individual photo-identification data to make inference about the abundance and movement patterns of mammal-eaters in the coastal waters around the Aleutian Islands and western Gulf of Alaska. The mammal-eating "transient" ecotype was identified based on analyses of mtDNA haplotype from skin samples, which were collected using remote-biopsy techniques. More than 7300 photographs from 84 groups of confirmed transients were used to identify 275 distinct individual whales. We applied mark-recapture methods to estimate the number of whales that remained undetected, using novel Bayesian models that take account of clustered identifications of whales within social groupings. Abundance estimates indicated that around 500 whales used these coastal waters over a three-year period. However, examination of seasonal patterns in individual identifications revealed that most (75%) of the killer whales seen feeding on gray whales (*Eschrichtius robustus*) during their northbound migration in late spring were not seen later in the summer months. Likewise, most (84%) of whales seen in the summer were not seen during the spring

survey periods. Further evidence of the "transient" presence of many of these whales is provided by photographic documentation of healed scars that appear to be caused by cookie-cutter sharks (*Isistius spp.*), which inhabit only warm and temperate waters, seaward of the continental shelf. These data highlight the importance of considering movements and residency time when evaluating predation pressure.

First Documented Reports of Harbor Seal Pups (*Phoca vitulina*) in New York Waters

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During May – June 2005 the New York State Marine Mammal and Sea Turtle Stranding Program documented for the first time strandings of three male harbor seal pups (*Phoca vitulina*) from Long Island, New York. The first pup was reported stranded on May 28, 2005 at Smith Point County Park in Brookhaven, New York (40.7331N - 72.8624W). The 75.5 cm, 10.9 kg animal was reported on the beach and was put back into the water by the public several times before the Riverhead Foundation for Marine Research & Preservation's Rescue Program was alerted. Upon arrival the rescue team identified the animal as a neonate harbor seal pup estimated to be 3-7 days old as the umbilical cord was still attached. The second emaciated harbor seal pup measured 75.6 cm in length and weighed 7.8 kg at the time it was recovered from Coney Island, New York (40.5745N, -73.9597W) on June 25, 2005. The third harbor seal pup was recovered from Center Moriches, New York (40.80241N, -72.75123W) on June 29, 2005 and measured 80 cm in length and weighed 10.1 kg. Additional information supporting harbor seal reproductive activity within New York waters include strandings of young weaned harbor seals estimated to be 8-10 weeks in age and the recovery and examination of pregnant harbor seal carcasses in the last ten years. The concentrated populations of many of Long Island and New York City shorelines introduces a real concern for the interaction of humans with dependent harbor seal pups and emphasizes the need for public education to ensure the safety of pups and the protection of the public from potential zoonotic diseases.

Distribution, Habitat Use and Abundance of Coastal Tucuxi (*Sotalia fluviatilis*) in the Gulf of Morrosquillo, Colombia

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Coastal Tucuxi have been catalogued in Colombia as a "vulnerable" species due to a moderate risk of extinction. The main threats for the Gulf of Morrosquillo populations are: changes in regional prey abundance and distribution, loss of habitat, and possible declining on population numbers. The main goal of this project is to evaluate the distribution, habitat use and relative abundance of coastal Tucuxi in the Gulf to develop guidelines for the management and long-term conservation of this species and its habitat. From November 2002 through November 2005 we collected data for a total period of seventeen months, making this project the longest ongoing research on coastal dolphins in Colombia. We collected behavioral, geophysical, environmental, photo-ID, acoustic, and carcass data. During 2005 we started recording the vocal behavior of this ecotype through a sister project. The data still being analyze using mainly ArcGIS and capture-recapture techniques. The results are being compare to previous Tucuxi studies in the area. In addition, we are comparing the distribution and habitat use results to the results of fisheries studies conducted in the area. Preliminary findings include: 1) Sightings of Tucuxi per unit of survey effort are less frequent now than reported in 1994, 2) use of the Cispatá Bay is significantly less than the use reported in 1994 and 1998, 3) some individual Tucuxi seem to be

permanent residents of the area over the last 10 years ($n = 3$), 4) there is a strong tendency of the individuals for site fidelity to the feeding grounds through the years, 5) the presence of specific individuals fluctuates through the seasons. Based on these data, the classification of these dolphins as "vulnerable" seems well justified. This project will continue during 2006.

Growth Rates of Northwest Atlantic Grey Seal (*Halichoerus grypus*) in Relation with Modification of the Population Size

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Density-dependence is often invoked as a mechanism limiting rates of population change, but for various reasons, few studies of large mammals have provided evidence that density-dependent changes occur. Early indications of density-dependence are expected to be reflected in changes in physical condition, followed by changes in individual growth, age of maturity and reproduction rates. The grey seal is a medium sized phocid associated with coastal and continental shelf regions of the North Atlantic. Although grey seals were rarely observed in the northwest Atlantic early in the 20th century, they have increased from an estimated low of 20,000 in the early 1970's to current estimates of over 250,000 animals. Such long term sustained growth begs the question: How much longer can growth continue? Changes in body size were examined in a sample of 3,302 grey seals collected from Atlantic Canada during 1954 to 2004 using nonlinear growth curves (von Bertalanffy). Randomization statistical tests were performed to examine temporal variation in growth between 1954-1970, 1982-1992 and 1993-2002. Changes in growth curve shape were observed over the three periods. Female growth differed between periods ($P < 0.009$), with asymptotic length declining from 207.8 ± 3.0 cm to 200 ± 1.3 cm between the periods 1954-1970 to 1982-1992 and increasing again in 1993-2002 to 203.7 ± 8.6 cm. Asymptotic lengths among males during the same periods were observed to decline ($p < 0.02$) from 237.1 ± 4.8 cm to 229.8 ± 6.0 cm and 224.3 ± 10.6 cm respectively. Changes in body mass were also observed among males ($P = 0.002$), but not females ($P = 0.505$), although sample sizes were limited. Male mass declined from 247.2 ± 10.8 kg in 1982-92 to 185.5 ± 14.6 kg during 1993-2002. Among females, body mass declined from 179.9 ± 5.2 kg in 1982-92 to 169.2 ± 9.4 kg during 1993-2002. Overall, there has been a decline in body size since the 1950's, suggesting density-dependence regulation might be occurring in the northwest grey seal population.

First Approach to Characterize the Major Histocompatibility Complex DQB in *Orcinus orca*

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This study is part of the Far East Research Orca Project studying *Orcinus orca* in the waters of Kamchatka, Russia. Here we report on the preliminary results of an investigation of variation at the MHC class II DQB locus in killer whales. This research was initiated to explore the fitness of Kamchatka killer whales and evaluate their level of DQB polymorphism in relation to other cetaceans. A 172 bp fragment of the DQB gene was amplified and cloned for 2 killer whales. Analysis of ten clones from each animal (Oror11 and Oror17) revealed two unique sequences. While a single sequence was obtained from the Oror11 clones, the Oror17 clones contained two distinct sequences, including one identical to that obtained from Oror11. Alignment of the two DQB sequences revealed 10 variable sites. All substitutions between sequences were nonsynonymous, suggesting that positive selection is acting on the killer whale DQB gene as indicated

in other cetacean MHC studies. A neighbor-joining tree was constructed using our sequences and an additional 33 sequences collected from GenBank and representing 18 cetacean species. In the tree, our killer whale sequences clustered with those of small to medium-sized North Pacific delphinids, including Risso's dolphin, short-beaked common dolphin, Pacific white-sided dolphin and short-finned pilot whale. These results lead to two hypotheses to be tested: (1) These sequences arose before speciation (Hayashi *et al.*, 2003) in delphinids and have been maintained since then; (2) These sequences formed in each species within the group independently in the evolutionary process due to exposure to the same pathogens or other selective forces. Given their worldwide distribution and the existence of sympatric, ecologically different populations killer whales could serve as the model species in cetacean MHC studies.

Dive Behavior of Florida Manatees at a Winter Aggregation Site

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In winter, Florida manatees (*Trichechus manatus latirostris*) aggregate in the warm-water outfalls of power plants seeking refuge from colder ambient waters. Aerial surveys that cover manatee habitat in well-defined areas, like these aggregation sites, have yielded minimum population estimates. However, for a variety of reasons, obtaining accurate population estimates or valid relative population indices from these surveys is problematic. One important reason is that surveys are not adjusted to account for imperfect detection of manatees by observers. For an animal to be available to be detected by an observer, it must be near the water's surface. However, manatees often bottom-rest when aggregated at warm-water sites. In locations with poor water clarity, it may be impossible to detect them. In winters 2000 thru 2004, time-depth-temperature data loggers were used to record the first dive profiles for manatees. Profiles were obtained for 15 manatees over-wintering in Tampa Electric Company's Big Bend power plant discharge canal in Tampa Bay, Florida. Data were recorded during cold periods, when manatees remained in the canal for several days. Preliminary assessment of dive profiles indicates that manatees exhibit regular and predictable behavior over a 24-hour period. In most cases, manatees rested in the warmest locations in the canal remaining submerged up to 17 minutes/dive in deep water. From 0900-1100 hr manatees, on average, were deeper than 1 m 89% of the time, and from 1300 to 1700 hr 85% of the time. Manatees spent most daylight hours below 1 m, and were slightly deeper in the morning than in the afternoon. Most animals showed prolonged deep diving (resting) during mid-day, followed by active periods (movement at the surface) in the evening and early morning hours, often leaving the plant at night to forage (nocturnal feeding). The longest dive was ~17 minutes and the deepest dive in the canal was 8.5 m (deepest outside canal was 14.0 m).

Duration Limits to Unassisted Swimming by Spotted Dolphin Calves (*Stenella attenuata*)

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Size-related differences in power production and swim speed duration may contribute to the observed deficit of nursing calves relative to lactating females killed in sets by tuna purse-seiners in the eastern tropical Pacific Ocean (ETP). Power production and swim speed duration were estimated for northeastern spotted dolphins, *Stenella attenuata*, (the species most often targeted by the fishery) ranging in size from neonate through adult. Estimated power required by neonates to swim unassisted was 3.6 times that required of an adult to swim the same speed. Estimated unassisted burst speed for neonates was only about 3 m s⁻¹ compared to about 6 m s⁻¹ for adults. Estimated long-term sustainable speed was about 1 m s⁻¹ for neonates compared to about 2.5 m s⁻¹ for adults. Weight-specific power requirements decreased as calf size increased, but power estimates for 2 year old spotted dolphin calves were still about 40% higher than power

estimates for adults, to maintain the same speed. These estimated differences between calves and adults are conservative because the calculations do not include reduced aerobic capacity in dolphin calves compared to adults. Discrepancies in power production are ameliorated under normal circumstances by calves drafting next to their mothers, but the relatively high swim speed and turning maneuvers associated with evasion of tuna purse-seine sets are likely to disrupt that energy-saving association.

Estimation of Number of Harp Seal Pups (*Phoca groenlandica*) on the Whelping and Molting Grounds in the White Sea in 2004

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In 2004, a multi-spectral airborne survey of the harp seal in the White Sea was conducted from scientific aircraft AN-26 "Arktika" according to a method developed at PINRO using an IR scanner, photo- and video cameras. During one season, the airborne survey of both whelping (16-24 March 2004) and molting (22-25 April 2004) grounds was carried out that permitted us not only to estimate the number of pups but also to monitor weather conditions affecting their survival. The airborne survey on the whelping grounds in the White Sea was carried out by parallel transects; over the low-density whelping grounds it was done in 14.5 km, over the medium-density and dense whelping grounds it was spaced every 7.3 km. The survey altitude over the whelping grounds constituted 150-200 m, while over the molting grounds the higher survey altitude was tried (350-400 m). The present paper gives examples of IR and photo images obtained from different altitudes. Based on the airborne survey results distribution of whelping and molting grounds of the harp seal in the White Sea in 2004 was mapped and compared with distribution pattern and number of harp seals in previous years. The number was counted on each transect using data from the IR scanner, video and aerial photography in different combinations. Total number of the harp seals was estimated based on the extrapolation method. Number of the harp seal pups on the whelping grounds in 2004 made up 238.5 thousand pups (SE=35.6) and their survival conditions were evaluated as quite favorable. Number of the harp seals on the molting grounds in 2004 was estimated to be 1,112.3 thousand seals (SE=224.1).

Abundance, Movements, and Temporal Sampling Design for Bottlenose Dolphins in Estuarine and Coastal Waters of the Mid-Atlantic Coast, USA, Using Photographic Mark-recapture Analyses

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Estimates of abundance and knowledge of stock structure is crucial for managing populations that are impacted by human activities, and several methods are used to collect such information. The turbid estuarine waters along the Atlantic and Gulf coasts of the US prevent the use of aerial surveys to estimate abundance of bottlenose dolphins. Mark-recapture is a viable alternative and also may help determine the extent of dolphin movements between estuarine and coastal waters. However, given the extensive coastline needing coverage, the cost may be prohibitive. We conducted a mark-recapture study of one defined stock of bottlenose dolphins to estimate abundance, determine the probability of movements between estuaries and coastal areas, and, given those results, estimate sampling frequency needed to obtain acceptable CVs for an abundance estimate. The photographic mark-recapture study occurred in estuaries and coastal waters from 6 July to

7 August 2003 from Cape Lookout, NC, to Cape Romain, SC. Using four boats, we surveyed 4,893 km of trackline. Using a multi-strata mark-recapture model, the estimated probability of movements from estuaries to coastal habitats was 0.103 (95% CI 0.05-0.19), whereas from coastal habitats to estuaries it was 0.007 (95% CI 0.003-0.016). Our finding regarding limited exchange between habitats was supported by another study indicating a significant difference in the stable isotope signatures between coastal and estuarine bottlenose dolphins. Based on these findings, we estimated abundance in the estuaries as a closed population. A mark-recapture analysis indicated 157 identifiable dolphins (CV=11.5%, 95% CI 137-203) inhabited the estuary. The estimated proportion of identifiable dolphins for the area was 0.41, resulting in an abundance estimate of 382 (95% CI 334-495). Results from a permutation analysis indicated sampling frequency can be reduced from 15 to 11 sampling days to obtain an abundance estimate with a CV < 30%, thereby reducing the cost of conducting further surveys.

Foraging Ecology and Microhabitat Use of Bottlenose Dolphins (*Tursiops truncatus*) in the Southern Portion of Turneffe Atoll, Belize

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Microhabitats are small zones within a population's habitat that differ biologically and physically from surrounding areas and that have a profound impact on foraging. Foraging microhabitats have been explored for a range of animals including birds, bats, small mammals and fish, but few studies have examined cetaceans, particularly bottlenose dolphins (*Tursiops truncatus*), on such a fine scale. I examined the microhabitats used for foraging by bottlenose dolphins in Turneffe Atoll, Belize and the distribution of possible prey species across the seagrass, boundary, and sand microhabitats. Through behavioral observation, substrate quadrat measurements, visual census transects and acoustic recordings, the dolphins were found to feed selectively in boundary microhabitats, areas where dense seagrass beds adjoined open sand flats. Fish distribution, particularly schools of grunts (family Haemulidae), was higher on the boundary than in the seagrass or the sand microhabitats. Five hundred forty-two minutes of acoustic recordings yielded less than twenty-three seconds of fish sounds, suggesting that passive listening was not a likely means of prey detection diurnally. Boundary areas were therefore likely preferred due to the abundance and visibility of prey.

Establishment of Epidermal Cell Lines Derived from the Skin of the Atlantic Bottlenose Dolphin (*Tursiops truncatus*)

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The Atlantic bottlenose dolphin (BND) has become a focus of attention as an indicator of the environmental conditions of Atlantic coastal waters because of pathologies and diseases previously unseen in these marine mammals. Humans are exposed to these same waters suggesting that dolphins may be sentinels for human health as well, especially considering similarities in life span, offspring number, and growth and maturity rates between the two species. Since the epidermis serves as the critical interface between the dolphin and its aquatic environment, we have established BND epidermal cell cultures and cell lines from skin tissue as an *in vitro* tool for evaluating

environmental stressors on this protected marine mammal. We have characterized the cell cultures by karyotype analysis, immunohistochemical staining for cytokeratin, and two-dimensional polyacrylamide gel electrophoresis, all of which revealed similar patterns between cell cultures and skin tissue. We also observed that the cytokeratin staining pattern was analogous to that of the human keratinocyte cell line, HaCaT. On the other hand, dolphin cells demonstrated a greater tolerance to high salinity conditions compared to HaCaT cells as indicated by morphology assessment and MTT assay; this is not entirely surprising considering the natural environments of humans and dolphins. Cell lines were obtained by transfection of the dolphin skin cell cultures with a plasmid encoding the SV40 small t and large T antigens in conjunction with the neomycin-resistance gene. Neomycin-resistant clones exhibited a marked increase in growth rate compared to the non-transfected cell cultures. The availability of BND epidermal cell cultures and cell lines provides a much needed tool for comparing the responses of marine organisms and humans to environmental stressors as well as a novel experimental approach to studying the dolphin.

Why Be Local? The Range And Movements Of Heaviside's Dolphins (*Cephalorhynchus heavisidii*) as Determined By Satellite Telemetry

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Heaviside's dolphin is a coastal delphinid with a limited inshore distribution off the west coast of southern Africa. Knowledge of its habitat usage is an essential precursor to assessing its potential vulnerability to fisheries interactions. Six Heaviside's dolphins (1 male, 5 females) were fitted with satellite-linked transmitters in 2004, and tracked for up to 54 days. Five of the tags transmitted continuously, allowing for analysis of movements at a fine temporal scale. Four dolphins showed an initial avoidance of the capture site by moving over a wider area in the first 2-5 days post-tagging than later in the deployment period. All dolphins had used their full 100% Minimum Convex Polygon home ranges at least 10 days prior to tag failure, suggesting measured home ranges were stable at this temporal scale. Resightings of photo-identified individuals indicate a similar long-shore range over the longer term, suggesting that the species in general may have a relatively limited home range. Home ranges of the tagged dolphins scaled positively with body size but varied in shape, usage and number of core use areas (using Local Convex Hull home range methods). Although the distance from shore and depth at which individual dolphins moved varied greatly, all dolphins showed a strong inshore-offshore diurnal movement pattern, generally being closest inshore between 6am and noon, and furthest offshore between 15h00 and 05h00. This pattern is assumed to be related to the movements of their principal prey, juvenile shallow-water hake (*Merluccius capensis*), which migrate into the upper water column at night. Movements inshore may be associated with rest, socializing and predator avoidance. The ecology of the species contrasts markedly with the sympatric dusky dolphin (*Lagenorhynchus obscurus*) and the relatively small home range (in cetacean terms) may be related to the more predictable availability of demersal compared to pelagic prey.

Investigations into the Relationship Between Pelagic Fish and Dolphin Distributions off the West Coast of Scotland

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Surveys of the main commercially exploited fish stocks are carried out on a regular basis in European waters, and provide an ideal platform on which to conduct passive acoustic surveys for cetaceans. This study looks at the effectiveness of such surveys and whether it is

possible to relate observations of cetacean distribution to simultaneously collected pelagic fish distribution data. A 2-element audio (100 Hz – 24 kHz) hydrophone was towed 400m behind a chartered pelagic fishing vessel, Enterprise, during two of the Fisheries Research Services (FRS) annual acoustic surveys for herring (*Clupea harengus*) in July 2004 and July 2005. The surveys covered the continental shelf waters (to the 400m depth contour) to the west of Scotland from 56°N to 60°N. One-minute listening stations were carried out every 15 minutes, and dolphin whistle and click sound levels were recorded to provide data on dolphin distribution. A Simrad EK500 echosounder operating at 38, 120 and 200 kHz was used, in conjunction with pelagic trawling, to collect data on the distribution and abundance of herring. The paper examines the relationship between dolphin and pelagic fish distributions. It will also discuss the issues associated with such methods, including the difficulty in determining dolphin species from their vocalisations, fish species from their echograms, and the possible effects of active acoustics at frequencies that are likely to be heard by cetaceans and hence may influence survey results.

Estimating Pre-whaling Stock Levels Through Genetic Diversity: A Novel Approach

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Although whaling is known to have reduced most large cetacean populations, historical abundance estimates based on catch records remain controversial. In 2003, Roman and Palumbi (Science 301:508-510), used genetic data to estimate historical abundances that can differ by an order of magnitude from demographic back-calculation estimates, which are based on whaling data. For example, back-calculated estimates for humpback and fin whales in the North Atlantic are 20,000 and 40,000 compared to the R&P estimate of 240,000 and 360,000, respectively. They challenge the practice of using the back-calculated estimates in current management. We present a novel approach to estimate historical population size through analysis of genetic neutral diversity that matches back-calculated estimates closely. We incorporate two demographic-history footprints derived from phylogeny reconstruction (number of haplotypes for each lineage and an intraspecific/intrapopulation mutation rate) into the standard relationship between genetic diversity and long-term effective female population size. We first calculate genetic diversity as the mean nucleotide diversity times the number of haplotypes in a population. We then calculate the mutation rate as the mean number of substitutions since the time of divergence of all haplotypes, which was recovered from the phylogenetic tree topology. This method estimates 21,680 humpbacks (95% CI 13,100 – 34,300) and 41,960 fins (95% CI 24,400 – 63,900) for the North Atlantic prior to commercial whaling. We also compare the R&P method to our method for isolated populations of fin whales in the Mediterranean and the Gulf of California, which have not been extensively whaled and have current abundances that should be close to historical abundances. Our method and current abundances match closely while the R&P method shows historical numbers at 15 to 30 times current abundance. If validated, our estimates could set a more confident baseline to evaluate recovery levels for whale stocks and, consequently, to improve management schemes.

Minke Whale (*Balaenoptera acutorostrata*) Habitat Selection in Three Ecosystems in the Northeast Atlantic Explored Using Geographic Information System

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Minke whale (*Balaenoptera acutorostrata*) habitat selection in the North, Norwegian and Barents Seas in 1988, 1989 and 1995 was studied by investigating spatial associations between minke whale distributions physical habitat (depth, slope, SST and fronts). Prey

distributions were obtained from semi-synoptic surveys in the Barents Sea in 1995, when the abundance of the preferred prey species herring and capelin was low. In the North Sea minke whales selectively used 12-14°C and occurred in either shallow (depth <100 meter) or deep waters (depth > 400 meter) by no or steep temperature gradients. In the Norwegian Sea minke whales preferred colder waters (2-4°C) in 1989 and 1995, but warmer waters (8-10°C) in 1988, and they occurred both on (1989) and off (1988, 1995) the shelf. Preferences for slopes and fronts differed between years. In 1989 and 1995, minke whales in the Barents Sea selectively used temperature ranges of 5-7°C and 250-350 m depth intervals with no associations to slope. Minke whales were associated with shallower, warmer water masses (7-11°C) in 1989. The analysis of prey selection in the Barents Sea in 1995 showed that minke whales were positively associated with plankton, cod and haddock, negatively associated with herring and not associated with capelin. Minke whales had wider distributions in warmer than colder years, possibly due to temperature related changes in prey distributions. The continental edge may be an important habitat for minke whales in some years. Polar front areas in the Barents and Norwegian Sea, and mixing areas in the North Sea seem to be important habitat when abundance of pelagic fish (capelin and herring in the Barents Sea, herring in the Norwegian North Seas) was suitable. However, when not suitable minke whales may switch to alternative prey such as zooplankton and gadoid fish, thus demonstrating the flexible nature of minke whale behaviour.

Does Size Matter? Estimating the Neocortical Cell Number in the Common Minke Whale

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The largest brain in the Animal Kingdom belongs to the cetaceans, but among mammals it is the least studied. Most research has been carried out on odontocete physiology and anatomy, while the only research on mysticete brains has been done on general morphology. This is the first attempt to estimate the neocortical cell number on any species of cetacean – using the common minke whale as a model of all mysticetes. Five brains from mature whales were included; three males and two females, and each brain were formalin fixated. Neuron and glial numbers are counted using the optical fractionator, which is a stereological probe for sampling objects according to their number. A single hemisphere was cut into 2.5 cm slabs using Cavalieri's method, which is based on unbiased principles for estimating volume of an object. Using a random start the brain was cut into parallel sections of equal thickness, and a predetermined fraction was sampled. The total number of cells is found by multiplying the total number of counted particles $\sum Q$ with the reciprocal sampling fractions, $N = 1/ssf \cdot 1/asf \cdot 1/tsf \cdot \sum Q \cdot 2$, where ssf is the section sampling fraction, asf is the area sampling fraction and tsf is the q-minus weighted fraction of the section height. A mean number of approximately 14×10^9 neurons and 10×10^{10} glial cells were found in the bilateral necrotic of the minke whale. This is 2/3 of the human neuron number ($19-23 \times 10^9$), but 14 times that of rhesus monkeys (1×10^9) and 900 times that of mice (1.5×10^6). The minke neurons seem larger than human neurons, whereas the glial cells seem to be the same size. But the glial cell number is 3 times larger in minke, which could suggest that large neurons need a higher number of glial cells than small ones.

Whistles as Potential Indicators of Stress in Bottlenose Dolphins

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Stress has proven to be a challenging state to assess in dolphins. Using the unique, long-term dolphin whistle library for bottlenose dolphins (*Tursiops truncatus*) residing in Sarasota Bay, Florida, we are investigating a variety of whistle parameters to see if they may serve as reliable indicators of stress. These parameters include rate of

whistle production, and repetition rate of loops (repetitive elements) in multi-looped whistles. The whistle library contains dolphin vocalizations collected during brief capture-release events in Sarasota Bay, as well as recordings of the same animals under free-ranging conditions. The following hypotheses are being tested: Whistle rates and number of loops will be greater a) at the beginning of a capture session than at the end of a session; b) during an individual's first capture session than during later capture sessions; c) when a mother is caught with a dependent calf than without a dependent calf; and d) during capture than during free-ranging conditions. Preliminary results suggest an increased whistle rate and a greater number of loops produced in temporarily captured vs. free-ranging animals. Cortisol data taken for each dolphin during each temporary capture will be explored as a benchmark for stress level and compared to these findings to determine if whistle parameters are an adequate indicator of stress.

Seagrass Growth and Productivity in Dugong-Grazed Beds in the South Visayan Sea, Philippines

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Growth and productivity of seagrasses in dugong-grazed beds in three sites in the south Visayan Sea, Philippines was investigated. Site 1 (Chambery) was a mixed seagrass bed of *Halophila ovalis*, *Halodule uninervis*, *Syringodium isoetifolium* and *Cymodocea rotundata*. Site 2 in Ilacaon Island was a pure *H. ovalis* bed while Site 3 Maca Reef was a pure *H. spinulosa* bed. In these sites, three 1 m x 1 m plots were established near grazing trails. Entire seagrass shoots, including rhizomes and roots within the plots, were completely removed using shovels. The site was re-visited after 10 days, one month and monthly thereafter for four months. At harvesting, entire shoots were carefully lifted from the substrate to avoid breakage, placed in net bags and kept refrigerated until processed. In the laboratory, the following were measured: total rhizome length, internode length, number of branches, if any and presence of fruits and flowers. The samples were air-dried, then oven-dried at 60°C to constant dry weight after which subsamples were ashed at 550°C for 4 hrs. As of this writing, samples are still being processed. Preliminary results of growth monitoring showed that at Chambery, *Halophila ovalis* grew from the edges of the plot towards the center ('edge effect'). At one replicate plot, *H. uninervis* grew from the center of the plot. It is suspected that the shoots emerged from rhizomes which were not completely removed. Similar results were obtained for Ilacaon Island and Maca Reef where seagrasses grew towards the center of the plots. This pattern was also observed in actual dugong feeding trails.

Inferring the Causes of Marine Mammal Population Declines from Ecological, Behavioral, and Life History Patterns: Sea Otters and Coastal Ecosystems in the Aleutian Archipelago

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Although there is little doubt that populations of sea otters (*Enhydra lutris*) and coastal-living pinnipeds have collapsed across much of southwest Alaska during the past several decades, the reasons for these declines remain the subject of broad speculation. The declines were almost certainly driven by elevated mortality, for which two general explanations have been proposed—nutritional limitation and predation. These two demographic drivers should result in predictably different patterns of change in food availability, body condition, population structure, and behavior, which in turn might be evaluated through retrospective analyses of appropriate time series of information. We provide such analyses for sea otters in the central/western Aleutian archipelago based on data collected at multiple sites

over the past 35 years. Our data indicate that 1) prey abundance (sea urchin biomass and density) has increased > 10-fold; 2) sea otter length and mass at age has increased significantly, indicating improved body condition; 3) the shapes of growth curves have changed over time reflecting an increased rate of growth to maturity; 4) sea otter population age structure has shifted to a higher proportion of younger animals; 5) dietary breadth and diversity has decreased, becoming increasingly dominated by sea urchins; 6) less time is spent foraging; and 7) the spatial distribution of foraging and resting otters has shifted to shallower water closer to shore. Overall, these patterns are more consistent with a sea otter population decline resulting from increased predation than nutritional limitation or compromised health. We propose that similar retrospective analyses could be used to better understand why Steller sea lion, harbor seal, and northern fur seal populations also have declined in these same areas.

A Potential Morphotype of Long Beaked Common Dolphin (*Delphinus* spp) in the Northeast Coast of Venezuela.

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Records of common dolphin in the northeast coast of Venezuela have been widely documented. The complex topography and bathymetry of this area, and the enhanced productivity due to upwelling processes promote the occurrence of common dolphin populations. However, there is not a clear definition of the species, whether *D. delphis* or *D. capensis*. The aim of this contribution is to review taxonomically *Delphinus* spp from the northeast coast of the country through skull morphometric analysis. A sample of 30 skulls composed by specimens collected in Nueva Esparta State (N=28) and Sucre State (N=2) were analyzed using morphometric parameters as rostrum length (RL) and zygomatic width (ZW), including the ratio of both measurements RL / ZW. Only skulls identified as mature individuals were included in the analysis. Data were also compared with published records of South Atlantic's dolphins from Brazil and West Africa. Rostral length showed significant differences between the Venezuelan sample ($P < 0.05$) compared with the dolphins from Brazil ($P = 2.2 \times 10^{-6}$) and West Africa ($P = 3.6 \times 10^{-6}$). Zygomatic width also showed clear differences (Ve - Br, $P = 1.5 \times 10^{-5}$; Ve - WA, $P = 1.7 \times 10^{-5}$). In contrast no differences were found between the values of rostral length - zygomatic width ratio (Ve - Br, $P = 0.21$; Ve - WA, $P = 0.34$). Observations during sightings of common dolphins in the study area, reported small size females with calves. These results suggest the occurrence of a potential dwarf morphotype of long beak common dolphin in the northeast coast of Venezuela, an area referred as a semi-closed basin. Habitat conditions in this kind of ecosystems support morphologic differences between smaller coastal forms and bigger off-shore forms. An effect that could be related with the feeding ecology.

Analysis of Arrival and Departure Times of North Atlantic Right Whales in the Bay of Fundy: A Predictive Model?

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The movement patterns of the endangered North Atlantic right whale in and out of the Bay of Fundy were investigated during the summer and fall of 1998, 1999, and 2000. A 1.4 km grid was overlaid on track lines and sightings per unit effort of right whales were calculated. Habitat characteristics, such as sea surface temperature, depth, slope, and chlorophyll content, were defined in an 8-day period for each grid cell as parameters that might influence the timing of arrival and departure of right whales in this important habitat. The arrival time of right whales varied in the three years, starting as early as mid-June and continuing through mid-July. During this time the mean sea

surface temperature rose from around 9°C to about 13°C. The number of grid cells that included sightings of whales increased dramatically in all three years in the first week after the mean temperature rose above 12°C. The reverse occurred when whales left the bay; a drop in sightings occurring after the mean temperature fell below 12°C. The departure times were more consistent, ranging only a week in late September. Additionally, all habitat parameters were input into a generalized additive model and run through a backward stepwise cycle to determine which of the variables contributed to the overall fit of the model. Only the years 1998 and 1999 were used in the creation of the original model, while 2000 was used to test the predictive power of the resulting equation. The final model used a 2-week lag chlorophyll term, depth, sea surface temperature, and year to describe the distribution of the sightings per unit effort. The model did not have good predictive power for the 2000 data, however, depth and 2-week lag chlorophyll values were found to be significant in all years.

Enhancing Science Education Through the Investigation of a 2500-Year Old Fur Seal Rookery on St. George Island, Alaska

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Over the past year, we have been investigating a paleontological accumulation of mammal bones at Staraya Artil, St. George Island, Alaska with the help of local children, adults, and elders. Although known to local residents for many years, this represents the first systematic study of this unique site. Sub-fossil bones of northern fur seal, Steller sea lion, walrus, sea otter and arctic fox have been identified thus far. Our research interest is in documenting baseline information for fur seals and sea lions regarding breeding history, genetic variability, and foraging patterns. Ten radiocarbon dates from bones in the deposit range from 1,770-2,684 years before present (calibrated), well before the establishment of human settlements on the island. We have evidence of fur seals breeding at the site in the form of bones from adult males and females, as well as pups. Indeed, they continue to breed there today. Sea lions, on the other hand, have only been represented thus far by adult males, suggesting that Staraya Artil has only ever been used as a haul-out by this species. Genetic analyses of both taxa are underway, and will be compared with the genetic composition of the modern populations. Preliminary samples are small, but there is no evidence to suggest a major loss of genetic diversity of the Pribilof populations through population bottlenecks. Likewise, fur seal and sea lion teeth recovered from the site will be the subject of isotopic and thin section analyses in the coming months to determine foraging patterns prior to significant anthropogenic changes in the Bering Sea ecosystem. Finally, we are capitalizing on the unique nature of the site to enhance science education in the community. Community members routinely participate in field work, and science curricula have been developed for use in Middle and High School science classes.

Sex in the Arctic: Evaluation of Molecular Methods Used to Sex Polar Bears (*Ursus maritimus*)

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The reproductive rate of polar bears, a K-selected species which has a low intrinsic rate of population growth, is largely a function of the proportion of adult females in the population. Thus an accurate assessment of the sex of harvested bears and sex ratio in the population is important to prevent over-harvesting adult females. Development of species-specific molecular markers for sex determination is increasingly common, and a large number of molecular-sexing markers, both published and unpublished, are available for sexing mammalian

species. Some of these markers are, however, known to be unreliable for sexing polar bears. We used muscle samples from polar bears of known sex to evaluate five molecular markers that have been used to determine sex in polar bears. Among the five markers, two target the sperm receptor gene (SRY), one the zinc finger gene (ZFX/ZFY), and two the amelogenin (AMX/AMY) gene. Among the five markers, two were found to most accurately determine the sex of polar bears. The most reliable molecular marker, which targets the (AMX/AMY) gene was developed by (Carmichael et al.) specifically for polar bears, requires the use of an automated sequencer. The other most accurate marker, developed at the USFWS Forensics Laboratory, was a modification of one of the methods targeting the SRY gene and does not require the use of an automated sequencer. The use of either of these two molecular markers for sex determination of polar bears will provide reliable results for harvest monitoring, population assessment, and population genetics studies.

Benthos and Food Supply Studies in Feeding Grounds of the Okhotsk-Korean Gray Whale Population

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For a long time, the Piltun feeding area (PA) was considered the only western gray whale (WGW) feeding location of the east coast of Sakhalin Island during the summer and fall period. However, some feeding WGW were discovered in an area offshore Chayvo Bay on September 2001 by marine mammal observers and subsequent aerial and vessel monitoring has indicated that this a second feeding area - Offshore area (OA). This area is located 20-45 km offshore between the middle part of Chayvo Bay and the southern part of Niyskiy Bay, at depths of 30-50 m. The purpose of the work was to obtain detailed information on the status of benthos communities that make up the food resources for WGW in the main feeding grounds off the northeastern Sakhalin coast. Preliminary data on benthic fauna of the PA were the only information available; benthos in the OA had never been studied before at all. There are two summer feeding grounds for gray whales of the WGW population off Northeastern Sakhalin differing primarily in the structure of benthos complexes. Whales feed in the PA mainly within a shallow-water (5-20 m) benthic complex with prevalence of amphipods and isopods. Mobile deposit-feeder amphipods distinguished by eurybiontic nature, short life cycle and high growth rates are dominant in the complex. Feeding areas in the OA are associated with complexes with prevalence of the santon-feeder amphipod *Ampelisca eschrichti*. High abundance levels and aggregation in the spatial distribution of the dominant species are characteristic of ampeliscid amphipod colonies, which are a classic example of gray whale food objects in the North Pacific.

Long-Term Variation in Northern Fur Seal Maternal Foraging Trip Duration, Pup Mass and Pup Mortality

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We examined interannual trends and associations among maternal foraging trip duration, pup mass and pup mortality of northern fur seals on Pribilof Island rookeries in the Bering Sea. Data span periods of high fur seal abundance (1960s), decline (1960s-80s) and low abundance with decline (since 1990). Mean maternal foraging trip duration from St. Paul Island during early pupping (Jul-Aug) decreased from 9.2 d to 6.5 d after 1977, but varying sampling methodologies and study rookeries complicated comparisons. The range in August trip durations measured since 1996 with satellite recorders encompassed the durations observed during the early 1960s at nearby rookeries. Mean pup mass at about 1-month old increased for both sexes by ~0.07 kg/yr during 1957-1971, but there was no significant trend during 1984-2004. Pup mass was unrelated to early pup mortality rates. Pup mortality rates at St. Paul Island were lower after 1977, corresponding in timing to a warming of mean summer air temperatures, but may also have been influenced by density-dependent effects. Though current fur seal abundance does not likely produce density dependency upon these metrics, their use in evaluating

environmental quality is complicated by an incomplete understanding of responses to changes in prey abundance or distribution.

Preliminary Health Assessment Findings in Bottlenose Dolphins Inhabiting the Indian River Lagoon, FL and Coastal Waters of Charleston, SC

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Assessing health of coastal dolphins can provide valuable baseline information for evaluating the relationship between exposure to biological and chemical agents and deleterious health effects. Comprehensive health examinations were conducted during 2003-2004 on 155 bottlenose dolphins during capture-release studies. Preliminary findings indicate several differences between dolphins inhabiting the Indian River Lagoon (IRL), FL and those in Charleston (CHS), SC coastal regions. IRL dolphins had a higher prevalence of infectious diseases such as lobomycosis, which was found to occur only in the south IRL at a rate of 30% and was not found in CHS. Mucocutaneous neoplasia associated with novel papilloma and herpes viruses were documented in both populations. Cytological evaluations in 2003 indicated higher occurrence of severe acute gastric inflammation in IRL dolphins compared to the CHS dolphins, but lower rates occurred in 2004 for both populations. Immunologic evaluations indicate differences in immune responses between IRL and CHS animals which also differed by year. In 2003 differences occurred in phagocytic function and humoral immunity, while in 2004 the primary differences were in cell-mediated immunity and natural killer cell function. CHS dolphins have a higher body burden of persistent chemicals, including emerging chemicals such as perfluorinated compounds and polybrominated diphenyl ethers. Biomarker studies showed higher cytochrome P4501A1 expression in CHS dolphins compared to IRL animals, which may be related to higher PCB exposure. Antibiotic resistance of *Escherichia coli* bacteria in fecal samples evaluated for resistance to 25 antibiotics showed CHS population with higher (70%) resistance compared to the IRL (20%). Serological tests indicate differences in exposures to a host of bacteria and viruses. Early findings reveal differences in several health parameters between these populations. Longitudinal analyses are essential for identifying hazards that pose the greatest health risks to these dolphins and determining relationships to environmental exposures.

Cetacean Habitats in the Gulf of Mexico – To Be or Not To Be

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Cetacean distribution data collected during systematic line-transect assessment surveys in the U.S. Gulf of Mexico (GOM) is integrated with environmental data to describe this ecosystem from a cetacean perspective, and to assess habitat requirements of these fauna. The survey vessel transited oceanic waters from Brownsville, TX to Key West, FL, extending from the 200m depth contour to the offshore extent of the US Exclusive Economic Zone in June-August 2003 and April-June 2004. Environmental data collected synoptically by satellites and used in these analyses include sea surface temperature,

ocean color (a proxy for chlorophyll concentration) and sea surface topography (to determine frontal features). Data collected *in situ* by the vessel include sea surface temperature, thermocline depth, Conductivity-Temperature-Depth (CTD) and Expendable Bathymeter-graph (XBT) profiles, bathymetry, fluorescence, river runoff, and weather features. In both years, the most frequently sighted cetaceans were Pantropical spotted dolphins, followed by sperm whales and bottlenose dolphins, and, in 2003, Risso's dolphins. Univariate and multivariate interspecies comparisons of environmental variability to that of effort is analyzed. A Generalized Additive Model (GAM) is developed to test for differences of each species and each environmental variable. This study expands the temporal and seasonal scales and incorporates profiling and satellite-derived data not available to previous integrative studies conducted in the Gulf, to obtain a more complete description of GOM cetaceans relative to their habitats. These results may be useful in management and conservation decisions by providing an ecosystem view of the habitat requirements of cetacean assemblages in these waters.

Intra-Population Variability in Migratory Destinations: Geographic and Temporal Trends in Movements of Humpback Whales Between the US West Coast and Eastern North Pacific Breeding Areas, 1986 to 2003

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Humpback whales that feed off the U.S. west coast during summer are known to migrate to breeding areas off Central America and Mexico. To examine variability and trends in migratory movement, photographs of 1,555 individual humpbacks sighted from southern California to northern Washington between 1986 and 2003 were compared to photographs taken concurrently in the four major eastern North Pacific breeding areas: Baja (722 cataloged whales), mainland Mexico (857 whales), the Revillagigedo Archipelago (1,037 whales), and Central America (77 whales). Of the 1,555 west coast whales, 371 (23.9%) matched to at least one breeding area. The majority matched to mainland Mexico (254, representing 29.6% of that collection), followed by Baja (84, 11.6%), Central America (69, 89.6%), and Revillagigedo (18, 1.7%). The proportion of whales matching to each of the four breeding areas varied significantly with the sub-area in which a whale was observed off the U.S. west coast. The proportion of whales matching Central America was highest in southern California and declined to the north; no whales sighted in Washington matched to Central America. Although few whales matched to the Revillagigedo Archipelago, they represent a much higher proportion of matches from Washington than from southern areas. The proportion of whales matched to mainland Mexico increased around northern California relative to areas north and south, however mainland Mexico contributed the highest proportion of matches across all sub-areas. Matches to Baja showed no geographic trend, consistent with prior observations that whales are largely transiting through this area. Observed match rates were stable throughout the study period. The abrupt shift in match rates in Washington may indicate an area of overlap with another distinct northern feeding aggregation, and is perhaps a region where a small number of Revillagigedo whales stop to feed along a preferred migratory route, previously unknown for these offshore whales.

Trace Element Composition in Vibrissae, Milk, and Serum of Alaska Steller Sea Lions (*Eumetopias jubatus*): Identification of Weaning and Dietary Shifts

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Acute physiological events such as weaning and dietary shifts may be represented in the trace element concentration(s) found in metabolically inert tissues and tissue products of Alaska Steller sea lions (*Eumetopias jubatus*). Keratin contained in nails and vibrissae, and mineralized deposits such as bone, contain time-integrated records of nutritional history and dietary regimes. We collected vibrissae from sea lions living in Southeast Alaska, Prince William Sound, and the Aleutian islands. Animals varied in age from birth to 2 years old. An elemental analysis system comprised of a CETAC LSX 200 laser joined with a Perkin Elmer 6000 inductively coupled plasma mass spectrometer (ICP-MS) was used to determine the elemental composition of each vibrissae from the root to the tip. These data provide a time series of the elemental changes during the life of each animal. The elemental composition of sea lion milk and blood serum samples collected from a subset of animals was also determined. Data were collected on over 25 trace elements, and consistent trends were identified for many trace elements. Significant increases from vibrissae tip (representing the youngest age) to the root (representing the age of the animal at the time of sample collection) were measured in copper, phosphorous, zinc, cadmium, magnesium, and strontium levels. We present data summarizing comparisons of elemental analysis of blood, milk, and vibrissae values, and discuss the implications for timing of weaning and dietary changes in developing sea lions from different Alaskan regions. Research supported by NMFS, NMML/NOAA and ADF&G. Samples were collected under NMFS permit # 358156406

Skin Sampling for Genetic Analysis of a South Atlantic Spinner Dolphin (*Stenella longirostris*) Population

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In genetic studies of cetacean populations some difficulties are posed in trying to establish less invasive methods to collect tissues and also to sample an enough number of individuals. For some species, one alternative sampling method is skin swabbing, which is less injurious since it does not puncture the cetacean skin and yields adequate amounts of material for genetic analysis. Our aims were to collect skin samples from a spinner dolphin (*Stenella longirostris*) population from Fernando de Noronha, Brazil, and to verify if the samples could be used for genetic analysis. A wooden dowel with a nylon scrub pad attached to the top was used to collect the samples. The scrub was passed on dorsal or lateral dolphins' skin surface. In 10 days of intensive effort, 92 contacts were made. Of these, 87 percent were effective, with a visible amount of skin tissue on the scrub. DNA extractions were realized with GenomicPrep Cells and Tissue DNA Isolation kit® and Chelex® resin. To verify if the DNA was suitable, amplification of mitochondrial DNA using primers of cytochrome b was carried out and the fragment was sequenced and compared to the sequences available at Genbank®. Amplification of nuclear genome through RAPD markers was successfully realized. The samples extracted by Chelex worked better than the others and a certain amount of skin on the scrub was determined as the best one to conduct the analysis. Microsatellites are now being developed for the species and with these markers we will be able to define the diversity and population parameters for the spinner dolphin population of Fernando de Noronha.

Assessing the Impact of Lungworm Infection on the Health of Wild Bottlenose Dolphins in Central West

Florida

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Parasitism of the respiratory or gastrointestinal system is relatively common in stranded cetaceans. Although nematode lungworms have been reported in stranded bottlenose dolphins, no systematic investigations regarding the severity, distribution, and clinical consequences of lungworm infection have been conducted previously. This study determined the prevalence and intensity of lungworm infection in stranded and live bottlenose dolphins from central west Florida during 2003-2005. Dead stranded bottlenose dolphins were recovered, necropsied, and lungs were examined visually, by palpation, and histologically for lesions consistent with verminous pneumonia. Nematodes were counted, measured, and identified. Dolphin feces and blowhole swabs were collected and examined for nematode larvae from dead animals and live dolphins sampled during capture-release health assessments. Preliminary results showed a 76% prevalence of lungworm infection in dead animals (n=21). The infections in most cases were mild, chronic and not the primary cause of death. Only 14% of dead animals examined had a patent infection with larvae present in blowhole and fecal cytology and only four animals had intact worms present, identified as either *Halocercus lagenorhynchi* or *Skrjabinailius cryptocephalus*. The most susceptible age classes appeared to be neonates and calves (n=10), including one stillborn calf. For live animals, all blowhole swabs (n=44) were negative and fecal cytology (n=22) showed a 4% prevalence of patent infection. Findings from this study support the theory that bottlenose dolphins can be infected transplacentally by lungworms. The impact that such infections may have on neonatal survival is unknown; however, these infections could lead to greater neonatal mortality. With rising anthropogenic impacts on coastal environments, natural diseases such as lungworm infection may play a larger role in regulating dolphin populations by adversely affecting individual health and decreasing survival.

The SEaOS Project: Southern Elephant Seals as Oceanographic Samplers

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We know where many species of marine mammals go, when they go there and which parts of the water column they visit. Yet we need to know more about their immediate environment in order to understand their biology. There is also a need for near real-time monitoring of ocean processes for long-term weather and climate analyses and forecasting. With developments in sampling and data retrieval devices it is possible to create a synergy between marine mammal and oceanographic studies. Animals can collect information from logistically difficult areas, at fine temporal and spatial resolution at

relatively low cost. SEaOS is a project involving oceanographers and biologists from France, Australia, the US and the UK, conceived to study the distribution and habitat requirements of southern elephant seals and the feasibility of using deep diving marine animals as platforms for operational oceanography. We equipped 70 elephant seals from Macquarie, Kerguelen, South Georgia and Livingston Islands with purpose built CTD sensors (Valeport UK) linked to satellite relayed data loggers (SMRU, UK). These animals spread out over the Southern Ocean and relayed 2-4 salinity and temperature profiles each day, providing us with cross sectional samples of the main circum-Antarctic fronts and convergences as well as oceanographic data associated with the marginal ice zone and areas deep within it. In just two seasons, these early deployments have provided many times the number of profiles from these critically important areas than has ever been collected before, while simultaneously providing a wealth of distribution and habitat information on seal behaviour. The data is being incorporated in ocean databases. The need for oceanographic information for understanding both the distribution of marine animals and for the development fine-resolution physical models grows more rapidly than the funding available. This project demonstrates the effectiveness and potential importance of this novel approach.

New Estimate of the Southeastern Pacific Humpback Whale Stock

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The winter migratory pathway for the Southeastern Pacific humpback whale stock (*Megaptera novaeangliae*) extends along the northwestern coast of South America, and possibly as far north as Costa Rica. A preliminary estimate of the size of the migratory population is reported here, using closed (Petersen) and open (Jolly-Seber) mark-recapture models. A database of 1,061 individual whales photo-identified off the coast of Ecuador (2°S, 81°W) between 1991 and 2004, was used. The best estimate with the Petersen model was 2,917 whales (95% CI 1,751-4,859; CV 0.19), obtained in the period 2003-2004. Estimates with the Jolly-Seber model were more heterogeneous, even when data were pooled in periods of two years. However, an estimate of 2,881 whales (95% CI 1,722-4,039), similar to results using the Petersen model, was obtained for the year 2004 (based on constant survival rate and time-specific capture probabilities). Although it is generally known that whale distribution is not homogeneous throughout the wintering area, our estimate is considered representative of the Southeastern Pacific migratory population because Ecuador is located in the southern part of the wintering area where whales are most likely to pass. A more extensive, collaborative effort including wintering areas further north will help to increase precision in abundance estimates.

The Development of Synchrony and Behavior in Bottlenose Dolphins

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Synchronous behavior is a common characteristic of adult bottlenose dolphins and is presumably important in foraging, defense, and social interactions, but little is known about its development. Systematic observations of interactions between 12 calves and their mothers in 3 captive settings showed that synchrony was maintained at a very high rate (94% of the time) through the 4th week of life, and then

began to gradually decline to an average of 63% by the 17th week of life. All newborn calves remained in direct contact with their mothers in echelon position until nursing had commenced (range: 3-28.5 hrs), suggesting that mothers controlled the synchronous interaction through physical contact. At nursing onset, touching decreased. Time spent synchronously with non-maternal pool-mates was rare before the 4th week. All calves spent less than 5% of their time not synchronous with another individual until the 6th week, when time spent non-synchronously began a gradual incline to an average of 29% at 17 weeks. The characteristics of synchrony were similar across calves despite substantial differences in habitats and social circumstances. The large proportion of time spent synchronously with the mother and other individuals provides ample opportunity for the calf to learn about social behaviors, relationships, and affordances of the environment. Detailed analysis of 5-minute video recording samples of one calf taken on alternate hours over 19 weeks revealed that more complex swimming patterns emerged at 7 weeks of age and that behaviors increased in complexity over time. For example, swimming on side, swimming ventral up, and rolling-over formed a developmental sequence extending over 8 weeks. During this time, behaviors were performed by adults, subsequently attempted by the calf, then physically guided by adults, and enhanced during synchronous swimming.

Mass Spectrometry of Otoliths: New Insights into the Fish that Pinnipeds Eat

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Scat remnant analysis is a non-invasive technique that has traditionally provided information about pinniped diets (*i.e.*, types and sizes of prey), but new techniques can obtain considerably more information about the prey consumed by marine mammals. For example, fish otoliths (ear bones), in pristine condition, can provide information on fish movements, contaminant loads, and life history because they assimilate chemicals, heavy metals, and other elements from the environment as a function of fish species, water concentrations, and other environmental factors such as temperature. Physical analyses and the elemental signatures of bones recovered from scat can potentially provide information on the species and age of fish consumed, the life history of the fish, and contaminant loads consumed by predators. The effect of digestion on the elemental structure of otoliths is unknown, however, so this study compared the elemental signatures of otoliths before and after they had passed through the digestive tract of captive Steller sea lions. Otoliths were removed from thirty pollock, Atka mackerel, and herring. One otolith from each fish was analyzed using inductively coupled plasma mass spectrometry (ICPMS), while the other otolith was fed (inside the stomach cavity of decapitated herring) to sea lions housed at the Vancouver Aquarium. Otoliths were recovered from sea lion scat and analyzed via ICPMS. The results of a stepwise discriminant analysis and MANOVA indicate that pristine and digested otoliths discriminated between fish species accurately, but there were significant differences in the chemical signatures of the pristine and digested otoliths within each species. Laboratory studies are in progress to develop robust regression analyses to relate the elemental signatures of pristine and digested otoliths.

Variance Estimation for a Spatial Model of Cuvier's Beaked Whale Density

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Recent developments in geo-spatial habitat modeling have allowed us to estimate cetacean density contours from line-transect data. However, we do not yet know how accurate those density predictions are. We used a parametric bootstrap method to estimate variance for Cuvier's beaked whale (*Ziphius cavirostris*) density (number of

individuals per unit area) predictions derived from generalized additive models (GAMs) relating encounter rate (number of groups per unit transect length) and group size to environmental variables. The variance estimate includes estimates of uncertainty due to model selection, stochasticity in the encounter rates and group sizes, and line-transect parameter estimation. Estimated CV's ranged from 0.462 to 3.01 and were highest where survey effort was low. The predictor variables included in the original models of encounter rate and group size were consistently included in the bootstrap models, and those variables were selected more often than the remaining variables. The degrees of freedom associated with the selected variables in the bootstrap models were not consistently the same as those selected for the original models. Several sources of uncertainty were left out of the variance estimates presented herein. Future efforts to model cetacean density should investigate the magnitude of the remaining components of uncertainty to the total variance estimate for the density predictions.

How Seals Divide up the World: Environment, Life History, and Conservation

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Pinnipeds display a remarkable variation in life-history adaptations while successfully inhabiting almost every marine environment. We explore how they have done this by grouping pinnipeds according to the kinds of environment they live in, their mating systems, the types of lactation strategies employed, and timing of life histories. Also, we determined which of these clusters provide information about risk of extinction. Seals at risk were not characterized by differences in lactation pattern (22% short vs. 46% long), mating system (24% multi-male vs. 35% harems), or timing of life-history events (23% fast vs. 42% slow) but did differ based on four environmental groupings. Grouping traits (rather than seals) described two clusters: one that included the environmental trait, primary productivity and a second that included all other environmental variables (seasonality, latitude, and temperature). Based on this result and theoretical considerations, we plotted seals according to energy (primary productivity) and variation (seasonality) and found a pattern analogous to the same four groups determined by cluster analysis of all environmental variables. Of the two groups representing low variation (equatorial and high productivity), 10 of 21 seal species have been designated at risk, in contrast to none of the 13 seals adapted to high variation. Seals appear to be best adapted to seasonal environments and thus, conservation efforts may benefit by concentrating on species inhabiting less variable environments.

Effects of Boat Traffic on Behavior of Harbor Seals in Norwalk, Connecticut, USA

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Where harbor seals (*Phoca vitulina concolor*) are found in close proximity to humans, recreational and commercial activities have the potential to disrupt the behavior of harbor seals while hauled out. We studied harbor seals on overwintering grounds in Long Island Sound, a highly-developed coastal region with a human population of over 8 million. From December to April in 2003 to 2005, we monitored harbor seal reactions to boat traffic using a remotely-operated video camera within 900 meters of the haulout area near Sheffield Island in Norwalk, Connecticut. We investigated the frequency of disturbance by boat traffic and the response of seals to various types of crafts (*i.e.*, kayaks, motorized boats). We also examined the effect of group size and time of year (*i.e.*, "habituation") on the seals' response to boat traffic. Boat traffic was observed within the haul out zone on 51 days during the 137 days seals were observed at the haul out site. Our results showed that 52% of the

boat traffic resulted in flushing of the seals from the rocks. The majority of these events were brought about by recreational power boats and fishing vessels. During our study, the haul out area was visited repeatedly by commercial shellfish boats and seal watch tour vessels. Our results suggested the seals did not habituate to reoccurring boat traffic. We concluded that disruption of resting behavior of harbor seals occurred on their overwintering grounds. Repeated disruptions by boats could cause increased energy expenditure of seals and lead to reduced fitness of individuals.

New Gas and Fat Embolic Pathology in Beaked Whales Stranded in the Canary Islands

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Recently, evidence of acute and chronic gas bubble lesions in tissues of different stranded cetacean species. Acute gas and fat embolic lesions have also been described in a mass stranding of beaked whales exposed to anthropogenic sonar signals (Neotapón, 2002). These findings raise some important pathological questions: (1) What the postmortem interval and necropsy technique necessary to diagnose acute gas emboli? (2) Are fat emboli common pathological findings in stranded cetaceans? (3) Do fat emboli develop at sea (*i.e.*, prior to stranding) or during the stranding process? Recent strandings in the Canary Islands provide valuable data to help address these questions. Firstly, two fresh stranded Blainville's beaked whales (*Mesoplodon densirostris*), one young adult female (stranded, 2003) and an old male (stranded, 2004) necropsied between 4 and 8 hours after death had massive, acute gas-bubbles within the porto-mesenteric system. Intravenous gas bubbles were found in other organs (*e.g.*, in the epicardial veins and meninges). Secondly, 18 out of 115 stranded cetaceans of six different species showed diverse grades of lung fat embolism. Most of the cetaceans with fat emboli in lung tissue belonged to deep and long duration diving species. The majority died due to anthropogenic causes like severe trauma caused by ship collision, or were associated with naval exercises and sonar activities. In some cases the cause of death could not be determined. Finally, four beaked whales arrived around the Canary Islands coasts approximately one week after the Majestic Eagle naval exercises conducted more than 100 km north of the Canaries in July 2004. The probability that the animals died at the sea is extremely high. All three beaked whales showed fat embolism (the fourth was not able to be analyzed due to extreme autolysis). Although mid frequency sonar was certainly used during the naval exercises, the use of other possible acoustic sources (*e.g.*, explosions, torpedos) is currently unknown.

Cetacean Socioecology?

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Socioecological models predict certain patterns of social organisation based on two main factors: predation pressures and feeding competition. Although initially developed based on studies on birds and primates, they are currently known as the Behavioural Ecology's theoretical framework to explain broader sociability in vertebrate species. Whether or not this can be done requires further studies on a broader range of species. Of particular interest are Ectothermic species, and species living under particularly different ecological pressures. *Sotalia guianensis* (grey dolphin, previously grouped with *Sotalia fluviatilis* or *tucuxi*) is a small odontocete (up to 2 m) that inhabits shallow and estuarine areas in south-american coasts. Along southern Brazilian coast, such species is described as forming small familiar (male-female-calf) groups when inhabiting estuarine bay waters. At Tibau do Sul (a 50 km coastal area in northeastern Brazil) a population of grey dolphin is observed in more open but shallow areas, rarely making use of an estuarine bay nearby. This population apparently forms groups larger than those described in southern areas (mean 5-6 individuals). This different social organisation seems to be related to

two factors: care of calf in risky waters, and greater success in collective than in solitary foraging (30% and 20%, respectively), although more detailed studies on the social structure of groups in both regions are needed. The socioecology of this group in relation to other *Sotalia* groups and in relation to socioecological models will be discussed.

Interspecific Interactions Between Marine Mammals and Turtles

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The National Marine Fisheries Service conducted an aerial survey, Mid-Atlantic *Tursiops* Survey (MATS) during July-August 2004 from Ft. Myers, Florida to Atlantic City, New Jersey. This survey was designed to estimate occurrence and abundance of bottlenose dolphins (*Tursiops truncatus*) on the western North Atlantic continental shelf. On several occasions, the junior author observed bottlenose dolphins and Atlantic spotted dolphins (*Stenella frontalis*) harassing loggerhead sea turtles (*Carretta carretta*). The dolphins chased the turtles, tossed them out of the water, and pushed the turtles underwater with their rostrums (beaks). We conducted a preliminary review of the interactions of marine mammals with both freshwater and sea turtles in the wild and in captivity. We located reports of interactions between nine cetacean, four pinniped, and two sirenian species with eight turtle species (two freshwater and six sea turtle). Interactions included dolphins apparently feeding on fish hiding under turtles, as well as apparently mischievous and possibly aggressive (*e.g.*, harassment) encounters by cetaceans, pinnipeds, and sirenians, which included physically moving turtles; chasing and poking at turtles; attempting to flip sea turtles onto their backs; pushing turtles underwater with their rostrums; and even tossing turtles high out of the water or onto sandy beaches. Interactions on land also occur, particularly on beaches used by nesting sea turtles. Attempted and successful predation attempts by both cetaceans and pinnipeds were also documented. Reported free-ranging interactions came from a variety of locations including Africa, Australia, the Azores, Brazil, French Polynesia, the Gulf of Mexico, Hawaii, the Mediterranean, Mexico, New Zealand, and Vanuatu.

Spatial and Temporal Variability in the Foraging Behaviour of Gray Whales (*Eschrichtius robustus*) in Clayoquot Sound

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Spatial patterns play a key role in many ecological models, but analysis is often limited to simple description of distribution. Research routinely links cetacean locations to simple variates in order to create a description of "habitat" and habitat use. In many cases such connections are poorly established links, while the significance of the scale selected for study is given little consideration. Understanding how animals use habitat on a fine scale is integral to wildlife ecology and responding to management questions. In this study, GIS analysis at two temporal scales of movement is used to examine the density patterns of whale habitat use and changes in the centres of activity. Eight maps of the 1997 – 2004 seasons of gray whale summer foraging behavior were produced displaying the overall seasonal density of whale activity, sequential weekly change of activity centres and the absolute density of animals using the site. From the results of this analysis a single map of the overall annual centres of activity for all years was created. Habitat use trends have some distinct spatial patterning. The overall within-season movement is interpreted as a product of typical patch foraging behaviour, where animals reduce patches to a "global" density. Rather than provide a full explanation of the vectors of movement of this process, we hypothesize a preferential use pattern; shifting from sheltered waters with more predictable prey to open water with a number of potential combinations of prey items. Change in habitat use between seasons is the result of fine and large scale components including the size of remnant prey

populations from past season use, combined with the bottom up pressure formed by the spring phytoplankton bloom and subsequent pulse of prey productivity.

Cetaceans and Prey in the Eastern Tropical Pacific, 1998-2000

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Models of cetacean abundance or distribution typically use environmental variables sampled during ship surveys or from satellite sensors. Prey availability is frequently missing from the suite of available explanatory variables; it cannot be measured quantitatively with adequate coverage and resolution except by active acoustic methods. We use 38 kHz acoustic backscatter data, collected during three years of NMFS cetacean surveys in the eastern tropical Pacific, to derive indices of the availability of small fish and krill-sized invertebrate prey organisms. Prey indices included average backscatter from the surface to 500 m depth and in surface, intermediate and deep layers, and depth and strength of maximum backscatter. The predominant echogram pattern throughout the region was an intense backscatter maximum in the near-surface layer at night, which decreased during the day when most of the nighttime near-surface scatterers migrated as a deep scattering layer to approximately 300 m depth. Although many cetaceans feed at night, analysis of relationships between daytime sightings and backscatter data shows that cetaceans were present in waters with relatively high mean backscatter, often where the deep-scattering layer was relatively intense and near the surface. These results demonstrate that prey indices from acoustic backscatter data may be useful explanatory variables in models of cetacean distributions. The response of four dolphin species (*Stenella attenuata*, *Stenella longirostris orientalis*, *Delphinus delphis*, *Tursiops truncatus*, *Stenella coeruleoalba*) and two species of baleen whales (*Balaenoptera musculus* and *Balaenoptera borealis/edeni*) to the backscatter data were analyzed to test hypotheses about the relationship among the six prey indices and cetacean species with different feeding strategies. Efforts are underway to upgrade the quality of acoustic backscatter and target strength data collected on cetacean abundance surveys in order to improve understanding of cetacean feeding and to model patterns of spatial and temporal variability of cetaceans and their habitat.

Rapid Decompression Does Not Induce Activation of Northern Elephant Seal Platelets: A Comparative Study with Human Platelets

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Diving mammals are routinely exposed to rapid pressure changes, and unlike human divers, do not appear to suffer from decompression-related disease. Human and other terrestrial mammal blood platelets become activated with decompression, leading to a loss of the number of circulating platelets and the formation of debilitating microthrombi. However, the effects of pressure changes on diving mammal platelets have not been examined. We used a variety of techniques to determine the response of platelets from the deep-diving Northern elephant seal (NES) to a high pressure-rapid decompression excursion. Platelets were isolated from whole blood collected from both juvenile and adult NES, and samples were subjected to a high pressure excursion using a specially designed high-pressure cell. Morphologically, NES platelets did not undergo significant activation in response to this excursion, unlike human platelets subjected to an identical excursion. To better understand this response, we used flow cytometry to assess platelet activation at the receptor level. Human platelets demonstrated a significant increase in fibrinogen binding following a high pressure excursion, indicating the occurrence of decompression-induced activation, which correlates well with the morphological studies. However, NES platelets did not display any differences in fibrinogen binding in comparison to control platelets, indicating that they are protected from decompression-induced activation. Using thin-layer chromatography, we determined that NES platelet membranes contain 21% by weight cholesterol, whereas human platelets only contain

approximately 7.5%. Cholesterol strongly modulates membrane fluidity by preventing a cooperative phase transition of membrane lipids in response to increased hydrostatic pressure. Membrane proteins, such as the fibrinogen receptor, may cluster together and become activated during a phase transition, and therefore can be significantly affected by pressure changes. We propose that the large amount of cholesterol in NES platelets has a role in preventing decompression-induced activation in these cells.

Dependence of the Acoustic Signals of Kamchatkan Killer Whale on the Behavioral Context

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Killer whale (*Orcinus orca*), as well as most of Delphinidae species, has a large vocal repertoire. Sounds of killer whales fall into three main classes: clicks, whistles and pulsed calls. The objective of this study was to reveal and describe quantitatively behavioral variability in acoustic signals of Kamchatkan killer whales. We defined the following types of group activity: traveling, foraging, socializing, resting. Sounds were classified to the following categories: echolocation clicks, whistles, discrete calls, variable calls, aberrant discrete calls, underwater tail-slaps. Discrete calls were divided into types and subtypes according to the existing classification. We have found the strong dependence of signals from the activity state. During foraging predominantly echolocation and discrete calls were used, but all other sound categories were also detected. The ratio of sound categories detected during traveling is similar to the ratio found during foraging, except underwater tail slaps, which were rarely detected during traveling. At the same time the total number of sounds from all categories during traveling was lower than during foraging. During resting only two sound categories were detected – echolocation and variable calls, and their numbers were lower than during other activity types. During socializing the number of variable calls and whistles was significantly greater. No underwater tail slaps were detected during resting and socializing. To find out the dependence of acoustic signals from the group structure we divided “foraging” into “carousel”, “asynchronous diving” and “dispersed” and “traveling” into “tight group”, “cluster” and “dispersed”. Three sound categories – echolocation clicks, discrete calls of type K1 and whistles – were correlated with group structure. All sounds of these three categories were used more rare when the group structure was tight and more often when the group structure was dispersed.

Large Sample Study of Dolphin Hearing Using Auditory Evoked Potentials

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Marine mammal hearing thresholds have traditionally been measured using behavioral techniques that are time consuming and require extensive subject training. As a result, direct information on hearing sensitivity exists for few marine mammal species and few individuals within those species. The National Research Council (NRC) has advocated the collection of audiograms of many individuals to establish baseline hearing capabilities but singled out the need to individually train behavioral subjects as the major barrier to large-scale auditory testing. To address these data gaps, a portable system was developed to assess hearing in dolphins using auditory evoked potentials (AEPs) — small voltages generated by the brain in response to acoustic stimuli. The AEP system used a transducer embedded in a suction cup to deliver amplitude modulated tones to the dolphin through the lower jaw. Evoked potentials were recorded non-invasively using surface electrodes. Adaptive procedures allowed hearing thresholds to be estimated from 10 to 150 kHz in a single ear in 45 minutes. AEP techniques were benchmarked by comparing AEP thresholds to behavioral thresholds in four individuals. Hearing thresholds were

measured in 31 bottlenose dolphins (23 male, 8 female), ranging in age from 13 to 46 years, at the U.S. Navy Marine Mammal Program. Considerable variation in frequency-specific hearing sensitivity was observed, including high-frequency hearing loss in some relatively young (early 20s) animals and good high frequency hearing in several older (35+ years) animals. For males, there was a weak, negative correlation ($r = -0.49$) between upper cutoff frequency (defined at the 120 dB re 1 μ Pa threshold) and age. For females, there was no correlation between age and cutoff frequency. These data help explain poor performance of some animals at certain echolocation tasks and suggest that estimating population level audiometry from single animal audiometric functions may be misleading.

Identifying Polar Bear Denning Behavior by Satellite Radio Telemetry

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Beaufort Sea polar bears den on pack ice, fast ice and land. Land and fast ice denning may have increased in recent years in response to the reduction of hunting pressures; changes in subsistence bowhead whale (*Balaena mysticetus*) harvest practices; as well as changes in climate which already have altered sea ice freeze and thaw patterns adjacent to Alaska. Visual searches have shown little promise in describing den distributions. To overcome biases of visual searches, long distance flights, radio tracking instrumented female polar bears, were used between 1983 and 1991, but have been discontinued due to the expense and high risk of survey flights over pack ice. To compensate for the absence of aerial radio tracking surveys, we examined the effectiveness of identifying polar bear denning behavior and distribution using satellite-linked radio telemetry data collected between 1985 and 2005 from 295 adult female polar bears. Telemetry data acquired through the Argos System included inferred movement paths, location quality indices, and radio-collar sensor data on temperature and animal activity. Of 544 bear behavior records that were monitored through an entire winter (bear-winters), we were able to assign 468 into 3 distinct behavioral categories: 236 free-ranging, 206 denning, and 26 dropped collars or animal mortalities. We used visual observations to assess the accuracy of 136 remotely assigned bear-winter behaviors, revealing complete concordance with all but 2 false-positive denning assignments (2.5% of the 79 cross-validated denning events). We believe that detailed analysis of Argos data can accurately assess polar bear activity patterns even in the absence of corroborating visual or other input.

Dolphin Flukes as Passively Self-Adjusting Flexible Propulsors for High Efficiency Transport

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The flukes are the primary locomotor structure in cetaceans, which produce hydrodynamic thrust as the caudal vertebrae are oscillated dorso-ventrally. Effective thrust generation is a function of the kinematics of the flukes, the angle of attack between the flukes and the incident water flow, and the shape of the flukes. We investigated the effect of bending within the caudal region of odontocete cetaceans to determine how changes in angular displacement between caudal vertebrae could effect passive shape change of the flukes. Lateral and posterior views from high-speed video of *Tursiops truncatus* freely swimming and statically pushing against a load cell showed substantial chordwise and spanwise flexibility of the flukes. Spanwise bending was restricted to the fluke tips. Fluke chord was maximally bent as the fluke changed vertical direction during the oscillatory cycle with a chord reduction of 31.6-35.1%. The internal and external changes

of bent flukes were examined with Computer Assisted Tomography (CT scan). Flukes and tailstock were removed from deceased *Delphinus delphis*, *Lagenorhynchus acutus*, *Phocoena phocoena*, *Peponocephala electra*, and *Tursiops truncatus*, and bent on an adjustable support at 0, 45, and 90°. At 0°, cross-sections of the flukes displayed a symmetrical profile. Cross-sections of bent flukes (45°, 90°) were asymmetrical and showed a cambered profile. Maximum cambering occurred close to the tailstock and decreased toward the fluke tip. Maximum angular displacement occurred at the “ball vertebra”, which was located posterior of the anterior insertion of the flukes on the tailstock. Bending at the “ball vertebra” passively cambers the flexible flukes. Cambering could increase hydrodynamic force production during swimming, particularly during direction reversal in the oscillatory cycle. In addition, bending at the fluke tips would act like winglets to control tip vortices, enhanced thrust production and increase hydrodynamic efficiency.

Influence of Season and Habitat on the Foraging Ecology of Bottlenose Dolphins (*Tursiops truncatus*) from the Charleston SC Region as Indicated by Stable Isotope and Fatty Acid Analyses

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Stable isotope (SI) and fatty acid (FA) analyses have been used to examine stock structure and foraging ecology in marine mammals; however, the use of both in combination likely provides more complete and accurate information. We investigated blubber FA composition and skin SI ratios of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$ for free-ranging bottlenose dolphins from three estuaries and the nearshore coastal waters around Charleston, SC during 2002 and 2003. Nine potential prey species were also examined. Neither FA composition nor SI values differed between estuarine and coastal dolphins. However a unique subset of dolphins, sampled primarily from the North Edisto River, was significantly different from the remaining dolphins. These dolphins were more similar in SI ratios and FA composition to striped mullet (*Mugil cephalus*) than their counterparts. Seasonal variation was also present among dolphin sample SI ratios (ANOVA; $\delta^{13}\text{C}$, $p < 0.002$; $\delta^{15}\text{N}$, $p < 0.0001$) and inner blubber FA composition (Welch ANOVAs of principal components; PC1 & PC3, $p < 0.0001$). SI and FA values of dolphins sampled in fall were more similar to those of striped mullet and red drum (*Sciaenops ocellatus*) while dolphins sampled in spring were more similar to spot (*Leiostomus xanthurus*). These seasonal trends corresponded with known availability of prey species in the study area. The agreement of SI ratios and FA composition with expected temporal distribution of the prey strongly suggests (of the species studied) dolphins in the Charleston area rely more heavily on mullet and red drum in fall with an increase in the dietary importance of spot during spring. The lack of a clear distinction between dolphins sampled in estuarine and coastal waters suggests diets of dolphins from these two habitats may overlap to a greater extent in waters around Charleston than in other areas, pending $\delta^{34}\text{S}$ results should help clarify this issue.

Episodic Evolution of Cetacean Major Histocompatibility DQB-1 sequences

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High nonsynonymous to synonymous substitutions rate ratios ($w = dn/ds$) are indicative of positive molecular selection. In most vertebrates, Major Histocompatibility Complex (*Mhc*) protein diversity due to higher nonsynonymous substitution rates, is considered an adaptation, that enable the organism to present variable self and antigenic peptides to T cells, and elicit immune responses against

pathogens. Recent sequencing analyses have found higher nonsynonymous substitutions in most cetacean *Mhc* molecules. The latter are criticized since it is considered that: i) analyzed sequences encode hypervariable regions, and are biased to show higher *w* values; ii) the analyses of sequences from distinct taxa with divergent evolutionary histories, creates “artificial” sequence diversity and spurious biased high *w* values, and iii) assessment of *w* should be based on a phylogenetic framework. Thus, this study tested several codon-based Maximum Likelihood (ML) models that allow for variable *dn/ds* ratios among distinct lineages, thorough likelihood ratio tests, to examine whether *w* for *DQB-1* genes is variable among cetacean lineages; whether *w* estimates for certain lineages differ from a background *w* estimated for the remaining lineages in the phylogeny, and whether *w* estimates for certain lineages is indicative of positive selection. Estimated *dn/ds* ratios values differed significantly among three selected lineages (Balaenopterids, Delphinids and Phocoenids), due to apparent increases of *dn/ds* substitution rates during short periods of intense positive selection, suggesting that beside being non neutral, evolution of cetacean DQB proteins is episodic. ML estimates of parameters suggested that nonsynonymous are greater than synonymous nucleotide substitutions in lineages leading to Balaenopterids, and Delphinids, with *dn/ds* >1 ratios. In contrast; in the lineage ancestral to Phocoenids *dn/ds* ratio was not significantly greater than one. Thus likelihood analyses support most conclusions regarding positive selection acting on cetacean *Mhc* genes, but also reveal that episodic selection is shaping the evolution of cetacean *Mhc*.

Biomechanics of Ship Strike Trauma — Skull Fracture Caused by Head Leveraging

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The remains of three suspected ship strike victims (one right and two humpback whales) were studied using forensic osteology techniques to determine the biomechanics of the injuries. All three presented similar substantial basilar skull fractures on the right side including a broken right occipital condyle and an associated open vault fracture. Fracture margins showed no evidence of crushing or depressions suggesting blunt force trauma did not cause the cranial fractures. Obvious diastatic fracturing involved the right parietal, palatine, and tympanic, and separated the squamosal and frontal from the cranium. Photographs of the beach-cast whales showed no external evidence of trauma at or near the region of the cranial fracturing. A contact injury was present on the opposite side at the mandible in each case—a broken mandible in one; a large hematoma in another; and not-so-obvious mandibular ecchymosis in the third. The nature of the trauma preserved in the bone and the location of contact injuries indicate the whales were struck at a wide part of the head on the left mandible causing the head to turn violently to the right. The inertia of the body and the force of the strike caused energy to concentrate at the right superior articular facet of the atlas and the right occipital condyle. The force sheared off the occipital condyle and much of the basilar cranium, leading to additional diastatic fracturing involving most of the right side of the skull. A review of other suspected ship-strike specimens may reveal additional incidences of catastrophic cranial fractures caused by head leveraging. The key indicator is a contact injury at the mandible on the opposite side of basicranial fracturing.

Correlates of the S4 Vocalization in Killer Whales (*Orcinus orca*): An Exploratory Study

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Researchers have made significant progress in describing the properties of pulsed vocalizations in the killer whale (*Orcinus orca*), but less towards identifying the factors associated with their emittance. We can explain what these vocalizations are, but not why they might be made. Indeed, starting points for investigation of such “why” questions have not been clearly discerned; we have little more than intuition by which to construct hypotheses linking vocalization to other aspects

of killer whale life. To help construct a more empirical foundation for continued research, an exploratory study of the S4 vocalization was performed within the Southern Resident Community (SRC) of the Pacific Northwest. All S4 vocalizations recorded within a study area off the coast of San Juan Island, WA in the summer of 2004 were measured and their properties compared with contemporaneous measures of whale presence, observed behaviors, environmental conditions, boat traffic and fish stocks. The results generally corroborate Ford’s (1987) identification of S4 as restricted to J-Pod within the SRC. Past that, a substantial relationship between S4 and observed physical activity was found, largely independent of the variation in those activities between pods. Several percussive behaviors, as well as activities such as spyhopping, porpoising and helping, were significantly more likely to occur in passbys where S4 was made. Within those passbys, moreover, the frequency by which S4 occurred and the duration of the calls correlated with the same and similar activities. Meanwhile, no significant relationships of either sort were found between the other measures tested and either S4 or its associated activities. That the physical activities do not appear directed towards any other measurable goal suggests that the relationship may merely represent an expression of arousal, and thus that relationships between vocalization and arousal levels would be a particularly fruitful starting point for further study.

Phylogeography of Harbour Porpoise (*Phocoena phocoena*) in the Eastern North Atlantic and in the Black Sea Explored by the Analyses of Nuclear and Mitochondrial DNA

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Study of the genetic population structure and the demographic history of the harbour porpoise (*Phocoena phocoena*) has been nearly comprehensive throughout its distribution in North Atlantic, most studies using the mitochondrial control region as a genetic marker. Although these studies have shown population structure in some parts of the North Atlantic, mitochondrial DNA is a single, maternally inherited locus and therefore insufficient to fully characterize

population structure and history. Polymorphism at 11 microsatellite loci was analyzed in harbour porpoises collected throughout the range of the species in the Central and Eastern North Atlantic from the Iberian peninsula northward to Arctic waters (Portugal, Spain, bay of Biscay, Irish waters, English Channel, the southern bay of the North Sea, Norway, Faroe Islands, and Iceland) and also along the coasts of the Black Sea (Turkey, Ukraine, Bulgaria and Georgia). Multilocus tests for allele frequency differences and population structure estimates indicate complete genetic isolation between Atlantic and Black Sea porpoises. No fine population structure was observed within the Black Sea, and this population displayed a low genetic diversity compared to those of Atlantic. These results can be interpreted in the light of the demographic history of this relict population and the strong founder effect and bottleneck it may have undergone in its past evolution. In Eastern North Atlantic waters, microsatellite data revealed fine scale partitioning of the genetic variation. These results will be compared to the pattern previously reported based on the analysis of the mtDNA control region, and seem to correlate with variation in oceanographic features.

Common Errors Made in the Mounting of Rorquals Skeletons in Most Natural Sciences Museums

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Most of the rorquals skeletons that can be seen in Natural science museums around the world present significant errors in the way they are mounted. Most peoples who do the work of mounting are not the same that collected the specimens. They look for clues in the museum mounted specimens and old osteological atlases (Gervais and Van Beneden's for example), often repeating the errors that were made previously. Most of the time, mandibles, hyoid apparatus, ribs and innominates positions are wrong. The mandibles curve in a horizontal plane when the mouth is closed and are suspended too close to the skull, the stylohyals are almost never attached in the right place, the ribs hang vertically from the vertebrae and the innominates are suspended too close to the vertebrae. As curator of the Musée du squelette, Ile Verte, Québec, I have collected several rorquals skeletons, and mounted some of them. So doing, I have gathered good data and experience on anatomy and position of the bones in the rorqual skeleton. They are used to illustrate the correct way to mount a rorqual skeleton and underline the gross errors usually made. Solutions are proposed that will prevent the repeating of them.

Linking Prey and Population Dynamics: Did Food Limitation Cause Recent Declines of 'Resident' Killer Whales?

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Two populations of fish-eating killer whales in British Columbia and Washington State, known as *northern* and *southern residents*, experienced declines in abundance of up to 20% during 1996-2001. As a result, these populations were listed under Canada's Species-at-Risk Act as Threatened and Endangered, respectively. Potential factors contributing to these declines include environmental contaminants, physical and acoustic disturbance, and changes in the availability or quality of food. Our recent research has shown that chinook salmon and, to a lesser extent, chum salmon, are important prey for resident killer whales, but other smaller salmonid species are not. The whales' strong preference for chinook salmon is likely due to this species' large size, high lipid content and, unlike other salmonids, its year-round presence in the whales' range. In this study, we assess whether food limitation was potentially a significant factor in recent declines of these whale populations. We examined the relationship between trends in killer whale population dynamics based on long-term photo-identification data, and abundance levels of chinook and chum salmon off the B.C. and Washington coasts over the past 25 years. Resident

killer whale population productivity is regulated primarily by changes in survival rather than reproduction. Periods of decline resulted from unusually high mortality rates that were experienced by all age- and sex-classes of whales and were synchronous in the two socially-isolated resident communities. Fluctuations in observed versus expected age- and sex-specific mortality rates showed a strong correlation with changes in chinook salmon abundance, but no relationship to chum salmon abundance. A sharp drop in coast-wide chinook abundance during the late 1990s was closely associated with a significant decline in resident whale survival. Although chinook salmon is clearly of great importance, determining whether this species is the principal factor limiting resident whale productivity will require on-going monitoring of both salmon and whale population trends.

Ecological Partitioning in Cetacean History

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From origins ~34 million years ago (m.y.a), modern Cetacea radiated explosively in Oligocene times to produce many new, subequally-speciose and structurally-disparate family-level clades. In contrast, amongst modern Cetacea, 3 crown-clades dominate in terms of species diversity: the Delphinidae, Ziphiidae, and Balaenopteridae. All are geologically young, perhaps little more than 10 m.y. old. Other modern families add to structural disparity, but most are low-diversity clades of limited geographic range and ecological impact. To contrast with the modern faunas, New Zealand Late Oligocene (~23-29 mya) fossils include stem-Balaenidae, possible stem-Balaenopteridae ("cetotheres"), stem-Delphinoidea, possible Eurhinodelphinidae and stem-Physeteridae, and diverse putative stem-Platanistoidea (Squalodontidae, Squalodelphinidae, Waipatiidae). Three other groups add an unexpected range of new species and structures: (1) In one clade of small dolphins (4 species; Dalpiazinidae?), the rostrum is long, narrow, and dorsoventrally flattened with polydont teeth including prominent apical (display?) tusks. The cranium shows limited directional asymmetry, and cranial topography indicates presence of enlarged nasofacial muscles. Mandibles are gracile with large panbones. (2) A cluster of toothless mysticetes (5+ species; Eomysticetidae?) has triangular to parallel-sided rostra with variably developed "baleen" grooves, and long gracile mandibles. Nasals are long, and temporal fossae large. Ear-bones differ markedly from coeval stem-balaenids and ?stem-balaenopterids. (3) Remarkably, 4+ species of archaic whales reminiscent of dorudontine archaeocetes are present. Features of the ear (amastoid periotic) place these cladistically between Eocene Dorudontinae and crown-Cetacea (Neoceti), but there are no features that might indicate echolocation or filter-feeding. Beyond New Zealand, other Oligocene Cetacea (e.g., in Japan-Oregon-Washington; South Carolina) further expand taxonomic diversity and structural disparity. At a global scale, these early fossils reveal no particular trend towards "modern" taxonomic partitioning, nor any hint of whether biological or physical processes (e.g., competition, or change in climate or ocean circulation) will dominate in later history.

Mortality and Injury of Cetaceans in the Hawaii-based Longline Fishery, 1994-2004

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Little published information exists on rates of cetacean mortality and injury in Pacific Ocean longline fisheries. The Hawaii-based longline fishery was observed during 1994-2004, with 4-25% coverage. Two separate components of the fishery, targeting tunas and swordfish, differ in geographic area of operation, gear types, and set characteristics. Observer coverage has varied considerably in these two fishery components, complicating analysis of fleet-wide cetacean interaction rates. This study uses a classification and regression tree (CART) analysis to stratify by gear type, set characteristics, and target species, with the goal of accurately estimating mortality and injury of cetaceans. Total fishing effort for January 1994-June 2004 was estimated as 132,622 sets, averaging

about 12,600 sets per year. During 15,859 observed sets, 55 cetaceans of 10 identified species were observed hooked or entangled (3.5 cetaceans per 1000 sets). Five of these interactions resulted in the death of the animal (two short-finned pilot whales, *Globicephala macrorhynchus*, one pan-tropical spotted dolphin, *Stenella attenuata*, one bottlenose dolphin, *Tursiops truncatus*, and one Blainville's beaked whale, *Mesoplodon densirostris*). The 50 other hookings and entanglements involved 16 false killer whales, *Pseudorca crassidens*, seven Risso's dolphin, *Grampus griseus*, four short-finned pilot whales, two bottlenose dolphins, two spinner dolphins, *Stenella longirostris*, three humpback whales, *Megaptera novaeangliae*, one sperm whale, *Physeter macrocephalus*, one short-beaked common dolphin, *Delphinus delphis*, and 14 unidentified cetaceans. Estimated fleet-wide annual mortality and injury of cetaceans averaged 43 (CV=0.22) animals. Interaction rates and species composition differed regionally and by component of the fishery. The mortality and serious injury of false killer whales within the U.S. EEZ of Hawaii is of concern because this stock is estimated to contain less than 300 individuals, and recent takes exceed the allowable level (PBR) under the U.S. Marine Mammal Protection Act. Take rates for all other cetacean species are below their respective PBRs.

Linking the Distribution of Bottlenose Dolphins in Kvarneria (Croatia) to Anthropogenic Factors: Implications for the Proposed MPA

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The Kvarneria region of the Adriatic Sea experiences heavy human exploitation, seasonally by tourism and year-round by small-scale fisheries. This exploitation has increased year on year. Our study analysed bottlenose dolphin distribution with the aim of providing information to managers on potential critical factors that may affect their habitat use. Dolphin data were collected April 1995 - October 2003. GIS was employed to integrate data from 341 sightings with depth, submarine slope, distance from the coast, and distance to sites affected by high intensity human use (bottom-trawling areas, marine petrol stations, and the main 'highway' of recreational boaters) into a fine-scale (1000 m² size cells) grid. Relationships with environmental and anthropogenic factors were analysed using GLMs. The distribution of sightings showed high annual and seasonal variability. The annual encounter rate showed a significant negative trend. GLMs indicated a significant negative impact on the presence of bottlenose dolphins of two explanatory variables: the distance from the main 'highway' and the distance from the main marine petrol stations. Two possible prime critical factors are suggested to cause such avoidance reaction: a) increasing level of noise, and/or b) high speed moving objects, inducing an anti-predator like response. The increase in the number of boats registered in the Archipelago was significantly correlated ($p < 0.05$) with the inclusion of the explanatory variable "distance from marine petrol stations" in the GLM for the following year, suggesting the possibility of "social memory" or learned response to avoid specific critical areas. Two factors positively affected the presence of dolphins: bottom depth and trawling areas. Predictive maps helped to identify avoided and preferred areas within the boundaries of the proposed Lošinj Marine Protected Area and to highlight possible management actions to decrease the possibility of displacing dolphins out of the MPA.

Utilization of Urbanized Estuaries by Northern Migratory Coastal Stock of Bottlenose Dolphins, *Tursiops truncatus* in Virginia, USA

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The northern migratory coastal stock of bottlenose dolphins in the western Atlantic was studied using standard small boat protocols. This stock is seasonally migratory, arriving in the area in late spring and departing in autumn. Passive observation and photoidentification methods were followed. Data recorded included location via GPS, estimates of numbers, activities seen at surface, environmental and incidental observations. Photoidentification was used for both population calculations and comparisons with the regional fin catalog. The areas of focus were the Lower James and Elizabeth Rivers of Virginia, USA. This estuary is bounded by urban, suburban and industrial developed areas, with high contaminant loads. Boat traffic ranges from small personal craft to the largest military and commercial ships. Traffic of all types in this area is expected to increase twofold over the next ten years. Several disturbance events from anthropogenic activity were observed. The animals showed a temporal pattern of distribution over the season, with few (1-2) present early, and mean group size increasing to a peak of 45 in August. Group sizes in the study area are larger than those observed at other sites for this stock. Probabilities of sighting also increased over the season. Activities observed showed variability over the season, with the range of activities increasing to the August peak. Animals transiting east and west through the study showed a marked preference for a short (2 km) narrow (30m) path along a particular stretch of shoreline. Identification of individuals showed high usage with little site fidelity. Fewer than 5% of the animals were resighted within a given season, and fewer than 2% were sighted more than twice. This implies a large number of animals using this area for short periods. Several individuals have been matched with known animals from catalogs of other researchers.

Mitigation and Research During Lamont-Doherty Earth Observatory's Marine Seismic Surveys — The Acoustic Side

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Marine mammal and sea turtle mitigation and monitoring activities are regularly implemented on L-DEO's seismic cruises, as specified under permits issued by the National Marine Fisheries Service. These cruises, carried out by the NSF-owned *R/V Maurice Ewing*, often take place in extensive, remote areas, for extended periods of time. Eco-ethological data collected during the monitoring and mitigation activities may thus provide high scientific value. The L-DEO's mitigation and monitoring program consists of direct observations of marine mammals and turtles, and shut downs of the seismic source if any of the animals enter or are about to enter the designated safety radius. A skilled team of visual observers is typically on watch from dawn to dusk during seismic operations, as well as during transits. In addition, since April 2004, passive acoustic monitoring has also been part of the monitoring and mitigation program. Underwater acoustics greatly extend the detection capabilities of the observers. CIBRA (Underwater Bioacoustics Research Centre, Univ. of Pavia, Italy) scientists have overseen the acoustic operations and the real-time acoustic classification during three recent L-DEO cruises. Biological sounds were collected by a Seamap 4-channel 20 kHz towed hydrophone array and analyzed by CIBRA's Seapro spectrograph analyzer. Recordings were made whenever meaningful sounds or events occurred. Depending on the seismic schedule and permit, acoustic monitoring was carried out during seismic operations, as well 24 hours/day if possible. The results show that acoustic contacts were often twice as frequent as visual detections, indicating the presence of vocalizing animals regardless of visibility conditions. Thus, passive acoustic monitoring can be a useful tool to complement visual observations during marine seismic surveys, and to collect interesting presence and acoustic behavior data like those gathered for sperm whales in the Lesser Southern Antilles, where almost no bibliography

is available.

Dolphins in Test Tubes: New-Tool to Investigate Toxicological Hazard Due to Endocrine Disruptor Organochlorines and Emerging Contaminants in Mediterranean Cetaceans

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Mediterranean cetaceans, particularly odontocetes, accumulate high concentrations of organochlorine contaminants (OCs) and are therefore exposed to high toxicological risk. Some OCs are known to be endocrine disrupting compounds (EDCs). The possibility that certain Mediterranean cetaceans (*Stenella coeruleoalba*, *Delphinus delphis*, *Tursiops truncatus* and *Balaenoptera physalus*) are subject to toxicological risk due to organochlorines and emerging contaminants, such as polybrominated diphenyl ethers (PBDEs) with endocrine disrupting capacity, was investigated using non-lethal "diagnostic" and "prognostic" methods. Benzo(a)pyrene monooxygenase (CYP1A1) activity in skin biopsies was used as a "diagnostic" indicator of exposure to organochlorines in odontocetes and mysticetes and in different populations of *Stenella coeruleoalba*. Marked differences in levels of OCs and CYP1A1 activity were found between fin whales and odontocetes. Organochlorine levels and CYP1A1 activity were significantly higher in the *Stenella coeruleoalba* population of the Mediterranean Whale Sanctuary than in those of two other study areas, suggesting that cetaceans are exposed to high risk in this protected area. As a new "prognostic" tool we explored interspecies and gender susceptibility to OC-EDCs and PBDEs using qualitative and semi-quantitative evaluation of target proteins, such as CYP450 1A1 and CYP450 2B in cultured cetacean fibroblasts, by western blot, immunofluorescence technique and PCR real time.

Suppression of Insulin Response to a Glucose Tolerance Test across Lactation in Elephant Seals

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Long-term fasting while lactating imposes metabolic conflicts on many phocid species. One important challenge is supplying fuel substrates to glucose dependent tissues while sparing lean body tissue. Prior research on lactating northern elephant seals has demonstrated hypoinsulemia and elevated plasma glucose levels while fasting. We performed glucose tolerance tests (GTT -150 g glucose) on 8 lactating female elephant seals at 5 and 22 days postpartum and on a separate group of 8 post-molt (~3 weeks fasting) adult females. Blood samples were collected at 15 minute intervals for 3 hrs post-injection. Plasma glucose was determined using a glucose autoanalyzer. Plasma insulin and glucagon concentrations were determined using RIA. Plasma glucose was increased by $\geq 130\%$ and remained elevated by $\geq 60\%$ at 180 minutes post-GTT. Glucose clearance rates were not significantly different among test groups. A significant insulin response was observed in early lactation, increasing by $127.0 \pm 24.4\%$ 10 minutes post-injection. No significant response was observed late in lactation as levels increased by only $1.4 \pm 19.3\%$ above basal 10 minutes post-injection. Post-molt GTT showed an intermediate increase in insulin ($61.6 \pm 11.6\%$). Glucagon was not suppressed following a GTT in any group. Variability in insulin response suggests that elephant seals may suppress insulin secretion in relation to fasting duration and/or lactation state. Hypoinsulemia may be critical to facilitate lipolysis late in lactation. Consistency in glucose clearance among test groups suggests insulin insensitivity. Elevated plasma FFA may disrupt insulin signaling through activation of protein kinase C, reducing insulin sensitivity. Lack of a glucagon response to insulin release in elephant seals suggests modification of the typical counter-regulation of insulin/glucagon. These findings suggest that metabolic features of diabetic-like conditions may be adaptive in the context of long-term fasting.

Field Metabolic Rates and the Calculated Aerobic Dive Limit in Juvenile Australian Sea Lions

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The Australian sea lion *Neophoca cinerea* is one of few species in which adults regularly exceed their calculated aerobic dive limit (cADL), with 80% of dives over predicted limits. Given that larger animals have disproportionately greater diving capabilities, we wanted to determine juvenile cADL and investigate the extent that physiology limited the development of diving and foraging in *N. cinerea*. Field metabolic rates for ten 23-month juveniles were derived from doubly-labeled water measurements at Seal Bay Conservation Park, Kangaroo Island, South Australia. Data on blood and muscle oxygen stores, as well as diving behavior, were collected concurrently from these juveniles. Total oxygen was divided by at sea metabolism to compute juvenile cADL's, which were compared to individual dive records. Mean at sea field metabolism was 10.35 ± 0.39 W/kg for juvenile *N. cinerea*, which is the highest mass-specific rate reported for a marine mammal. This is 1.5 times over published adult rates and higher than would be predicted from allometric relationships. Due to high metabolic rates and a slow development of oxygen stores, the mean cADL at 23-months (five months after average weaning) was only 1.14 ± 0.07 min, or less than half the adult cADL. Young sea lions, like adults, exceeded their predicted limit on 80% of dives. Although juveniles did not exceed their cADL more often than adults, they exceeded it to a greater degree, with a mean dive duration to cADL ratio of 2.52 ± 0.18 . Furthermore, juveniles exceeded their cADL to a greater extent than all adult otariids measured, yet did not achieve the depths typical of other benthic foragers. Because juveniles operate at or near their physiological maximum, the capacity to increase dive depth, duration, or foraging effort would be extremely limited. Our data indicate that young *N. cinerea* may be living on the edge.

Analysis of Photoidentified Common Bottlenose Dolphin's (*Tursiops truncatus*) Social Structure in North Eastern Sardinia (Italy)

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Bottlenose dolphins (*Tursiops truncatus*) have been regularly monitored in the Maddalena Archipelago National Park since 1999. Between March 2002 and December 2004, 282 days were spent surveying, resulting in 1027 hours of sea surveys, 190 sightings and 953 observations, with an overall sighting frequency of 0.185. Sighting frequencies have shown marked seasonal variations. Research was carried out through boat surveys, with the use of photo-identification techniques and with detailed recordings of behavioural data. The number of photoidentified dolphins from the beginning of the research (1999) to 2004 is 87. Thirty individuals were photoidentified during 2004, 26 in 2003, 12 in 2002, 12 in 2001, 6 in 2000 and 1 in 1999. The sex of 61% is indeterminate, 29% are females and 10% males, while the 91% of the sample are adults, 7% subadults, 2% juveniles and 0% calves (they don't show evident markers to be photoidentified). Index of Association was calculated on a sample of 25 sighted at least 3 times during 2004; 10 are females, 5 males, 10 indeterminate; 22 adults, 1 subadult, 2 juveniles. Highest Association Indexes result for photoidentified females with their juveniles and only in one case is relative to 3 adults individuals always seen together. Anyway there are not other long term associations. This study confirms the importance of the use of photoidentification technique for the long term study of common bottlenose dolphin's social structure. Although representative of only a small portion of their home range, the study area represents crucial breeding grounds for the dolphins, in particular for females and young. Many years of study are required to know better the common bottlenose dolphin population dynamic and urgent conservation measures are required to protect the species.

Bone Lesions in Cetacean Flippers of the Southeastern Brazilian Coast

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Cetacean flippers are one of the most susceptible areas for injuries caused by fishery interactions. Informations about bone lesions are scarce in cetaceans of the South Atlantic Ocean. This work intends to analyze the occurrence of lesions in specimens of the Southeastern Brazilian coast. We studied 143 flippers of 74 stranded or incidental caught animals along the coast of Rio de Janeiro. The species were: *Sotalia guianensis* (n=35), *Lagenodelphis hosei* (n=11), *Stenella frontalis* (n=9), *Delphinus capensis* (n=5), *Steno bredanensis* (n=4), *S. longirostris* (n=2), *Pseudorca crassidens* (n=2), *Tursiops truncatus* (n=2), *S. coeruleoalba* (n=1), *Grampus griseus* (n=1), *Kogia sima* (n=1) and *Balaenoptera acutorostrata* (n=1). Flippers were radiographed and subsequently prepared in current water to remove all soft tissue. The physical maturity was based on the fusion degree of the epiphyseal plates. The phalangeal formula that includes metacarpal bones was different in some individuals (n=13) and presented bilateral asymmetry. Thirty-nine (53%) individuals presented bone lesions and unexpected shape (n=21), number (n=13), discontinuity (n=5) or proportion (n=5) were also verified. Eight cases of traumatic injuries were recorded including four dolphins that showed evidences of lesions caused by fishery interactions. The bone signs showed that the dolphins had lived some years after the trauma. One specimen presented serious humerus injuries caused by infectious arthritis. Cases of arthrosis with evidence of erosion, eburnation and osteophytes were observed in twenty-one individuals (28%). The analyses of flipper lesions could be used as an important tool for access information about effects of human activities and environment impacts on cetacean populations.

Gray Whales Hear and Respond to a 21-25 kHz High-Frequency Whale-finding Sonar

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A high-frequency whale-finding sonar was tested off Diablo Canyon, CA in January 2004. The sonar (21-25 kHz, 215 dB re 1 μ Pa at 1m) was designed to detect and track whales, was deployed from a vessel moored in the migration path of southbound gray whales. Two shore stations, north and south of the vessel, visually tracked whale movements with theodolites. The sonar transmitted for half of each day, breaking the day into transmit and control conditions, the order of which was randomized daily. Observers were blind to experimental condition. They did not observe any obvious responses by gray whales to the sonar. Data from the two shorestations were combined to form long whale movement tracks which were then analyzed for differences between transmit and control conditions. The analyses found that the minimum measured separation between the whales and vessel was significantly higher during sonar transmit conditions (1.49 vs. 1.28 km). The relative orientation score (Bowles *et al.* 1994, JASA) was also significantly lower (0.26 vs. 0.39), indicating avoidance of the source during sonar transmissions. These results suggest that gray whales can detect and respond to high-frequency (21-25 kHz) sound. It is important to note that the responses of the whales were small, deflecting on the order of 200 meters. Furthermore, these responses were not detectable to visual observers during the experiment. This was in contrast to previous studies where gray whale responses to low-frequency sounds were obvious (Tyack and Clark 1998). The comparative difference in these responses suggests that gray whales may be more sensitive to low-frequency sound than high-frequency sound, which is consistent with anatomically-based predictions.

Furthermore, there may also be differential behavioral response to different types of sounds. These findings have implications for the management of anthropogenic sound sources and gray whales, and perhaps all mysticete whales.

Patterns of Male Reproductive Success in the Endangered North Atlantic Right Whale

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The endangered North Atlantic right whale has shown little-to-no signs of recovery despite international protection for over 65 years. The reproductive rate is three times lower than expected, which is recognized as a primary reason for the lack of recovery. However, the factors influencing reproductive success remain unknown. We have combined over 20 years of photo-identification data with high-resolution genetic analyses (using 35 microsatellite loci) for 278 individuals, representing ~66% of all identified individuals in this species, to assess male reproductive success and the factors influencing reproduction and species recovery. Analyses show that the majority of successful males have not been sampled, which is surprising given that genetic profiles are available for 69% of all males ever identified. The implication is that the population size may be significantly larger than currently estimated based solely on photo-identification data. Males are not obtaining their first fertilization until over the age of ~15 years, which is almost twice the average age for females. The relatedness of males relative to females in apparent mating groups was significantly higher than expected, showing that this behaviour may serve a social function other than reproduction that has not yet been considered. Parental relatedness of offspring of known mating pairs was significantly lower than expected, suggesting that matings are only successful between genetically divergent individuals and that low genetic variability is likely influencing reproductive success and species recovery.

Movement Patterns of Satellite Tagged Ringed Seals (*Phoca hispida*) in Svalbard, Norway

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We analysed movements of 22 ringed seals equipped with satellite transmitters. All animals were tagged at the same location on Svalbard (approximately 78°40'N, 20°20'E) and during the same period of the year (third week of July of 2002 and 2003). Contact with the seals was maintained for an average of 152 days (range: 37-280 days). Two types of movements were identified and they were independent of gender and maturity status of the seals. While 13 animals performed inshore movements along the coasts of Svalbard, the other 9 undertook long distance offshore trips. The latter group stayed offshore for periods ranging from 11-78 days, reaching maximum distances of 205-585 km from the tagging place, however, they all returned to the coasts before the fast-ice formed in winter. A First Passage Time analysis revealed that these offshore seals spent long periods of time in specific areas, and they travelled relatively fast to and from these areas. The areas where these seals spent most of their time were characterized by high ice-concentration and/or being close to the continental shelf break; two areas that are expected to be highly productive due to various oceanographic phenomena. The directions of these trips were not random - all animals moved north or northeast, indicating that the seals may either follow some special cues or have previous knowledge of where these areas are located. The ringed seals

that stayed coastal also concentrated their time at specific locations, generally close to glacier fronts, and moved faster when travelling between such areas. Such glacier fronts are known to be highly productive areas. It is likely that the two observed movement patterns both represent Area-Restricted Search Behaviour, but in different spatial scales, where animals maximize time spent in areas with favourable feeding conditions, travelling faster and directionally between these regions.

Genetic Analysis of Prehistoric Marine Mammal Bones from an Ancient Aleut Village in the Southeastern Bering Sea

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Recent declines and lack of recovery in many marine mammals highlight the need for a better understanding of abundance and distribution relate to climate and environmental change. Analysis of 'ancient DNA,' combined with radiocarbon dating of archaeological remains, enables us to determine species diversity and potentially, population structure and genetic diversity of animals at specific times in the past. We report here on genetic analyses of selected marine mammal remains recovered from an ancient Aleut village in the eastern Aleutian Islands, dated to c. 3,500-2,500 BP (*years before present*, uncorrected radiocarbon years), which includes the identification of a species not previously recorded in the eastern North Pacific. In a specially designed clean laboratory, we modified recently developed silica-based ancient DNA extraction methods, allowing us to regularly amplify and sequence up to 500bp of mtDNA control region from 0.3 g of drilled bone. This highly efficient method, in combination with similarity, distance- and character-based phylogeny reconstruction analyses, identified 16 bone elements to species and in some cases individual mtDNA lineage. We identified six cetacean species from ten samples: *Eubalaena japonica* (North Pacific right whale), *Megaptera novaengliae* (Humpback whale), *Balaenoptera physalus* (Fin whale), *Berardius bairdii* (Baird's beaked whale), *Globicephala melaena* (Long-finned pilot whale), and *Delphinapterus leucas* (Beluga whale). In addition, six phocid seal samples were analyzed, confirming the presence of *Phoca largha* (Spotted seal) at this location at the height of the Neoglacial period, a more southwesterly occurrence than found today. More significantly, *G. melas* is currently listed as extinct in the North Pacific, with the only known records coming from prehistoric deposits in Japan, with identifications based on morphology only: the specimens reported here, identified by morphological and genetic methods, are the first records for *G. melas* in the eastern North Pacific.

Modeling Cetacean Distribution and Occurrence Patterns in Relation to Environmental Features and Prey Fields off the Western Antarctic Peninsula

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The Western Antarctic Peninsula (WAP) is a biologically rich area supporting large standing stocks of krill and top predators (including whales, seals, and penguins). Physical forcing mechanisms greatly affect productivity, recruitment, survival, and distribution of krill in this area. In turn, such interactions likely affect the distribution of baleen whales. The Southern Ocean GLOBEC multidisciplinary research program aims to understand the relationships and interactions between the environment, krill and predators in the late summer/

early fall in Marguerite Bay (WAP). We used an iterative approach employing (1) tree-based models to identify oceanographic and ecological variables (depth, slope, deep temperature maximum, surface chlorophyll-a concentration, distance to shore, distance to marginal ice edge, distance to inner shelf water boundary, distance to slope, along track acoustic volume backscatter 25-100 m, and 100-300 m) which contribute significantly to variability in humpback and minke whale distribution, and (2) generalized additive models (GAM) to elucidate functional ecological relationships between these variables and whale density. Our tree-based models indicated cetacean density is tightly coupled with zooplankton acoustic volume backscatter in the upper (25-100 m), and middle portions (100-300 m) of the water column. Whale density is also affected by distance to the marginal ice edge, inner-shelf water boundary, and bathymetry. The GAM indicated a strong, positive relationship between increasing zooplankton volume and whale density. Furthermore, there was a lower limit for averaged zooplankton acoustic volume backscatter below which the relationship between whales and prey dissipated. The GAM also supports a significant relationship between whale density and distance from the marginal ice edge, suggesting that this ecological zone is an important feature even at its minimum extent. Our results demonstrate strong linkages between synoptic measures of whale distribution and prey biomass. Quantifying such ecological relationships is a necessary prerequisite to predicting how upper trophic predators will respond to climate change and variability.

Florida Manatee Avoidance Technology: a Program to Mitigate Manatee/Boat Collisions

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Since 1976, approximately 25% of annual Florida manatee (*Trichechus manatus latirostris*) mortality has been attributed to collisions with watercraft. In 2001, the Florida Legislature appropriated \$200,000 in funds annually for research projects using technological solutions to directly address the problem of collisions between manatees and watercraft. During the first four years of the Florida Manatee Avoidance Technology program, ten projects were funded. Funded topics included alerting manatees to the presence of boats and alerting boaters to the presence of manatees, as well as baseline research on manatee sound localization. The selected proposals were designed to explore technology that had not previously been applied to the manatee/boat collision problem and included concepts related to voice recognition, sonar, infrared technology, and a device on boats for alerting manatees. At the conclusion of the first four years of funding, seven of the projects have been completed and three are on-going. The most promising results to date are from projects employing voice-recognition techniques to identify manatee vocalizations and warn boaters of manatees' presence. Preliminary results of readily available infrared technology indicate that because manatee skin temperatures are close to that of ambient water temperatures, unmodified infrared technology is unlikely to prove effective in identifying the location of manatees. Sonar technology, much like that used in fish finders, is promising but it, and the manatee alerting device, have met with regulatory problems regarding permitting and have yet to be tested. Final reports for completed projects are available at <http://research.myfwc.com>. The state of Florida found results of the initial years of funding compelling and plans to fund further manatee avoidance technology research in a continued effort to mitigate the problem of manatee/boat collisions.

Diving Behavior, Habitat Use, and Movements of Bearded Seal (*Erignathus barbatus*) Pups in Kotzebue Sound and the Chukchi Sea

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Bearded seals are harvested by Alaska Natives for subsistence and live and pup in pack ice habitat that may be affected by climate change. Almost no recent research has been conducted on bearded seals in Alaska and no data exist on their seasonal movements, habitat use, or diving behavior. In a cooperative effort between scientists and subsistence hunters, two young-of-the-year bearded seals were captured and instrumented with satellite-linked dive recorders (SDRs) in Kotzebue Sound in October 2004. This is the first time bearded seals have been instrumented with SDRs in Alaska. One pup remained near the southern coast of Kotzebue Sound. The other moved into deeper waters between Kotzebue Sound and Point Hope (Oct-Nov), and later into the southcentral Chukchi Sea (Dec-Jan). Both pups tended to remain in localized areas for days or weeks before moving to new locations. Bearded seals are benthic foragers, so we analyzed the amount of time seals spent near the sea floor, presumably foraging. Location data were plotted and linked to local bathymetry using standard GIS techniques. Dive data were analyzed to determine if benthic foraging time varied between individuals or in relation to bathymetry, time of day, or apparent behavior (*i.e.*, “foraging” or “traveling”). The pups spent almost half of their total time near the sea floor, in contrast to harbor seal pups that feed in the water column and spend little time near their maximum diving depth. The amount of time spent near the bottom varied between individuals and by time of day, with most time (50-55%) spent at the bottom at night. We expect to tag 8-12 more pups in summer 2005 and will include those data in subsequent presentations of results. Information on seasonal movements and diving behavior will be used to identify important habitats and to improve census techniques.

Temporal Trend in the Bycatch of a Small Resident Population of Bottlenose Dolphins *Tursiops truncatus* in Southern Brazil

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In south of Rio Grande do Sul state coast, southern Brazil, a small resident population of bottlenose dolphins ($n = 80$) inhabits the Patos Lagoon estuary. Until recently, coastal fisheries were thought not to harm bottlenose dolphins. However, a recent investigation has suggested an increase in the number of bottlenose dolphins washed ashore with evidence of interactions with fishing operations. The aims of this study are to describe the temporal trend of bottlenose dolphin strandings and assess the potential effects of fishing-related mortality on the viability of the Patos Lagoon population. From 1976 to 2005 beach surveys covering a stretch of 45 km to the north and 65 km to the south of the Patos Lagoon estuary took place once a fortnight to investigate bottlenose dolphins strandings. Stranding rates were calculated for each year as the number of carcasses per km of coast surveyed. Fishing-related mortality was determined based on the presence of net marks or mutilations. The annual number of carcasses presenting evidence of interactions with fisheries was compared to the Maximum Allowable Fishing-Related Mortality (MALFIRM). A total of 21,950 km of beach were surveyed and 102 bottlenose dolphin strandings were recorded. Strandings were clearly seasonal. From 88 bottlenose dolphins with date of stranding 71 was recorded between November and March (80.6%). Forty-eight (47%) bottlenose dolphins were found washed ashore between 2000-2005. Stranding rates were much higher in the last five years (0.007 dolphins/km; $SD = 0.003$) than previously (0.002 dolphins/km; $SD = 0.002$). From the 26 fresh carcasses 12 (46%) showed signs of entanglement in nets. Even considering the most optimistic scenario, the minimum

number of dolphins killed in nets (*i.e.* only those with clear evidence of entanglement) in the last five years is up to three times above the MALFIRM for the Patos Lagoon population. Therefore, this local population is probably declining.

Age at First Calving of Female Humpback Whales in Southeastern Alaska

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Female humpback whales in southeastern Alaska have never been observed with their first calf at ages 5 to 7 years, the documented age at first reproduction in the Gulf of Maine humpback whale population. Long-term sighting histories of 10 individually identified females of known age in southeastern Alaska were used to investigate this disparity. These females were sighted with their first calf at ages 8-16 (mean 11.8) years, significantly older than Gulf of Maine females' 5.91 years mean age at first calving ($F = 57.3$ $df = 11$ $p = 0.0001$). We summarize potential sources of bias and other factors that likely contributed to the difference in age at first calving. Despite their limitations, these are the only available data to assess the age at first calving in North Pacific humpback whales. Our results highlight the need for caution when applying generalized reproductive parameters to different populations, despite the temptation to do so due to the rarity of data on life history parameters of large whales.

Loss of Genetic Diversity and Relationships Between Eastern and Western North Atlantic Right Whales (*Eubalaena glacialis*) Revealed Through Analysis of Historical Samples

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The existence of two separate stocks of North Atlantic right whales has been suggested from review of historical whaling data. Sightings and catches of right whales in the eastern North Atlantic along the coast of western Europe and western Africa have been well-documented. Much of the remaining population in the eastern North Atlantic Ocean was hunted to near-extinction by Norwegian whaling at the turn of the 20th century. Sporadic sightings have been made of right whales in the eastern North Atlantic, including one case in which an individual known from the western North Atlantic population was identified in Norwegian waters. However, the differentiation of the eastern and western ranges of right whales in the North Atlantic has not previously been tested. With the possible extirpation of right whales from the eastern North Atlantic, the ability to reliably isolate DNA from historical specimens of baleen and bone permits temporal and spatial evaluation of levels of genetic diversity and population distinctiveness among North Atlantic right whales. We extracted DNA from 20 North Atlantic right whale samples recovered from the eastern portion of the species' range and sequenced the mitochondrial DNA control region. The most common haplotype observed in the extant western North Atlantic right whales is also the most common haplotype among the eastern specimens we sequenced. Overall, analysis of historical samples suggests that little to no genetic diversity has been lost from the western stock in the last 120 years. However, of the 20 samples representing the eastern stock, six have been characterized with haplotypes not known from the western portion of the species' range. The discovery of numerous haplotypes suggests that the loss of the eastern stock severely reduced the amount of genetic variation present in North Atlantic right whales. The finding of a common maternal lineage in both the eastern and western populations, but encountering unique maternal lineages in the eastern stock is evaluated in relation to establishing whether these were

genetically differentiated populations. Loss of genetic diversity in North Atlantic right whales is apparently greater than previous studies have suggested.

Long-finned Pilot Whales Chase Killer Whales in the Strait of Gibraltar

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Two groups of killer whales (*Orcinus orca*) are known to occur seasonally in the Strait of Gibraltar, following the bluefin tuna (*Thunnus thynnus*) migration. The orca group of interest contained 7 individuals, including two calves, and is generally observed in the south-western part of the Strait. On the 30th of July 2004, this group was observed from a whale-watching boat displaying normal behavior, *i.e.* milling around small Moroccan fishing boats. Suddenly, the orcas dove and simply vanished. Inspecting the area, we detected a group of 30-40 long-finned pilot whales (*Globicephala melas*) at approximately 1 km, traveling at high speed towards us. It was composed of a faster group of 7-8 adult individuals, followed by a larger group of 20-30 individuals, including some calves. The orcas resurfaced 8 minutes later, swimming rapidly towards the Moroccan coast, fleeing from the pilot whales. During the following 13 minutes of chase, the pilot whales approached the orcas to a distance of approximately 500 m. The chase stopped as abruptly as it had started, leaving the orcas at less than 2 km from the Moroccan coast. The pilot whales made a 360° turn and swam towards the middle of the Strait, their usual year round territory. The orcas also stopped and spent approximately 10 minutes resting at the surface with high breathing frequencies. This chasing behavior could be due to either territoriality, food competition, offspring protection, or a combination of these options. As prey overlap seems improbable, territoriality and offspring protection could be the most probable options. Although aggressive behavior from orcas towards pilot whales has never been observed in the Strait, there seems to be a quite obvious exclusion behavior, according to local fishermen. From the literature it seems that this is the first report of pilot whales chasing orcas.

Presence of Blue Whales (*Balaenoptera musculus*) and Sei Whales (*Balaenoptera borealis*) During 2004 and 2005, in Northwestern Chiloe Island, Southern Chile

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We report on near shore sightings of blue and sei whales off the Northwestern coast of Chiloe Island from different platforms, during 2004 and 2005. One marine and three aerial surveys were conducted on board various Chilean Marine Navy platforms and ten additional marine surveys were conducted on board fishing vessels. Photo-identification of blue and sei whales, sound recording and plankton samples were collected with associated data on location, group composition and behavior. Land observations, were conducted during 29 days in 2004 and 28 days in 2005, from different stations. For each group of whales sighted, the species when possible, minimum number of whales, angle and estimated distance of the whales from the coast was recorded. A total of 471 groups of whales comprising 783 animals were recorded for the 2004 and 2005 seasons. 87 groups of whales comprising 168 individuals were positively identified as *B. musculus* and 22 groups of whales comprising 49 individuals were positively identified as *B. borealis*. During aerial surveys, blue whales were registered as far north as 41° 05' 40" S, emphasizing the need for further research to determine seasonal distribution. An unusual, vessel-based sighting was made on 10 February 2005, when at least three groups of seven skinny blue whales were observed feeding, highlighting the importance of the area as a feeding ground for the species. Additionally, feeding behavior and defecation was recorded for blue and sei whales, either by species or in association. Continual sightings off the north western coast of the Chiloe Island, strengthen the importance of the area for feeding activities of baleen whales and

highlight the necessity to design and implement comprehensive marine protected areas.

Swimming Speed in Foraging Grey Seals: What Affects Their Behaviour?

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The duration of breath-hold dives and the available time for foraging in submerged prey patches is ultimately constrained by oxygen balance. There is a close relationship between swimming speed and oxygen utilisation so it is likely that marine mammals optimise the speeds of ascent and descent to their feeding patches. Optimal foraging models suggest that transit swimming speed should decrease to MCT speed in deeper dives. Observations also suggest that ascent and descent swimming mode and speed may vary in response to changes in buoyancy resulting from changes in pressure. We measured swim speed on 5 female grey seals (2 adults and 3 pups) in 2002 and 2003. Seals had to swim horizontally underwater from a breathing box to a feeder situated at 40, 80 and 120 m away, in a pool (42x6x2.5m). There was therefore no effect of pressure in our set-up. Data recorded during these experiments (1,723 dives) were similar to those recorded in the wild. Seals spent an average 80% of the dive cycle submerged, with a mean and a maximum dive duration of 3.66 min, and 17.33 min respectively. In term of swim speed, descent speed decreased significantly in 3 of the 5 seals between dives to 40 m and 80 m, while it remained constant after 80 m. Ascent speed also decreased significantly with deeper dives for 4 of the 5 seals. This indicates that grey seals adjusted their speed in response to travel distance, consistent with model predictions. Most interestingly all seal swam between 10% and 20% slower on their way back to the surface despite not having to work against negative buoyancy. This suggests that buoyancy and pressure effect cannot completely explain why negatively buoyant seals swim more slowly during the ascent of the dive in the wild.

Marine Mammal Conservation Through Youth Involvement in Peru: Strategies from and for a New Generation

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Involvement of young initiatives are critical for conservation of marine mammal species in the new millennium. The development of stranding networking, volunteering and campaigns are the beginning to place these species in young people's priorities, different from those of adults. For decades, negative imprinting has been a constant in Peru as teenagers and children many times are involved in marine mammal killing, heritage from the adult concept that marine mammals are suitable for commercial or feeding purposes. The following work has focused in the conservation strategies developed in a year by two different groups of high school teenagers: group A living in the reality of Lima City, indifferent to ocean life; group B living in a fishermen town closely related to the ocean environment. Both groups received the same knowledge on marine mammal biology, their importance and threats. Strategies proposed by group A included campaigns to create awareness on pollution, its effects in the ocean, promote recycle of plastic and organize ecological fairs to provide information about marine mammal conservation to the public. Group B developed art contests with conservation messages to be displayed to the public, beach clean ups with companions from school and letters to authorities to give environment conservation a priority in their town. Both groups concluded that education is the most important tool to make a difference in the animal's future, so both dedicated to transmit what they have learned about marine mammals to children in both public and private schools. All these activities were accomplished without external fundraising, all of them developed for free. They used communication lines, information, team work and creativity. Their effort and dedication lead to the origin, promotion and development of the ORCCAMM Junior Program to be expanded to other schools

in 2006.

Fisheries Science for Marine Mammalogists: Factors to Consider When Selecting a Method for Sampling Fish Populations

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Many marine mammalogists wish to obtain data on the abundance or distribution of the prey of their primary study animals. However, few marine mammal scientists are trained in fisheries science. One of the most important decisions to make when designing any fisheries survey regards the choice of sampling method to be used. The method selected will depend on: 1) the research question; 2) the habitat(s) being sampled; 3) the behavior of the target species; and 4) financial/logistical constraints. Research questions can be either quantitative or qualitative. Of critical importance to quantitative studies of fish abundance, are the gear's efficiency and selectivity. In this presentation, we discuss the efficiencies and selectivities of passive gears (e.g., traps, gillnets, trammel nets, fyke nets, and hook gear), active gears (e.g., trawls and seines), and acoustic systems (e.g., sonar). For illustrative purposes, we will present data from a fine-scale, habitat-specific purse seine survey of bottlenose dolphin prey near Sarasota, Florida. Within seasons (summer or winter), abundance and sizes of prey varied significantly among the eight habitats sampled (Kruskal-Wallis tests, $p < 0.01$). Species richness and evenness, measured by the Shannon-Weaver index, also differed significantly among habitats. Distribution of dolphins did not match that of the prey, suggesting that factors in addition to prey availability influence dolphin habitat selection. Careful selection of sampling methods can result in improved data quality, allowing one to test more refined hypotheses and to have greater confidence in the conclusions.

Fine Scale Natal Philopatry and Sex Differences of Bottlenose Dolphins in Sarasota Bay, Florida

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At least some bottlenose dolphins, *Tursiops truncatus*, are thought to exhibit large scale natal philopatry (tens to hundreds of km²) in certain coastal areas, in that they are found in their natal bays and estuaries for years or their entire lifetimes. In Sarasota Bay, Florida, a long-term study of the resident bottlenose dolphin community allows us to test for natal philopatry on a finer scale than previously examined (km² to tens of km²). We compared ranging patterns from 18 mother-calf pairs to determine: (1) what percentage of mothers change ranging patterns during calf rearing; (2) what percentage of calves exhibit fine scale natal philopatry after independence (half-weight coefficient of association with their mother < 0.5); and (3) whether the spatial scale of natal philopatry differs between males and females. To test for differences in range use we applied a procedure proposed by Syrjala, based on a generalization of the Cramér von-Mises nonparametric test for the difference between probability distribution functions. Mothers' ranges during calf rearing and prior to the calf's birth were statistically similar in 66% of the cases ($n=15$). Ranges of calves before independence compared to ranges after independence were similar 53% of the time ($n=15$). Juvenile females exhibited ranges similar to their mothers' 100% of the time ($n=3$) while males had ranges similar to their mothers' only 20% of the time ($n=10$). Juvenile calves of unknown sex exhibited ranges similar to their mothers' 100% of the time ($n=2$). These results suggest that most females do not change their ranging patterns while rearing a calf; that males are likely to disperse beyond their mother's range; and that females are likely to exhibit natal philopatry at finer scales than males. This supports previous findings, which indicate that these patterns continue through development, with adult males ranging

farther than adult females.

Testing Association Patterns Among Northern Elephant Seal Females

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During each winter, northern elephant seals landing in reproductive areas. From December to early March, females congregate in breeding groups, where they give to birth, rear pups and mate. Site fidelity had been suggested for this species, that is, females' trend to return year over year at the same reproductive areas to breeding. But, do females select the breeding group? A null hypothesis of a random association among the females into the reproductive groups was used to answer this question. The data used was collected at San Benito Islands (Mexico) during 2001-2002 and 2002-2003 breeding seasons. A half-weighted association index was calculated for each female's dyad and the random association hypothesis was tested using a Monte Carlo simulation. The null hypothesis was not rejected with $0.025 < p < 0.975$. Twenty-five association matrices were analyzed and only three of them the random association hypothesis could not be rejected (p values of 0.04, 0.28, and 0.19). Results support the general idea of site fidelity and suggest that female's distribution into groups was not aleatory and could be related with a selective group process.

Is the Manatee (*Trichechus manatus*) Disappearing from the Northern Coasts of the State of Veracruz, Mexico?

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Knowledge about the distribution and abundance of the manatee (*Trichechus manatus*) along the coast of the Mexican state of Veracruz is scarce. Since very few studies have been conducted, investigations were carried out to determine if there are still herds of manatees in the vicinity of the coastal towns of Tamiahua, Tuxpan, Tecolutla, Casitas, and Nautla. Boat-based surveys and surveys among local fishermen were taken. Boat-based surveys were done on a 7 m panga powered by an outboard 65 HP engine. Results showed that seventy four percent (371 fishermen) of the survey respondents had not seen a manatee, and 26% (131 fishermen) responded that the last time they saw large groups of manatees was in 1986, and they saw small groups in 1995. Since 1996 however, these fishermen have not observed another manatee. No manatees were observed during the boat-based surveys (Effort: 963 km approximately). It appears that anthropogenic influence and natural phenomena such as cyclones, flooding, and storms have altered the manatee habitat significantly. More surveys along the coast of Veracruz are needed to determine the number of manatees present in this Mexican state. Also, it is urgent to implement conservation measures in their northern range in Mexico to ensure the survival of this species along its original distribution.

¹³C and ¹⁵N Stable Isotopes Analysis in Bottlenose Dolphins, Common Dolphins and Harbour Porpoises in South Spain

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In the last years stable isotopes analysis have been used to provide some insight in dietary studies of many species since the isotopic composition of a predator is similar to that of its prey. ¹⁵N is used as an indicator of the trophic level of the species and ¹³C is used as tracer of carbon sources through the food web. In marine systems this property is used to discriminate between animals that obtain their

resources from inshore versus offshore environments. There is no information about trophic ecology of the marine mammals species that inhabit waters in South Spain, at the entrance of the Mediterranean Sea. Little is known about diets of bottlenose dolphins, common dolphins and harbour porpoise in the region. Stomach content analyses of stranded animals are not always possible since the stomachs are often empty, and stable isotopes analyses are an efficient alternative to approach this issue. Samples of common dolphins and harbour porpoises were obtained from dead animals. 21 common dolphins and 4 harbour porpoises stranded along andalusian coast in the last 3 years were used in this work. All animals were recently dead and skin and muscle samples of all individuals were collected. 44 samples of bottlenose dolphins were analyzed, 6 from stranded animals and 38 obtained by remote biopsy sampling. Along with the cetacean samples, 120 fish samples of 17 different species were collected in the same areas and used in the work. To calculate the proportional contribution of each fish species to the common dolphins' and harbour porpoises' diet mixing models described by Phillips and Gregg in 2003 were used. In the case of bottlenose dolphins' diet the mixing model described by Phillips and Koch in 2002 was chosen. The results show clear differences among three cetacean species in their dietary habits and also clarify the population structure of bottlenose dolphins along the south Spanish coast.

Age Estimation of Narwhals (*Monodon monoceros*) from West Greenland Using the Aspartic Acid Racemization Technique

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Age estimation of individuals is important for deriving the age structure of a population, for estimates of survival rates and age specific reproductive parameters, as well as for assessing density dependent changes in life history parameters. Age estimation methods are thus critically important tools in population assessments and are indispensable in studies concerning reproduction, growth and mortality. Age estimation of odontocetes has traditionally been done by counting growth layer groups in the teeth; however, this method has failed to provide reliable results for narwhals (*Monodon monoceros*). Here, we present new results for the age estimation of narwhals using the aspartic acid racemization technique. The technique utilizes the fact that aspartic acid racemize from the L-form to the D-form in metabolically inactive tissues. Eyes from a total of 75 narwhals taken by Inuit hunters were analyzed. The ratio of the D- and L-enantiomers was measured using High Performance Liquid Chromatography (HPLC). Age estimates were successful for all 75 narwhals. The aspartic acid racemization rate (k_{Asp}) was estimated to be $1.045 \times 10^{-3} \text{ yr}^{-1}$ by correlation of D/L ratios to age estimated by length of 15 young narwhals (<298 cm in length) and to earplug laminations from 13 fin whales (data from Nerini, 1983). The D/L ratio at age 0 ($(\text{D/L})_0$) was estimated by correlation of D/L ratios to estimated age for the 15 young narwhals. The intercept of the slope, providing the $(\text{D/L})_0$ value, was 0.02880. About 20% of the whales were older than 50 yrs and there seemed to be a tendency for greater longevity in females than in males. The maximum age obtained was from a 115 (SE + 10) yr old female. Using the Von Bertalanffy growth model, age at sexual and physical maturity was estimated to be 5 yrs and 20 yrs for females, respectively, and 9 yrs and 24 yrs for males, respectively.

Trends in Age Structure and Productivity of Pacific Walrus Harvested in the Bering Strait Region of Alaska, 1952–2002

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Pacific walrus (*Odobenus rosmarus divergens*) are harvested by subsistence hunters in Alaska as they migrate north through the Bering Strait in the spring. Harvest records and biological specimens have been collected from the Bering Strait communities of Little Diomedé, Gambell and Savoonga since the 1950s. Harvest levels in the Bering Strait region peaked in the late 1980s and declined thereafter. There was considerable variation in the size and composition of the harvests among communities and over time. The proportion of females in the catch increased over time in all three communities, while the proportion of fecund animals among harvested females declined over the range of sample years. The ages of harvested walrus increased over time in all three communities until the 1980s. Trends in age stabilized or began to decline in the 1990s. The age of first reproduction was significantly older for females sampled in the 1980s than for females sampled in the 1960s or 1990s. Factors thought to have influenced the size and composition of the catch over the past fifty years include hunter preferences, harvest management regimes, environmental conditions and changes in the population itself.

A Spatial Model of the North Atlantic Right Whale Calving Habitat in the Southeastern United States

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The only known calving area for the North Atlantic right whale (*Eubalaena glacialis*) is on the continental shelf of the southeastern United States off of Florida and Georgia. Aerial surveys conducted during the last decade have demonstrated significant interannual and within-season variability in both the spatial distribution and numbers of calving females (i.e. pregnant females and new mothers) within this region. Identification and protection of the calving habitat is a critical component of conservation efforts for this highly endangered species. In this analysis, generalized additive models were used to evaluate the relationship between a suite of environmental variables and the spatial distribution of right whales in the southeastern United States calving area. Average sea surface temperature within the surveyed region was derived from satellite imagery in two week periods during each calving season. A suite of additional environmental predictors were examined including bathymetry, monthly average wind intensity, and bathymetric slope. Step-wise selection was used to determine the habitat variables that are important predictors of spatial distribution and the relative density of calving right whales. Water temperature and depth were significant predictors of spatial distribution in the surveyed area. The spatial extent of the right whale calving habitat varies strongly both between and within years in response to interannual variability in regional temperature distribution. The model results suggest that suitable calving habitats may extend north of the traditionally surveyed area, and this is consistent with the results from recent broad scale survey efforts. Habitat models developed using this approach can be used to inform management actions designed to protect right whales within the calving ground.

Sea Otter Small Boat Surveys: Tribal Stewardship

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Local knowledge is critical to more fully understanding the distribution and relative changes in many marine mammal populations. Locals spend countless hours on ocean and notice the appearance and seasonal

distributions of marine mammals over decades. Native people have a collective recollection of these changes. They know what their grandfathers and fathers taught them about marine mammals, and have their own knowledge, honed by decades of living in their traditional territories. The Alaska Sea Otter Commission (TASSC) and The U.S. Fish and Wildlife Service (USFWS) have developed a program to work with Tribes to collect information on the relative abundance and distribution of sea otters. Tribal members are trained to conduct sea otter surveys using a standardized protocol. Boat captains with a wealth of local knowledge are able to determine transect locations and lengths based on sea otter movements and abundance. Captains and crew generally know local wind and tide patterns, and locations of dangerous rocks and shallow beaches. Craig Tribal members have conducted three years of sea otter surveys in their territory. The data is mapped and made available to TASSC and USFWS and the public. This information can reveal a long-term pattern of sea otter population growth and expansion. This is important to Tribes as they continue to serve as stewards to their traditional territories. It is also valuable to the USFWS as they are responsible for conserving sea otter. Federal and State agencies can benefit by expanding on these types of local research efforts. Locals can contribute a wealth of ecological and population information to managing agencies at a fraction of the cost. This type of information can contribute baseline data which is usually cost prohibitive and whose value is realized only after an ecosystem is damaged.

Foraging Habitat of Harbor Seals Relative to Cruise Ship Routes in Glacier Bay National Park

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Glacier Bay National Park has historically supported one of the largest populations of breeding harbor seals in Alaska. However, the number of seals has declined by as much as 14.5% per year since 1992 (Mathews and Pendelton *in press*). Simultaneously, the number of cruise ships that have entered the park has increased by 25% over the same period. Although the park has initiated restrictions on cruise ships to minimize disturbance at important breeding locations (including terrestrial and ice haul-outs), the extent of overlap between important foraging habitat of seals and areas used by cruise ships is unknown. Our objective was to identify foraging areas, as determined by real-time tracking of tagged harbor seals, and compare these to areas utilized by cruise ships. Over two years, a total of 46 seals were tagged (18 from ice, 28 from terrestrial haul-outs). Foraging areas were determined for 36 different seals by observing foraging bouts on 74 occasions. Seals using terrestrial haul-outs foraged predominantly in nearshore shallow and pelagic habitats (range 0.1-3.48 km of shore) within 5 km of haul-outs. Seals captured in ice habitats likewise foraged nearshore (range 0.1-3.51 km) but traveled further from haul-outs, (range 0-102 km). On only 3 occasions did we observe seals foraging within areas used by cruise ships, and less than 17% of all foraging bouts were within 2km of the ship routes. Perhaps more importantly, acoustic estimates of prey densities were higher where seals foraged compared to other areas suggesting that foraging locations were a function of choice, rather than displacement. We conclude foraging habitat of seals is sufficiently protected from cruise ships because of the productivity of near shore communities. However, future research should focus on the effects of other vessel classes and their effects on the distribution of forage fish.

Baja California: A Key Area for Blue Whale Recruitment in the Northeast Pacific

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Survey and sighting data on blue whales suggest that most of the Northeast Pacific population summers off the coast of California. During winter, part of this population is known to migrate south into the Gulf of California. Mother and small-calf pairs are only known from this area, where females nurse their young and feed themselves on dense winter-spring euphausiid aggregations. Although we don't know if calves are born in this area, it is evident from the resighting history (1993-2004) of 430 individuals (189 sexed and haplotyped), that the Gulf is used as a nursing area and represents a critical recruitment habitat for the Northeast Pacific blue whales. Results from the sex ratio are skewed toward females, which exhibit more extensive use of the area (longer residency times and interannual return rates) than do males. Additionally, females with a calf appear to prefer coastal areas, where there is a high annual rate of calf production (8-22%). Molecular biology data points out 17 maternal lineages in at least two divergent groups. Both groups seem to share the Gulf of California temporally and spatially, and both are producing calves. Moreover, simulations of the maternal lineage encounter rate suggest that our sample is representative of the Northeast Pacific stock. Twenty-three photo-recaptures of 10 individuals, first sighted as calves, demonstrate that skin pigmentation pattern does not change in subsequent years. The recapture of these young blue whales will lead to the determination of important reproductive parameters, including the age at first reproduction; a critical demographic indicator of population status.

A Comparative Study of Bottlenose Dolphin Cross-Border Movements in the North East Adriatic Sea

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Bottlenose dolphins (*Tursiops truncatus*) are the only regularly sighted cetacean species in the northern Adriatic Sea. A study on the socio-ecology of bottlenose dolphins inhabiting the Slovenian Sea and the surrounding waters was started in 2002 by Morigenos – marine mammal research and conservation society. The study area covers approximately 600 km², including the Gulf of Trieste and adjacent waters. Resightings of individuals in the study area suggests that this population, or population segment, is resident. Boat surveys and land-based surveys were conducted randomly throughout the three years. A total of 31 sightings were recorded between August 2002 and October 2004. Dolphins were encountered throughout the year and are believed to be using this area as feeding, breeding and nursing habitats. During 14 sightings it was possible to carry out standard photo-identification procedures, identifying 36 bottlenose dolphins over two subsequent years. Several dolphins identified in 2003 were also resighted in 2004, showing a significant rate of site fidelity. In order to gain insight into the bottlenose dolphin home range and movements in the northern Adriatic Sea, all identified dolphins were compared to those of the Adriatic Dolphin Project catalogue, carried out in Kvarneria by the Blue World Institute of Marine Research and Conservation (Croatia). Early results indicate little overlap between the dolphins observed in the two study areas. This study however represents the first step towards the definition of the population structure of north-east Adriatic bottlenose dolphins. Thus this information is essential to establish and develop the implementation of management and conservation strategies in future. Further, combined studies are necessary before an accurate assessment of the status of bottlenose dolphins in the Adriatic Sea can be determined.

Sea Ice Density and Bowhead Whale Body Condition

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We examined the body condition of bowhead whales landed by Alaskan Eskimos and ice concentrations in the Eastern Beaufort Sea for the years 1982-1999. The body condition index was estimated as the mean of the residuals from a fitted model to a body mass index for a specific year. Data from both the spring and autumn hunts were used. The body condition model was the axillary girth area (girth²) as a function of body length. Ice conditions were calculated from the mean monthly sea ice concentrations in a series of pixels within the known summer feeding range of bowhead whales. The estimates are based on daily ice concentrations from the Scanning Multichannel Microwave Radiometer (SMMR) and the Special Sensor Microwave/Imager (SSM/I) satellite; pixel resolution is 25 km². We used the number of ice-free days per month for each pixel (where ice-free was defined as < 15% sea ice concentration). Bowhead whale body condition was negatively correlated with the amount of feeding habitat in the Eastern Beaufort Sea (EBS) that was covered by sea ice. That is, bowhead body condition was higher when average ice concentration is lower in the EBS. The areas with the highest correlations are those independently believed to be important feeding areas for bowhead whales based on direct observations. A possible explanation is that low ice cover leads to higher primary productivity in the E. Beaufort Sea, which in turn results in higher average body condition of the whales. Further analysis is underway using a longer time series of measurements and treating spring and autumn caught whales separately.

Who cares? Between-Group Variation in Alloparental Care-Giving in Sperm Whales

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Some have hypothesized that the matrilineal society of the sperm whale functions to provide protection for calves at the surface while mothers make deep dives for food. Sperm whale females do have a system of babysitting, but the details are unknown, partially because of a scarcity of calves in previous study areas. This study aimed to elucidate the behaviour involved in sperm whale allocare, in particular who babysits whose calf and whether or not allosuckling, suckling from a non-parent, occurs. We compared patterns of adult-infant interaction of 28 sperm whale calves in both the Sargasso and Caribbean Seas. Photo-identification and behavioural calf-follows were used to draw up matrices of association and interaction for adults and calves. Permutation tests were used to explore preferred associations. Encounters off Dominica were dominated by the continuous presence of one particular social unit, Go7 (encountered on 40 different days over a 54 day period), consisting of five adults, one juvenile and one calf. We used shorter behavioural follows (ranging between 1 and 9 days) of the remaining 27 calves (12 Caribbean, 15 Sargasso) to compare and contrast with patterns observed in the detailed follow of Go7. Suckling attempts by the Go7 calf were only observed with one particular adult, presumably the mother, which preferentially avoided all other unit-members other than its calf ($p < 0.01$). The Go7 calf was observed with all six unit-members, but preferentially avoided all but one non-parent, "the babysitter" ($p < 0.01$). Similarly, allosuckling was not observed during any follows of the other twelve calves off Dominica. In contrast, in the Sargasso Sea, allosuckling was observed in follows of 7 different calves and two adults were observed each nursing two different calves. These contrasting patterns of allocare among sites may be based upon variation in social system, predation pressure, prey availability, or possibly culture.

Responses of Tropical Ceteceans to an Echosounder During Research Vessel Surveys

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During large-scale line-transect surveys in the eastern tropical Pacific in 1998, 1999 and 2000, the scientific echosounder (SIMRAD EQ50) and Acoustic Doppler Current Profiler (ADCP) were both turned off on alternate days to determine their effect on cetaceans. The echosounder operated at frequencies of 38 kHz (SL=212 dB re 1 μ Pa)

and 200 kHz (SL=225 dB re 1 μ Pa). The ADCP operated at 150 kHz (SL=223 dB re 1 μ Pa). Thus both the echosounder and ADCP produced sounds within the hearing range of most dolphins, but at a source level and direction that would indicate sounds received at typical sighting distances of 2-4 km were faint, possibly even below the hearing threshold of many species. We compared school sizes, sighting distances and sighting rates on pairs of days during which the echosounder and ADCP were on one day and off the other for 12 species of dolphins and whales. When the echosounder and ADCP were on: (1) the average size of detected schools was reduced for spotted dolphins and pilot whales but increased for bottlenose dolphins; (2) perpendicular sighting distances increased for spotted and spinner dolphins; (3) sighting rates decreased for beaked whales. Results may differ between coastal and offshore waters. Baleen whales did not show any significant responses to the echosounder and ADCP, but sample sizes were small. Based on vocalization frequencies, it is presumed that baleen whale hearing ranges are below the echosounder operating frequencies (<38 kHz). Results may be due to changes in behavior in response to weak anthropogenic sound levels, primarily affecting spotted dolphins, spinner dolphins and beaked whales in this area. The results indicate that when the echosounder and ADCP were on, spotted and spinner dolphins were slightly more, and beaked whales less, likely to be detected during visual surveys.

Health Assessment of Free-ranging Hector's Dolphins (*Cephalorhynchus hectori hectori*) Captured for Satellite Telemetry Around Bank's Peninsula, New Zealand

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Three Hector's dolphins (*Cephalorhynchus hectori hectori*) were caught in the waters surrounding Banks Peninsula, New Zealand, in March 2004, and released following attachment of lightweight satellite transmitters. The animals were an adult female and a juvenile of each sex. The trial was intended to evaluate the efficacy and safety of satellite tagging for potential application to the critically endangered Maui's dolphin (*Cephalorhynchus hectori maui*). A complete health assessment was conducted on each captured dolphin prior to tagging and release. This was designed to provide the first baseline health data for this species, and secondly, to assess the physiological effect of capture and handling on these animals. Body condition was assessed by standard measurements and ultrasound of blubber depth. Blood was collected for hematology, serum chemistry, serology (morbillivirus, calicivirus, influenza A, leptospirosis, and brucellosis), and endocrinology (cortisol, oestrogen, testosterone and progesterone). Blood samples were also collected for extraction of RNA to characterize function diversity of MHC genes. Expired breath and body orifice swabs were cultured for bacterial and fungal pathogens and viral culture was conducted on blood leukocytes. Heart rate and respiration rate were monitored and recorded throughout handling. Based on respiration rates, heart rates, and cortisol levels, there was no evidence that the dolphins experienced deleterious health impacts from the tagging, nor did they exhibit disruption to normal behaviours. All three dolphins were in good body condition. Progesterone levels suggested the oldest female may have been in early pregnancy. No pathogens were isolated but the older female was seropositive for *Brucella*, the first record of this pathogen in an Australasian marine mammal.

Bottlenose Dolphin (*Tursiops truncatus*) and Fisheries Around Lampedusa Island (Sicily-Italy)

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Starting from 2003, in the framework of the LIFE project NAT/IT/000163, a dolphin-fishery interaction study has been conducted in the Archipelago of Pelagic Islands (South of Sicily, Italy). Since 1997 bottlenose dolphin population has been regularly monitored in the area by the Nature Conservation Department of CTS. During March-December 2004 and January-December 2005 surveys, data have been collected on bottlenose dolphin and fishing boat presence and distribution, while regularly surveying the area of study along transect. In case of simultaneous sighting of dolphins and boats, behavioral data were collected, in order to highlight positive or negative interaction among dolphin and fishery. Data on spatial distribution and group composition of dolphin have been analyzed with respect of presence/absence of fishing boats, and type of fishing gear. A comparison among data collected during the period of intense professional fishing activity is done with data collected during the first period of biological total stop of fishing activity for the area (10 of August – 9 of September 2004). In 2004 141 surveys were conducted, and 102 sightings were realized with a medium group size of 3,76 of animals per group. 2004 and 2005 data are compared. Spatial distribution of dolphin and dolphin-fishery interaction will be implemented in the Action Plan for Bottlenose Dolphin in the Pelagic Archipelago, due by 2007 as part of the Life Project. Aim of the AP is to guarantee and improve the survivorship of the species in the area.

Age-Distribution, Growth and Reproductive Rates of Australian Fur Seals in Relation to Changes in Population Size

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Like most fur seal species worldwide, the Australian fur seal (*Arctocephalus pusillus doriferus*) was hunted to near-extinction during the commercial sealing era. While the population is still well below its estimated pre-sealing size, it is currently growing at rates of 6–20% p.a. A small demographic study in 1971-72, when the population was half its current size, indicated it had low reproductive rates, a high proportion of older individuals and was experiencing substantial illegal hunting pressure (which no longer exists). In view of the increasing population size, there is a fisheries and wildlife management need for accurate contemporary information on population demographic variables. The present study determined age-specific survival, growth and reproductive rates of breeding age females ($n = 160$) at the Kanowna Island colony (39°10' S, 146°18') during 2003-04 when it was growing at 9% p.a.. The earliest age of first parturition was recorded as 3 yr and the oldest individual as 20 yr. While the mean age (9.06 ± 0.34 yr) was similar to that in the 1970s study (9.37 ± 0.41 yr), the age distribution was not skewed to older individuals as was found in the earlier study (26% >10 years, compared with 41% in the 1971-1972). Asymptotic length was similar between the studies (1970s: 163 cm; 2003-04: 160 cm) and mean mass was not significantly different (77.1 ± 1.1 compared to 76.9 ± 1.3 in 1971-72, $P > 0.05$). Pupping-rate (58.5% $n = 65$) was similar to the late pregnancy rate of the early 1970s (55%) confirming this species has a low reproductive rate and that some individuals will extend lactation into a second or even third year. The results of the present study, therefore, suggest that the population has yet to reach levels where density-dependence influences demographic variables and still has substantial capacity for growth.

Early Development of Sex-specific Association Patterns in Wild Bottlenose Dolphin (*Tursiops* sp.) Calves

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Adult bottlenose dolphin associations have been well documented, but little attention has been paid to the emergence of sex-specific patterns. With a long period of dependency, these patterns may develop as early as the calf period and under maternal influence. However, calves have social options because they separate from their mothers frequently and often at long distances. Thus, we examine the effects of calf sex, age, and separation from the mother on association patterns using focal observations of 42 mothers and 77 calves (32 females, 25 males, and 20 of unknown sex; 482 hrs). The only overall significant sex difference is that compared to females, focal males have a higher proportion of male calves in their groups ($\text{mean}_f = 0.11 \pm 0.01$, $\text{mean}_m = 0.17 \pm 0.02$; $F = 23.46$, $P < 0.0001$). However, the age-sex class composition of calf groups changes with age. Both sexes associate with proportionately fewer female calves ($\text{mean}_{y1} = 0.12 \pm 0.02$, $\text{mean}_{y4} = 0.05 \pm 0.03$; paired $t = 2.01$, $P = 0.04$), fewer adult females ($\text{mean}_{y1} = 0.32 \pm 0.02$, $\text{mean}_{y2} = 0.24 \pm 0.02$, $\text{mean}_{y3} = 0.20 \pm 0.04$; paired $t_{y1-y2} = 2.5$, $P = 0.01$; $t_{y1-y3} = 2.8$, $P = 0.01$), and more adult males ($\text{mean}_{y1} = 0.04 \pm 0.03$, $\text{mean}_{y4} = 0.20 \pm 0.03$; $F = 17.74$, $P < 0.0001$; paired $t = -6.6$, $P < 0.0001$). The latter is likely due to mating interest in the mother. Female calves associate with proportionately more juvenile females with age ($\text{mean}_{y1} = 0.20 \pm 0.04$, $\text{mean}_{y4} = 0.32 \pm 0.05$; paired $t = -2.19$, $P = 0.03$). The age-sex class composition of calf groups also changes with separation from the mother. Both sexes associate proportionately less with adult females ($\text{mean}_{\text{present}} = 0.35 \pm 0.02$, $\text{mean}_{\text{absent}} = 0.16 \pm 0.02$; paired $t = -8.56$, $P < 0.0001$; $F = 73.24$, $P < 0.0001$) and with proportionately more male calves ($\text{mean}_{\text{present}} = 0.04 \pm 0.01$, $\text{mean}_{\text{absent}} = 0.15 \pm 0.01$; paired $t = 7.47$, $P < 0.0001$) when away from their mothers. However, this increase in association with male calves is significantly higher for focal male calves than focal female calves ($\text{mean}_f = 0.15 \pm 0.02$, $\text{mean}_m = 0.29 \pm 0.03$; paired $t = -3.86$, $P = 0.0001$). These results suggest that some same-sex biases emerge early in life, particularly for males.

Microscopic Morphometrics of Right Whale Integument

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Northern right whales (*Eubalaena glacialis*) are a highly endangered population of approximately 350 individuals. The biggest threat to this population is related to human interactions; the impact of infectious and non-infectious diseases remains unknown due to the difficulty of tissue collection and diagnosis. Field observers have reported skin lesions of unknown cause as well as evidence of traumatic and line-induced head injuries. Histopathology, culture, and molecular techniques could lead to determination of lesion etiology and a better understanding of fishery- and ship-related injuries. A baseline survey of unaffected integument is necessary for comparison. The aim of this study was to provide information about normal right whale integument collected from stranded animals. Serial samples of formalin-fixed integument from the dorsal midline of the maxilla were collected at 100 cm intervals from the snout. Hematoxylin and eosin and S-100 stained 5i sections were examined histologically and analyzed with Bioquant morphometric software. We analyzed depth and width of epithelial rete pegs, intervascular distance, and quantified nerve density comparing skin segments at closely-corresponding distances. There was no evident inflammation, vasculopathies, or neuropathies in any of the sections examined. Overall, the average length and width and intervascular distance did not change with distance from the snout. There was a non-significant difference in horizontal and vertical distances of blood vessels in the superficial reticular dermis. Finally, nerve density was greater in the upper 2.5 mm of the superficial reticular dermis, decreased from approximately 2.5 mm to 1.0 cm, and increased at depths ranging from 1.0 cm except at measurements 900 and 1000 cm from the snout where nerve density increased at depths greater than 7 mm. With continued effort to collect lesion tissue from free-living and dead cetaceans,

survey data of normal integument will serve as a baseline for histopathologic examination in whales with obvious injuries or disease.

Patterns of Mortality for Northern Sea Otters from Alaska

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Causes of mortality influence both survivorship and population demographics; in northern sea otters *Enhydra lutris kenyoni* in Alaska, such causes are poorly understood. In 2002 we initiated a study to determine causes of mortality with beachcast northern sea otters in Alaska suitable for comparison with similar studies of southern sea otters *E. l. nereis* in California. We conducted comprehensive necropsies, including histopathology plus extensive screening for protozoal, viral, and bacterial pathogens when carcasses were fresh enough. Since 2002, necropsies have been performed on 74 otters (45 frozen, 29 fresh). Males (63%), prime-age adults (ages 4-10 years; 49%) and animals from the southcentral Alaska stock (84%), accounted for a large majority of all otters recovered (prime-aged males from southcentral; 25%). The leading cause of death was infectious disease, specifically valvular endocarditis (36%) which was associated with the bacterium *Streptococcus bovis/intermedius*. Valvular endocarditis is typically a sporadic disease secondary to chronic bacterial seeding from a primary source of infection (*i.e.*, tooth abscess, bite wound) however this was not identified in these cases. In comparison, only 1% of southern sea otters have been identified with this infection (n=298; 1998-2005). Inter- and intra-specific trauma accounted for 20% while no cause of death could be determined for 26% of the cases. Other causes of death included emaciation, colonic impaction, oil exposure, neoplasia, and congenital defects. Interestingly, protozoal meningoencephalitis, caused by the parasites *Toxoplasma gondii* and *Sarcocystis neurona*, one of the most common sources of southern sea otter mortality, has not been isolated in the northern sea otter carcasses. Continued comparisons of pathological processes affecting northern and southern sea otter populations will improve our understanding of the environmental hazards and pressures facing both populations and may help to determine means for mitigation of some of these factors for the long-term benefit of this species.

Spatial and Seasonal Distribution Patterns of Harbor Porpoises in the German Bight of the North Sea

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We investigated seasonal differences in the distribution of harbor porpoises (*Phocoena phocoena*) in German national waters of the North Sea (EEZ plus 12 nm zone) based on data collected between 2002 and 2004 during aerial surveys. Aerial surveys were conducted year-round following standard line transect methodology and covered a total area of about 28,600 km². Survey effort amounted to 25,170 km that were flown on effort, during which a total of 2,840 harbor porpoises were seen. Using standard Distance procedures and a grid of 10 x 10 km, we converted the line transect point locations into mean density estimates. The density estimates were corrected for missed animals and sighting conditions, as effective strip widths (including g(0)) for good and moderate conditions were calculated. We then used permutation simulation analyses to investigate porpoise occurrence in relation to a number of predictor variables (depth, several depth

derivates, distance to land and sea surface temperature) during different times of the year (spring, summer and fall). The results indicated significant seasonal differences in porpoise distributions, and suggested that shifts in distributions were linked to changes in harbor porpoise habitat requirements associated with different stages of their annual life cycle. In particular, porpoises appeared to be aggregated and more closely associated with depth, slope and sea surface temperature during the summer months than during other times of the year. Our results emphasize the importance of year-round monitoring programs and the consideration of seasonal aspects when developing habitat prediction models and when investigating critical habitat, particularly in the context of anthropogenic impact assessments. However, harbor porpoise habitat selection on smaller geographic and temporal scales is likely influenced by additional environmental and biological parameters such as prey distribution which need to be taken into consideration in this context.

Killer Whales Prey Upon a Blue Whale Calf on the Costa Rica Dome: Genetics, Morphometrics and Composition of the Herd

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Among killer whale (*Orcinus orca*) communities in high latitudes (*e.g.*, Norway, North Pacific, Antarctica), the norm now seems to include prey specialization among two or more, sympatric, non-interbreeding ecotypes. Still nearly nothing is known about populations that inhabit open ocean areas or tropical latitudes. On 26 September 2003, while conducting a cetacean survey in the eastern tropical Pacific Ocean, we encountered a group of 20-22 killer whales feeding on a blue whale calf (*Balaenoptera musculus*) they had presumably just killed. The location was 10° 58'N, 88° 40'W, 230 km west of Nicaragua. We collected biopsy samples, acoustic recordings, aerial and lateral photographs, and recorded behavioral observations. Using aerial photogrammetry, we measured body lengths of 17 different animals: the largest male (who carried the blue whale carcass most of the time) was 8.0 m long; the largest female (with a calf) was 6.1 m. A distinctive physical feature of these animals was the near absence of a dorsal saddle, a trait that appears to be common among tropical populations. We photographed a minimum of 19 individuals, including 5 males (4 adult and 1 subadult) and 5 cow/calf pairs. Two subgroups were evident and at least two animals showed fresh tooth rake marks on them, indicating aggressive interactions were taking place. Among the 12 biopsy samples, we identified two haplotypes that differed from "resident" (*i.e.*, fish-eating ecotype) killer whales in the northeast Pacific by only one and two base pairs, respectively. Killer whale population densities are much lower in warmer (*i.e.*, less productive) waters, and it has been suggested that most baleen whale species migrate to lower latitudes for calving to reduce predation pressure on calves. Our observation reaffirms that calves of even the largest whale species are vulnerable to predation, and therefore it seems likely that baleen whales can increase their overall reproductive fitness by seeking out breeding areas with low killer whale densities.

Monitoring North Atlantic Right Whale (*Eubalaena glacialis*) Distribution North of the Southeastern U.S. Calving Ground Critical Habitat

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The winter calving grounds off Georgia and Florida in the Southeastern United States have been designated as critical habitat for the endangered North Atlantic right whale (*Eubalaena glacialis*). An Early Warning System was created to alert military and commercial vessels transiting the critical habitat of the presence of right whales to mitigate ship strikes. The region just north of the critical habitat, including northern

Georgia and South Carolina, is known to be an important migratory route. However, recent survey effort and photo-identification data has suggested that some individuals utilize this area not only as a migratory route, but as a residency area as well. Resource managers are currently uncertain about the extent or the importance of this southern mid-Atlantic region to the reproducing population. The purpose of this aerial survey effort is to provide more complete distribution and use information to facilitate effective management actions and potentially support the expansion of the critical habitat designation. Seventy-five aerial surveys were conducted in the study area from 01 December 2004 through 14 April 2005, totaling 424.4 hours of flight time. Thirty-seven right whale sightings were documented, consisting of 12 single animals, 11 cow/calf pairs, and 14 groups of two or more adult/juvenile whales. Preliminary photo-identification analysis documents seven separate cow/calf pairs, in addition to 18 identified and 12 unidentified adult/juvenile whales. One mother/calf pair, EGNO 1970, and one mother/yearling pair, EGNO 2145, were not sighted further south within the boundaries of the calving ground critical habitat. A previous survey effort also documented EGNO 1970 only along the coast of South Carolina, indicating a possible residency pattern well north of the current calving ground critical habitat boundary. This study will continue during the 2005-2006 calving season to further document right whale use of this region.

Observations on Distribution and Abundance of White Whales in the White Sea in 2000-2005 (*Delphinapterus leucas* Pallas)

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Regular studies on abundance and distribution of belugas in the White Sea have been conducted until the 1990s. The number, distribution and structure of beluga's population appear to be highly variable depending on season. In mid summer the population is represented by two semi-equal parts: groups of migrating adult animals and resident groups of adult females, calves, juveniles and few adult males. The free-ranging part doesn't show signs of site fidelity and migrates all over – and even out of – the White Sea. Residents barely move around and tend to concentrate in the certain coastal regions favorable for calf-nursing. Relationship and level of exchange between these two parts of the summer population are not studied yet. On July 4-8, 2000 an aerial survey of belugas was conducted in the White Sea and in adjacent part of the Barents Sea. Study area covered mainly coastal waters while only few flights lied offshore. Total of 1174 belugas including 142 calves were counted in 434 sightings. Encounter rate ranged from 3 to 13 sightings per 100 km, maximum group size was 50 animals, mean – 2.71. We found 6 stable coastal female-calf aggregations in different regions of the sea. More than 50% of the animals surveyed were transients sighted outside these reproductive gatherings. During flights on 9-12 July 2002, coastal locations of reproductive gatherings were confirmed, and two more found. Five-hundred one belugas were sighted, of which 62 were calves; 53 calves were observed with adult females. Survey in 2002 was exclusively limited to the coastal zones. As previously conducted surveys have not provided a clear picture of abundance and distribution of belugas in the White Sea, a full-scale aerial line transect survey with distance sampling approach will be performed in July 2005. The comparative results are to be presented at the conference.

Clonogenic Toxicity of Benzo[a]pyrene is Higher in Reproductive Tissue Than in Somatic Tissues of the North Atlantic Right Whale (*Eubalaena glacialis*)

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Polycyclic aromatic hydrocarbon compounds (PAHs) are widespread environmental contaminants but their toxicity in whales is largely unknown. There is growing concern about the potential effects of these and other chemicals on the reproductive and overall health of the endangered North Atlantic right whale (NARW). The NARW population consists of only about 300 individuals and is reproducing at an insufficient rate. Specific *in vitro* models are critically needed to assess the toxicological effects of contaminants in this species and other great whales. Primary fibroblast cell lines from NARW somatic and reproductive organs, created in our laboratory, were exposed to the PAH benzo[a]pyrene (BP) as part of a multi-chemicals toxicity testing project. Fibroblasts were exposed to 0.001-10 μ M BP and cytotoxicity measured with a clonogenic assay using standard methods. In skin, toxicity increased with time ($p < 0.01$) as 10 μ M induced 74, 57 and 27 percent relative survival after 24, 48 and 72 h exposure, respectively. Increased toxicity with exposure time was also observed in lung and testis ($p < 0.01$) as 10 μ M induced 51, 44 and 23 percent relative survival and 83, 25 and 3 percent relative survival respectively after 24, 48 and 72 h exposure. Our results show that BP was more toxic to reproductive tissue than to somatic tissues with a 72h LC80 of 1.5 μ M in testis, compared to 4.2 and 5.3 μ M in lung and skin, respectively. Testis was also the only organ for which a LC100 was reached (at 7.93 μ M). Supported by NOAA/NMFS NA03NMF4720478.

Intracytoplasmic Eosinophilic Globules in Hepatocytes of Stranded Cetaceans in the Canary Islands

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The presence in hepatocytes of intracytoplasmic inclusions has been described both in human and in veterinary medicine, being associated to different agents and pathogenic mechanisms. In cetaceans, the presence of this type of globules has been frequently described in animals stranded individual or massively. For the accomplishment of this work, samples of liver, corresponding to 108 cetaceans of 17 different species, stranded in the Canary Islands had been studied. In the cytoplasm of hepatocytes of 58 animals of 12 species, hyaline eosinophilic globules were observed, with a size between 4 and 20 μ m. In 49 out of the 58 livers showing those inclusions, histochemical (PAS-diastase) and immunocytochemical (detection of alpha-1-antitrypsin) techniques were performed on formaline-fixed, paraffin-embedded sections. The results showed 26 positive livers to both techniques, 22 of which were associated with hepatic congestion, 10 were just PAS diastase positive, 6 only a-1-AT positive and 7 negative to both staining procedures. In the present study, the acute hepatic congestion was observed in 53% of the a-1-AT positive animals. The origin of these intracellular changes is probably related to hemodynamic phenomena suffered by the cetaceans stranded alive, in addition to hyperthermia and/or other factors which may induce the production and storage of a-1-AT and as other acute phase proteins (under current study) in the hepatocytes.

The Effects of Non-Lethal Post-Canine Tooth Extraction in Lactating Antarctic Fur Seals

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Understanding demography and population age structure are important for effective resource management and conservation. Advances in the application of gas anesthesia and tooth extraction techniques have allowed non-lethal determination of an individual's age. The

invasiveness of the method has led to concerns about its impact on individual survival and reproductive success. We report on a study of the effects of post-canine tooth extraction on female Antarctic fur seal survival, natality, attendance behavior, and pup mortality and growth. Over five years of study (2001-2005), the return rate in the year following tooth extraction ($90.2\% \pm 2.9$, $N=285$) did not differ from females that did not have a tooth extracted ($89.1\% \pm 1.1$, $N=796$). Females that carried VHF radio transmitters before and after tooth extraction showed no change in trip durations ($2.99d \pm 0.17$ vs. 3.04 ± 0.27). In a separate study of attendance behavior and pup growth for the first six postpartum trips to sea, 29 females were captured one day postpartum and instrumented with VHF transmitters; 13 had a post-canine extracted. Mean trip duration was not significantly different (controls: $4.3d \pm 0.40$, $N=16$ vs. tooth extracted: $3.5d \pm 0.40$, $N=13$; $P=0.06$) nor were visit durations (controls: $1.5d \pm 0.16$, $N=16$ vs. tooth extracted: $1.4d \pm 0.16$, $N=13$; $P=0.15$). No difference in perinatal growth rates or pup growth to mid-lactation was detected (controls: $108.7g/d \pm 7.70$, $N=15$ vs. pups of tooth extracted moms: $106.0g/d \pm 9.05$, $N=13$; $P=0.82$). The only significant difference in behavior that we were able to detect was in the duration of the tooth extraction visit. Females on average remained on shore 0.5 days longer than undisturbed visits. Females captured and restrained using the same techniques but without tooth extraction also remained on shore longer, though not as long. We conclude that capturing and tooth extraction has an additive affect prolonging visit duration.

Dive Duration and Travel Speed of Humpback Whales on Their Hawaiian Wintering Grounds Vary with Behavioral Role and Activity Level

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Humpback whales occupying different behavioral roles on their wintering grounds engage in different activities; we explored whether these difference were reflected in diving and travel behavior. This report presents part one of the first comprehensive description of humpback whale diving behavior on their wintering grounds. Groups of whales were tracked using small research vessels; respiration and dive data were collected on Palm Pilots using Spectator Go software. Behavioral roles and amount of surface-active behaviors performed by each animal were also recorded and approximate travel speeds were determined for each group using GPS data. A total of 106 adult animals were sampled, yielding 680 dives. In general, dives were longer on the winter grounds than feeding grounds (Dolphin, 1987), with 51% of non-calf dives exceeding four minutes and 16% of dives longer than 10 minutes. Dive duration varied significantly with behavioral role ($n=680$, $F = 15.7193$, $p < 0.001$) and level of surface activity ($n=680$, $F = 8.2524$, $p < 0.001$). This finding corroborates Baird *et al.*'s (2000) report that behavioral role was a factor in the variation of dive-depth profiles between individual male humpback whales. Travel speed also varied significantly with behavioral role ($n=680$, $F = 43.064$, $p < 0.001$) and activity level ($n = 680$, $F = 37.472$, $p < 0.001$). Escorts in competitive groups (with and without a calf) had the shortest dive lengths, while singers, solitary escorts to a mother and calf, and members of a dyad had the longest dive times. Similarly, animals in competitive groups and lone animals traveled faster, with singers having the slowest travel speed. On average, dive duration decreased and travel speed increased with increasing surface activity. These data provide a quantitative basis for inferring the energetic demands of behavioral roles and allowing more informed analyses of behavioral choices of adult animals.

Summer Habitat Preferences of Beluga Whales (*Delphinapterus leucas*) in Cook Inlet, Alaska

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The Cook Inlet beluga whale (*Delphinapterus leucas*) population is comprised of 360 individuals and occurs in a semiconfined body of water. This small population is susceptible to local physical, ecological and anthropogenic stressors. Proposals are currently being considered to develop portions of Cook Inlet, so it is particularly timely to identify the habitat requirements of these whales. We integrated Geographic Information Systems (GIS) and statistical methods to describe habitat preferences of this population in quantitative terms. Our objective was to predict the summer habitat (June/July) using a variety of available environmental parameters. We obtained beluga sightings ($n = 226$) from 12 years (1993-2004) of dedicated aerial survey effort. Logistic regression and Classification and Regression Tree (CART) were used to determine the importance of bathymetry, the distribution of mudflats, and flow accumulation values in structuring the habitat of this species. Flow accumulation values were used as a proxy for the availability of anadromous prey. Although bathymetry was not significant, our results indicate that mudflats are important predictors of beluga whale distribution during the early summer. The importance of flow accumulation varied slightly between the two models but, in general, beluga whales preferred higher flow accumulation areas. Remarkably similar regions of habitat were predicted by both the logistic regression ($A=232 \text{ km}^2$) and CART ($A=298 \text{ km}^2$) models. Using a 0.69 probability threshold for habitat, as suggested by the Receiver Operator Characteristic (ROC) curve, the logistic regression model correctly discriminated between beluga sightings and non-sightings 92% of the time. In addition, the CART model correctly classified 88% of the sightings, showing that the majority of beluga sightings were within 2.7 km of mudflats and 11.5 km of medium flow accumulation inlets. These habitat models will help managers meet current conservation goals and make future decisions to promote the recovery of Cook Inlet beluga whales.

The Diving Kinematics of Fin Whales During Foraging Dives

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To investigate the body mechanics of fin whales during foraging dives we attached high-resolution digital tags, equipped with a hydrophone, pressure transducer, and an accelerometer, to fin whales in the southern California bight. Daily tagging efforts from 8/20/03 to 8/26/03 resulted in the successful recording of 27 foraging dives among 7 fin whales. Body pitch and roll were estimated by changes in static acceleration detected by orthogonal axes of the accelerometer and periods of active fluking were represented by small amplitude oscillations in the accelerometer signals. The tag was towed by an underwater wing to determine the relationship between flow noise recorded by the hydrophone at different flow speeds. This relationship allowed for the instantaneous speed of the whale to be estimated throughout the dive cycle. Body speeds estimated by flow noise were confirmed by kinematic analysis, where the resultant velocity of the body is equal to its vertical velocity divided by the sin of the body pitch angle. Fin whales primarily employed gliding gaits during descent, executed a series of lunges at depth, and ascended to the surface by steady fluking. Maximum body speeds during descent were $5.7 \pm 0.3 \text{ ms}^{-1}$ while maximum velocities during ascent were significantly lower at $3.4 \pm 0.4 \text{ ms}^{-1}$. Our examination of body kinematics at depth reveals variable lunge-feeding behavior in the context of distinct kinematic modes (*i.e.* lateral lunge feeding), which exhibit temporal coordination of rotational torques with translational accelerations. This kinematic sequence was conserved among individuals within each mode despite variations in dive profile topology. The maximum speeds attained during each lunge were $3.0 \pm 0.5 \text{ ms}^{-1}$ ($n=121$) and closely match previous estimates of the flow velocities needed to completely expand the buccal cavity, supporting the hypothesis that engulfment feeding is exclusively powered by swimming.

Postnatal Growth of Body and Skeleton of the Harbour Porpoise in the Sea of Azov and the Black Sea

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Harbour porpoise (*Phocoena phocoena*) is one of the smallest and the best studied cetaceans, so detailed investigation of its morphology and life history can bring numerous insights into the understanding of cetacean biology. Material for this study was taken from stranded and by-caught 270 porpoises from the Sea of Azov and the Black Sea (representing the smallest subspecies *P. p. relictus*) in 1997-2003. External and osteometric measurements were taken, age was determined using growth layer groups in dentine and bone tissue. Body growth has two stages (as in other species): the first stage stops after weaning, the secondary growth spurt starts at the age of 1-2 years and gradually ceases after 3-4 years. However, this growth pattern is caused primarily by the growth of caudal part; the other body parts demonstrate 1-staged growth. In the skeleton, only several bone measurements demonstrate 2-staged growth. On the whole, growth of skeleton retards and lasts substantially longer than growth of the corresponding body parts. For example, growth of flipper stops at the age of 3-4 years but growth of manus bones lasts at least up to 8 years. Thus, growth of soft tissues forming a body contour "pre-determines" subsequent skeletal growth. One of the effects of this process is frequently observed positive allometry in many postcranial skeleton structures, even not correlating with the allometry of the corresponding body part. Another interesting phenomenon is the "relay effect" in skeleton growth: one part of the structure grows, then another one begins to grow. In particular, this effect is observed in the growth of rostrum.

Sub-lethal and Long-term Effects of Exposure to Domoic Acid in Stranded California Sea Lions (*Zalophus californianus*)

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Domoic acid is an excitatory neurotoxin produced by marine algae, such as *Pseudo-nitzschia australis*. Acute domoic acid toxicosis resulting from the glutamate agonist action of domoic acid was well documented in California sea lions (*Zalophus californianus*) that stranded off California in 1998. Animals displayed neurologic signs, including ataxia, disorientation, seizures, and death. Pathologic findings in acutely affected animals consisted of acute ischemic neuronal necrosis in the pyramidal cells of the hippocampus and granular cells of the dentate gyrus. From 2000 to present over 500 sea lions have stranded with signs of neurological disease at times when domoic acid producing plankton blooms were not always present along the Pacific coast. Approximately 50% of these animals exhibited neurological effects longer than 2 weeks after initial stranding. Additionally, 9% of affected sea lions have re-stranded following release, compared with 0.5% that re-strand following treatment for other reasons. Magnetic resonance imaging on live animals and histopathology from animals that died or were euthanized revealed varying degrees of unilateral and bilateral hippocampal atrophy, neuronal loss and gliosis in the limbic system. While all age classes and sexes are affected, 79% of cases have been adult females. Reproductive failure as a result of abortion and premature parturition was observed in approximately one third of affected adult females. Domoic acid was detected by liquid chromatography with tandem mass spectrometry in amniotic fluid, fetal urine and gastric fluid tested up to 2 weeks after stranding. This suggests the fetus acts as a

sink for domoic acid that is typically rapidly cleared from mammalian species (half life in primates is 4 hours). These data suggest that exposure to domoic acid can have effects on sea lion reproduction and survival beyond acute mortality documented to date and that animals may be exhibiting signs of persistent, sub-lethal exposure to the toxin.

Population Identity of Humpback Whales (*Megaptera Novaeangliae*) in Baja California Sur, México

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Every winter the humpback whales aggregate in the coasts of Baja California Sur (BCS). Based on photo-identification studies we know that the coasts of California-Oregon-Washington (COW) are their main migratory destination, although there are matches with other feeding regions. We analyzed the pigmentation pattern and rake marks by killer whales in flukes photographs, and the haplotypes of humpback whales from BCS, in order to distinguish whales from different migratory origins throughout the winter season. The field work consisted of three surveys in January, February and April of 2003. We photo-identified 166 individuals, 56, 58 and 52 respectively in each survey. The flukes photographs were classified according with their pigmentation pattern, type 1 to 5 (light to darks). Type 4 and 5 were predominant with more of 60% throughout all the season. Coincidences in the proportions of flukes pigmentation with any of the feeding grounds were not observed (including COW). But it was notice that males, which have lighter pigmentations, were predominant at the beginning of the winter season. The proportion of fluke photographs with rake marks in BCS was 25.3%, higher than in any of the feeding grounds. There were not differences throughout the winter season. These indicate that the killer whale attacks happened mainly in Mexican waters. Based on the analyses of the mtDNA of 149 samples collected between 1991 and 1996 in BCS, the haplotypes "A" dominate with 51.6% followed by "E" 29% and "F" 19%. This haplotypes proportions are different from the COW feeding area. Considering the few matches with the other studied feeding regions we suggest that a high proportion of the whales that wintering in BCS came from an unstudied feeding ground with a high proportion of haplogroup "A", probably from coasts of British Columbia and/or oceanic waters of the Gulf of Alaska.

The Use of Side Imaging Sonar to Study Manatees in Cuero y Salado Wildlife Refuge, Honduras

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Sonar, in theory, is an efficient way to study large aquatic animals because oxygen trapped in the organism creates a strong response. Attempts to use sonar to study manatees in Florida (1980's) proved to have minimal success due to large amounts of submerged vegetation which release oxygen, thus creating too much noise to distinguish manatees their surrounding (Rathbun, personal communication). We attempt to use a new side imaging sonar (Hummingbird 987c SI) to study manatees in water conditions that have minimal or no submerged vegetation due to high levels of water turbidity. We hypothesize that in river and lagoon systems with these conditions manatees will be detectable. The study site selected was Cuero y Salado Wildlife Refuge (CYSWR), which is located on the north coast of Honduras. CYSWR consists of two main rivers (Salado and Cuero), which are connected by a series of canals. Although CYSWR was established in 1987 to protect manatees there is a lack of peer-reviewed literature relating to them due in part to the complicated water conditions. Rathbun *et al.* (1983) sighted manatees 18 and 2 times over the Salado river and Cuero river respectively during 6 aerial surveys. Recently Gonzalez *et al.* (*in prep*) sighted manatees 15 times in the mouth of the Cuero

river during stationary boat surveys. We tested the sonar device at various times of day (morning, evening, night, *etc.*) and at various weather conditions (rain, cloudy, sunny, *etc.*) to determine its utility to detect manatees. We also experimented with various ways of using the sonar (linear transects and point transects). Based on sightings of manatees and subsequent observation by sonar, we believe that manatees can be detected by the side imaging sonar in turbid water conditions and can potentially be used as a tool to monitor and study manatees.

How Many Populations of Harbor Porpoise Are There in UK Waters? New Insights from Microsatellites and Individual Based Genetic Analyses

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Conventional approaches for assessing genetic population structure (such as comparison of allele frequencies, calculation of *F*_{st}, or assignment methods) require prior assumptions of what constitutes a 'population' and lumping of individuals in such units before analysis begins. This can be problematic for highly mobile species and where there are no obvious barriers to dispersal, as is the case for the harbor porpoise (*Phocoena phocoena*), since population units defined by investigators based on geography may be arbitrary. New individual based techniques for assessing population structure have now been developed that require no prior assumptions to be made about an individual's population of origin. These potentially avoid biases that can be introduced by prior population assignment in allele frequency based approaches. Such methods have not previously been applied to genetic studies of European porpoises. In this study, using a combination of traditional allele frequency based methods, Bayesian cluster analysis (using the 'Structure' computer program), and individual based isolation-by-distance analysis, we aimed to determine the most likely number of porpoise populations in UK waters, and to test for sex-biased dispersal and seasonal mixing of stocks. The data set was derived from 9 microsatellite loci, genotyped in more than 550 individuals sampled from around the UK coast by the UK cetacean strandings program. The greatest statistical support exists for just two populations in the UK (posterior probability=1, compared to 0 for other models), split between east and west coasts. Structuring among the female component appears to be twice as large as for males, suggesting male biased dispersal and the degree of structuring also appears to vary seasonally. The results potentially have important implications for porpoise conservation in Europe, particularly with regard to the parameterization of models for setting by-catch limits which are sensitive to the number of assumed populations.

Remote Biopsy Sampling of Bottlenose Dolphins: Think Twice Before Shooting into Large Crowds

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Biopsy sampling is becoming an increasingly important tool to collect samples for genetic, contaminant, and hormone analyses. Numerous studies have evaluated the effects of biopsy darting on target animals, but darting may have unintended effects on the behavior of nearby non-target animals. We investigated reactions of target and non-target animals as functions of group size, hits or misses, inter-animal distance, habitat, depth, and number of sequential biopsy attempts. Sampling was conducted in February-March 2005 off Hilton Head, SC (n=140) and in August 2004 off Folly Beach, SC (n=48) and Jekyll Island, GA (n=106). Immediately prior to each biopsy attempt, the number and distance of animals from the target animal were recorded. Immediately after, we recorded the magnitude of reaction of the target animal, number of non-target dolphins reacting, and inter-animal distance. Reactions were categorized as none (no modification

of pre-biopsy behavior), low (acceleration/dive), medium (tail slap), and strong (breaching) (Weinrich *et al.* 1992). In this analysis, 294 biopsy attempts (194 hits, 100 misses) were used. The majority of reactions were categorized as low (82% for hits, 74% for misses). Overall, there was a significant effect on reaction of the target animal (GLM, *p*=0.0189), with hit or miss of the target animal the most important factor (*p*<0.0001). The interaction of group size and number of sequential attempts per group was also significant (*p*=0.0460). Reaction of non-target animals decreased with increased distance from the target animal (Chi-square, *n*=312, *p*<0.001) with reactions during 58%, 24%, and 16% of attempts for animals <1, 1-3, and >3 body lengths distant, respectively. With effort toward biopsy darting increasing, it is important to minimize impacts. Our results help establish that impacts are low for the majority of both target and non-target animals and provide a means to continue to quantify potential effects on non-target animals.

Bayesian Estimates of Hector's Dolphin Survival from Mark-Recapture Data via the Metropolis Algorithm

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Hector's dolphins are small, coastal dolphins endemic to New Zealand. In 1988 a marine mammal sanctuary was established around Banks Peninsula to mitigate against gillnet entanglement. Estimates of vital rates, such as annual survival rate, are essential for continued management. Mark-recapture models, such as the Cormack-Jolly-Seber (CJS) models, are commonly used to provide estimates of survival. CJS models allow any combination of constant and/or time dependent survival and capture probabilities. We extended the CJS models to include individual covariates as an index for capturability. Parameter estimates for CJS models are commonly obtained via Maximum Likelihood Estimation (MLE). This talk outlines the implementation of a Bayesian approach using Markov-Chain Monte Carlo (MCMC), specifically using the Metropolis algorithm. A number of candidate models were coded and run in MATLAB for 100,000 iterations after a 10,000 run adaptive phase. The Deviance Information Criterion (DIC) was used to choose among the models. We also used Program MARK to obtain MLE estimates for the candidate models. Akaike's Information Criterion (AIC) was used in MARK to choose among the models. Both methods selected the same "best" model and gave the same parameter estimates (annual survival: mean=0.920, SD=0.014). An advantage of Bayesian methods is that they allow direct sampling from the posterior distribution for a particular parameter, a fact that is very useful for the purposes of running population model simulations. Sampling directly from the posterior may also be important due to the often skewed distribution of parameters, such as survival, that may be close to one of their bounds. In addition, Bayesian methods allow the uncertainty to be expressed directly in terms of probability statements. Preliminary analysis of a matrix population model suggests that this estimate of survival is not high enough to ensure population growth.

Distribution and Abundance Indices of Marine Mammals in the Gully MPA, Nova Scotia, Canada, Before and During Nearby Seismic Exploration Operations in April and July, 2003

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The Gully is a submarine canyon that provides habitat to the endangered northern bottlenose whale (*Hyperoodon ampullatus*). Plans for seismic surveys for hydrocarbons conducted in the vicinity of this MPA in 2003 prompted an evaluation of its marine mammal species composition and abundance. Vessel-based line transect surveys were conducted in the Gully on 30 April (148 km) prior to seismic

operations, and on 8, 10, and 11 July (395 km) during seismic operations. In the nearby Shortland and Haldimand Canyons, 175 km of lines were surveyed on 1 May prior to seismic activities. Seven species of marine mammals (45 groups; 84 individuals) were identified in both areas in spring, and later 11 species (207 groups; 563 individuals) were identified in the Gully in July. Northern bottlenose whales, the most abundant species detected in the spring (four groups; 18 individuals), were outnumbered in July (eight groups; 35 individuals) by common dolphins (*Delphinus delphis*), pilot whales (*Globicephala* sp.), and grey seals (*Halichoerus grypus*). Abundance indices {not corrected for $g(0)$ } of northern bottlenose whales in the Gully were 44 (95% CI: 19–105) in April and 63 (95% CI: 20–230) in July. In the Gully, combined abundance indices of fin (*Balaenoptera physalus*) and sperm whales (*Physeter macrocephalus*) detected in both spring and summer, along with blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) detected only in summer, were estimated to be 89 (95% CI: 31–254) in April and 114 (95% CI: 61–214) in July. Common, Atlantic white-sided (*Lagenorhynchus acutus*), and bottlenose dolphins (*Tursiops truncatus*), plus harbour porpoises (*Phocoena phocoena*) were combined as small odontocetes and were estimated to number 121 (95% CI: 21–686) in April and 1,763 (95% CI: 849–3659) in July. Changes observed between spring and summer surveys most likely represent seasonal variation rather than an effect of seis-mic activity.

Echolocation Clicks of Free-Ranging Chilean Dolphins

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As a member of the genus *Cephalorhynchus* Chilean dolphins (*C. eutropia*) could be expected to produce only ultrasonic clicks but their vocal repertoire has not been investigated previously. Here we characterize the sounds recorded from free-ranging Chilean dolphins at Isla Chiloé (43°S) in southern Chile during February 2005. Recordings were made from a drifting 4m inflatable boat using a Brüel and Kjær 8103 hydrophone with a B&K 2635 charge amplifier connected to a high-speed data acquisition card (sampling rate 500 kHz) and a laptop computer. To ensure that only on-axis clicks were analyzed we selected the two loudest clicks per click train from recording sequences during which a dolphin was approaching the hydrophone. The 30 clicks fulfilling these criteria were recorded from single dolphins associated with a group of four others engaged in foraging behaviour. Clicks were of short duration (20-dB duration: 75 μ s), narrow-band (rms-bandwidth: 12 kHz), ultrasonic pulses with median centre-frequencies of 125.5 kHz. Instantaneous frequencies (Hilbert transformation) tracked over course of the signal showed a nearly constant frequency characteristic of the click. Higher centre-frequencies were correlated with longer click intervals suggesting that slightly higher frequency signals were used at longer target ranges. Audible sounds resembling “buzzes” were frequently recorded when dolphins engaged in foraging behaviour with minimum click intervals of 2 ms. As expected, no unpulsed pure tones, such as whistles, were detected during 40 minutes of additional recordings with bandwidth-limited equipment. The vocal repertoire of Chilean dolphins matches those described for *C. hectori* and *C. commersonii*. This novel characterization of Chilean dolphin sounds opens prospects for fine-tuning existing passive acoustic detection techniques for use in future distribution surveys of this elusive species.

Development of ELISAs and Molecular Probes for Porpoise and Dolphin Morbilliviruses

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During the past two decades, various epizootics in marine mammals with high mortality were shown to have been caused by porpoise morbillivirus (PMV) and dolphin morbillivirus (DMV). During the

onset of acute morbillivirus infection the most abundant and rapidly produced antibodies are specific for the nucleocapsid (N) protein. Although there have been successful efforts to design ELISAs for detection of antibodies to these morbilliviruses, assays have not yet been developed to unambiguously differentiate between antibodies to PMV and DMV. The carboxyl end of the N protein gene, highly divergent among all known morbilliviruses, may allow for the serological differentiation of antibodies and for the specific detection of nucleic acids of these viruses. The RNAs of PMV and DMV were reverse transcribed and the complete N genes from each virus were amplified by PCR, cloned and sequenced to verify gene integrity. The genes were subcloned into a baculovirus vector and co-transfected into Sf-21 insect (*Spodoptera frugiperda*) cell cultures. Recombinant baculoviruses that express the specific N protein were produced and confirmed by PCR and protein analyses. These recombinant proteins can be used in ELISAs for the detection of antibodies in sero-epidemiological surveys. The N genes are being truncated to remove conserved sequences and develop DNA probes for the identification of PMV and DMV RNA in infected cell cultures and tissues.

Using Overlap Indices to Assess the Efficacy of Regulations Designed to Reduce Competition Between Fisheries and Steller Sea Lions

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We developed spatially explicit distribution models for commercial fisheries and Steller sea lions (*Eumetopias jubatus*) to test whether increasingly stringent fisheries regulations reduced the overlap between fisheries and adult female sea lions in the Gulf of Alaska and the Bering Sea. Results from telemetry studies were used to parameterize the sea lion habitat model, while the distribution of commercial fishing effort was estimated from observer data and reported landings. The spatial overlap between the two derived distributions was calculated for discrete sets of years, delineated by significant changes in fisheries management regulations. We calculated niche overlap and mean crowding indices for each management period. Changes in these indices over time provided a means of assessing whether increasingly stringent fishing regulations corresponded with decreases in the spatial overlap of sea lions and commercial fisheries. We found that the overlap between fisheries and sea lion distributions was higher in winter than in summer, but was relatively low overall, compared to the total predicted sea lion distribution. A reduction in overlap was detected only during the late 1990s when management actions imposed the greatest spatial restrictions on fisheries. While fishing regulations are only one of the variables that determine the overall distribution of fishing effort, our results suggest that indices of overlap provide a means of assessing the relative strength of human impacts on marine mammal distributions. The niche overlap method, combined with spatially explicit estimates of prey abundance, will ultimately lead to measures of competition at resolution that is ecologically meaningful to sea lions, and potentially to other species of marine mammals as well.

Transplacental Transfer of Organochlorines in California Sea Lions (*Zalophus californianus*)

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Organochlorine contaminants have been linked to disease and physiological impairment in marine mammals. In California sea lions, high blubber levels of DDTs and PCBs have been associated with cancer and reproductive failure. The role of organochlorines in the etiology of reproductive failure is unclear because of the confounding effects of maternal transfer to the developing fetus. To clarify the

epidemiological associations between contaminants and disease, our objective was to gain a better understanding of the effects of transplacental contaminant transfer on maternal blubber levels. To evaluate the placental transfer of PCBs and DDTs in California sea lions, blubber was collected from 20 fetuses and their mothers that stranded in central California with acute domoic acid toxicosis. Blubber was analyzed for selected organochlorines including dioxin-like PCBs and DDTs by rapid high-performance liquid chromatography photodiode array. Fetal PCBs were 45% of mean maternal PCBs by wet weight and 97% by lipid weight. Fetal DDTs were 53% of maternal DDTs by wet weight and 112% by lipid weight. PCB congeners with the greatest contribution to contaminant load were 101, 105, 118, 128, 138, 153, 170/194, and 180. Using canonical discriminant function analysis, adult females, premature fetuses, and late term fetuses could be separated based on their different congener profiles. Maternal "PCBs, fetal percent lipid and maternal percent lipid explained a significant proportion of the variance in fetal Σ PCBs (multiple $R^2=0.93$). Likewise, maternal Σ DDTs, fetal percent lipid and maternal percent lipid explained a significant proportion of the variance in fetal Σ DDTs (multiple $R^2=0.95$). On a TEQ basis, the variance of fetal TEQ was explained by maternal TEQ, fetal percent lipid and maternal length with fetal age also retained in the model (multiple $R^2=0.92$). These results demonstrate that substantial organochlorine burdens, especially DDTs, are transferred from female sea lions to their fetuses across the placenta.

Assessing Changes in the Diet of Grey Seals in the North Sea Over Two Decades

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There is much debate about the state of North Sea fish stocks, especially cod, of which the grey seal is a major predator. Grey seal diet in the North Sea was last studied comprehensively in 1985, when commercial fish stocks were much larger than today, and the grey seal population much smaller. There is therefore great interest in obtaining current estimates of grey seal diet to assess their impact. We applied experimentally derived correction factors (to account for partial and complete digestion) to >105,000 fish otoliths and cephalopod beaks recovered from 1,740 grey seal scat samples collected from around the North Sea in 2002, and estimated grey seal diet composition and consumption of commercially important fish species. We also re-analysed the 1985 data using the new correction factors. As in 1985, grey seal diet varied both regionally and seasonally in 2002. Gadoids and sandeels dominated the diet in all seasons and regions except for in the southern North Sea, where benthic fish prey were also important. Overall, despite the decline in North Sea cod stocks (SSB = 117,996 tonnes in 1985, 39,153 tonnes in 2002) individual grey seals consumed the same amount of cod in 2002 as they did 20 years ago (0.72 kg cod per seal per day in 1985 compared to 0.64 kg in 2002). Similarly, 2.50 kg sandeels were consumed per seal per day in 1985 compared to 2.55 kg in 2002. However, in 2002, the North Sea grey seal population consumed the equivalent of 28% of cod catches and 9% of sandeel landings. This is in contrast to 1985 when consumption was equivalent to 3% of both cod catches and sandeel landings. These differences in annual consumption arise because the size of the North Sea grey seal population has more than trebled in the last two decades. Implications for the recovery of cod stocks in the North Sea will be discussed.

Distribution of Cetaceans in and Around the Moray Firth Special Area of Conservation (Scotland)

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Studies of distribution are necessary to protect and manage vulnerable populations and to designate Marine Protected Areas (MPAs). The Moray Firth Special Area of Conservation (SAC), the largest MPA in

the UK, was established to protect a small and isolated population of bottlenose dolphins. However, surveys have only covered a small portion (190 km²) of the SAC (1,513 km²) and have been mainly coastal. Higher effort in near shore areas may have biased the understanding of this as a coastal species. Better information on the distribution and relative density of bottlenose dolphins and other cetaceans in the Moray Firth is therefore required to support integrated coastal zone management of the SAC. To address this issue, simultaneous visual and passive acoustic surveys of the Moray Firth were conducted in 2004 and 2005 to identify the distribution of cetaceans. The surveys covered a distance of 3,040 km (area 1,506 km²) over 236 hours. Data were analysed within 4 km² grid cells in relation to depth, slope, seabed sediment type, sea surface temperature, salinity and distance to shore. Bottlenose dolphins mainly occurred within the coastal fringes (<10 km from the shore), further indicating the importance of inshore waters for this population. Harbour porpoises were the most frequently sighted species, occurring throughout the survey area. Minke whales were only found in depths > 20m and were in similar areas to harbour porpoises. The results highlight the importance of the SAC and outer Moray Firth as a habitat for three cetacean species but indicate that species distribution patterns vary within this area. These findings are discussed in relation to spatial variations in likely anthropogenic impacts and current efforts to mitigate their threats.

Movement Patterns of Atlantic Spotted Dolphins (*Stenella frontalis*) and Bottlenose Dolphins (*Tursiops truncatus*) in Relation to Oceanographic Fronts

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Frontal systems are important areas for aggregation of potential dolphin prey or increased secondary productivity. If high prey densities are associated with frontal boundaries, then dolphins probably travel or selectively forage with reference to these oceanographic boundaries. We conducted group follows of Atlantic spotted dolphins (*S. frontalis*) and bottlenose dolphins (*T. truncatus*) over a five-year period, and used circular statistics to examine relations between short-term dolphin movement patterns and oceanographic features. Sea surface temperature (SST) and ocean color data were combined with the dolphin survey data, providing synoptic views of oceanic phenomena at both high spatial and temporal resolutions. When analyzed by seasons (warm=June-October; cool=November-May), *S. frontalis* travel headings and SST/Chl frontal vectors were not uniformly distributed. During cool season, mean animal travel vectors trended in a north/south direction, and did not significantly differ from SST frontal vectors, while differing from Chl frontal vectors. During the warm season, the mean animal travel vector trended in an east/west direction, and differed from both Chl and SST frontal vectors. Conversely, *T. truncatus* travel vectors were uniformly distributed in all seasons, and mean vectors significantly differed from both types of oceanographic fronts. In earlier work, we have found differences in habitat use of these two species. Species differences in travel relative to oceanographic features may reflect differences in foraging strategy. Seasonal differences in *S. frontalis* travel vectors shed light on seasonal density variation previously found in this species. *S. frontalis* may remain in nearshore waters for long-term foraging during winter, while making shorter term forays into nearshore waters during summer. Use of alternate survey techniques for *S. frontalis* may be advised to take advantage of seasonal variation in movement patterns.

Creatures of Habit? Inter-Annual Site Fidelity in the Pacific Harbor Seal (*Phoca vitulina richardii*)

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Haul-out space is an important and possibly limiting resource for harbor seals in urbanized estuaries such as the San Francisco Bay (SFB). Seals are generally considered to exhibit high site fidelity to established haul-out sites, and when assessing population status in impacted areas like SFB, it is important to understand patterns of local seal use of such sites. Using a combined approach including vhf telemetry (2001-2005) and visual resightings of tagged and naturally-marked seals (1998-2005), we assessed inter-annual site fidelity and haul-out duration of seals at Castro Rocks (CR), a major SFB haul-out and pupping site. Site fidelity and haul-out duration of tagged seals varied widely, with 41% of seals using CR on more than 50% of days tagged, and 24% using CR on more than 90% of days tagged. When CR was used as the primary haul-out site, mean time spent hauled out ranged from 4.39 ± 0.47 hrs/day to 9.68 ± 0.72 hrs/day. Of 6 seals (4 males, 2 females) tagged as weaned pups at CR in 2001, one female was resighted until 2005, and one male was resighted until 2003. Three of four females tagged as weaned pups in 2002 were resighted in 2005, and one female tagged as a yearling in 2001 was sighted with a pup in 2005. These resightings suggest at least some natal site fidelity in these animals, although resighting rates of male weaned pups tended to be lower, with only 2 of 6 males resighted at CR more than one month post-tagging. Resightings of naturally marked animals indicate that seals may continue to use CR for at least 8 years. These results confirm site fidelity by harbor seals in SFB; duration of time hauled out at CR each day may be limited by availability of this low tide site.

Characterization of Epidemic *Klebsiella pneumoniae* Isolated from New Zealand Sea Lions in 2002 and 2003 and Its Serological Prevalence in the Population

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Epidemics among New Zealand sea lions on the Auckland Island in the 2001/02 and 2002/03 breeding seasons resulted in a dramatic increase of pup mortality (up to 50%). Tissue and serum samples were collected for bacteriology and serology during the post mortem examinations in the field. The bacterium consistently isolated was a gram negative rod, growing as lactose-fermenting mucoid colonies on MacConkey agar. *Klebsiella* isolates were purified to be subsequently identified phenotypically with miniaturised MICROBACTTM test kits and were finally frozen at -80°C for future reference. Frozen isolates were randomly selected from various tissues from sea lions that died during the epidemics, and also from animals that died in subsequent seasons, for fingerprinting by a molecular genomic analysis using pulsed-field-gel-electrophoresis (PFGE). Two *K. pneumoniae* human isolates and a few *K. oxytoca* isolates from sea lions were processed for comparison by PFGE. We also tested clonality by determining Minimum Inhibiting Concentration (MIC) patterns for isolates to look for evidence of antibiotic resistance that may suggest a human source of infection. The results from PFGE and MIC tests established that the bacterial isolates were all clonal between years and did not show antimicrobial resistance. Therefore the anthropogenic source could neither be ruled out nor confirmed. Lastly, to determine the prevalence of infection in the New Zealand sea lion population as a whole, we are developing a serological test based on Western blotting that can be used on archived frozen sea lion sera collected over the past 7 years and for future samples. Such a serological screening for anti-*Klebsiella* antibodies will indicate whether this pathogen has recently entered the population as seems likely or if it is a widespread commensal that was present prior to 2001 causing outbreaks under unusual circumstances.

Right Whales (*Eubalaena australis*) off Southern Brazil:

Annual and Seasonal Patterns of Occurrence, Site Fidelity and Group Structure

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Southern right whales (*Eubalaena australis*) in Brazil were historically distributed from northeastern to southern coast, but intensive commercial whaling held until 1973 almost extirpated whales from the region. From 1986 through 2003 we conducted aerial surveys off southern Brazil primarily for photo-identification of the remnant population. A standard 120Km coastline between Santa Catarina Island ($27^{\circ}25'S, 48^{\circ}30'W$) and Laguna ($28^{\circ}36'S, 48^{\circ}48'W$) was always surveyed. 481 whales (223 groups) were sighted in 16 surveys during peak whale abundance. Groups consisted mostly of two whales (67.3%, $n=150$); groups of up to 8 whales were sighted. 149 sightings were mother/calf pairs; 183 were unaccompanied whales. Whales concentrated between Garopaba and Araranguá (peak in Laguna). Distribution of mother/calf pairs and unaccompanied whales differed, though not supported statistically (Mann-Whitney $U=71.5$, $z=0.301$, $p=0.763$, $n_1=11$, $n_2=14$). Because unequal survey coverage and irregularity throughout the period, we compared cumulative density of whales/bin (12 minutes latitude long) between blocks of years with similar survey coverage and approximate date of flight to verify tendencies on distribution. Within-season distribution was described after monthly surveys conducted between July- November 2002 and 2003. Whales arrived in July/August, reaching peak in September, declining in October/November. 39 non-calf whales provided information on intra-annual resighting patterns. 31 whales were resighted inter-annually at least once (sighting interval: 1-10 years). 71% occurred in 2003 (none before 1994). 93.5% ($n=29$) were resighted once. From 120 females identified in Brazil, 19.2% ($n=23$) have shown some level of site fidelity. 82.6% ($n=19$) were in calving years. 3.4% ($n=8$) of the 149 unaccompanied whales have been resighted (one-year modal interval). Distribution was not uniform, indicating specific areas as important wintering habitat for this recovering species. Survey effort varied, but patterns of distribution are identified. Distribution of mother/calf pairs and unaccompanied whales is somewhat overlapped, but a major concentration area was identified, especially for mother/calf pairs, which coincides with previously recognized aggregation area off Brazil.

Pathological Changes on Vertebrae of a Humpback Whale (*Megaptera novaeangliae*) Stranded in Brazil

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The study of vertebral abnormalities in cetaceans is a challenge since multiple conditions may share similar features and diseases can occur concomitantly making diagnoses and nomenclature still a topic of discussion with no current consensus. Diagnosis of a disease found in cetacean skeletons should be accompanied by a comprehensive description of the abnormality(ies) to allow for better interpretation in comparative studies. The objective of this work is to describe pathological conditions found in the axial skeleton of a 13.7 meters long humpback whale (*Megaptera novaeangliae*) stranded in southern Bahia State ($17^{\circ}47'S, 39^{\circ}07'W$), Brazil. The specimen was found floating close to shore, then towed by a boat and buried in sand. After three years, the bones were recovered and had the remaining soft tissue removed. The skeleton was grossly examined for bone abnormalities. The specimen presented irregular and exuberant bony excrescences on the vertebral bodies of six caudal vertebrae (Ca6 to Ca11). These bone outgrowths were present on the whole circumference of the vertebral bodies, except on Ca11 where this abnormality was only found on the left side. Three of these vertebrae (Ca7 to Ca9) and two chevron bones were ankylosed. There was severe

erosion with destruction of normal features of vertebral epiphysis of Ca10 and Ca11. In the cervical region, three vertebrae (C2 to C4) presented non-marginal sindesmophyte formation on the right side of the vertebral bodies leading to ankylosis of C3 and C4. The lesions found in the six consecutive caudal vertebrae indicate that a progressive chronic condition was present. Severe discopathy was evident in at least one intervertebral disk. Tentative diagnoses include infectious spondylitis and spondyloarthritis. The lesions found may have had deleterious implications on the general health of the animal, as well as compromising spinal mobility.

Manatee Directional Response to Sound: Behavioral Patterns Elicited to Audible Sound Frequencies May Be Related to the Interactions Taking Place Between Different Manatee Pairs

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Over a 3 year period our group has been studying swimming activities and positive avoidance responses (PVR, i.e., moving away from the transducer producing the sound) in 4 pairs of captive manatees, housed at the Cincinnati Zoo, to learn why they are killed in boat collisions. We have demonstrated significant PVR in the Stoneman ($p=0.01$) and Douglas ($p=0.035$), $n=208$, pairing when they were exposed to audible mixed frequencies of sound (10 kHz, 15 kHz, 2 Hz) but not when they were exposed to ultrasonic mixed frequencies (25 kHz, 35 kHz, 2 Hz). In other pairs studied Stoneman was always the common animal, but other males were rotated through the Cincinnati Zoo under the direction of the USF&WS (the order of pairing was Stoneman with: Douglas>Dundee> Hurricane >Rodeo). Significant PVR was not observed when Stoneman was paired with any of these other animals, nor was there any significant PVR observed in these other partners, but Stoneman's individual directional patterns (vector) of movements clearly varied due to the partner he was housed with ($p=0.0000002$). Regarding swimming activity, measured as the number of tank quadrants (QT) traversed, Stoneman's behavior changed as a result of different manatee pair interactions. Stoneman/Douglas pairing: Stoneman (5.4 QT) vs. Douglas (3.5 QT) ($p=0.0000005$, $n=238$). Stoneman/Dundee pairing: Stoneman (3.69 QT) vs Dundee (2.54 QT), $n=61$; Stoneman/Hurricane pairing: Stoneman 4.97 QT) vs Hurricane (6.62 QT), $n=143$; Stoneman/Rodeo pairing: Stoneman (3.08 QT) vs Rodeo (4.84 QT), $n=46$. We hypothesize that the dominant animal in the pairing demonstrates reduced QT when compared with the submissive animal. This trend held for Stoneman/Douglas, Stoneman/Dundee and Stoneman/Rodeo. It does not hold for Stoneman/Hurricane because Hurricane was ill and highly agitated (and thus removed by USF&WS). This trend is also supported by the changes in Stoneman's vector pattern of movement which varied significantly when he was paired with other animals.

Determining the Significance of Radiographic Evaluation of Flippers in Age Estimation of the Florida Manatee (*Trichechus manatus latirostris*)

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A novel roentgenographic classification is presented for use in age determination of the Florida manatee (*Trichechus manatus latirostris*).

This staging system is based on Ogden et al. 1981, which describes a scheme for estimating skeletal maturity in cetacean forelimbs. In this project, we applied this method to the manus (carpal bones and phalanges) of the Florida manatee. A total of thirty-one, known-age flippers were radiographed for application of the Ogden classification. Radiographs were analyzed by measuring the length of the epiphysis of the distal metacarpals III to V, and compared in a percentage to the length of the metaphysis to which it was to fuse. This was also done in the proximal epiphysis of the proximal phalanx (P1) for digits 3 and 4. Each distal epiphysis of metacarpals III to V, and the proximal epiphysis of phalanx 1, in digits 3 and 4 was given a grade of 0 (no secondary ossification center present) up to a grade of 6 (closure of the physis with a scar visible in < 50% of the bone). Our preliminary data suggests there is a significant correlation between ear bone age and roentgenographic classification. Therefore, we present a possible method for aging live Florida manatees. Radiographic analysis of physis closures in the flipper may prove to be important in revealing life history traits necessary for the study population biology. These results suggest that we may be able to obtain age-specific information previously not available for live Florida manatees.

Diurnal Vocal Activity of Gray Whales in Laguna San Ignacio, BCS, Mexico

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Three sets of portable horizontal acoustic arrays were deployed during a week in February 2005 to gather acoustic recordings of gray whales (*Eschrichtius robustus*) in Laguna San Ignacio, one of the three major breeding/calving lagoons in Baja California, Mexico. These arrays, which were constructed by attaching a pair of autonomous flash-memory acoustic sensors to a rope, were deployed on two occasions for 36 consecutive hours. The deployments covered the narrowest point of the lagoon near Punta Piedra, the area of the highest concentration of whales. Additionally a single hydrophone was deployed off a small boat to record during "friendly" encounters with single whales and cow/calf pairs. Each recorder's time series was analyzed for the presence of Type 1 gray whale sounds (called "pops"), which are broadband pulses that have substantial acoustic energy between 100 and 600 Hz. Two automated detection methods from the software package ISHMAEL were used: spectrogram correlation with a synthetic kernel, and energy detection in a specific frequency range, once a spectral estimate of the background ambient noise levels had been subtracted. The number of automated acoustic detections was then manually checked to correct for biases in the automated analysis. Finally the corrected number of detections per hour was compared with lagoon census data estimated by two visual surveys conducted by scientists of the Autonomous University of Baja California Sur, La Paz. Preliminary results from several automated analyses of both the bottom-mounted and boat-deployed recordings will be presented, with indications of potential diurnal patterns in vocal activity.

Fluke Scarring to Determine Anthropogenic and Predatory Interactions of Sperm Whale Populations

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Degree of fluke marking/scarring on sperm whales may vary between regions depending on type and abundance of predators; therefore, it may be a good indicator of population discreteness and may provide insights into life experience of sperm whales. However, to date, few consistent differences in marking/scarring were found among populations. To investigate whether sperm whale populations with different environmental and anthropogenic pressures can be distinguished by amount of marking, we compared two populations inhabiting different oceans. Data were collected in the Sea of Cortez (SC) in 2002-2003 and in the Gulf of Mexico (GoM) in 2002-2004, using photo-identification. Sixteen different mark types were identified on the flukes, for 12 of them the number for each type (*i.e.*, scallops, nicks, holes) was counted for each individual, and for the other four, only presence/absence (*e.g.*, missing portions) was recorded. Differences between populations were investigated using discriminant analysis and two-sample hypotheses test. In the GoM, 171 individuals were identified, and we randomly chose 171 individuals from the 297 identified in the SC. There were significant differences in the occurrence of 7 of 12 marks ($F_{12,329}=13.38$, $p<0.001$), and 2 of 4 presence/absence marks ($p<0.05$). In the GoM, individuals had significantly more holes (30% vs 9%), more missing portions (34% vs 21%), but fewer scallops (52% vs 87%) than in the SC. In the GoM, the large amount of boat traffic may be responsible for the increased proportion of missing portions, and a higher proportion of cookie cutter sharks (*Isistius* sp.) may relate to the larger number of holes. Sperm whales in the SC may be subjected to higher predation by sharks, killer whales and other odontocetes, resulting in more scallops. Therefore, the substantial differences in markings between these populations may reflect habitats with significant differences in anthropogenic- and predator-caused scarring.

Skull Morphometrics of Three Killer Whales (*Orcinus orca*) Stranded in the Gulf of California, Mexico

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Questions regarding evolutionary relationships and species delineation have stimulated molecular and ecological studies, but in order to give significant insights into phylogeny they need to be carried out along with paleontological, anatomical, physiological, and genetic studies. We present the first report of skull, teeth and periotimpanic bone measurements, from three stranded killer whales (*Orcinus orca*) in Mexican waters. Killer whales are widely distributed along the Pacific coast of Mexico, although they are occasionally seen in some areas. In 31 July 2000, eight killer whales stranded alive at the southern tip of Isla San José, in Bahía de La Paz (24° 54.0 'N; 110° 35.6 'W). The group consisted on an undetermined number of females, immature males, and two calves. The skulls were collected between August and October 2000 and were catalogued as MHNUABCS-0043, 0042 and 0041. They were measured according to Perrin (1975) methods. The recorded condylobasal lengths were of 88, 85 and 84 cm, respectively; while the recorded widths of the rostra at base and the greatest postorbital widths were of 25, 25 and 20.5 cm, and of 54.5, 51.5 and 48.5 cm, respectively. Skull anatomy is a prime basis for cetacean taxonomy and skeletal morphology has also being used in studies of population discrimination. Nevertheless, there are not many comprehensive comparative accounts describing the skulls of killer whales, and the lack of this type of information mainly resides in the low tendency of the species to strand. The next step of this study will be to compare these skulls measurements with others from U.S. and Canadian museum collections in order to define the population identity of the killer whales that inhabit Mexican waters.

A Comparison of Maternal Attendance Patterns on Two Steller Sea Lion (*Eumetopias jubatus*) Rookeries in Russia

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Attendance patterns of Steller sea lion adult females with pups were observed during the summer reproductive period (late May to late July) on two Russian rookeries. The first, Antsiferov, belongs to the Kuril island - Sea of Okhotsk group of rookeries with stable populations. The second, Medny, is a population on the Commander islands associated with the western Aleutian island stock that has been showing similar signs of decline in recent years. During daylight hours presence and absence of animals identified by brands, plastic tags and natural markers was recorded every half-hour, as were departures and arrivals when observed. From these observations, trip and visit lengths are estimated and analyzed according to several variables: island, time of day, age of mother and days since parturition. Sea lions from Medny were found to depart earlier in the day, to take significantly shorter foraging trips than on Antsiferov, and to show less seasonal change in behavior or trends according to age. On Antsiferov, data was more variable in general, with trip durations increasing and visit durations decreasing as pups aged. Trends against age of mother were also stronger on Antsiferov, where older mothers take shorter trips and spend longer times on the rookery. In all, mothers from Medny spend on average 19% of their time away from the rookery while mothers from Antsiferov spent some 35% of their time away. These counter-intuitive results indicate that there are significant qualitative differences in the nature of the foraging base between these two islands and that it is therefore difficult to verify a hypothesis that nutritional stress driven population decline might be reflected in foraging patterns on geographically disparate rookeries.

Variation in Weaning Strategies Utilized by New Zealand Fur Seal Pups

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Maternal provisioning in otariids has been described based on differences in maternal attendance patterns; however, there has been little focus on offspring and how maternal provisioning strategies may effect weaning. During a three-year study investigating weaning in New Zealand fur seals (*Arctocephalus forsteri*), six behavioural weaning strategy groups were identified during late lactation using a Bray-Curtis similarity matrix and hierarchical clustering analysis. These groups were separated based on maternal provisioning behaviour (foraging trip durations, shore attendance, proportion of time ashore and post-weaning haul-out) and pup utilization of maternal presence (missed suckling, difference in attendance and timing of weaning). Behavioural groupings demonstrated significant variance in the timing of weaning between groups. Earliest weaning was evident in groups where females demonstrated shorter foraging trips, a higher proportional time ashore and pups utilized less maternal presence. GLM was used to investigate the influence of measured maternal and pup parameters on the timing of weaning and was found to account for 57% of variance in weaning date. Analysis from this study indicates that the greatest influence on the timing of weaning are factors that have a greater influence on pup size, potentially allowing bigger pups the capacity to allocate more time and energy into developing the behavioural skills required for independence. Variation in weaning dates within and between years suggests flexibility in maternal provisioning behaviour that may accommodate interannual variation in pup requirements, potentially influence by environmental variability. The apparent differences between pups in utilization of maternal presence suggests varying levels of behavioural independence during the weaning process and the combined interactions of maternal

provisioning and pup dependence are indicative of weaning strategies.

Depredation by Bottlenose Dolphins on Gill Nets in Dare County, North Carolina

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It is well documented that many kinds of fishing operations have impacts on marine mammals. Because many species of marine mammals prey on the same kind of fish that are targeted by commercial fishing operations, most coastal marine mammals around the globe have some type of interaction with fisheries. For many marine mammal populations, mortality from fisheries bycatch poses a high risk. But there is disagreement over which factors may or may not put a species at risk of depletion or extinction, and this disagreement hinders important management decisions. In North Carolina, gill net fishermen have observed bottlenose dolphins taking fish directly out of their nets, a behavior termed "depredation", and report that this behavior occurs more frequently each year. Attempting to feed on the caught fish may increase the chances of a dolphin becoming entangled in nets. However, these claims are not well documented. During February and March 2002, I surveyed one hundred and twelve gill net fishermen, primarily concentrating on Dare County, North Carolina, where most instances of dolphin bycatch in gill nets occur. Results describe the extent to which depredation occurs on gill nets in this area, as well as whether gill net fishermen in this area perceive an economic loss from this activity and if they believe depredation could lead to entanglement. Depredation levels on gill nets in North Carolina were previously undocumented. The results of this project target many different audiences including fishermen, scientists, and managers. Assessing previously undescribed local levels of dolphin depredation, as well as identifying which fishery is most affected by this activity, is significant because of the different policy implications for future management. Ways in which these results have been utilized in recent management decisions, how this project has led to additional scientific research, and suggestions for further investigation, are identified.

Alternative Mating Strategies Followed by Different Individual Male Humpback Whales

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Male terrestrial mammals (e.g., rhinos, bison) associate with females of different reproductive potential depending on the male's ability to compete. Craig *et al.* (2002) demonstrated that male humpback whales in general show a preference for escorting females without calves over females with calves; females without calves have the greater reproductive potential. We hypothesized that individual males would not randomly associate with calf and non-calf groups, and that two subsets of males would prefer different mating strategies: one would choose females without calves and the other would choose females with calves. We examined the association patterns of 110 individual males from a dataset of 2,551 groups containing two or more adults on the Hawaiian wintering grounds that were surveyed between 1996-2001. Analyses revealed that (i) males seen initially as escorts in non-calf competitive groups were sighted in non-calf competitive groups again, a second time, significantly more often than would be expected by random association ($P < 0.05$), (ii) males seen initially as the solitary escort in calf groups were sighted again in that role significantly more often than would be expected by random association ($P < 0.05$), and (iii) males seen initially as escorts in calf competitive groups were as likely to be sighted in non-calf groups as calf groups on their second sighting. Inasmuch as other data show that groups associated with non-calf females are, on average, significantly larger, and hence more competitive, than groups associated with mothers, our data suggest different reproductive strategies: some males may choose to associate preferentially with

females of higher reproductive potential (no calf) but at a greater competitive cost, while others may choose to associate with females of lower reproductive potential (with calf) at a lower competitive cost.

Salmon Fishery Related Mortality Estimates of Harbour Porpoise in British Columbia

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Harbour porpoise (*Phocoena phocoena*) suffer incidental mortality in commercial fishing gear throughout their range. Successful conservation therefore requires both biological research and a cooperative relationship with commercial fisheries. Though the British Columbia (BC) coast represents a substantial portion of the eastern North Pacific habitat, few studies have examined this species biology, ecology or fisheries interactions. The goal of our study was to provide the first quantitative estimate of the level of harbour porpoise incidental mortality in the BC salmon fishery. Data were collected directly and indirectly through the Federal Fisheries Observer Program and a license holder questionnaire (n=979). We included all commercial gill net, seine net and troll fisheries operating in southern British Columbia coastal waters from 1997 to 2001. Requests for bycatch information yielded a 27.6% return rate, with respondents also documenting other previously unreported cetacean by-catch events (n=87) dating to the 1950's. Observers in two licensing areas (5% coverage per area) reported four single phocoenids incidentally caught in gill nets within one-month. Mortality was 50%. Harbour porpoise were observed near fishing gear by almost half of all respondents, with 11.7% (n=14) reporting a gill net entanglement event. Ten of the 19 entangled porpoise were alive and successfully released. Effort-based extrapolations and Poisson distribution estimates of entanglement were determined. Annual mortality estimates ranged from 11 – 102 individuals. Recommendations to reduce incidental catch and increase live release rates were classified in four categories - gill net fishery modifications, observer training, rescue and release protocols and biological research. Area closures or implementation of acoustic net alarms were not recommended due to the regionally poor understanding of harbour porpoise ecology and risk of habitat degradation. Mitigative efforts that emphasized industry collaboration and refinement of existing experimental fishing techniques were deemed the most promising for a province-wide reduction of harbour porpoise incidental mortality.

The Role of Leptin in Marine Mammals: Regulation of Fat Stores and Respiratory Physiology

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We have found mRNA expression of the hormone leptin in the lung tissues of mature grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals, as well as the in the blubber and bone-marrow. A seal-specific antibody confirmed the presence of the protein. The role of leptin in the long-term regulation of body weight in terrestrial mammals is well recognised and it may play a similar role in pinnipeds. However, its function in the stretch-induced signalling pathway for the production of pulmonary surfactants during development has only been established in the rat foetus. We suggest that leptin is produced in the lungs of seals in response to the pressure changes experienced during diving. Alveolar type II cells secrete surfactants to keep the alveoli open during expiration. In foetal rat lung leptin mediates the paracrine effect of parathyroid-hormone-related protein (PTHrP) on this secretion. It seems likely that seals, unlike other terrestrial mammals, retain the ability to secrete leptin throughout

life to maintain the rapid turnover of surfactants required for re-inflation of the lungs following their collapse during dives. PTHrP expression was also found in seal lung, which corresponds with this hypothesis. The amino acid sequence of phocine leptin differs from other carnivore leptins in regions normally highly conserved. However these differences are unlikely to have a functional effect. We have also cloned and sequenced a 336 bp region of the leptin gene from harbour porpoise (*Phocoena phocoena*) blubber. This fragment is identical to a published beluga whale (*Delphinapterus leucas*) fragment and has the highest degree of amino acid identity to the pig (98.89 %) with 87.5% identity to human and only 64.44% to the grey seal. It is likely that porpoise leptin is also involved in body weight regulation and studies of its role in respiratory physiology are ongoing.

Whale Watching in Trans-Boundary Waters: A Cooperative Approach

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Cetaceans are the center of a relatively new, non-consumptive industry that unlike other fisheries has little historical basis for conservation or management. Whale watching has evolved from sporadic serendipitous encounters to the regularly scheduled departures that now occur in the coastal waters of every continent. Our goal was to provide a synopsis of the first international cooperative effort between resource managers, scientists and the whale watchers that operate in the inland waters of British Columbia and Washington. These trans-boundary waters provide core habitat for the southern resident killer whale (*Orcinus orca*) population. This closed population is small ($n < 100$), considered "At Risk", and is central to the success of the whale watching industry. More than 60 vessels operate from US and Canadian ports with the goal of watching these whales. The unique trans-boundary aspect of the region prompted local operators to form the Whale Watch Operators Association Northwest (WWOANW) in 1994. The WWOANW framework was based upon on a principle of open exchange and provided a platform for communication between government managers, research scientists, enforcement authorities and commercial operators. This integrative approach resulted in significant conflict reduction between competing interests (e.g. researchers, commercial operators etc) and improved organization of vessels engaged in whale watching. Further achievements include increased rigor of whale watch guidelines specifying spatial, behavioural and species-specific operating procedures. Conservation-oriented results included voluntary exclusion zones contributing to vessel-free areas. The WWOANW framework also provides an avenue for financial and in-kind contributions to trans-boundary research projects. From this, we conclude that the collaborative process supplied the incentive for significant industry modifications that resulted in noteworthy conservation actions. The WWOANW framework is dynamic and iterative, and it is hoped to provide a reference for other whale watch operators, and the managers responsible for the conservation of coastal cetaceans.

Predictive Habitat Modeling of Marine Mammals: Combining Archival Observations with Remotely-Sensed Oceanographic Data

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Predicting expected habitat areas of marine mammals is critical for many emerging conservation and management planning activities. The development of empirical models based on the largest observation sample sizes and longest periods of time possible offer the best available solutions to satisfy this need. In this analysis, individual observations from more than 30 large aerial and ship borne survey datasets covering the United States Atlantic coast and Gulf of Mexico were spatially and temporally referenced with a suite of environmental predictor

variables derived from bathymetric and satellite derived oceanographic data. Environmental predictors were both directly sampled from satellite data, such as sea-surface temperature (SST) and chlorophyll, and depth as well as derived products, such as slope and distance from shoreline, shelf break, SST fronts and chlorophyll aggregations. The marine mammal survey data were collected by NOAA Fisheries Science Centers and individual researchers and cover the early 1990's to the present. The datasets were processed and collated through the OBIS-SEAMAP program (<http://seamap.env.duke.edu>) for this analysis. Multivariate statistical models (CART, GLM, GAM, Bayesian approaches) were developed and tested to estimate species habitat usage areas for 17 guilds of marine mammal species in the two study regions. These habitat models were then evaluated for their efficacy and robustness as applied to past, current or future oceanographic conditions. Post-hoc model evaluation methods, such as the application of Receiver-Operator Characteristic (ROC) curves are evaluated to provide model users with additional tools for more appropriately relating model choices to specific management applications.

Nursing Duration and Frequency in Determining Steller Sea Lion Weaning

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Some simple components of Steller sea lion biology, such as timing of weaning, are not well understood but are critical for understanding the causes of population recovery or decline. This study focuses on whether time of day, season, age and sex of nursing individuals affect nursing duration and frequency. I focused on weaning time for Southern Oregon Steller sea lions by recording pup (under 1 year old) and juvenile (1-3 years old) nursing durations through the winter, spring, and summer months of 2005. Research was conducted at Sea Lion Caves located 11 miles north of Florence, Oregon. To monitor nursing duration, I randomly selected marked individuals, and observed them for a period of 40 minutes to detect nursing behavior. Individuals were observed until the nursing bout ended, even if this was longer than the given 40 minutes. The population's nursing frequency was monitored by scan samples every hour to determine the total number of pups nursing at specific times. Through multivariable analysis I found that neither sex (p -value=.7323), time of day (p -value=.2032), or month (p -value=.1875) had any significant effect on duration. The average nursing duration for male and female pups was slightly different, 16.28 and 14.38 minutes respectively, but statistically insignificant (p -value=.7196). These nursing durations were lower than previously recorded durations in Alaska. Both month and time of day had a statistically significant effect on nursing frequency (p -values<.0001). Peaks in nursing frequency were observed at 09:00, 12:00, and 16:00. The percent of nursing individuals peaked in January and March and has continued to decline through spring and summer. This suggests that Steller sea lions wean their young in late spring. Further research should focus on marking offspring and mothers together to better understand the effects of migration of mothers to rookeries on nursing behavior and weaning.

The *Platanista* Conundrum: Remarkably Low Mitochondrial Diversity in Geologically Disjunct Populations

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The monotypic genus *Platanista* is one of the most ancient and unique among extant mammalian lineages. Two recognized subspecies of this obligate freshwater dolphin inhabit disjunct river basins, the Ganges river dolphin *Platanista gangetica gangetica* in India and Bangladesh, and the Indus river dolphin *P. g. minor* in Pakistan. These two basins have been distinct for millions of years, except for

mountain tributary shifts associated with Himalayan tectonics. Gene flow between the Indus and Ganges populations has therefore been limited, presumably leading to morphological and molecular divergence. However, morphological comparisons fail to conclusively support separate species status. We present the first comparison of intragenomic molecular diversity in *Platanista*, based on published sequences for four mitochondrial genes and two new *P. g. minor* samples. The new Indus samples were sequenced for comparison with an 858bp control region (CR) fragment from 14 published *Platanista* sequences, and a 786bp cytochrome *b* fragment from 22 published sequences. For both CR and *cytb*, nucleotide diversity is a strikingly low 0.002, an unexpected result given *Platanista*'s long evolutionary history and vast geographic range. Only 6 polymorphic sites are found in the 16 CR sequences, defining a single *P. g. minor* haplotype and three *P. g. gangetica* haplotypes differing by just 1-2bp. The CR distance (D_{xy}) between sampled Indus and Ganges dolphins is a negligible 0.005. The 24 *cytb* fragments defined 5 haplotypes, differing by single base transitions. The genetic distance between Indus and Ganges *cytb* sequences is only 0.004. The few 12s and 16s sequences show a similar pattern of extremely low variation within and between basins. Given the highly threatened status of *Platanista* throughout its range, we urge local biologists to further investigate this surprisingly low mitochondrial diversity that is difficult to reconcile with the evolutionary history and geologic setting of this unique freshwater dolphin.

DIGITS: Digital Image Gathering and Information Tracking System. Software to Process, Match and Track Digital Images and Data for Individual Identification Studies

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The advent of digital photography has required a substantial change in the way photo-identification data are stored and retrieved. Although some researchers have incorporated automated recognition software to facilitate the matching for some species, other species do not have identifying features that are compatible with such software. With support from the National Science Foundation, the New England Aquarium has developed new software to manage all aspects of the data and images in the North Atlantic right whale catalog. This application uses a coding system to describe many of the matching features and is designed to be adaptable for any photo-identification study that uses some form of identification codes. The application was built using the MS .Net framework and MS SQL Server database so that it would perform well with large digital images in low bandwidth network environments. Named DIGITS, it 1) is server based and allows for multiple users to manage images and data remotely using password protected access, 2) allows for digital images to maintain their initial filenames which are referred to in field data, thereby maintaining the link between field data and electronic data, 3) allows for complex searches of whales with similar attributes and presents them side-by-side, 4) automates the majority of the data entry required when animals are matched and confirmed, and 5) provides screens to perform annual scarring and health assessments of whales. The system has increased the speed and efficiency with which the North Atlantic right whale population can be effectively monitored. The software is available from the New England Aquarium free of charge, though some cost would be required to modify it for a different species and/or another database structure.

When Are There Too Many Harp Seals?

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The northwest Atlantic harp seal (*Phoca groenlandica*) population has been exploited commercially since the 1700s. Over the last 300 years, total abundance has fluctuated markedly, due to changes in harvesting pressure. After the second world war, an increase in

harvesting, resulted in a decline of the population to a minimum of 1.75 million animals by the 1970s. Conservation measures and market changes allowed the population to increase to almost 6 million animals by 2004, making it the most abundant pinniped in the North Atlantic. With such large changes occurring in the population, density-dependent processes would be expected to operate at various levels. An analysis of harp seal body growth in the 1990s, when the total population was estimated to number around 4.2 million showed that animals wintering in the Gulf of St. Lawrence were smaller and in slightly poorer condition compared to animals sampled in the 1970s (Hammill *et al.* 1995. Can. J. Fish. Aquat. Sci. 52: 478-488). Since then the total population has increased by about another 40%. Changes in body growth and condition of harp seals (N=336) were re-examined using a Gompertz growth curve and a condition index. Further declines in body size and condition were expected. However, the analyses indicate that there has been little change in body growth parameters and condition indices of harp seals in the Gulf of St. Lawrence component of this population since the last study. In the early 1990s, overfishing lead to important structural changes in the northern Gulf of St. Lawrence ecosystem, from one dominated by large long-lived piscivorous groundfish towards a system dominated by planktivorous pelagic fish and invertebrates. Such changes may have been favourable to harp seals wintering in the Gulf of St. Lawrence.

What's a Marine Nose For? A Comparison of the Structure and Function of the Sea Otter Nasal Cavity with Those of Terrestrial Mammals

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Nasal anatomy and olfactory sensitivity were measured in the sea otter, *Enhydra lutris*, and compared with those of eleven terrestrial mammals. Nasal cavities were scanned by CT and sectioned for light microscopy. Using measurements from scan and histological sections, nasal cavity morphometry was compared among species. Olfactory sensitivity for seven odorants was also measured in two sea otters. Animals were trained using operant conditioning to distinguish and report an odorized or odorless stimulus produced by an air-dilution olfactometer. A descending staircase protocol was used to determine the absolute detection threshold for each stimulus. Sea otter nasal morphology is consistent with its evolutionary history (Arctoidea) and its presumed respiratory heat exchange requirements. The cavity is a high resistance airway and contains a novel structure not found in the other mammals examined. The sea otter nasal cavity shares with those of primates a predicted airflow distribution that delivers relatively little air to the olfactory region. However, the sea otter olfactory region is predicted to be highly efficient at stripping odor molecules from the delivered air, so the sea otter nasal cavity has predicted odor uptake efficiency (OUE) intermediate between those of primates and other mammals. Sea otter general olfactory sensitivity is also intermediate between those of primates and the otter's closest available relative (domestic dog). The olfactory importance of OUE is supported by a strong correlation ($P=0.02$) with relative olfactory bulb size. Sensitivity to particular odorants appears to be under selective pressure. A comparison of sea otter and dog for all tested odorants shows a strong correlation ($P=0.04$) between the odor's ecological relevance and sensitivity. The sea otter nasal cavity is anatomically suited for the metabolic demands of its marine lifestyle and may have adapted for that purpose. It nevertheless retains functionality and anatomical investment suggesting that olfaction remains an important function.

Natural Killer Cell Receptors for MHC Class I in the Grey Seal (*Halichoerus grypus*) and Harbour Seal (*Phoca vitulina*)

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Natural killer (NK) cells are lymphocytes of the innate immune system essential for survival and reproduction. These cells use many differentially expressed receptors, creating diversity within the cell population, to facilitate a variety of functions. Receptors recognising major histocompatibility complex (MHC) class I molecules on host cells allow NK cells to provide the first line of defence in viral infections. The primate leukocyte receptor complex (LRC) encodes the mainly conserved leukocyte immunoglobulin-like receptors (LILR) and the highly diverse killer cell immunoglobulin-like receptors (KIR). The rodent natural killer complex (NKC) encodes the C-type lectin Ly49 receptors, the functional paralogues of KIR that are the structurally unrelated but equally diverse. All the known ligands for LILR, KIR and Ly49 are MHC class I or class I-like molecules. MHC is extremely diverse in all species studied and key to immune fitness. Accordingly, MHC receptors have had to evolve at the same pace to recognise their multiple and diverse ligands. The predominant NK receptors in non-primate/rodent mammals can be KIR or Ly49. Horses have multiple Ly49 genes and no functioning KIR while cattle have multiple KIR and probably one Ly49. Differences in MHC have been proposed as a likely reason for the dramatic difference in grey and harbour seal susceptibilities to phocine distemper virus. The repertoire and variation of NK cell MHC class I receptors is an essential part of this. We have cloned full cDNAs for LILR, KIR and Ly49 as well as other NK cell receptors from both species. These sequences show that there has been almost no diversification between KIR but other genes are less well conserved. Studies are ongoing to characterise the extent of diversification in each of these gene families that have an ancient and co-evolving relationship to MHC.

Bottlenose Dolphins, *Tursiops truncatus*, in Turneffe Atoll, Belize Demonstrate Long-term Site Fidelity and Social Bonds

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Data from 734 bottlenose dolphin photo-identification surveys carried out over a five-year period (1992-1996, 2001-2002) in Turneffe Atoll, Belize were analyzed for evidence of site fidelity and social structure. Group size ranged from one to 27 (mean = 3.7, SD = 3.32), but 65% of the groups contained one to three individuals. Sighting frequencies for the 125 photographically identified individuals ranged from 1 to 71 (mean = 10.7, SD = 13.86). Dolphins sighted at least twice in four of the five study years with one of those years being 2001 – 2002 were labeled continuous residents (n = 16), and included 20% of the seventy-nine animals originally identified between 1992-1996. These continuous residents also had significantly more sightings in the wet season than the dry season. Coefficients of association (COA) between dolphins were measured using the half-weight index (HWI), and were calculated within as well as across years. Maximum association levels for continuous residents ranged from 0.11 – 0.72; and these dolphins associated non-randomly between days in each year as well as across the entire study period. Among continuous resident dolphins of known sex, male-male associations (mean = 0.28, SD = 0.10) were significantly higher than either mixed sex or female-female associations. Eleven of the sixteen continuous residents had 1st level associates that were also continuous residents. The small group size for Turneffe dolphins is similar to those reported for other protected areas such as the west coast of Florida, and Shark Bay, Australia. Further, the smaller groups found in Turneffe may reflect less abundant and patchily distributed prey. The small number of residents and significant associations between these residents may also indicate that prey is relatively difficult to find and only a small number of dolphins are able to exploit it together efficiently.

Refractive State, Accommodation, and Corneal

Topography in Harbor Seals (*Phoca vitulina*)

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Harbor seals are amphibious mammals that spend most of their time underwater. Their visual system is suggested to be adapted for underwater vision, and therefore, their eyes are assumed to be nearly emmetropic underwater. Emmetropia underwater would however result in myopia in air, because corneal refractive power increases due to the larger difference in refractive index. We report here measurements of refractive state in air and water in three trained and experimentally experienced harbor seals, using infrared (IR) photoretinoscopy, which has not been previously applied to seal eyes. Repeated measurements in air revealed a high degree of myopia in both ocular meridians and an astigmatism against the rule. Underwater, the eyes were emmetropic or moderately hyperopic with little astigmatism. In both media, the brightness distributions in the pupils suggest the presence of a multifocal dioptric apparatus. We found first indication for accommodation by dynamic recordings underwater. Photokeratometric measurements of corneal topography, carried out with a Placido's disc, showed a central flattened stripe in the vertical meridian and severe corneal astigmatism. Together with a pupil that forms a vertical slit, if ambient illuminance is sufficient, the flat vertical meridian can minimize the optical effects caused by the transition from water to air. During evolution, only one corneal meridian of harbor seals' eyes was flattened. This can probably be explained as a compromise between optical constraints in air, and mechanical constraints underwater. Under certain light conditions, visual acuity can be good due to the alignment of the slit pupil with the more emmetropic meridian, and due to the pinhole effect. Underwater, the animals might take advantage of a strongly curved horizontal meridian considering ocular streamlining, as it possibly reduces local flow velocities and the risk of injury by floating particles.

Visual Fields and Eye Motility in a Harbour Seal (*Phoca vitulina*)

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The boundaries of the visual fields of a harbour seal were measured using static perimetry. Two bow perimeters were designed to present a LED light stimulus of 5 mm diameter in defined positions on a hemisphere (radius 500 mm). The seal was trained to lie on a plane board and position its head at a stationing target with its neck straight, the point between its eyes in the center of the hemisphere. It was further trained to respond to the presence of a stimulus according to a go-no-go response paradigm. Experiments took place in a chamber with defined ambient light conditions (average 9 cd/m²). Stimulus luminance was twice the background luminance for each stimulus position (luminance meter Konica Minolta LS 110). In one set of experiments, eye movements were allowed, in a second set, the seal was trained to fix its eyes upon a fixation stimulus straight ahead. Eye movements were monitored with a video system in all experiments. Eye motility was assessed based on selected video sequences using a geometrical model. The visual field with fixed eyes extended over 208° horizontally and reached from -12° to +69° in the vertical direction (fixation point "0°" straight ahead at eye-level). The binocular visual field extended over 67°. Eye movements of 12° to the sides and 66° upwards could be induced. With eye movements allowed, the visual field measured psychophysically was 210° in the horizontal plane and 121° to the dorsal side, thus narrower than expected from eye motility by 22° (14°). Thus, the visual field of Harbour seals allows good stereoscopic vision. Eye motility to the dorsal side is remarkably high, allowing the seal to view prey against the water surface from below or benthic prey when swimming upside-

down. Lateral eye motility is less pronounced, but significant.

Social Foraging of Alaskan Humpback Whales: Feeding Call Diversity Within and Between Individuals

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Although humpback whales (*Megaptera novaeangliae*) are generally described as asocial, a community of whales in Southeast Alaska has been found to participate in social foraging. Past research has indicated that within Southeast Alaska (population estimated at approximately 1,000 individuals), whales in Chatham Strait participate in social foraging with some regularity. However, of the up to 400 group-foraging whales that have been photo identified in Chatham Strait, only about 50 individuals constitute a core group that consistently feed in this manner. Evidence suggests that individual whales take on specific roles in the group and stable associations between whales occur in feeding groups from year to year. A stereotyped vocalization, named a feeding call, is associated with social foraging and has been described generally in the scientific literature. Within the Chatham Strait core group of social foragers, a limited number of approximately 20 individuals appear to be the source of feeding calls. Past research has suggested that the communicative value of feeding calls is primarily to manipulate prey, but other features of feeding calls suggest that it can serve more than one purpose. Bouts of feeding calls follow stereotyped pattern of usage, but there are quantifiable differences between individuals in the timing and acoustic frequency of feeding calls. Some of this variation may be attributable to individual differences. These individual differences may be able to be extended to social sounds. If this proves to be the case, identifying vocalizations could allow for remote sensing of the presence of individual whales and possibly their close associates. This would be an appealing tool for monitoring animal movement and censusing populations. We will present the examples of the diversity of feeding calls in Chatham Strait humpback whales and quantify the variation in acoustic parameters that may indicate individual differences in call structure.

Focal Behavioral Observations and Fish-eating Killer Whales: Improving Our Understanding of Foraging Behavior and Prey Selection

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Foraging studies of free-ranging cetaceans are potentially fraught with observational biases. Focal behavioral observations can help in understanding and resolving these biases. Despite intense study of the fish-eating ("southern resident") killer whales in Washington state over the past 30 years, we know little about their foraging behavior. Although salmon, particularly chinook, are thought to be preferred, this is based on collection of prey remains from a limited number of opportunistic observations and a few stomach contents. We hypothesized that a large proportion of prey captures occur out of sight of surface-based observers, and are unlikely to be documented in most observational studies. In 2004 and 2005 we quantified behavior while conducting close-range focal follows beside whales or in their fluke prints, noting behavioral cues of predation and collecting prey remains. We recorded 52 events suggesting predation and collected prey remains from 13 (25%). Of 12 samples that were identified, most were chinook, but two other species (chum and coho) were identified. Only four of these confirmed predations involved fast non-directional surfacings or active prey chases, characteristics that have been previously used to indicate feeding. Behavioral observations from several sampling events indicated that the prey chase and capture

occurred out of sight of surface-based observers. Prey captures were observed concurrent with social interactions that were not related to foraging, suggesting that foraging behavior and social behavior can occur simultaneously. Further, this suggests that studies observing behavior from distances that are too far to observe prey in the water column may not always accurately characterize the behavior of fish-eating killer whales. The approach used in this study provides an improved method for understanding foraging behavior for many cetaceans, but is of particular value for "southern resident" killer whales because it provides additional data that will be important for impending conservation measures.

Experience Counts: Mating Success in Male Weddell Seals

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For polygynous mammals with no paternal care, the number of offspring sired is often the sole measure of male reproductive success. The potential for polygyny is highest when resources or other environmental factors, such as restricted breeding sites, force females to aggregate. In these circumstances males compete intensely for females and mating success may vary greatly among males, further intensifying selection for those traits that confer an advantage in reproduction. Determinants of male success in competition for females are therefore likely to be under strong sexual selection. We acoustically tracked male Weddell seals (*Leptonychotes weddellii*) breeding at Turtle Rock, McMurdo Sound (77.727°S, 166.85°E) between 1997-2000 during the breeding season. We then used paternity analysis in conjunction with age, site fidelity and territorial behavior to assess variance in male breeding success. Mean age of successful males was 11.3 ± 0.7 years. Some males vigorously defended territories of varying volume under the ice while others adopted wait and see strategies. Weddell seals at Turtle Rock show a modest degree of polygyny with the greatest number of pups sired by any individual male in a single season equaling 5, or ~10% of the pups born. Over four consecutive years most (78%) of males sired at least one pup. Age, territorial status and tenure were unrelated to mating success but site-specific experience over the reproductive lifespan of males explained nearly 60% of variance in total mating success. While learning where females are likely to be in a particular colony may enhance individual male reproductive success, aquatic mating reduces the ability of males to monopolize females, and thereby increases equity in mating success.

Rhythm Production by the Bottlenose Dolphin

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Rhythm is an important component of many natural communication systems, but it has rarely been the focus of laboratory studies of non-human species. Recent cognitive studies with a bottlenose dolphin revealed that a dolphin could discriminate among six different rhythms. In the current study, a dolphin's ability to produce rhythms was investigated. The dolphin learned to produce six different rhythms in an object labeling paradigm; an object was presented and the dolphin responded with a rhythm. Original training required the dolphin to produce the rhythms using a pneumatic switch that led to the in-air projection of computer-generated tones. However, the dolphin spontaneously began to produce the rhythms vocally as well. Productions were identified by observers naïve to the identity of the sample stimulus. To date, the dolphin has accurately labeled 6 objects

with unique rhythms at over 80% accuracy using both production systems. Rhythmic patterns (vs. exact replicas of acoustic features) were reinforced. The dolphin's productions were consistent in rhythmic pattern but varied within rhythms in terms of absolute durations and, in the case of vocalizations, frequencies. These results indicate that dolphins can produce arbitrary rhythms, a skill that has never been documented in a non-human organism. In addition, these data suggest that dolphins' categorization of natural vocalizations may allow specific feature variation around stable general characteristics.

Histopathologic Comparison of Dolphins Stranded with and Without Evidence of Fisheries Interactions

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Bottlenose dolphins, *Tursiops truncatus*, stranded along the coast of North Carolina, USA, frequently are found with line or net marks suggesting mortality due to incidental entanglement in fishing gear. Fishermen have suggested that only those dolphins already compromised become entangled in gear. We utilized a tissue bank of dolphins stranded in North Carolina to address the question retrospectively with a histopathologic-based approach, and then continued the study prospectively with more complete sampling. Inclusion criteria for the retrospective study were bottlenose dolphins stranded in North Carolina between January 1997 - February 2002, condition code 1 or 2, for which a standardized human interaction evaluation had been completed and scored as fisheries interaction (FI) or no fisheries interaction (non-FI), and for which preserved tissues included three of four of the following: heart, lung, spleen, and lymph nodes, plus at least three additional tissues. Out of 82 candidate cases, 33 animals met the inclusion criteria, including 18 FI and 15 non-FI cases. Histology slides were examined by a board certified veterinary pathologist (DSR) blinded to FI category. Between six and 18 tissues were evaluated for each case. The suite of lesions were graded 1 (no lesions with systemic effects), 2 (one or two tissues with lesions having potential systemic effects), 3 (several tissues with lesions having potential systemic effects) or 4 (lesions with probable systemic effects). Contingency table analysis revealed no significant differences between lesion severity between FI and non-FI categories, with a non-significant trend towards more severe lesions in non-FI cases. Length and age were more variable in the non-FI group. An additional 21 cases have accrued prospectively and are being analyzed.

Trace Element Concentrations in Stranded California Sea Lion (*Zalophus californianus*) Populations: Trends in Age, Sex, and Mortality

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Trace element concentrations were determined in the hepatic and renal tissues of stranded California sea lions (*Zalophus californianus*) along the coast of southern California. The specific objective was examination of burden associated with age, sex, and cause of mortality. Concentrations of nine trace elements (As, Cd, Cu, Fe, Hg, Pb, Mn, Mo and Zn) were determined by inductively coupled argon plasma emission spectrometry (ICP a) in liver and kidney tissues of 80 California sea lions that stranded in 2003 and 2004. These animals were in rehabilitation for 1 hour to three weeks prior to death. Each animal received a necropsy with in 24 hours of death and a complete histopathological evaluation. Tissue concentration means were compared using the Kruskal-Wallis test. An alpha value of $P < 0.05$ was used in data analyses. Significant age-dependent increase was

observed in the concentrations of cadmium and mercury in both liver and kidney tissues and renal zinc levels, with adults having higher concentrations than sub adults or pups. Iron concentrations were significantly higher in females than males in liver tissues. No other significant differences were observed between sexes. Animals that died of domoic acid toxicosis had significantly higher concentrations of cadmium in both liver and kidney tissues as opposed to animals that died of disease or trauma, and significantly higher mercury concentrations in liver tissues. Animals that died of disease showed higher concentrations of molybdenum and zinc in liver tissues. These results are comparable to trace element studies in other marine mammal species, and are valuable for monitoring comparative changes in metal toxicant levels in sea lions and related species.

Intra and Interindividual Variability of Plasma Chemistries in the Adult Female Weddell seal (*Leptonychotes weddellii*)

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Blood chemistry values, at individual or population levels, are valuable tools for assessments of physiological states. In particular, relationships of observed values to relative terms of health (e.g., pathologic conditions) are of importance. However, reference values (ideally from multiple reference groups) are required in order to make diagnostic interpretations relating to health status. Such diagnoses in wild animals however are relatively limited, especially for free-ranging individuals. These limitations stem from difficulties in obtaining positive and negative controls for hypothesized factors affecting the health status of reference individuals. In this study, we aim to address short-term variability (hourly specimens collected over 24-48 hr period) in the plasma chemistry of free-ranging adult female Weddell seals (*Leptonychotes weddellii*), and assess relationships between hypothesized nonpathogenic biological factors and alterations in analyte values. Our objectives are to assess how rest (hauled out and nonlipemic), exercise (diving and nonlipemic), rest and digestion (hauled out and lipemic), and exercise and digestion (diving and lipemic) relate to alterations of 23 commonly analyzed plasma analytes within and between individuals. We hypothesize that: 1. intraindividual variability will be less than interindividual variability; and 2. diving and lipemia will correlate to altered values within individuals but that general trends will not differ between individuals. Results (N=8) suggest intraindividual variability is less than interindividual variability, and that diving and lipemia alter some, but not all analytes measured. This study provides valuable information on the dynamics of plasma chemistry values, and advances their development as tools for health assessments in wild animals.

A Quantitative Analysis of Whistle Variability found in Mother-Calf Pairs of Bottlenose Dolphins in Shark Bay, Western Australia

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Bottlenose dolphins (*Tursiops truncatus*) produce individually distinctive signature whistles that are used in individual recognition and group cohesion. This has been reported from a variety of captive facilities and from the wild. However, signal repertoires and variability may vary in different locations. Bottlenose dolphins in more sheltered and visually accessible environments may not have the same requirements for an acoustic identification system as offshore animals. To test this hypothesis we investigated whistle variability between bottlenose dolphins in Shark Bay, Western Australia, and compared it with that found in Atlantic animals. We collected acoustic and non-acoustic behavioural data from a 10 m catamaran on 15 lone mother-calf pairs. Only seven of these produced sufficient whistles for further analysis. We traced the frequency modulation pattern of 169 whistles from these animals and compared them in a cross-correlation analysis

that allowed time-warping of the extracted contours. The results showed that mother-calf pairs of Shark Bay dolphins do not differ sufficiently in their whistles to be identified individually by this analysis, while the analysis performed much better with the Atlantic individuals. Our results suggest that inter-individual whistle variability differs between populations. It is too early to identify the main reason for this difference. It might be rooted in the fact that Shark Bay provides very different habitats from the Atlantic Ocean. Another possible reason is genetic differences between populations.

Characterizing Pinniped Stranding Trends in Virginia and North Carolina from 2000-2005

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From 2000 through June 2005, pinniped strandings were consistently recorded in Virginia and North Carolina. In this project, we compiled Level A data for pinniped stranding events. A stranding event occurred when a pinniped was (1) recorded as dead, (2) collected and died before rehabilitation, (3) euthanized, (4) placed into rehab. The data included 105 pinniped strandings ranging from ten in 2002 to 25 in 2003. Harbor seals ($n=71$) were the predominant species recorded, although harp ($n=16$), gray ($n=8$), and hooded seals ($n=10$) consistently appeared in the stranding record. Of the 105 stranding events, 75 were alive. Most of the live seals were sick, presenting with respiratory distress and heavy parasite loads. Others showed signs of predator and/or fishery interactions. Temporally, most strandings occurred from November through April. We also examined sex and age class (using length as a proxy for age). When sex was recorded, males ($n=55$) stranded more often than females ($n=34$) and, based on length, most of the stranded seals were young of the year (YOY). We observed that multiple pinniped species, primarily YOY, consistently appeared along the coasts of Virginia and North Carolina in cooler months. We suspect these stranding data, along with reports of apparently healthy seals, indicate some seals are over-wintering in this region each year. Little is known about the southern distribution of pinnipeds on the U.S. coast. This may be the first report of consistent seasonal pinniped presence in Virginia and North Carolina. Furthermore, pinniped presence in this region may be related to increasing pinniped strandings along the northeast U.S. coast. Future research will focus on quantifying potential shifts in sex/age class ratios, and post-release monitoring of rehabilitated seals via satellite telemetry.

Estimating Actual Population Size of Harbor Seals in California Using a Correction Factor Based on Haul-Out Behavior of Radio-Tagged Individuals

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Aerial surveys of pinnipeds only provide a minimal count of populations because some unknown proportion of individuals is in the water during surveys. To determine an actual population estimate for California, flipper-mounted radio tags were placed on 120 harbor seals in central and northern California during the spring pupping period. Those individuals tagged represented the relative proportion of sex and age classes in the population, and the number tagged per region was proportionally stratified. Counts of harbor seals ashore were conducted at all haul-out sites in California during an aerial survey soon after tagging in May and June 2004 (Mark Lowry NMFS). Additional surveys were flown to determine variability in the correction factor (CF). The mean proportions of tagged individuals ashore during four complete surveys were not different between central and northern California ($F = 1.85$, $P = 0.18$) or between sexes ($F = 0.57$, $P = 0.45$) but were significantly different among age classes ($F = 7.97$, $P = 0.001$). A lesser proportion of weaners/yearlings were

ashore in northern California than in central California. The CF calculated for the state-wide aerial survey of harbor seals was 1.65, using only those transmitters known to be operating at the time of the survey ($n = 114$). The mean CF for central California was not significantly different than the mean CF for northern California. Using a CF of 1.65 and the count of 26,333, the estimated number of seals in California was 43,449. The behavior of radio-tagged individuals allowed us to predict the number not counted during surveys, and this correction factor was similar to a CF of 1.53 determined for Oregon and Washington by Huber *et al.* (2001).

Habitat Use by Grey Seals Within the Gulf of St. Lawrence According to Water Depths

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Space use by individuals results from the selection of habitat attributes that favour individual fitness. This process occurs hierarchically from distribution area to foraging area and varies temporally according to individual condition or period considered. Habitat use by grey seal (*Halichoerus grypus*) was examined in the Gulf of St. Lawrence, Canada. We expected that water depth would be a primary determinant of broad-scale distribution of individuals. Home range size (fixed 95% kernels) of 34 seals fitted with satellite-linked recorders was estimated. Habitat selection was assessed based on the proportion of home range areas occupied by 4 water depth bins compared to the availability of those habitats within the study area. Despite large variability in home range sizes, winter home ranges ($x \pm sd = 58,000 \pm 9,000 \text{ km}^2$) were larger than summer home ranges ($5,000 \pm 10,000 \text{ km}^2$). Age and sex did not affect home range size. Generally, seals used water depths between 0-50 m more than expected based on availability and areas 50-100m deep proportional to their availability. Depths between 100-200m were avoided in summer and used proportionally to their availability in winter. Use of habitats with depths >200 m were significantly less than expected. Our results indicate that water depth is an important habitat variable affecting grey seal distribution in the Gulf of St. Lawrence.

Serum Electrophoresis in Harbor Seals (*Phoca vitulina*)

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Serum electrophoresis has been used as an immunology status marker in human medicine for a long time. It has also been performed on several marine mammals, including cetaceans and pinnipeds. Studies on serum electrophoresis in harbor seals is scarce though. Three groups of harbor seals were tested in this project: seals held permanently in captivity, rehabilitated seal pups (both Rehabilitation Center Friedrichskoog, Germany) and wild seals caught in the Wadden Sea of Schleswig-Holstein. Blood was taken during several years. The densitograms of the animals held in captivity show very little differences even though the animals are of different ages and sex. Whereas in Hall (1998) differences in the serum chemistry of gray seals were clearly related to age and sex. The densitograms of the rehabilitated pups look similar to those of the animals held in captivity. The end of the graphs of the captive animals as well as of the wild catches show a distinct peak of a protein that cannot be found in the pups (nor humans or other mammals). It seems that an unknown stationary protein is present at the starting point of the electrophoresis. The analysis of the serum electrophoresis of the wild catches proved to be rather difficult. The actual contamination was most likely caused by lipemia, which is a common phenomenon in marine mammals such as harbor seals. In Davis *et al.* (2001) the high molecular weight of the apoE in pinnipeds, especially in harbor seals, is mentioned. It seems that the wild catches dispose a higher amount of lipoproteins, therefore also of apoE, that might interfere with the migration of the other serum proteins and blur the bands on the cellulose acetate. Why only the wild catches show this

phenomenon is not clear yet.

The Effects of Age on Foraging Behavior and Success in Female Northern Elephant Seals

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In the northern elephant seal, resources gained from extended foraging trips are stored for future reproduction. Previous work has shown that older, larger mothers have higher reproductive success, but endure significantly greater absolute mass loss over the lactation period on land than their younger counterparts. However, few studies have examined how maternal traits influence energy acquisition, and indirectly impact reproductive success. Here, we examined patterns in dive behavior for insights to how females develop the ability to harvest more energy for their offspring at sea over time. At Año Nuevo State Reserve, known aged breeding females between 4 and 11 years old were equipped with time-depth recorders and satellite tags. We examined dive behavior in 21 records from the 2004 post molt and 18 records from the 2005 post breeding foraging trips. Body composition and mass were measured on each female upon departure and return to the rookery as an index of foraging success. Dive shapes were categorized using diving parameters and discriminant functions from previous visual typing. Putative dive types were input to an optimal foraging model to quantify a ratio of travel and foraging periods between age classes. Results indicate that older, larger females exhibited longer patch residence and travel time between prey patches, traveling greater distances than their younger counterparts. While younger females exhibited higher patch encounter rates, residency time was shorter, indicating patch encounters of reduced quality. Older, larger females were more successful foragers than younger females, as evidenced by rates of mass gain and a higher percentage of fat deposition. These findings suggest that females improve foraging efficiency with age by developing skills to locate higher quality patches of prey. These foraging differences may contribute to age related differences in the resources available for reproduction.

The Influence of Depth on a Breath-hold Diver: Predicting the Diving Metabolism of Steller Sea Lions

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Previous studies have provided a wealth of information on the diving behavior of wild sea lions and have been integral in understanding their foraging ecology. However, to place these data in an energetic context, information on the costs of diving in relation to aspects of dive behavior and environmental conditions were required. We quantified the influence of a range of behavioural parameters and environmental determinants on diving metabolic rates (DMR) of Steller sea lions, and constructed a model to predict DMR for wild sea lions. Three captive-reared Steller sea lions were housed in an ocean holding pen and transported by boat to diving trial areas in the open sea. Each animal was trained to dive from a respirometry dome on the surface (where metabolism was estimated using open circuit respirometry) to predetermined depths for controlled periods of time. At the end of each dive the sea lions returned to the respirometry dome. The influence of a range of behavioral and environmental parameters on DMR was evaluated in a generalized linear modeling framework. Results from the model suggested that two of the behavioral parameters were significant influences on DMR; there was a positive relationship between the total distance swam during a series of dives and DMR (Deviance = 13.8, $P < 0.001$) and a negative relationship between maximum dive depth and DMR (Deviance = 4.48, $P = 0.03$). These results provide valuable insights into the physiological responses and adjustments made by Steller sea lions to increase foraging durations at depth. They also allow behavioral

information from wild animals to be placed in an energetic context and consequently allow more refined predictions of diving energetics for wild animals to be made.

The Manatee Forum: A Process by the Florida Fish and Wildlife Conservation Commission and the US Fish and Wildlife Service to Resolve Conflicts Surrounding Manatee Conservation in Florida

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In July 2004, after a series of legislation and litigation related to manatee conservation, the Florida FWC and USFWS initiated the "Manatee Forum" to bring together 22 stakeholders in manatee issues for productive dialogue and, ultimately, issue resolution. The forum is held quarterly, typically for two days, and is facilitated by a professional. Each has focused on a different topic. Forum One was used to update the stakeholders on current local, state, and federal manatee management efforts, and to establish the willingness of participants to engage in on-going dialogue. Forum Two was devoted to developing a governance framework for member interaction and decision-making. Forums Three and Four focused on research topics: a comprehensive review of current manatee population research and studies related to boating and manatees, respectively. Both included highly interactive discussions between researchers and the Forum participants, with a review of the strengths, weaknesses, and gaps of existing studies. Although the Forum has not yet formally initiated discussions related directly to conflict resolution, several results and areas for improvement have been identified. The Forum has been a useful venue for stakeholders to express their concerns and communicate directly to the management agencies rather than through legislation or litigation. There has been open dialogue which gives participants insight into various perspectives about the issues and allows for clarification of myths by the agencies. One of the most important outcomes has been the interactive dialogue between scientists and stakeholders which has made manatee research more transparent and has quelled many suspicions held by stakeholders relating to the science. However, the communication of scientific data and research results remains challenging, as forum members will have varying interpretations of the same research. The Forum has fostered better communication between the agencies and stakeholders; whether it will facilitate conflict resolution remains to be seen.

Surgical Implantation of Tracking and Physiological Monitoring Instruments in Pinnipeds

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Monitoring the movements and physiological parameters of free-ranging marine mammals is important for ecological and life history research as well as assessing the post-release survival and behavior of stranded animals that have undergone rehabilitation. Studies to date have been limited by the available instrumentation, as most such instruments have typically been attached to the hair coat of the animal under study and are often dislodged due to molt or degeneration of the hair shafts at the attachment site. Surgical implantation of instruments may increase their longevity. However, previous surgical

implantation in pinnipeds has been hampered by excessive tissue reaction and subsequent rejection of implanted materials. Pinnipeds are reputed to generally react poorly to suture materials and have a high rate of wound breakdown following surgery. The purpose of this study was to evaluate the safety and efficacy of three types of surgically implanted instruments under controlled conditions on animals in rehabilitation: subcutaneous VHF radio transmitters in harbor seals (*Phoca vitulina*); subcutaneous heart rate and temperature loggers in California sea lions (*Zalophus californianus*) and elephant seals (*Mirounga angustirostris*); and a novel intraperitoneal satellite-linked Life History Transmitter in California sea lions. To date, approximately 16 VHF radio transmitters have been successfully implanted in harbor seals, although resin-coated transmitters resulted in more tissue reaction than wax-coated instruments. Two heart rate loggers have been successfully implanted in sea lions, while three loggers implanted in elephant seals resulted in a large amount of inflammatory response and required early removal. Six Life History Transmitters have been successfully implanted into four sea lions. This study shows that a variety of instruments can be successfully implanted intraperitoneally and subcutaneously in several species of pinnipeds, although there are species differences in the inflammatory response and potential for rejection of the implant.

Southern Resident Killer Whale (*Orcinus orca*) Summer Distribution Patterns: Effects of Changing Temporal Scales

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Patterns of environmental variation range over spatial and temporal scales to influence ecological processes and population responses. A consideration of temporal scale is one necessary component of community and landscape ecology. In the case of the so-called Southern Resident killer whales (*Orcinus orca*), recent concerns over declining population numbers have led to conservation listings in the United States, Canada, and Washington State. Habitat protection, such as "critical habitat" designation, is a condition or recommendation of each listing. While extensive, long-term demographic studies have provided background for conservation planning, little is known about the changing patterns in spatial behavior of this population. Using historical Southern Resident killer whale (SRKW) location information within the semi-enclosed marine waters of British Columbia and Washington State, we modeled summer distribution patterns as measured variation in the density of sightings on a uniform spatial grid. Data consist of validated sightings by commercial whale-watch operators from 1996-2001, and sightings were summarized over the entire six year period, inter-annually, monthly, and weekly. Our specific objectives were to describe SRKW distribution along this gradient of temporal scales, use landscape metrics to quantify composition and configuration of the distribution pattern at each scale, and identify temporal trends in space use for SRKW. Secondly, we examined temporal changes in distribution of SRKW pods, or stable, long-term associations of individuals. Our results suggest that SRKW exhibit dynamic patterns of space use, which should be considered in any habitat management schemes. Although there appears to be limited inter-annual variation, SRKW space use varied at monthly and weekly temporal scales. The pattern of spatial complexity in high density areas exhibited a non-linear relationship with changing temporal scale, further suggesting that management approaches must be explicit to a given temporal scale and a need for continued studies into the ecological processes motivating the observed patterns.

Saving Hawaiian Monk Seals: A New Recovery Plan

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The Hawaiian monk seal (*Monachus schauinslandi*) population has not demonstrated a significant turn toward recovery since its

endangered listing in 1976. A 1983 Recovery Plan recommended actions that led to reductions in human disturbance, fisheries interactions, mortality from adult male seal attacks, entanglements and shark predation. Projects to enhance survivorship of female pups also proved effective. While many of these actions have been successful, they have not been sufficient to result in a recovering population. The Hawaiian Monk Seal Recovery Team submitted a revised draft plan to NMFS in 2005. Key threats are food limitation, habitat degradation, entanglement, shark predation, fisheries interactions, adult male aggression, increased human disturbance, bio toxins, contaminants, and vessel groundings. The spread of the population to the Main Hawaiian Islands also increases the potential for the catastrophic impacts of infectious disease. The major actions identified as critical to improve recovery potential are: 1) Improve the survivorship of females, particularly young seals, in sub-populations of the Northwestern Hawaiian Islands (NWHI) by defining and protecting habitat needs and prey base and intervening to enhance female survival where appropriate because current trajectories indicate continuing declines in these island populations seals due to high female losses; 2) Maintain field personnel presence during the breeding season to monitor the populations, identify impediments to survival and mitigate threats; 3) Ensure the continued recovery of monk seals in the main Hawaiian Islands (MHI); and, 4) Reduce the probability of the inadvertent introduction of infectious diseases into the monk seal population. Detailed recovery actions addressing these threats are prioritized, assigned to agencies, and costs are estimated. The numerical goal to downlist monk seals to threatened is 2,900 seals in the NWHI and 500 in the MHI, and other demographic and management criteria are also required. Delisting would be possible if these population sizes were maintained for 20 years without the appearance of new threats.

Association of Acoustics and Behaviour of Provisioned Inshore Bottlenose Dolphins (*Tursiops aduncus*) at Tangalooma, Moreton Island, Queensland, Australia

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Acoustical emissions and behaviour of eight provisioned inshore bottlenose dolphins (*Tursiops aduncus*) were compared from 27th March - 27th April 2002 at Tangalooma, Moreton Island, Queensland, Australia. Acoustic recordings were made continuously during hour-long feeding sessions using a single hydrophone with HP-A1 series amp and Sony TCD D100 DAT recorder (44kHz sample rate). Behaviour was recorded both visually by observers and electronically using a JVC digital video camera. Behaviours defined specifically for the provisioned dolphins were divided into five states; pod separation, milling, scanning (associated with orientation and foraging), feeding (not including human provisioning), and socialising. Provisioning episodes (when dolphins were hand fed fish by people entering the water) were treated as separate behavioural events and are not included in this paper. Sound recordings were analysed using CoolEdit 2000 (Syntrillium Software). This paper focuses on 'whistles' emitted. Whistles were divided into sine, upsweep, down-sweep, flat and concave categories based on the tonal shape of the sonogram. A total of 5037 whistles was analysed from 943 minutes of recordings, and 68 distinctive whistle types were identified based on their sonogram characteristics. Whistles were then categorised as either 'common' (whistles emitted at least 100 times over the study period), or 'uncommon', (whistles emitted between 10 and 99 times). Repetition rate and diversity of whistles varied with behaviour state. The highest number and diversity of whistles was emitted during milling behaviours (diversity=66; number=2177) and the least during pod separation occasions (diversity=29; number=358). Chi-squared tests showed that individual common and uncommon whistle types were statistically associated with particular behaviours.

Real-Time Quantitative PCR Development for Low Quality Mitochondrial and Nuclear DNA of Cetaceans and Pinnipeds

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Using all potential DNA sources, including ancient, degraded, and hard tissue samples, is often necessary to attain needed sample size in conservation studies. Critical samples are often available only in ancient bone or tooth material in historical studies. Low quantity DNA in such samples can result in either unreliable data or wasted laboratory effort for samples that are too degraded for use with current method. We develop two highly sensitive fluorescent assays for mitochondrial and nuclear DNA quantification of low concentration cetacean and pinniped DNA samples that allow more efficient and reliable sample selection. Samples are amplified and analyzed on a real-time quantitative PCR detection system. Primers for the 129 basepair (bp) mitochondrial DNA (mtDNA) assay were designed in the 12s ribosomal gene region based on alignment of 13 families of Cetacea (48 sequences), 10 species from 3 families of pinnipeds (17 sequences), and a human sequence for exclusion purposes. Primers for the 51 bp nuclear assay were designed from the BMI-1 gene based on alignment of 2 cetacean sequences (one Mysticete and one Odontocete), 5 additional species in the Cetartiodactyla, 3 species of Carnivora (no pinniped sequences were available), and 4 primates. Quantification of both regions was detected using Sybr Green fluorescence and a comparison to a standard dilution series of *Tursiops truncatus* cloned DNA ranging from 10⁷ to 10¹ copies of the DNA fragments. Both assays detected DNA from a single copy of the cloned *Tursiops truncatus* target. Subsequently, we assayed DNA from 26 species for both nuclear and mtDNA: 22 cetaceans from 9 families and 4 pinnipeds from 2 families. Neither the 12s nor BMI-1 assays amplified the human DNA. These assays are powerful new tools for screening and quantification of marine mammal DNA samples with low expected DNA concentrations or small fragment sizes.

Diversity of Expressed MHC Class I and Class II Genes in the Hector's Dolphin

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High levels of variation in functional genes of the Major Histocompatibility Complex (MHC) are thought to be maintained by balancing selection as a result of the exposure to pathogens. This polymorphism is considered to be important for recognizing a variety of pathogens and subsequently triggering an immune response. Therefore a low diversity at MHC genes in a population could indicate a higher susceptibility to disease. Previous studies have suggested that cetaceans show unusual low diversity at the MHC compared to terrestrial mammals, perhaps due to reduced pathogen exposure or "pathogen escape" in the marine environment. However, studies of diversity at MHC genes in cetaceans are very limited and evidence of the functionality of these genes in dolphins is even more limited. To identify functional diversity in the Hector's dolphin (*Cephalorhynchus hectori hectori*), cDNA was generated from total RNA, extracted from whole blood of two individuals during a temporary live capture. Expression was confirmed for two Class II (DQ α , DQ β), and one Class I gene by amplifying exons from both cDNA and genomic DNA. Amplicons were bacterially cloned and analysis of these clones revealed four alleles for DQ α and two alleles for DQ β for each individual, suggesting two and one locus for these genes, respectively. For Class I up to five alleles have been found in one individual, indicating at least three loci, but expression of only one allele could be confirmed from cDNA. The variability found in exon2 at DQ α and DQ β within the Hector's dolphin (*Cephalorhynchus hectori*) is among the lowest reported for mammalian species. Further work is underway to describe the MHC diversity in the Maui's dolphin, a critically endangered subspecies to the Hector's dolphin.

Bryde's Whale (*Balaenoptera edeni*) Sounds Recorded on Autonomous Hydrophones in the Eastern Tropical Pacific, 1999-2001

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Vocalizations resembling known Bryde's whale sounds were recorded on seven autonomous hydrophones moored in the eastern tropical Pacific (12° N–8° S and 95°–110° W). As part of a seismic experiment, hydrophones spaced approximately 900 km apart were moored between 12° N–8° S and 95°–110° W, and continuously recorded the frequency band 1–110 Hz from Nov. 1999 to Nov. 2001. Five short (<3 s), low-frequency (<80 Hz) phrase types were found. Two alternating tonal phrases were observed: "swept alternating tonal" phrases included a 37 Hz tone and often a 25–16 Hz downswept tone, while "non-swept alternating tonal" phrases had a predominant tone at 29 Hz and often additional tones at 16 Hz and 47 Hz. Alternating tonal phrases were found in 79% of the total hours in which phrases were detected, and occurred primarily at the eastern hydrophone sites. Two types of "burst-tonal" phrases were identified and were so named because they included tones that were often preceded by a wide-band burst of noise. The "low burst-tonal" phrase contained tones at 19 Hz and 30 Hz, and was detected at five of the hydrophone sites. The "high burst-tonal" phrase included a 42 Hz tone and was observed only on the northwestern hydrophones. A single "harmonic tone" phrase type was observed that included a fundamental tone at 26 Hz and at least two harmonics; this phrase was observed exclusively at the eastern hydrophone stations. Four of the identified phrases closely resembled vocalizations previously reported by Oleson *et al.* (Mar. Mamm. Sci. 19:407419, 2003). This opportunistic survey has shown that acoustic methods can provide useful information about this poorly understood, pelagic balaenopterid.

Closed, Small and Localized: Conservation Implications Derived from Abundance Estimates and Ranging Patterns of Chilean Dolphins at Isla Chiloé, Southern Chile

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Managing impacts of escalating human activities on coastal cetaceans requires information on a species' population size and distribution patterns at appropriate spatial scales. Nearshore habitats of endemic Chilean dolphins (*Cephalorhynchus eutropia*) overlap with rapidly expanding aquaculture farms for salmon and mussels in the Chiloé Archipelago (42–43°S) in southern Chile. Systematic boat-based surveys were conducted during the summer months of 2001 to 2004 to estimate local abundance and determine ranging patterns of Chilean dolphins using photo-identification techniques. Re-sighting rates of 59 dolphins identified in southern Chiloé were high within and between years (>50% of individuals sighted in consecutive years, 25% in all 4 years) strongly suggesting a resident population. Annual estimates of abundance were derived using mark-recapture methods and a model-fitting approach for closed populations in the computer program MARK. Derived Estimates were scaled by estimated proportion of marked animals in the population (~40%) to provide a total population size of 54 dolphins (CV=0.06) in 2004. No trend in population size was discernible over the four-year period. Individual Chilean dolphins ranged over small distances (<25 km) and concentrated their activities in discrete bays and channels. In one of these bays, expanding mussel farms appear to restrict the dolphins' movements to about 1/3 of the available area. In central Chiloé, sighting and identification rates of Chilean dolphins were too low for application of mark-recapture models. Four of 12 identified dolphins were re-sighted between years and exhibited the same small scale movement patterns as their southern counterparts. Given the small size of resident and apparently localized populations of Chilean dolphins current aquaculture activities in the dolphins' range should be assessed and expansions carefully regulated to ensure the dolphins'

continued occupancy.

Isolation of MHC Related Sequences from Franciscana (*Pontoporia blainvillei*)

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The genes of Major Histocompatibility Complex have an important role in maintenance and modulation of immune response of vertebrates. Their products are involved in eliciting immune response against pathogens, individual surviving and population integrity. The low levels of diversity in this genetic system, conversely, have been associated with both low reproductive success and increase susceptibility to disease in isolated populations and endangered species. The Franciscana (*Pontoporia blainvillei*), an endemic dolphin of coastal waters of Brazil, Uruguay and Argentina, has been considered the most threatened small cetacean in the Southwestern Atlantic Ocean. To date, there are no published MHC sequences from this specie or complete information about diversity levels at this genetic system. In a preview study based on PCR-SSCP methodology, the analysis of a variable region of HLA-DQB exon 2 in three Franciscana populations suggested very low diversity, but the investigation failed in characterizing and quantifying the amount of differences in this region. At the present, we initiated the isolation of MHC sequences from this specie to survey the full HLA-DQB gene and then do comparative analysis between Franciscana and their counterpart mammals in marine and terrestrial inhabit. Tissues samples from one individual by-catched was used for genomic DNA extraction and a 172 pb fragment corresponding to Protein Binding Region of HLA-DQB exon 2 was amplified, cloned and sequenced. The similarity to HLA-DQB exon 2 was confirmed by BLAST and the sequences used to design primers to carry out Inverse PCR amplification in Franciscana samples to amplify flanking DNA sequences from this region. This is the first time that the specific MHC-exon 2 sequence has been described in this species. This cloned sequence is being used as a probe in Southern blot in order to identify genomic DNA fragments, which will be circularized before an inverse amplification.

Culturally Significant Units (CSUs) as a Conservation Tool for Unique Populations

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One of the most intriguing discoveries in the biology of social odontocetes over the past 30 years is the existence of culturally and ecologically distinct populations of the same species occupying adjacent, or in some cases overlapping, ranges. This segregation has been described in detail in killer whales, bottlenose dolphins and sperm whales, and may also exist in related species. Genetic differences between such populations provide statistically reliable evidence of segregation, but tend to be small in absolute magnitude relative to the differences measured between allopatric populations of many other species. These small but consistent genetic differences present a challenge to conservation managers, who normally rank the conservation priority of populations based on their genetic distinctiveness and seek to preserve so-called Evolutionarily Significant Units (ESU). Here, we propose the adoption of an analogous conservation unit called the Culturally Significant Unit (CSU), which would apply to socially and behaviourally sophisticated species with well-established cultural traditions. The CSU is based on the assumption that culturally-transmitted information a) is locally adaptive (e.g., seasonal and temporal distribution of resources, foraging and prey handling techniques, and distribution and behaviour of predators), b) reinforces mating barriers between populations that

lead to increasing genetic divergence, and c) is either unlikely to reoccur in a similar configuration once lost or take an extremely long time to recover over numerous generations. CSUs can be used as a framework for systematically ranking and assigning conservation priorities for unique populations where strict ESU criteria are insufficient to protect unique populations that are culturally distinct but genetically similar. Managers must ensure that the size and demographic structure of the CSU is sufficient to maintain the transmission of cultural information, as well as any environmental features that provide a foundation for the maintenance of cultural traditions.

Does Tiger Shark Predation Risk Influence Foraging Habitat Use by Bottlenose Dolphins at Multiple Spatial Scales?

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Prey availability and predation risk often are important determinants of habitat use, but their importance may vary across spatial scales. In many marine systems there is a mismatch between prey abundance and the distribution of foragers at small spatial scales because of anti-predator behavior or spatial unpredictability of prey. Prey availability and tiger shark (*Galeocerdo cuvier*) predation risk influence patterns of Indian Ocean bottlenose dolphin (*Tursiops aduncus*) habitat use at the scale of habitat patches, but the importance of these factors at the microhabitat scale is unknown. We investigated the importance of prey abundance and predation risk on dolphin microhabitat use in Shark Bay, Western Australia and used microhabitat variation in patch attributes and shark density to determine the component of predation risk that is most important to dolphins' decisions about patch and microhabitat use. Dolphins were distributed across microhabitats of deep and shallow patches proportional to prey density when shark predation risk was low. When shark density was high, dolphin distribution continued to match the proportion of prey across microhabitats of deep waters (channel vs. open). In shallow seagrass patches, however, dolphins greatly reduced their use of interior portions relative to edges despite no change in the distribution of their prey and higher shark densities in edge microhabitats. Together, these results suggest that intrinsic habitat risk (i.e., a higher probability of escape in an encounter situation), which is probably highest within interior microhabitats, is more important to dolphins than predator encounter rate. Lack of covariation in intrinsic habitat risk and shark density leads to varying patterns of dolphin distribution relative to sharks and teleosts at the patch and microhabitat scale. Our findings suggest that conservation measures that consider spatial variation only in disturbance frequency and ignore intrinsic habitat risk may be less effective as a result.

Marine Mammal Bioacoustics as a Tool for Technology and Career Training for Teens

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The Ocean Institute, in Dana Point California, is a non-profit informal science education center and has developed a model program called SeaTech. This program trains teens in after-school environments of Boys and Girls Clubs to analyze marine mammal acoustic data. SeaTech, funded by the National Science Foundation, provides 8th and 9th grade teens with important technology and workplace skills in the context of bioacoustic research. SeaTech trains students to work with acoustic analysis software, recognize patterns of marine mammals and other ocean sounds in the data, and report findings. Students are mentored during a two-year program with After-School IT Clubs, Field Experiences, and intensive summer Bioacoustics Academies.

This poster will present the results from a one-year pilot study showing teens participating directly in the analysis of acoustic data provided by the Scripps Institution of Oceanography. An Autonomous Acoustic Recording Package (ARP) was deployed for 370 days offshore from Mawson, Antarctica, an area of the Southern Ocean for which it is difficult to obtain information on the abundance and distribution of marine mammals. Students examined these acoustic data to detect calls of blue whales, minke whales, and seals, and the results of their analysis will be presented.

The Ontogeny of Echolocation in Atlantic Bottlenose Dolphins (*Tursiops truncatus*)

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The ontogeny of echolocation in Atlantic bottlenose dolphins (*Tursiops truncatus*) was investigated by collecting echolocation recordings and concurrent behavioral observations from six calves and their mothers housed at the U.S. Navy Marine Mammal Program in San Diego, CA. A total of 361 echolocation trains from calves and 187 trains from their mothers were recorded during the first 6 months of the calves' lives. The earliest recording of calf echolocation occurred 22 days postpartum and sequential sampling demonstrated that the frequency of echolocation efforts by calves increased steadily with age. Calf echolocation trains increased in duration and the number of clicks per train with age, but interclick interval values remained relatively constant. These findings indicate that the first 2 months of life are significant to the development of echolocation ability in dolphin calves.

Exploring the Humpback Whale Mating System Using CRITTERCAM

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For the first time, CRITTERCAM, an animal-borne imaging, audio and data-logging tool, was deployed on humpback whales in their winter grounds. A new rear-facing CRITTERCAM was developed to better observe the interactions in competitive groups, which are believed to be the epicenter of mate selection. During 20 days of fieldwork in Maui waters, we achieved five successful deployments using front- or rear-facing CRITTERCAMs on escorts in competitive groups. The duration of deployments ranged from six minutes to three hours; four deployments were on a Primary (PE) or Challenging Escort, and one deployment was on a Secondary Escort. This work revealed data on social interactions, vocalizations, energetics and habitat use that could not be easily obtained without CRITTERCAM. (1) We observed secondary escorts inflating their ventral pleats, bubble streaming, and striking other secondary escorts. (2) In two groups, the female extended a pectoral fin towards the PE in apparent affiliation. (3) The production of social sounds appeared in some cases coincident with male-male agonism. (4) Tail stroke frequency revealed the female, positioned next to a PE in a fast swimming competitive group, was at times apparently drafting in the PE's pressure wave. (5) During the latter parts of several descents a PE ceased tail stroking, but downward movement continued, possibly revealing a negatively buoyant state. (6) Whales in three deployments swam to the seafloor, in two cases over 500 feet down. (7) In one case, a secondary escort rested on the bottom while sculling its pectoral fins through the substrate, throwing up clouds of sand. In summary, CRITTERCAM, especially rear-facing types, allowed us to observe sustained micro-interactions between animals in competitive groups. Such observations can have significant

bearing on interpretation of the mating system by assisting in uncovering behaviors that may be involved in mate guarding and female choice.

Time and Frequency Parameters of Bottlenose Dolphin (*Tursiops truncatus*) Whistles as Predictors of Surface Behavior in the Mississippi Sound

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The categorization of dolphin whistles has long troubled researchers due to a lack of evidence about which features dolphins use to discriminate between whistles. Without these data, attempts to categorize dolphin whistles are based on human judgments. Categorization issues aside, there appear to be geographic differences in whistle rates and parameters (Bazúa-Durán and Au, 2004; Bazúa-Durán, 2004; Jones and Sayigh, 2002). The present research attempted to identify salient whistle features by relating acoustic parameters to surface behavior. Wild bottlenose dolphin (*Tursiops truncatus*) whistles were recorded during boat surveys of Ship Island and Cat Island in the Mississippi Sound, part of the northern Gulf of Mexico between April 2004 and March 2005. The surface behaviors of the focal group were categorized as follows at one minute intervals while acoustic recordings were being obtained: mill, travel, mill/travel, feed, social, with boat or with shrimp boat (Urian and Wells, 1996). Due to turbidity in the study area, observations of underwater behavior were not possible. The following acoustic parameters were obtained for each whistle: minimum frequency, maximum frequency, beginning frequency, ending frequency, peak frequency, peak time, duration and number of turns. A discriminant function analysis compared these parameters with observed surface behaviors, and suggests that different sorts of whistles are used in different behavioral contexts by dolphins in the Mississippi Sound.

Genetic Divergence Between Commerson's Dolphin (*Cephalorhynchus commersonii*) Subpopulations in Southern Argentina

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Quantification of levels of genetic variation, patterns of genetic differentiation with respect to geography, rates of interchange ("gene flow") and degree of philopatry, all contribute to the identification of "population structure". Structure can be considered the genetic subdivision of species into discrete units which, because of their genetic uniqueness, are managed independently from other such units in order to avoid the risk of extinction of potentially important adaptations to local environments. *Cephalorhynchus commersonii* is distributed in the coastal waters of South America south of 41°, and thus is particularly vulnerable to bycatch in coastal gillnets, trammel nets and mid-water trawls. *C. commersonii* is listed by IUCN as Data Deficient - estimates of by-catch, abundance, and population structure analysis are needed for proper status assessment. Our study documents genetic diversity in four presumed Commerson's dolphin subpopulations along the southern Argentina coastline, from Ría Deseado in the north to Ría Gallegos in the south, and focuses on the potential for depletion in the apparently more heavily impacted Ría Gallegos area. Only three control region (485 bp) haplotypes were shared among these locations (out of 17 identified), and striking differences in haplotype frequencies between areas are apparent. AMOVA analysis, using mitochondrial sequence data (microsatellite analysis is ongoing), indicates significant population subdivision ($F_{st}=0.10$, overall $p<0.002$, pairwise comparisons $p<0.02$) between northern samples ($n=18$), Ría Gallegos ($n=26$) and a small sample of

dolphins from the captive colony at SeaWorld San Diego ($n=7$) that were originally captured in the Straits of Magellan. Comparisons based on haplotypic distances indicated strong differences between regions ($F_{st}=0.19$, $p<0.002$). This research provides the first indication of low genetic diversity, reduced gene flow and statistically significant genetic differentiation within local subpopulations of *C. commersonii*, along a relatively small stretch of coastline.

Taxonomic Patterns of Vulnerability in Marine Mammals

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While many (34 of 87) of the world's marine mammal species are imperiled, for many more ($n = 42$) not enough is known to properly assess their status. Understanding taxonomic selectivity (non-random vulnerability) among marine mammals globally may provide the information needed to predict susceptible species thereby helping to focus conservation efforts. We determined if taxonomic patterns exist among the world's marine mammal species groups (family, sub-order and order) currently at risk of extinction, for both species and lower taxonomic units (species, subspecies and stocks) identified by IUCN Red List. In total, 14 of 21 families contained at least one threatened species and 16 contained at least one threatened unit. Taxonomic selectivity was indicated in families (Monodontidae, Otariidae, Balaenidae, Balaenopteridae), sub-orders (Mysticetes) and orders (Sirenia), indicating that they have more threatened species than expected. The classification of unknown risk species also showed non-random patterns and they were concentrated in several families, particularly within Cetacea. Taxonomic selectivity patterns were significantly affected by how unknown risk species were assessed indicating the need for focused research. If these unknown species are in fact vulnerable then selectivity is indicated for additional families (Delphinidae, Ziphiidae, and Phocoenidae), sub-orders (Odontoceti) and orders (Cetacea). These results indicate opportunities to triage conservation planning on certain key marine mammal groups and indicate areas where critical conservation information is lacking.

Observations of the Integration of a Stranded Dolphin (*Tursiops truncatus*) Calf into an Established Social Group of Captive Dolphins

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A stranded bottlenose dolphin (*Tursiops truncatus*) calf, approximately six months of age, was rescued and kept in isolation until a decision had been reached to keep her in captivity. At this point, an attempt was made to integrate her into an established captive population of adult female and juvenile dolphins. Observations of her behavior and that of the other dolphins were conducted throughout the following year in order to monitor the calf's integration into this established social group. Initially, the calf was kept in an enclosure with a net barrier that separated her from the other dolphins, but allowed visual and acoustic contact. Once the net barrier was removed, the calf and the other dolphins had free access to one another. Over the course of the study period, the calf's resting behaviors decreased significantly, while her play and social behaviors increased significantly. Analyses of the calf's social interactions revealed that even though she interacted with all six of the other dolphins, she was most likely to interact with a young female. Although most of these interactions were affiliative, the young female was also the animal most likely to be aggressive toward the calf. The calf's interactions with four of the other five dolphins were also mostly positive, but those with a nine-year-old female were primarily negative. When this dolphin interacted with the calf, it was most likely to chase or bite her. These data demonstrate that it is possible to integrate a strange dolphin into an existing social group, but that there are substantial individual differences

in the ways dolphins react to new group members.

Status of the Beluga Population of Cook Inlet: Is This Population Poised for Recovery?

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During the 1990's the estimated abundance of the Cook Inlet beluga (CIB) declined by 47% (653 to 347). By the end of the decade the CIB was declared depleted under the US Marine Mammal Protection Act and severe restrictions were placed on the harvest by native subsistence hunters. During the period from 1994 to 1998 the harvest had averaged around 70 beluga per year, between 1999 and 2004, a total of 3 whales have been harvested. Annual abundance estimates by NOAA Fisheries since 1999 have not indicated significant growth and analysis using a simple logistic population model indicates that the most likely growth rate for this population is between 0 and 1%, far below the 4% growth rates typically assumed for small cetacean populations. However, this apparent lack of recovery in the initial years after termination of the unsustainable harvest level was predicted by an age-structured model which accounted for the preference of harvesters to take larger older whales. Selective harvest of older animals resulted in an age distribution skewed toward immature animals. As immature animals mature, this model predicts a surge in growth. This talk discusses the data requirements and management implications of these two models.

Comparisons of Blubber Fatty Acids Between Sexes of Adult Steller Sea Lions (*Eumetopias jubatus*)

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One hypothesis for the decline of the western stock of Steller sea lions (*Eumetopias jubatus*) is nutritional stress, which may have adversely affected female fecundity. Fatty acids in the blubber of sea lions are an index of diet. Thus, comparisons of blubber fatty acids between adult male and female Steller sea lions may indicate if dietary differences exist. Such differences could affect nutritional status. Blubber samples were collected from adult male ($n = 33$) and female ($n = 14$) Steller sea lions at four locations near Kodiak, AK in 2004. A total of 68 fatty acids were identified in the samples. Of those, 43 were normally distributed using a one sample K-S test. These 43 fatty acids were used as variables in a Principal Components Analysis (PCA). The first principal component (PC1) accounted for 23.67% of the variance in the data while the second component (PC2) accounted for 13.54%. The fatty acids with the highest loadings in the rotated component matrix were 20:1n-11 and 24:1n-9 for PC1 and 16:3n-4 and 18:4n-3 for PC2. Males and females showed some differentiation on the second principal component. No distinct separation was seen between the sites from which samples were collected. A second PCA conducted on a subset of 31 fatty acids believed to come primarily from diet yielded much clearer separation of males and females by the first two principal components. Here PC1 and PC2 accounted for 49.51% and 14.86% of the variance respectively and the fatty acids with the highest loadings were 22:5n-6 and 20:1n-9 for PC1 and 20:5n-3 and 18:3n-3 for PC2. Scores for females formed a tight cluster while those for males had a wide spread. This implies that, between individuals, female diet is less varied than male diet. Again, no separation by sampling site was observed.

Evolution of Population Genetic Structure of Killer Whales (*Orcinus orca*) in the North Pacific

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The killer whale is distributed throughout the world, and most abundant in temperate and polar waters. In the North Pacific there are coastal populations from California to the Kamchatka Peninsula that are the subject of long-term studies. In several regions the tracking of individually identified killer whales has led to a detailed understanding of association patterns and foraging behavior. This has permitted the classification of different 'ecotypes' across this distributional range, as well as populations of the same ecotype that are separated geographically. The primary distinguishing characteristic is prey choice (especially marine mammal vs. fish prey), though there are other aspects of social group structure and behavior that distinguish these putative populations. Earlier studies identified the low level of mtDNA variation for this species, and the fact that mtDNA haplotypes appear to be fixed within most regional populations. In this study we use 16 microsatellite DNA loci to compare over 200 whales (from putative populations in California, Washington State, Southeast Alaska, the Bering Sea, the Kamchatka Peninsula, and including Iceland as an outgroup). We used a combination of F-statistics, likelihood assignment and coalescent methods to show that regional populations are genetically differentiated both by ecotype and in geographic isolation. Populations of the same ecotype show a strong correlation between geographic and genetic distance, while populations of different ecotypes are differentiated in sympatry. The magnitude of genetic differentiation (and estimated gene flow) is similar for geographically distant populations of a given ecotype (e.g. Kamchatka vs. Washington State) and sympatric ecotypes (e.g. fish vs. marine-mammal-eating groups in SE Alaska). Taken together the microsatellite DNA and mtDNA data suggest that North Pacific population structure evolved by the founding of geographic regions and niches by matrilineal groups (perhaps from offshore stocks after the last Ice Age), and their local expansion and differentiation by drift.

Seeing Through the Clutter – Acoustic Imaging in Dolphins

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Modeling the echolocation system of dolphins has been a topic of active research in the last decade. Although the sound production system is now fairly well understood, the reception and processing of the perceived signals still poses a challenge to a general model of dolphin echolocation. Previous experiments have shown that dolphins can recognize shape through echolocation and are able to transfer this information to the visual sense and visa versa. The dolphin's receiving system is not a 2-dimensional fully populated array as would normally be expected for imaging systems. This poses the question of how the dolphin is able to reconstruct the shape of an object within the constraints of a sparse array. Beamforming of broadband signals with sparse arrays produce uncertainties in the exact location of the reflective point if multiple reflective points are present. This is indeed the case when a dolphin's echolocation signal is reflecting back from an object and the echoes from several points on the object arrive at the receiving system within a small time window. Hence, dolphins must have developed processing capabilities that would allow them to resolve this ambiguity. We present an approach with 3-dimensional algorithms based on an acoustic adaptation of the Marr-Poggio algorithm and the use of incoherent synthetic aperture that would allow a sparse array system to resolve these spatial ambiguities.

Female Bias in the Dispersal of Southern Elephant Seals at Marion Island

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Sex bias in dispersal is usually characterized by reference to a species' social structure and social adaptation to environment. Social systems showing mate defence polygyny generally show male biased dispersal. One of several theories advanced to explain this states that benefits accrue to females from site fidelity since local knowledge aids them in competition with other females for resources. On Marion Island (46°54'S, 37°45'E), however, female southern elephant seals *Mirounga leonina* compete for few, if any resources, during the breeding season. We attempted to ascertain whether this would affect patterns of sex bias in dispersal. All elephant seals born on the island over a twelve year period were tagged, and resights recorded as part of a larger study. The distances displaced between natal sites and breeding haulouts were determined and used to calculate dispersal distances. While both male and female southern elephant seals hauled out to breed closer to their natal sites than expected, a significant female bias for both natal and breeding dispersal was found. Female seals moved an average of 8.6 km from their natal site to breed for the first time, compared to the 6.4 km of males. Returning to breed in subsequent seasons females hauled out 6.1 km from their first breeding site, almost twice that of males (3.1 km). While it is possible that competition between females is important in explaining sex bias in dispersal, the later arrival of female seals at parturition sites during the breeding season, and their inability to move site once accompanied by dependant young may also be important in determining their patterns of movement.

Can Whale Blow Be Used to Measure Reproductive Hormones?

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Do we really need to kill whales to study their reproductive physiology? Studying the internal physiology of great whales was easy during the whaling days, however since whaling ceased in the mid-20th century, there has been no non-fatal method to assess their reproductive physiology. Some whale populations are not recovering so a greater understanding of their reproductive behaviour is vital; leading to better population management and a greater understanding of their reproductive dysfunction. Saliva has been used in humans and some animal species to determine reproductive hormones. This study examines the feasibility of measuring reproductive hormones in whale blow exudate using liquid chromatography-mass spectrometry (LCMS). A rapid, accurate and reproducible assay utilising LCMS has been developed for measuring testosterone and progesterone concentrations in saliva and blow exudate of bottlenose dolphins. This assay was used to qualify the presence of reproductive hormones in blow exudate from 29 humpback whales. During assay development we found that steroid hormones (testosterone and progesterone) were unstable at room temperature, -20°C and -80°C, in saliva and blow exudate. Hormone concentrations increased by up to 65% at room temperature. However, when a suitable inhibitor was added, changes in hormone concentrations slowed but did not cease until samples were extracted. This study highlights the need for stability studies to be conducted on non-invasively collected samples which are commonly used to determine reproductive hormone concentrations in endangered species and other wildlife.

Taking Marine Mammals Incidental to Maritime Activities: An "Insurance Policy" for Scientific, Industrial and Military Maritime Activities?

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The Marine Mammal Protection Act (MMPA) prohibits the taking of marine mammals unless exempted by the MMPA or authorized under a permit. One of these authorizations is for the taking (harassment, injury or mortality) of marine mammals by legal maritime activities

provided the taking will have only a negligible impact on the affected species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking and requirements for monitoring and reporting any takings are provided in the authorization. Although not implemented until late in 1981, when the MMPA was amended by Public Law 97-58, the National Marine Fisheries Service since that time has authorized the incidental taking of marine mammals for such widely diverse activities as seismic exploration by both the U.S. oil industry and scientific research institutes; highway bridge construction in California; military and oil industry undersea explosives detonations; and Navy sonar operations. This presentation provides a brief historical overview of these authorizations, reviews improvements in the program, including new mitigation and monitoring protocols for reducing impacts on marine mammals to the lowest level practicable, and how new acoustic information is being addressed when making the legally required impact determinations for marine mammals under the MMPA.

Investigating the Assumption of Signal Homogeneity in Marine Mammal Stable Isotope Studies: Within and Across Tissue Comparisons in Otariids

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In marine mammal ecological studies, stable isotope analysis (SIA) may be used to examine issues of trophic dynamics and diet choice. However, the technique makes a number of assumptions that are largely untested to date. One assumption is within-tissue signal homogeneity; that is, marine mammal SIA studies typically sample a small section of tissue that is assumed to be representative of the whole animal, since sampling an entire carcass would require the sacrifice of that animal, and is also logistically impractical. To specifically test this assumption of signal homogeneity we repeat-sampled biopsies of muscle and skin taken from Steller sea lions ($n = 5$) and Californian sea lions ($n = 6$) at six standardized locations across the animal's body. Multivariate analyses demonstrated that both skin and muscle isotope signatures could be used to determine species. For $\delta^{15}\text{N}$ values, skin values were significantly higher than muscle values in both Steller sea lions (mean difference [MD] = 0.46‰) and Californian sea lions (MD = 0.93‰). Similarly, skin values for ^{13}C values were significantly higher than muscle values in Steller sea lions (MD = 1.21‰), and in Californian sea lions (MD = 0.82‰). Importantly, a lack of significant differences between tissue sampling locations indicated signal homogeneity within skin tissues for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. Similarly, muscle tissues demonstrated signal homogeneity for both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ variables. These results indicate that sufficient homogeneity exists within skin and muscle tissues for point sampling to be a representative technique in marine mammal stable isotope studies. However, as a note of caution, preliminary data also suggested that isotopic signal may become more variable in poorer condition carcasses.

Evidence of Continuing Declines in Fecundity of Steller Sea Lions in the Central Gulf of Alaska

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From 2000 to 2004, index counts of western stock Steller sea lions (*Eumetopias jubatus*) in the Gulf of Alaska and Aleutian Islands increased by ~10%, reversing a 30-year, 80% decline. A demographic model based on counts of pups and non-pups and the proportion of juvenile sea lions on haul-out sites in the central Gulf of Alaska indicated that the steep decline experienced by the population in the 1980s was caused primarily by a large drop in the survival rate of juvenile sea lions, but smaller decreases in the rates of adult survival

and female fecundity occurred as well. As the rate of population decline slowed through 1998, juvenile and adult survival rates increased, but the decline in fecundity persisted. Here we report that these trends continued through 2004. These findings support the hypothesis that factors affecting the condition and reproductive potential of adult females (e.g., disease, nutritional stress), rather than direct mortality sources affecting some or all of the population (e.g., illegal shooting, predation), are the primary threats to recovery of the western Steller sea lion population.

Occurrence of Cetaceans During Shipboard Surveys in the Eastern Tropical Pacific Ocean off Central America, November–December 2004

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Visual and acoustic surveys were done as part of the monitoring and mitigation program during Lamont-Doherty Earth Observatory's seismic survey in the Eastern Tropical Pacific. Few if any systematic surveys for cetaceans have taken place in the study area at that time of year. One or two observers watched for cetaceans from the flying bridge of the source vessel, *R/V Maurice Ewing*. A total of 4965 km of visual observations were made. Most (69%) effort occurred during the day with 31% at night. Eighty-four percent of the effort occurred during seismic operations with a small source consisting of three Generator-Injector (GI) guns; the maximum discharge volume was 315 in³. A total of 2091 individual cetaceans were seen in 81 groups; 23 of these groups were also detected acoustically, as were an additional 194 groups. The pantropical spotted dolphin, *Stenella attenuata* ($n = 13$ sightings) and humpback whale, *Megaptera novaeangliae* ($n = 11$) were the most commonly identified species, followed by the bottlenose dolphin, *Tursiops truncatus* ($n = 8$). *S. attenuata* was also the species most frequently detected acoustically. On an individual basis, more spinner dolphins, *S. longirostris* ($n = 1350$ individuals) were seen than any other species. In addition, single sightings of the following species were made: short-beaked common dolphin, *Delphinus delphis*; *Delphinus* spp.; Risso's dolphin, *Grampus griseus*; false killer whale, *Pseudorca crassidens*; short-finned pilot whale, *Globicephala macrorhynchus*; and minke whale, *Balaenoptera acutorostrata*. A small concentration of humpbacks was seen (and heard) in the Gulf of Fonseca on 9 December. To our knowledge, concentrations of humpbacks, particularly singing humpbacks, have not been reported in this specific area. A humpback mother-calf pair was also seen off northern Costa Rica on 25 November. Northern and southern hemisphere humpbacks may overlap geographically off southern Costa Rica during November.

Behavioral and Playback Investigations of Call Directionality in Male Northern Elephant Seals

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Most animal vocalizations are directional, that is, the signals are focused in a particular direction that is dependent on caller orientation. However, few attempts have been made to address the behavioral significance of vocal directionality in animal communication systems. Such signal design may serve to maximize propagation, direct calls to intended receivers, reduce the likelihood of eavesdropping, and mediate appropriate listener responses. During the breeding season, male northern elephant seals (*Mirovunga angustirostris*) form dominance

hierarchies through multiple dyadic interactions involving acoustic, visual, and seismic signals. Male vocalizations are both highly stereotyped and directional. The objective of this study was to test whether males in sexual competition attend to the directional cues of the calls of conspecifics (*i.e.*, variation in call spectra and source level) using *in situ* behavioral observations and vocal playbacks. Individual males at Año Nuevo State Reserve, California were identified within a breeding season by unique dye markings. Playback calls were multiple exemplars of a dominant male from an isolated area that were edited into a prescribed natural sequence. Control playbacks were recordings of ambient rookery sounds with male calls removed. Playbacks were conducted on 20 males (10 adults and 10 subadults). Calibrated playback presentations were broadcast 7m from each subject. Responses to playbacks were easily classified into the following categories: visual orientation, postural change, calling, positive or negative phonotaxis, and re-directed aggression. Hierarchical and developmental variables were also considered. Calling in response to playbacks was only observed in older, more dominant males and rarely occurred during control sequences. Phonotaxis was correlated with the directionality of recorded calls and consistent with behavioral observations. These results suggest that call directionality is an important cue used in male-male competition and, thus, elephant seal reproductive behavior.

Resting Metabolic Rate in Free-ranging Juvenile Steller Sea Lions (*Eumetopias jubatus*)

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Nutritional stress, resulting in reduced juvenile survival, is the leading hypothesis for the dramatic decline in the western stock of the Steller sea lion (SSL) population. This hypothesis suggests that energy intake is insufficient to meet daily energetic demands. Some animals are able to compensate for limited food intake by limiting their energy expenditures, with the most common physiological response being a lowering of resting metabolic rate (RMR) known as metabolic depression. To assess the potential significance of metabolic depression in juvenile SSLs, RMR was determined by measuring in-air oxygen consumption rates of free-ranging animals captured from western stocks in Prince William Sound (PWS, n=30) and the Central Aleutian Islands (AL, n=16), and from the eastern stock in Southeast Alaska (SE, n=43). RMR was measured in post-anesthetized animals aged 2, 5, 8, 11, 14, 20 and 26 months at ambient air temperatures (-6 to 18 °C). SSLs were anesthetized for the purposes of deuterium administration and blood sampling (part of a larger study) and no significant differences in RMR were detected in the subset of animals that were measured both pre- and post-anesthesia. Mean RMR ranged from 11.0 to 32.3 MJ d⁻¹ across all aged animals, and as expected, increased with increasing body mass. Similarly, mean mass-specific RMR ranged from 0.13 to 0.28 MJ d⁻¹ kg⁻¹ and decreased with increasing body mass. These values represent a mean (\pm SE) of 2.2 ± 0.6 times the expected mammalian value. Although ambient air temperatures and animal ages varied between locations, similar air temperatures existed between PWS and SE locations. RMR was not significantly different for similarly aged pups and yearlings from PWS and SE. From this study there was no evidence of metabolic depression in western stock animals.

Use of Pupping Phenology to Assess Reproductive Success of Harbor Seal Populations

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During the past three decades, numbers of harbor seals (*Phoca vitulina*

richardii) in regions of the Gulf of Alaska have diminished 60-90%. Although the decline occurred concurrently with large-scale ecosystem shifts, causal mechanisms for the decline harbor seal populations remain elusive. Nutritional stress associated with ecosystem change could affect seal populations by decreasing survival or reproduction. Otariids and phocids have shown prolonged embryonic diapause associated with nutritional stress. Mean parturition dates of harbor seals occurred 6-10 days earlier during periods of stable or increasing pup production than during periods of decline. Our objective was to retrospectively assess pupping phenology and productivity of harbor seals in Aialik Bay, a tidewater glacial fjord in southcentral Alaska, during periods of regional population decline (1979-1981) and increased pup productivity (2002-2005). During the decline, field observations documented maximum numbers of pups on 6/18/1979 (256 pups), 6/13/80 (358 pups) and 6/11/81 (235 pups). Parturition rates, identified by sightings of bloody natal icebergs from 1979 through 1981, showed a bimodal tendency, with peaks clustered around 25 May and 6 June. By 1994 only 40 pups were counted (6/13/94). Since 2002 harbor seals have been monitored using remotely controlled video cameras. From 2002-2005, numbers of pups have increased. Maximum numbers of pups were counted on 3 June 2002 (42 pups), 7 June 2003 (45 pups), 1 June 2004 (59 pups), and 1 June 2005 (70 pups). Coincident with increased pup production was a shift to earlier parturition dates, as indicated by the earlier maximum pup counts. Both phenology and production of pups reflect improved reproductive success of the harbor seal populations in Aialik Bay. The shift toward earlier parturition as the number of pups increased may be suggestive of the duration of embryonic diapause and the condition of pregnant females during the previous summer and fall.

Using a Combination of Swim Speed and Stomach Temperature Sensors to Determine Feeding Events and Prey Encounter Rates in Southern Elephant Seals (*Mirounga leonina*)

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Simultaneous recordings of dive depth, light levels, swim speed and stomach temperature were collected for a post-breeding female southern elephant seal from Macquarie Island. Feeding events were clearly detectable from marked declines in stomach temperature, and occurred at a mean rate of 8.4 events per day (or 1.6% of all dives) for the first 5 days of the foraging trip (after which the temperature sensor was lost). Feeding occurred in both day and night, but was more common at night. The period of acceleration was often in an upward direction indicating that the seals attacked their prey from beneath, and this behaviour was most prevalent during the day. There were other behavioural correlates with feeding events, most notably a marked period of acceleration immediately prior to 85% of all ingestion events. Using the characteristic burst of acceleration as an prey encounter index (PEI), we determined that prey encounters were more common at night, and increased in the days after the seal left the island to be most common while the seal was in the vicinity of the Antarctic Polar Front. Extending this analysis across the entire 58 day foraging trip indicated that the PEI varied considerably, ranging from a PEI of less than 50 per day during the outward and inward phases of the trip, to 150 per day during the middle phase. During this middle phase, prey encounters also varied considerably, ranging from 100 to 150 encounters per day (or 1.5 – 2.6 encounters per dive, per day), suggesting that the prey were patchily distributed in both space and time. This study demonstrates that combining stomach temperature and swimming speed provides a powerful tool for study the foraging ecology of this species.

Differentiation of Adipocyte Collected from Steller Sea Lion *Eumetopias jubatus*

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Stellar sea lion *Eumetopias jubatus* is the biggest otariinae, living in the North Pacific rim from Hokkaido, Japan to California, U.S.A.. Their world population is declined from late 1960s to date. Although nutritional stress is thought to be the cause of declining, physiological mechanism between nutritional stress and population declining is not clear. Recent studies in rodent and human showed various hormones excreted from adipocyte affect on the energy store, immune system and reproduction. Thus adipocyte function disorder caused by nutritional stress may cause the physiological change which connects with population declining. Adipocyte was differentiated from fibroblast-like preadipocyte and this differentiation was affected by various factors, such as vitamins and fatty acids. However factors affecting on differentiation of sea lion adipocyte were not known. In this study, we examined factors affecting on the differentiation of sea lion adipocyte. Sea lion blubbers were collected from harvested or bycaught individuals in the Hamamasu and Rausu town. Blubbers were dissected from breast within 24 hours from death and then stored in phosphorus buffered saline with antibiotic during the transportation. Fibroblast-like cells were collected from blubbers by collagenase digestion and then cultured with Dulbecco's Eagle's Medium/Ham's Nutrient Mixtures F12, 10% calf serum and antibiotic. Since cells reached confluence, they were treated with the medium supplemented with insulin, dexamethazone, isobutylmethylxanthine and troglitazone (induction medium) to induce the differentiation of preadipocyte. After cultured cell with induction medium for 3 days, cells were treated with maturation medium which was the medium removed dexamethazone and isobutylmethylxanthine from induction medium. Preliminary experiment showed that a small part of cultured cells differentiate to adipocyte with this method. However, no cell differentiation was observed when 10 micro mol/L of all-trans retinoic acid which is metabolite of vitamin A was added to induction and maturation medium.

Emerging Perfluorinated Contaminants in Bottlenose Dolphins (*Tursiops truncatus*) from the Atlantic Ocean and the Gulf of Mexico

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Perfluorinated compounds (PFAs) are persistent and bioaccumulating contaminants that are used in stain repellents, paper protectors, paints, and polishes. PFAs have been detected worldwide in sea water, human blood and wildlife. A few studies have assessed PFA concentrations in tissues of stranded cetaceans. To our knowledge, no assessments have been done on wild marine mammals. The objectives of this study were to investigate 1) the geographical as well as the temporal/seasonal

trends of PFAs in plasma of bottlenose dolphins from different locations, 2) the potential PFA bioaccumulation through the dolphin's food web and 3) the potential correlations between PFA plasma concentrations and life-history parameters (age, gender, reproductive history) of dolphins. PFA were extracted from matrices using an ion-pairing method and analyzed with HPLC-MS/MS. Here, for the first time, PFAs were assessed in plasma and milk of live-captured, sampled, and released bottlenose dolphins (*Tursiops truncatus*) from the Atlantic Ocean and the Gulf of Mexico. High concentrations were detected in plasma of animals from Charleston, SC (n=47; total PFAs: 1738 ng/g wet weight (w.w.)) and Delaware Bay, NJ (n=5; 1588 ng/g w.w.) compared to other locations. The lowest mean concentration (49 ng/g w.w.) was detected in 2 animals from the offshore waters of Bermuda. PFA concentrations were not correlated with gender of animals (p>0.05). No overall significant temporal trend in PFA concentrations could be observed in animals sampled from 2002 to 2005. At Charleston, negative relationships between PFAs in plasma and age were found. Levels detected in mother/calf pairs sampled in Sarasota Bay, FL (Gulf of Mexico) showed similar results where calves had higher plasma concentrations than their mothers. Zooplankton (n=3) and fish (n=50) were analyzed and results suggest that several PFAs may bioaccumulate through the dolphin's food web. Results from this study show that PFAs are widely distributed in the marine ecosystem and that these chemicals may reach elevated concentrations in high trophic level organisms.

Vitamin E Protects Steller Sea Lion Cells from Reactive Oxygen Radical Induced Damage

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A number of hypotheses have been proposed to explain the decline of the Western stock of Steller sea lions (*Eumetopias jubatus*), including nutritional stress caused by a major change in the quality and quantity of prey consumed by sea lions. Earlier captive feeding experiments showed that Steller sea lions had lower levels of plasma vitamin E when consuming pollock compared with eating high-lipid herring. Poor vitamin E absorption is associated with increased levels of oxidative stress in mammals, which could be the mechanism responsible for the hypothesized nutritional stress in Steller sea lions. Oxidative stress is an imbalance between the production of reactive oxygen species and antioxidant defense mechanisms — and is known to be caused by environmental contamination, ultraviolet light radiation and/or malnutrition, such as deficiency of antioxidant vitamin absorption. In our current study, skin and liver cells obtained from Steller sea lion tissue were cultured in cell culture media and exposed to different experimental conditions. Both cell types were challenged with reactive oxygen species (i.e., hydrogen peroxide and peroxyl radical for 24-48h), and the viability of the cells in each dish was tested with a modified MTT test. We found that adding supplemental vitamin E to the cell cultures increased the survival of Steller sea lions cells when exposed to sublethal concentrations of hydrogen peroxide. This supplemental vitamin E significantly suppressed (p<0.05) intracellular oxidation in both skin and liver cells. Results derived from our study thus provide in-depth evidence of the importance and benefit of antioxidant vitamin to marine mammal health and wellness. The use of cell cultures also provides an alternative non-invasive method to understand how environmental and nutritional stress induced-toxicity can affect marine mammals health.

Spatiotemporal Pattern of Cetacean Strandings in Taiwan

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In order to understand spatiotemporal variations of cetacean stranding in Taiwan, we compiled 268 cetacean stranding events since 1994 to March 2005. We used the following factors to relate stranding records: coastal zone, seasonal monsoon, lunar cycle, and weather harshness (cold air mass). Our results indicated that stranding rates were correlated to monsoons, lunar cycles, and coastal zones. Stranding rates were higher during northeasterly (NE) monsoon seasons (October to next April, 25 events/month) than that of southwesterly (SW) monsoon seasons (May to September, 17.8 events/month). The proportion of dead or live strandings differed by seasons; more dead records were found in NE monsoon seasons, while no differences were found in SW monsoon seasons. Furthermore, one-third of the stranding events coincided with the cold air mass occurred during the NE monsoon seasons. Regarding the lunar cycles, stranding rates reached peaks in day 1-3 and day 15-18 while spring tides occur, and this might be relevant to fish movement patterns. Spatial variations differed between two monsoon seasons as well. During season of NE monsoon, strandings occurred frequently in many coastal places in Taiwan; in the other hand, southwest Taiwan was relieved from strandings during SW monsoon seasons. Most stranding events occurred at the coastal section from Tou-Cheng to Bei-Fang-Aou, and this might be relevant to the notorious eddies in the surrounding waters.

Strategies of Prenatal Reproductive Investment in Cetaceans

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Few numbers of offspring for a mother can afford for her whole life means great reproductive investment and risk of each calf of cetaceans. We explore the potential strategies of maternal investment to prenatal growth by reviewing 79 species of cetaceans. Four traits were collected from publish literatures: female asymptotic length (L_{∞}), length at birth (L_b), gestation period (GP), calving interval (CI), and one derivative prenatal growth rate (PGR) which was calculated by L_b/GP . Based on discriminant analysis among 14 taxonomic (family) groups, 7 groups can be found. Allometric regression of the original 5 traits of 7 groups shows that L_b is significantly correlated with maternal length with a group (Type 2) of species significantly higher. In addition, L_b is significantly correlated with GP only for the smaller cetaceans (include 8 families, Type 3), but not for larger cetaceans. Furthermore, based on the regression between maternal length and PGR, larger cetaceans can be significantly grouped together (Type 1 and 2) and they are significantly higher. Therefore, from the perspective of prenatal investment, 7 groups of cetaceans can be further grouped into three general types with different strategies of reproductive allocation: Type 1 is composed by baleen whales characterized with fast foetal growth but short GP, Type 2 by beaked whales, sperm whale and killer whale by fast foetal growth and long GP and CI, and Type 3 by the rest of cetaceans by slow foetal growth but long GP. Mothers of Type 2 species may invest more in total prenatal growth. The species of Type 1 and Type 3 have similar prenatal investment but with different emphasis. Type 1 takes high PGR with short GP which may be helpful to reduce the metabolic waste, while Type 3 take low PGR with long GP to balance their cost.

Feeding Season Movements and Fall Migration to Wintering Areas for Chilean Blue Whales

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In January and February 2003, we tagged five blue whales in a recently re-discovered summer feeding habitat off southern Chile. We received data from all of the tags. The longest operation was a tag which provided data for up to 203 days and 9,433 km. We tracked the five whales for a total of 25,932 km. This is the first information on the movements of individual southern hemisphere blue whales. We characterized the oceanographic features of the summer feeding areas, including home ranges. The whales stayed in the Chilean waters longer than expected, staying near-shore and in fjord areas for the most part. Some made round trips out of the fjords region to offshore areas. Two of the whales migrated north to the region of the Nazca Ridge (25°S and 800 km offshore), an area of upwelling. We hypothesize that this may be the winter reproductive area for this population, where they can also continue to feed. Characterization of the wintering area is underway.

Assessment of the Diet of Southern Sea Lion (*Otaria flavescens*), and Appraisal of the Structure of the Pelagic Food Web off Central Chile Based on Stable Isotopes Analysis

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The abundance of stable isotopes was used to examine feeding habits of southern sea lions (*Otaria flavescens*) and to discern their position in the food web. The diet of sea lion is poorly known along the coast of central Chile (32°-39°S), where a population of about 17,300 sea lion occurs, and the pelagic ecosystem sustains one of the most important fishing industries in the world. The primary objective of this study was to determine the composition of the diet of sea lion through the stable isotopes technique and to get an appraisal of the food web structure off central Chile. Isotopic ratios ($\delta^{13}C$ and $\delta^{15}N$) were determined from samples of sea lion, previously identified prey species, the euphausiid *Euphausia mucronata* (keystone species of the ecosystem), and Particulate Organic Matter (POM). Jack mackerel (*Trachurus murphyi*) appeared as the principal prey item in the diet of sea lion (57.8%), followed by anchovy (*Engraulis ringens*) (13.7%). Sea lion consumed prey with both demersal and pelagic carbon signatures. Trophic Positions (TPs) varied between 2 for *E. mucronata* and 4.57 for sea lion. TPs of fishes ranged between 3.4 and 4.47. The diet of sea lion off central Chile has changed in the last 20 years, with an increased importance of jack mackerel. The central Chile ecosystem consisted of at least 5 trophic levels, where sea lion constitutes the top predator and *E. mucronata* is the primary consumer of POM. This is the first study of the diet of sea lion based on stable isotopes for Chilean waters, and one of the few dietary studies conducted during the last two decades in Chile. It is also the first approach to the foraging ecology of the species, and to the trophic position and role of sea lion on the ecosystem off central Chile. Funding: Society for Marine Mammalogy, Sociedad Chilena de Ciencias del Mar, Minera Escondida Ltda., Escuela de Graduados-Universidad de Concepción

Inter-Island Movements and Re-Sightings of Melon-Headed Whales Within the Hawaiian Archipelago

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Although distributed throughout the tropics world-wide, little research has been undertaken on free-ranging melon-headed whales due to their oceanic habits and apparent frequent avoidance of vessels. We studied melon-headed whales as part of a multi-species assessment of odontocete populations around the main Hawaiian Islands. We surveyed 27,864 km of trackline on 271 days between 2000 and 2005, and encountered this species on 18 occasions, the sixth-most

frequently-encountered species of odontocete (representing 3.4% of odontocete encounters). While melon-headed whales were found over a range of depths (255 to 4,407 m; mean = 1,999 m; SD = 1,167 m), an analysis of depth distribution in relation to effort indicated a preference for depths > 2,000 m. Groups were generally extremely approachable, with individuals often bowriding. Group size ranged from approximately 17 to 800 individuals (mean = 305; SD = 190). Melon-headed whales were seen avoiding killer whales on one occasion, but were frequently seen associating with other species: rough-toothed dolphins (4), short-finned pilot whales (2), humpback whales (1), and pantropical spotted dolphins (1). Over 9,000 photographs were taken, most (>8,500) off the island of Hawai'i, with only small numbers of photos off Kaua'i (527, one encounter) and O'ahu (131, one encounter). While photographic matching is still underway, using only good quality photos we have thus far documented 307 distinctive individuals, including 214 from Hawai'i, 21 from O'ahu, and 74 from Kaua'i. Distinctive individuals had from 1 to 10 notches (mean = 3.3; SD = 1.9) on the trailing edge of the dorsal fin. Five individuals have been re-sighted between years off the island of Hawai'i, suggesting some residency to the area. Despite this overall low level of re-sightings, two individuals have been re-sighted between Kaua'i and the island of Hawai'i, suggesting that interchange among islands may frequently occur.

Persistent Organic Pollutants in Blubber of Male Steller Sea Lion (*Eumetopias jubatus*) from Different Locations in the Northern Pacific Ocean

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Steller sea lions (*Eumetopias jubatus*) are endemic to the Northern Pacific Ocean and belong to the eared seal family (Otariidae). This species has undergone a drastic population decline during the past 3 decades, which has led to its listing as threatened and endangered in 1990 and 1997. The cause of this decline is unknown. Omnipresent in our environment, persistent organic pollutants (POPs) include polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs). PBDEs are widely used flame-retardants and structurally similar to PCBs. The use of PCBs as coolants and lubricants has been restricted in most developed countries during the 1970s-1980s, but PCBs are still present in high concentrations in the environment. In the marine environment, POPs accumulate to the greatest extent in marine mammals, which occupy the highest trophic levels of the marine food chain. High concentrations of POPs have been found to cause adverse effects especially in the reproductive and immune system of marine mammals. Our hypothesis is that the Steller sea lion population decline, or their failure to recover is due to long term exposure to POPs. POPs (PBDEs, PCBs and OCPs) were analyzed in blubber of male Steller sea lions from three disparate locations to gain a broader view of possible pollution. The sample sites ranged from Olutsky Gulf (Russia n=10), St. Paul (Bering Sea n=8) to Tatitlek (Prince William Sound n=7). The blubber samples were extracted with carbon dioxide supercritical fluid extraction, followed by a clean up step using florisil and lipid removal by sulfuric-acid silica. GC/ECD in combination with MS/MS was used for quantitative determination of the compounds. POP profiles and concentrations will give further needed basic data and provide more insight into the pollution profiles in animals from geographically different regions of one habitat.

Quantitative Analysis of Habitat Use of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in Hong Kong Waters

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We have studied a resident population of Indo-Pacific humpback dolphins in Hong Kong intensively since 1995. As habitat degradation (e.g. coastal reclamation, intense vessel traffic, overfishing) threatens the survival of local dolphins, a detailed study has been initiated to quantitatively assess their habitat preferences, and to identify their critical habitats in Hong Kong for better conservation and management. Positions of 2,369 on-effort dolphin sightings from line-transect vessel surveys conducted from 1996-2004 were plotted onto 1 km x 1 km grids on a GIS basemap of waters around Lantau Island where the dolphins generally occurred. Density of sightings in each 1 km² grid was calculated and normalized by survey effort, with the density unit termed "SPSE" (number of sightings per 100 units of survey effort). The SPSE values ranged from 0.38-35.09 per grid, with an average of $4.7 \pm \text{s.d. } 6.69$ (n=337). Density grids with higher SPSE values were generally located around outlying islands or in proximity to natural coastlines, indicating the dolphins' preference for these habitats. In particular, most grids along the west side of Lantau Island had much higher SPSE values than those along the north and south sides of the island, showing a clear habitat preference to West Lantau waters where there is more natural coastline, less human disturbance and stronger influence from the Pearl River outflow. Moreover, most grids west of Lantau Island had higher sighting densities of dolphins exhibiting feeding and socializing activities and that included mother-calf pairs, further indicating these grids as critical habitats for the dolphins in Hong Kong. This fine-scale, quantitative analysis of habitat use has proven to be a valuable tool for EIA studies in Hong Kong to identify specific important dolphin habitats that should be avoided for proposed development projects, or be established as marine protected areas.

A Multiple Regression Model for Predicting the Energy Requirements of Marine Mammals

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Marine ecosystem management has prompted the need for better understanding of the effect of marine mammals in the oceans. Using the wealth of published information, we developed a rule-based multiple regression model to estimate the energy requirements of all 124 marine mammal species. This framework provided a simple method for estimating marine mammal energetics (metabolism or consumption, kJ/d) under varying conditions, as a function of easily obtained or estimated physiological and environmental variables (including morphology, growth, sex, reproductive state, health, activity, postabsorptive state, thermoneutrality, and season). Based on different combinations of input variables, a set of empirical equations was developed. Extensive model validation indicated that all equations were robust in their statistical assumptions, including phylogenetic independence, and captured a substantial amount of the observed heterogeneity in energy requirements (up to 85% residual variance). Equations also synthesized evidence of a uniform pattern of energy use, from consumption to expenditure, and provided quantitative estimates of the components of the bioenergetic framework for all marine mammal species. Results suggest that mass is a better predictor of energy requirements than length, although length may be used when mass cannot be estimated or measured. By including flexibility in prediction and uncertainty in estimates, results extend the simple allometric scaling relationships with mass alone (e.g., Kleiber's Equation), and refine current estimates of marine mammal energy requirements. Results serve as a starting point from which complex analyses can proceed, and provide a basis against which other models can be compared. Resulting equations provide an objective means for researchers and resource managers to select an equation most appropriate for their predictive needs, even for data-deficient species, given different levels of available input information. The equations are useful tools for parameterizing ecosystem models and can be used to address ecological questions and issues pertaining

to conservation and resource management.

Consistency in Click Characteristics with an Echolocating *Tursiops truncatus*

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In this experiment the dolphin was asked to perform a discrimination task between two simulated targets. The echoes from these targets were digitally created using a phantom echo generator which replicated the actual echo characteristics of solid spherical stainless steel or brass targets. The system recorded each click produced by the dolphin and the corresponding echo received by the dolphin. During the discrimination task the dolphin used a range of clicks that differed widely in peak frequency and bandwidth. However, the echoes that were returned to the dolphin showed significantly less variability in these characteristics. A closer analysis of the clicks made by the dolphin revealed a high degree of consistency in just a portion of the full bandwidth of its clicks between 29 and 43 kHz. This is the frequency range that was both within the dolphin's hearing range and had the best reflectivity off the target. The frequency spectrum above 43 kHz showed a much higher degree of variability. The dolphin most likely demonstrated less control of frequencies above 43 kHz because they were outside its hearing range. This indicates that the dolphin most likely uses its own hearing to adjust the frequency content of its clicks.

The Function of Dugongs' Chirp Calls, Revealed in a Wild Playback Experiment

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Dugongs, *Dugong dugon*, are listed as vulnerable to extinction in the IUCN Red List. They are known to vocalize bird-like calls, such as chirps, trills and barks, but the functional definitions of the calls are yet to be clarified. We first recorded dugong vocalizations in Thailand and focused on the chirp call, the most frequent in the area. We then conducted a playback experiment to investigate dugongs' vocalization-associated behavior. The dugong population was exposed to 4 different playback stimuli: (1) a recorded chirp call of a wild dugong in the focal area (DC), (2) a synthesized down-sweep sound similar to a real dugong chirp (FM), (3) an artificial call without frequency modulation (CF), and (4) no sound as a control (NS). Positions of the sound sources of both the playback stimuli and the calls from dugongs inhabiting the area were located by analyzing the data from 4 sets of stereophonic underwater sound-recording systems, using the hyperbolic navigation method. The number of calls recorded after the playback of DC was significantly higher than those of CF and NS. When DC and FM were played, the closest distances between vocalizing dugongs and the playback source were 5.7 m and 4.9 m, respectively. However, in the case of CF and NS, they were 58.4 m and 91.3 m, significantly greater than in the former case. These results suggest an attractive function of dugongs' chirp call, and that the attraction occurs and/or increases while they exchange calls. There was neither a seagrass bed nor a dugong feeding trail near the playback source. Also there was no sighting of a cow-calf pair, but mating behavior was observed twice. Considering these observations, we interpret the dugongs' close approach to the playback source as suggesting that their vocal exchange plays an important role in their mating or territory protection.

Historical Status and Future Prospects for Dugongs

(*Dugong dugon*) in the Gulf of Mannar, Based on Interview Surveys

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Interview surveys (131 interviews in 44 villages) were carried out in 2004 to assess the present status of the dugong population inhabiting the Gulf of Mannar between India and Sri Lanka. The area has been an important dugong habitat in the past but there is little recent data. The Gulf is highly productive and intensively fished by both countries resulting in extensive mortality of dugongs due to direct hunting, accidental bycatch and destructive fishing practices, causing the species to be at high risk of local extinction. Locally focused interviews were used among fishing communities to assess perceptions regarding dugongs in the region. Responses show that number of dugongs have declined drastically, with decreases in sightings and group sizes in both countries. Illegal hunting and accidental bycatch of dugongs still takes place in both countries due to the popularity of dugong meat that continues to drive the illegal market despite legal prohibitions. Fishing communities adjacent to the Gulf of Mannar are familiar with the protected status of the dugong and the dugong's life history and behaviour but do not consider it to be economically important. It is clear from this work that the population of dugongs is now very small and scattered in the region. The population is in critical need of conservation action but any measures will be unsuccessful without the support of local fishermen. The recent tsunami has increased the resolution amongst fishers to revive their economic status, increasing fishing intensity with new fishing gears. Another new development is the initiation of Sethusamudram Project, the dredging of a deep channel across Adam's Bridge between the two countries, for ship movement. Recommendations for dugong conservation are an intensive and widespread community based conservation program offering various economic incentives to fishers, and a joint management plan between India and Sri Lanka.

Seasonal Patterns in Nutritional Quality of Pelagic Prey at a Steller Sea Lion Rookery in Alaska

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Pinniped metabolic needs vary seasonally, and surveys have shown that the distribution and abundance of fish stocks also vary spatially and temporally. Thus, pinniped species may have to meet their energetic demands while foraging on a nutritionally changing prey base. We collected Steller sea lion prey samples around a rookery in the central Gulf of Alaska to study this potential variation in prey base. Midwater trawl surveys were conducted at night within a 10 nm radius of the Chiswell Island rookery/haulout. Surveys were timed to parallel key metabolic periods for the sea lions (pupping/breeding, post breeding/molting, winter). Nutritional quality of prey was assessed by the following parameters: energy density, proximate analysis, amino acid profile, and mineral and vitamin content. Walleye pollock were the major component of the prey base in the surveys. Other fish species collected in the trawls were Pacific herring, eulachon, sable fish and surf smelt. The mineral, amino acid and vitamin content did not vary significantly between surveys. The energy density of the prey did show temporal variability: adult fish sampled in April had a lower energy density than in November. The energy density of juvenile fish varied temporally and with age class. In spring and summer Chiswell Island pollock fed primarily on euphausiids. Euphausiids exhibit diel vertical migration. Adult pollock were consistently found in the upper 100m at night, presumably having migrated to the surface to feed on their euphausiid prey. In November the pollock did not exhibit this behavior and occupied greater depths. Based on

information from captive feeding studies and current knowledge of Steller sea lion metabolic and physiological requirements, our results suggest that the population at Chiswell Island has access to a nutritionally adequate pelagic prey base.

Using Data Collected from a Whale Watching Tour-boat to Examine the Effects of Benthic Topography and Oceanographic Features on the Distribution of Fin Whales (*Balaenoptera physalus*) and Minke Whales (*Balaenoptera acutorostrata*) in the Lower Bay of Fundy, Canada

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The distribution of fin (*Balaenoptera physalus*) and minke (*Balaenoptera acutorostrata*) whales in the Bay of Fundy, Canada was examined using data collected from a commercial whale-watching vessel during July to September 2002. The use of platforms of opportunity offers scientists the opportunity to visit and collect data on whales at sea with a marginal cost. An observer recorded the positions, numbers and species of whales encountered and their surface activity during commercial trips. To control for biased search effort, the study area was divided into a grid of cells measuring 2° latitude by 2° longitude. We measured search effort based on the number of visits by the tour boat to these cells and together with sighting locations calculated a sightings rate for fin and minke whales for each grid cell. Relationships between sighting rates and benthic topography including depth and benthic slope were analysed using generalised linear models. Minke whale sighting rates were significantly higher in steep sloping areas; with sightings concentrated in areas subject to tidal wakes near the northern tips of Grand Manan and Campobello Island. Fin whales were also found off the northern tip of Grand Manan and sighting rates for this species were significantly higher in deep areas with sloping topography adjacent to the relatively deep Owen Basin. Foraging was recorded during 87% of all whale encounters and our results indicate that whale distribution in this area is likely influenced by depth, bottom topography and fine scale oceanographic features that facilitate foraging.

Survival Rates of Marine Mammals in Captivity: Temporal Trends and Institutional Analyses

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The Marine Mammal Inventory Report (MMIR), mandated by the Marine Mammal Protection Act and maintained by National Marine Fisheries Service, provides valuable information about the locations and fates of captive marine mammals. We used the MMIR to examine differences in annual survival rates (ASRs) of captive marine mammals over time (1973 to 2003) and to compare ASRs at individual facilities with mean rates for the industry. Specifically, we hypothesized that survival rates have increased significantly over time as animal care techniques improved, and that ASRs at certain facilities may be significantly higher or lower than the industry's mean rates. We performed temporal analyses for five species of pinnipeds and four cetacean species; these were the only species for which adequate data were available. We used chi-square homogeneity tests to determine whether significant differences in ASRs existed over time or among institutions, and estimated confidence limits, incorporating adjustments for multiple comparisons, to identify which time periods

or institutions were different. Survival rates increased significantly over time for all pinniped species and for bottlenose dolphins (BD), but did not change for the other cetacean species. Conclusions regarding the survival of the other cetacean species are limited by small sample sizes and resultant low statistical power. More than 25% of facilities holding harbor seals and California sea lions, but only 4% of facilities holding BD, had ASRs that were significantly higher than the industry's mean survival rates. Our analysis provides current, comprehensive survival analyses for captive marine mammals in the U.S. and demonstrates that husbandry practices have improved since pinnipeds and BD entered captivity. Such analyses enable facilities to measure their success at animal husbandry, which is in their own economic interest. Finally, we highlight the great utility of the MMIR as a resource for managers and researchers.

Relatedness Patterns and the Potential for Nepotism Among Territorial Adult Male Northern Fur Seals

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Male northern fur seals (*Callorhinus ursinus*) show high levels of natal philopatry and territorial site fidelity during reproduction, conditions in which nepotism (preferential treatment of kin; necessary for kin selection) and/or reciprocity (preferential treatment of known individuals) could confer selective advantages. The overall goal of this investigation is to demonstrate the potential for nepotism and test whether vocal recognition could act as a mediating mechanism. Here we report on the population genetic component of the study. Our primary question is whether the population genetic structure at a fine scale is sufficient for nepotistic interactions to occur. To address this question we analyzed the five most variable microsatellite loci (of 13 screened) for 68 males breeding in two low-density sites on St. Paul Island, Alaska. Low density sites were chosen for their logistical advantages and because the apparent lower annual turnover increases the likelihood of local relatedness. All males were marked for identification; tissue was collected remotely with biopsy darts; territorial tenure and interactions were recorded daily along with other behavioural records and experiments. Our sample differentiates between males holding territories with females (1⁰ males), males holding peripheral territories without females (2⁰ males), and local non-territorial roaming males (peripheral males). Estimates of relatedness were carried out with fixed allele frequencies based first on samples of subadult males in the local area and second on island-wide samples. Based on mean pair-wise relatedness values, the current results suggest that local males are more closely related than are males from the larger background sample. In addition, 2⁰ males appear to be significantly more related to the local 1⁰ males than they are to the background males. Together, these results indicate that the fine scale of genetic structuring, necessary for nepotistic interactions, exists within the population.

Characterizing the Diel Dive Habits of Blue Whales off California

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Seven blue whales off of California were tagged with implantable Telonics ST-21 Argos satellite-monitored depth of dive tags which summarized the maximum dive duration, count of the number of dives, and the percentage of time spent in nine different depth ranges for four 6-hr summary periods daily. Locations, water depths, and conservative calculated speeds within segments between Argos-acquired locations were also used for analyses with the average dive depth per six hour period. Diel variation in average dive depth was determined using a two sample t test for each tag using two 'Night' (#1-2) and

two 'Day' (#3-4) periods, revealing significant diel differences in dive depths. Deeper dives occurred during the day than at night, when blue whale prey, krill, migrate toward the surface. Various linear regressions and ANOVAs were also performed on the data. A linear regression with average dive depth and time period (1,2,3,or 4) resulted in significant coefficients for all four time periods, meaning that each time period has a separate significant effect on the average dive duration. The p values were <0.0001 for all except time period 2 (p=0.028). Speed was never a significant explanatory variable in any of the models examined. Separate regressions using 'max dive duration' and 'dive count' as response variables (on the unaveraged data) revealed that all four time periods had a significant effect on both.

Genetic Characterization of Bottlenose Dolphin (*Tursiops truncatus*) Populations in the Southern Gulf of Mexico and the Caribbean

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The bottlenose dolphin, *Tursiops truncatus*, shows a worldwide distribution with a greater occurrence in coastal temperate and tropical waters, although they also occur in pelagic waters. In Mexico their presence is well documented, and the movements between populations of the southern Gulf of Mexico have been assessed by means of photoidentification. In this study we analyzed 59 individuals with four nuclear microsatellite loci and 332bp from the mitochondrial DNA control region to provide a preliminary assessment of the genetic structure of the southern Gulf of Mexico and Caribbean populations of bottlenose dolphins. The studied populations showed high genetic diversity levels with both markers. The microsatellite loci suggested gene flow within the Gulf of Mexico-Cuba group as was previously suggested by ecological and acoustic studies, while mtDNA showed greater evidence for genetic structure, as is often seen due to the difference in effective population size represented by the two marker types. Phylogeographic analyses were used to assess the historical pattern of relationship among these regional populations in the context of previously published data for populations in the Gulf of Mexico and Western North Atlantic.

Comparison of Offspring Body Condition and Maternal Behavior of the California Sea Lion (*Zalophus californianus californianus*) in Two Reproductive Zones at Los Islotes Rookery, B.C.S., Mexico

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Individuals of the same population may have different features relevant for their preservation. They may unequally use the habitat (individuals with more experience and a better condition may settle in the best quality areas), perform various behavioral strategies (reproductive and social); hence, showing a different reproductive success and a distinct survivorship. Such differences might be related to other differences connected to habitat quality, the dynamics of the reproductive groups, and anthropogenic factors. During the reproductive season, Californian sea lions *Zalophus californianus californianus* at Los Islotes colony, Gulf of California, are differently distributed in three main zones of the island. The objective of this work was to compare the offsprings body condition and the maternal behavior of two reproductive zones (SE and W) with different characteristics (density and number of territories) and anthropogenic flow (high and low touristic activity) during the 2003 reproductive season. Offsprings were captured and measured to estimate their body condition and growth rate, the maternal behavior was also recorded to determine possible differences between zones. Moreover, the nursing pattern was determined during the season. The population area, size, and structure, as well as the reproductive areas density and number of territories were calculated. No differences between zones were found; nonetheless, the tendencies registered suggest that offsprings of zone SE have a better condition and a greater maternal investment which

suggests a good condition of the mothers. As opposed to zone W, zone SE shows a greater area, a less population density, a greater number of territories, and a greater touristic flow. This zone is then suggested to a better site for breeding, although the touristic flow is high.

Myology of the Mandible and Hyoid Apparatus of a Fetus of the Antarctic Minke Whale (*Balaenoptera bonaerensis*)

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Rorquals have unique oral morphology to achieve the highly specialized filter feeding mechanism. The purpose of this study is to describe the muscles of the mandible and hyoid apparatus of the Antarctic minke whale (*Balaenoptera bonaerensis*), and to consider their function. A male fetus (BL 145.2 cm, BW 32.45 kg) was fixed in 10% formalin solution then reserved in 40% ethanol. Detailed dissection, using the gross anatomical technique with two pairs of tweezers and a scalpel, was conducted. We identified 1) masticatory muscles: M. masseter, M. temporalis, M. pterygoideus lateralis and M. pterygoideus medialis, 2) suprahyoid and infrahyoid muscles: M. digastricus (venter anterior), M. depressor mandibulae, M. mylohyoideus, M. sternomandibularis, M. sternothyroideus, and M. thyrohyoideus, 3) muscle of tongue: M. genioglossus, M. hyoglossus and M. styloglossus. The M. depressor mandibulae arises from the angle of mandible and attaches on the exoccipital bone, which draws the mandible caudally. The M. digastricus and M. mylohyoideus are very thin and small without any attachment to the hyoid bone. Both of them are adhere closely to the large platysma muscle and these three muscles are unified. The large supple connective tissue sheet is located immediately deep to these muscles, which is substantially formed a wall of the ventral pouch. The M. omohyoideus, M. geniohyoideus and M. sternohyoideus, all of which insert on the hyoid bones in the ordinary land mammals, are not detected in our specimen. Instead of these muscles, a massive M. sternomandibularis arises from the sternum and inserts on the ventral margin of the posterior part of the mandible and not on the hyoid bone. This muscle can be considered to play a major role in jaw opening and its structure might allow the expansion of the ventral pouch when the animal engulfs the food and water.

Calibration of Fatty Acid Signatures as Indicators of Diet in Captive Hawaiian Monk Seals (*Monachus schauinslandi*) and Application to Free-ranging Individuals

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A decline in available prey has been one of the leading hypotheses to explain the continuing population decline of the endangered Hawaiian monk seal. We conducted a study of captive monk seals to determine whether blubber fatty acid (FA) signatures could be used to better understand monk seal diets. We then applied results to assess geographic, age and sex differences in diets of free-ranging individuals. Ten captive monk seals, held at SeaWorld San Antonio, were maintained on Atlantic herring (8.8% fat) for e³1yr. Eight seals were then switched to a diet of Spanish mackerel (2.6% fat) for 4wks, while two seals remained on herring as controls. We collected full-depth blubber biopsies before and after the diet change. Concurrently, we obtained blubber biopsies from free-ranging monk seals (n=250) and sampled >180 prey species in the Northwestern (NWHI) and Main (MHI) Hawaiian islands. The FA composition of Atlantic herring differed remarkably from that of the natural prey in the NWHI/MHI.

This difference was reflected directly as large differences in FA signatures between captive-fed and free-ranging monk seals. Calibration coefficients calculated from the herring-fed monk seals were similar to those estimated for other phocids and indicate that monk seals metabolize and deposit dietary FAs similarly. Experimental diets were well-estimated using quantitative FA signature analysis (QFASA), despite mass and fat loss when the diets of seals were switched to lower-fat mackerel. Thus, FA signature analysis can be applied to free-ranging monk seals. Although large variability was apparent among individuals, we detected differences in diets between juveniles and adults ($P < 0.001$); differences between sexes were less pronounced. We also detected differences in diets among atolls ($P < 0.001$), consistent with known differences in prey-species assemblages between MHI and NWHI. Our results suggest that QFASA may be an important tool for understanding the foraging ecology of this endangered species.

New Beaked Whale Mass Stranding in Canary Islands Associated with Naval Military Exercises (Majestic Eagle 2004)

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Four Cuvier's beaked whales (*Ziphius cavirostris*) stranded on the Lanzarote and Fuerteventura islands. The first animal was found the 21th of July and the last one the 26th. The previous week (11th-16th July), an international naval exercise (including 10 countries) took place between the Canaries and Morocco waters. Up to now, no specific official information about naval acoustic activities has been achieved by our University. Necropsies were performed in 3 out of 4 stranded whales. The advanced autolytic conditions of the last animal did not allow to take samples for histology. Tissue samples were processed for histology and for detecting fat embolism. The preliminary pathological results may conclude: (1) A new atypical beaked whale mass stranding temporal and spatially associated with an international naval exercise ("Majestic Eagle-2004"; (2) The three necropsied whales showed very similar macroscopical (including full stomachs with non-digested food) and histological findings to those observed in beaked whales stranded during or after the "Neotapon-2002" naval exercises; (3) Gas embolism was not possible to demonstrate due to postmortem autolysis, but all three whales showed a systemic fat embolism as it was also detected in fresh and autolytic stranded beaked whales associated with "Neotapon-2002" naval exercises.

Alaska Native Hunters Photographic Guide to Steller Sea Lion Biosampling

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In 2004, The Alaska Sea Otter and Steller Sea Lion Commission (TASSC) developed protocols whereby Tribes can determine ecological trends of Steller sea lion (*Eumetopias jubatus*) within their Tribal jurisdiction. The Tribe first conducts a Local and Traditional Knowledge survey. From the survey effort, protocols are developed to monitor those aspects identified as important. One such monitoring protocol is highlighted here. Past and present cultural/ecological knowledge (TEK) of Steller sea lions was collected by the Old Harbor Tribal Council (OHTC) and analyzed by TASSC. The TEK survey revealed that sea lion numbers have declined in Alaska's Kodiak region. Fifty percent of the Tribal members wished to participate in a Biosampling program to assist with investigating the observed decline. TASSC, in cooperation with the OHTC, are co-authoring a Photographic Biosampling guide as a resource for those that wish to contribute specimens to provide further insights into the health and status of the species. In March of 2005, TASSC and OHTC researchers

began a series of photographic specimen collection events in concurrence with customary and traditional coastal Alaska Native subsistence hunts. In this poster, we share results of the TEK survey, photographs taken during the specimen collection and documents developed for the *Alaska Native Hunters Photographic Guide to Steller Sea Lion Biosampling*. The guide enhances and standardizes the quality of scientific information and samples that can be gathered by subsistence users of sea lions. The results of the TEK survey and information collected through the guide contribute to the greater body of knowledge on Steller sea lions and offers a perspective and samples not otherwise available to the scientific community. Documentation of TEK and findings from the analysis of biosamples is valuable to the jurisdictional Tribal government and contributes to sound Tribal and federal management practices.

Signature Whistle Shape Conveys Identity Information to Bottlenose Dolphins

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Many animals recognize the identity of a calling individual by listening to its voice. Voice features are caused by the individually distinctive anatomy of the vocal apparatus and affect all calls produced by an individual. Bottlenose dolphins (*Tursiops truncatus*), however, produce individually specific signature whistles, which consist of distinctive frequency modulations over time. The pronounced differences in these modulation patterns suggest that this parameter encodes identity in dolphin communication. To test this hypothesis we synthesized signature whistles of known individuals from the resident Sarasota Bay, FL, community and compared the reactions of individual dolphins to synthetic whistles of their kin and non-related associates. All general voice features were removed from our stimuli; synthetic whistles differed only in the modulation pattern of the fundamental frequency. We emulated the playback design of Sayigh *et al.* (1999), in which temporarily held wild dolphins listened to 10 repetitions of the whistle of a close relative followed by 10 repetitions of the whistle of a known conspecific of the same sex and similar age. We compared the number of times that each dolphin turned towards the speaker in the 5 minutes after the first synthetic whistle was played. Playbacks were conducted on 14 individuals. Dolphins turned significantly more often towards the speaker if they heard the synthetic signature whistle of a close relative than a synthetic signature whistle of another individual (Wilcoxon signed-ranks test, $p < 0.05$). Our results demonstrate that the frequency modulation pattern of signature whistles alone can provide information on the identity of the caller and that voice features are not necessary to identify a caller by its signature whistle.

How Stable Are Social Clusters of Long-finned Pilot Whales Identified off Northern Nova Scotia, Canada? An Application of Bayesian Methods to Photo-Identification Data

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Genetic data obtained from drive-fisheries suggest that schools of long-finned pilot whales (*Globicephala melas*) are relatively stable social entities, but long-term behavioural studies are needed to evaluate this hypothesis. The objective of this study was to investigate the stability of social clusters of long-finned pilot whales, between study years and sites. Photo-identification data were collected using whale-watch vessels in July and August, from two sites off northern Nova Scotia, Canada (Bay St. Lawrence 1998-2000, 2003; Pleasant Bay 2002-2003), approximately 40 km apart. From a total of 15,604

good quality dorsal fin pictures, 238 unique individuals were identified on 3 or more days. A Bayesian hierarchical mixture model estimated the number of social clusters in the sightings data, and assigned individuals with similar sighting histories to a cluster. Using the method on the 1998-2000 sightings data from Bay St. Lawrence yielded seven highly probable social clusters, whose membership corresponded well to previously identified long-term social units (defined as individuals seen together at least 3 times >30 days apart). The Bayesian model was then applied to each season of sightings data, treating the 2003 data separately for each site. The average median number of clusters detected in each field season was 10 clusters (range 6-18). The majority of clusters were only identified in one field season, since this is an open population. Clusters containing re-sighted individuals did have variable membership. A few individuals changed cluster membership over the study period. However, there is evidence for some smaller groups of individuals which have changed cluster membership together. The current results suggest that a smaller number of individuals may form a stable social group, and possibly associate with other such groups on a time scale of weeks to months.

Song Evolution of the Cape Verde Island Humpbacks (*Megaptera novaeangliae*) 1999-2005

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Humpback whales are known for their songs: the complexity and the evolution of these songs has been well documented around the world (West Indies, Pacific Mexico, Hawaii, Tonga, Japan, Western and Eastern Coast of Australia). One of the first locations from which humpback songs were described are the Cape Verde Islands (Tropical eastern Atlantic), but since that first recording of 1979, (Winn *et al.* 1981), no other documentation or analysis of humpback songs from this region exists. A comparison of humpback songs recorded in the Cape Verde Islands from 1999 to 2005, documents the evolution of the song structure within this Eastern North Atlantic breeding ground. A comparison between Western North Atlantic humpback recordings from the West Indies in 2000 demonstrates a certain degree of similarity between phrases of songs recorded in the Cape Verde Islands in both 1999 and 2000. The presence of similarities with the humpback song of the West Indies and Cape Verdes suggests that there is still an exchange of information between the humpbacks breeding in the Cape Verdean archipelago (Eastern North Atlantic) and those breeding in the Caribbean Islands (Western North Atlantic).

Remote Sensing of Rapid Shifts in Harbor Seal Population Structure

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The floating ice emanating from tidewater glaciers supports some of Alaska's largest aggregations of harbor seals (over 5,000) during the vital periods of pupping and molting. Recent population declines in some glacial fjords underscore the need to understand population structure and trends. We developed a technique for estimating the size-class structure of a harbor seal population in a glacial fjord using aerial photogrammetry and a geographic information system. Using geo-referenced, high-resolution digital images of seals hauled out on ice, we measured the lengths of 1200+ seals observed in six days of transect sampling prior to and during the pupping season (May-June 2004). At peak abundance prior to pupping, seal sizes were normally distributed. At the onset of pupping, when abundance had declined 40%, the distribution was skewed toward larger seals, with a minor mode of smaller (juvenile) seals. This juvenile mode strengthened as the pupping season progressed but the mode of adult-sized seals gradually diminished, even as abundance returned to pre-pupping levels. These findings indicate that the composition of harbor seal populations can vary dramatically over short time periods. Our

method for acquiring large samples to assess age-class structure can provide detailed context for related studies of seal abundance, trends, movements, and genetic population structure.

A New View of Sperm Whale Social Organization: Potential Influences of History, Habitat and Predation

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Knowledge of intra-specific variations in social organization and breeding behavior provides valuable insights into selective forces in social evolution. However, obtaining sufficiently large sample sizes to compare sperm whale social organization between multiple areas is challenging, and presently information comes only from the South Pacific. To address how potential factors influence sociality, we compared two populations with different habitats and whaling histories. Data were collected in spring/summer/fall 1998-2004 in the Sea of Cortez (SC) and in spring/summer 2002-2004 in the Gulf of Mexico (GoM), using standard techniques of photo-identification and behavior observations. Group size was calculated from photographic mark-recaptures using a Petersen estimator. Social organization was investigated with the SocProg program. Mean group sizes were significantly larger in the SC (16 ind, SD=2.7, n=44) than in the GoM (8 ind, SD=1.4, n=16, t-test, p=0.0228). Standardized lagged association rates suggested different social organization between areas. In the SC, sperm whale social organization best fitted a constant companion/casual acquaintance model, with casual acquaintance disassociating at a rate of 0.01132/day (SE=7.8215/day). In the GoM, social organization best fitted a different (casual acquaintance) model, with a disassociation rate of 0.001404/day (SE=0.001228/day). Occurrence of large breeding males differed by habitat, with large males representing 3% of identified individuals in the SC, and none identified in the 3-year GoM study, a result unlikely due to differential seasonal effort. In the SC, group size, social organization and occurrence of large males were similar to other areas of the Pacific (Galápagos, Chile) but very different than in the GoM. Therefore, social organization and mating systems described in the South Pacific are not representative of the entire species. It is possible that intense whaling histories in the Pacific have contributed to shape sperm whale social organization, although other habitat characteristics and/or different predation pressure may also be responsible.

Elements to Design a Refuge to Protect the Vaquita (*Phocoena sinus*)

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In 1997 a systematical survey, specifically designed to estimate abundance of vaquita, was done as a recommendation from the International Committee for Vaquita Recovery (CIRVA) to obtain a base line of vaquita population status. The Potential Biological Removal calculated, from the abundance of 567 vaquitas (95% C.I. 177-1073), indicates that is necessary to eliminate, as soon as possible, the bycatch in gill nets. Due to the very small size of the population, a protection scheme based on catch quotas was not recommended. Instead, the better scheme is to protect the area of higher concentration of vaquitas as a first step of the recovery plan. In this zone the use of gill and trawl nets must be forbidden. Here we present a summary of the results obtained from survey cruises by the National Marine Mammal Program during the last seven years. These results have been used by the International Committee for the Recovery of Vaquita to propose a vaquita net free zone or refuge. The home range of vaquita has been defined from the analysis of historical records and from the information generated during the systematical survey to

estimate abundance. Since 1997 we have been applying passive acoustics techniques to detect vaquitas. This methodology has been applied using fixed stations throughout the vaquita habitat. The position of the stations where most of the vaquita detections have been obtained marks the center of the protection polygon. The extent of this refuge has been defined based on the mobility of the detected vaquita groups, which indicates that vaquitas are able to navigate the extent of the proposed protected area during a single tidal flux or reflux cycle. The overlapping of the proposed refuge with fishing grounds, which is the main controversy around the problem, is also presented.

Lesions Observed on By-Caught Harbor Porpoises (*Phocoena phocoena*) Along the Belgian and Northern France Coastline, from 1995 to 2005

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The multidisciplinary research group MARIN (Marine Animal Research and Intervention Network) investigated the causes of death of marine mammals stranded in the southern North Sea and more precisely along coasts of Belgium and France. All animals are necropsied, sampled and a cause of death identified. Frequently, by-catch diagnosis is based on external lesions. In addition, for comparison with sick animals, by-caught porpoises are considered as being "control" animals for toxicological or biological studies, based on the assumption that they are healthy. As fishermen frequently release net-entrapped animals, by-catch can be only diagnosed on stranded animals for the Belgian and northern France coastline and represent 22% of stranded harbor porpoises (*Phocoena phocoena*). The aim of the present study is to identify lesions on by-caught porpoises and their health status. From 1995 to June 2005, 52 stranded porpoises out of 232 animals were diagnosed as being by-caught. External lesions associated with net-entrapment (net marks, penetration incision into body cavity) were observed in 50%. Internal lesions were subcutaneous hemorrhages (29%), lung edema (63%), lung congestion (54%), lung hemorrhage (10%). Surprisingly, 82% of the animals were mild to severely emaciated and 30% had no evidence of recent feeding. Slight parasitism (respiratory or gastric) was observed in 21%, being severe in 15% with associated acute pneumonia or gastritis. Our study showed that by-catch diagnosis can not be based on external observations only because such lesions are present in just half of the animals and that by-caught porpoises are not always healthy and therefore should not be declared control animals by default. Such considerations should be taken into account in toxicological or biological investigations and confirm the rule of necropsies in multidisciplinary studies on the cause of death of marine mammals.

Walrus Haul-out Dynamics in Spring Sea Ice of Southeastern Bering Sea

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Arctic marine mammals respond to variable weather and ice conditions in ways that are poorly understood. The Pacific walrus is dependent on sea ice throughout most of the year. After wintering in the Bering Sea, most female and young walruses migrate into the Chukchi Sea with the northward retreat of sea ice while most adult males move to coastal haul-outs in spring. The regional concentration of ice required to support large walrus aggregations is not known and little is known about walrus haul out dynamics in ice habitats. We remotely deployed satellite transmitters on male and female walruses in southeastern Bering Sea in spring of 2004 and 2005 to obtain continuous hauling

out chronologies from 55 walruses. We examined ice conditions during the onset of northern migration and weather events associated with changes in haul out behavior. In 2005 ice was sparse in the tagging region compared to 2004, yet walruses remained in the region, sometimes hauling out on very small strips of moderately thick first year sea ice, and began their northward migration no sooner than they did during heavier ice conditions in 2004. This demonstrates that they were able to utilize relatively low concentrations of ice to maintain their presence in the region; however, the impact of sparse ice on their foraging energetics is not known. Periods of hauling out on ice ranged from < 20 min to 1.6 d (median 0.25 d), and periods of immersion ranged from < 20 min to 9.8 d (median 0.61 d). These immersion periods are shorter than those reported for animals using land haul-outs, which may be due to differing foraging strategies (non-central-place vs. central-place foraging). Some of the long immersion periods in ice habitats were associated with storm events.

Stellar Sea Lion Energetic Priorities During and After a Nutritional Stress: Are Proteins the Key?

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When faced with decreased energy intakes, marine mammals must adjust their energetic priorities between conflicting functions such as metabolism, growth and thermoregulation, as well as the type of internal energetic fuel (lipids, proteins), which can, in turn, affect the energy budget. While Steller sea lions can catabolize their insulative blubber layer to provide energy, this lipid reserve is small compared to that of phocids. Consequently, they may rely more on core tissue proteins to sustain their energy expenditures during episodes of nutritional stress. Although some of the resulting physiological consequences may be overcome during subsequent recovery periods, others can lead to irreversible health impairment. Therefore, these physiological strategies can have profound impacts on the performance and life history of individuals, and could potentially contribute to this species' population decline. Our study utilized an integrative approach to investigate the pattern of energetic priorities and fuel utilization during a one-month food restriction followed by a one-month recovery period in eight captive female Steller sea lions fed two different diets. The bioenergetic costs of growth, daily metabolism, thermoregulation and exercise capacity were quantified biweekly. Emphasis was placed on determining the contribution of protein catabolism to daily energy use via an innovative measure of urea kinetics using a stable isotope tracer, ¹⁵N₂-urea. Lipid catabolism was assessed by ultrasonic measurements of the subcutaneous blubber layer. Both results were compared to changes in overall body composition determined by deuterium dilution. Blood parameters and metabolic hormones were also measured to assess physiological mechanisms during nutritional stress and recovery. These numerous measurements of physiological and biochemical parameters, including both less widely known protein metabolism and physiology during recovery periods, expand our understanding of Steller sea lion nutritional physiology. Ultimately, this study would lead to refinement of bioenergetic models that form the basis of conservation and management decisions.

Strandings, Mortality, and Morbidity of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in Hong Kong, 1995-2004

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We investigated the factors related to mortality and disease in Indo-Pacific humpback dolphins (*Sousa chinensis*) from Hong Kong waters, by detailed examination of dolphin specimens found stranded from 1995-2004. A total of 86 specimens were necropsied, but many of these were too badly decomposed to provide much information. We also collected skin and blubber biopsies from six identified living

individuals, and concentrations of DDTs, PCBs, HCHs, mercury, and BTs were determined from blubber and liver samples of stranded and biopsied (blubber only) dolphins. A large proportion of the strandings (53.2%) were young-of-the-year. The most commonly diagnosed causes of death were net entanglement and vessel collision, although contaminants were suspected to be a factor as well. The prevalence of dermal disease in various age classes was 0-14%, and was low in comparison to most bottlenose dolphin populations. The pesticide DDT showed the highest concentrations among the organochlorines, and the ratio of DDT to its breakdown products (and other information) suggests that there may be a recent or nearby source of DDT into the dolphins' ecosystem. Concentrations of both DDTs and PCBs showed a pattern of increasing with age in males. In females, they increased until sexual maturity, then decreased, and finally increased again in late life. This is consistent with a hypothesized transfer of pollutants from mother to offspring during gestation and lactation. Inter-laboratory differences and effects of decomposition of specimens are two potential biases that may affect the quality of the present results, but we believe the results are still valid. In order to resolve the potential problems associated with these issues, and to obtain better information on the life history and mortality factors of this dolphin population, a long-term biopsy collection program is recommended.

Movements and Foraging Ecology of Sea Otters in Coastal Washington

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Focal observations of sea otter (*Enhydra lutris kenyoni*) diving behavior, foraging patterns, and prey selection were collected in Washington between 1993 and 1999. Records consisted of 13,847 individual dives from 841 feeding bouts ranging from 1 min to >4 h. Average dive time was 55 sec (SD 25) and average surface time was 45 seconds (SD 45), irrespective of dive success. At least 77% of all dives (n = 10,636) were successful prey captures (dives in low light or of undetermined success were excluded). On average, at least 86% (SE 26) of dives on a given foraging bout were successful, yet prey capture success was significantly lower for sub-adults (63%, SD 37) than adults (82%, SD 25) (p < 0.001). Sea otters occupying an established population range on the outer coast of Washington fed heavily on bivalves (63%) and had a diverse diet consisting of a large number of prey groups (n=10). In contrast, sea otters occupying new habitat in the Strait of Juan de Fuca had a restricted diet dominated by >60% red urchins (*Strongylocentrotus franciscanus*) with only two other prey species comprising >10% of their diet. Data on movements of individuals was collected during VHF radio telemetry studies of 75 individuals tagged and located at least once per week from accessible areas along the coast. Sea otters dispersed widely from their tagging site and covered on average 29% (SD 15) of the total population range in at least 6 months. Forty-three percent of the tagged animals moved north of Cape Flattery and east into the Strait of Juan de Fuca, new habitat that had not been occupied by sea otters for over 100 years. The growth and expansion of this isolated population provided a unique opportunity for testing traditional ecological paradigms that surround sea otters and their prey.

Effects of Ice Cover on Bearded Seal Vocal Patterns over 16 Years

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We know little about bearded seals, *Erignathus barbatus*, as their preference for ice floes and the ice edge make them difficult to study. Climate change has already been demonstrated to adversely affect breeding in ringed seals. However, without a good understanding of the ecology of bearded seals it will be impossible to determine whether and how changes in ice conditions are affecting this species. Male bearded seals vocalize during the breeding season in order to attract females as well as for male-male competition. In this study variation in male vocal patterns is examined in relation to diel, seasonal, year and ice cover over four years (1985, 1993, 2000 & 2001) off Point Barrow, Alaska. Days were randomly selected in each week. The number of vocalizations present during a 15-minute segment each hour was counted over randomly selected 24-hour periods during the breeding season (April and May). Vocalizations were separated into nine known call types and were classified according to spectrogram quality. A diurnal pattern existed in male vocal behavior: in all years calling increased in the early morning. Clear differences in vocal patterns existed between years, with more vocalizations recorded in 1993 and 2001 than in 1985 and 2000. Similarly, a seasonal trend, was clear in 1993 and 2001, but not in 1985 or 2000. The latter two years were 'heavy ice years' where little open water was present at the site through the breeding season. 1993 and 2001 were 'light ice years' with a lot of open water being available. Males require open water to display and maintain aquatic territories. Therefore, this study shows that differences in ice conditions affect vocal patterns, and male behavior of bearded seals over long time spans.

Beaked Whales, Sonar and the "Bubble Hypothesis"

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Although spatio-temporal links exist between some deployments of active mid-frequency sonar and beaked whale mass strandings, the underlying mechanism(s) remain a topic of debate. On theoretical grounds, acoustically mediated *in vivo* bubble formation in marine mammals exposed to high level anthropogenic sound sources has been proposed as a potential mechanism. More recently, pathological findings consistent with systemic gas and fat embolism and associated lesions observed in severe decompression sickness have been reported in 10 beaked whales (of three species) that mass stranded in the Canary Islands in 2002 during naval sonar operations. Acute and chronic gas embolic lesions have also been demonstrated in single UK-stranded cetaceans, with the highest prevalence in deep-diving species such as beaked whales and Risso's dolphins (*Grampus griseus*). These findings demonstrate that cetaceans can experience *in vivo* gas bubble/emboli development, possibly through decompression-related off-gassing of nitrogen supersaturated tissue or embolization of intestinal gas. Emerging beaked whale dive profile data shows a typical combination deep dives (>100 m) and short surface intervals, with deep foraging dives having considerably slower ascent than descent rates. These dive profiles are predicted to contribute to higher levels of nitrogen supersaturation than would occur in cetacean species with typically shallow dives (< 20 m), longer surface intervals between dives, or more rapid ascent and descent rates (> 2 m/s). It is hypothesized that behavioural disruption of normal beaked whale dive profiles could occur at received levels of sound significantly lower than that causing direct tissue damage, and may precipitate potentially fatal bubble formation driven by excessive tissue nitrogen supersaturation on surfacing. Alternatively, it may be necessary for an external stimulus, such as acoustic exposure, to induce destabilization of pre-existing bubble nuclei. Confirmation of *in vivo* nitrogen gas bubble formation in diving cetaceans, and the characterisation of acoustic signal types and levels necessary to trigger bubble formation via adverse behavioural responses or the

destabilization of existing bubble nuclei, are future research priorities.

Vaccination of Southern Sea Otters (*Enhydra lutris nereis*) for Canine Distemper and Interpreting of Serosurveys

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There are approximately 2800 southern sea otters (*Enhydra lutris nereis*) living off the coast of Central California and they are listed as "threatened" under ESA. Epidemics and cumulative effects of pathogens and toxins in recent years have resulted in record mortalities. Disease organisms coming from terrestrial sources are likely significant contributors to mortality and appear to be limiting potential for population recovery. Until recently we had found little evidence of serum neutralizing (SN) antibodies to canine, phocine or cetacean morbilliviruses and assumed that these viruses were not common in nearshore ecosystems of California. However, new information suggests that these potential pathogens may be widespread and that commonly used serum neutralization (SN) antibody titers may be misinterpreted. We were led to this conclusion by experience with vaccination of captive sea otters for canine distemper and between lab comparison of results. Thousands of hours are spent training captive southern sea otters for behaviors that facilitate minimally invasive research and display. Although housed at relatively secure sites, potential exists for morbillivirus, particularly canine distemper, exposure. An intramuscular 3 shot series of modified live recombinant canine distemper (Purevax) vaccine, which had been developed for and tested in black footed ferrets was used at the standard dosage approximately 30 days apart. All animals responded to vaccination by developing SN antibodies and none showed any signs of untoward side effects. Comparisons of SN antibodies to canine distemper from two laboratories before vaccination and at approximately 3-4 week intervals thereafter suggest that the two SN tests provide comparable results but have quite different sensitivities. One appears too insensitive to detect lower SN titers and lower antibody levels in exposed animals would likely be interpreted as negative.

Asymmetry of the Odontocete Skull: Methodological and Interspecific Comparisons

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Directional asymmetry is a hallmark of odontocete skulls, which have a consistent leftward deviation of the midline and enlarged right facial area. Although it is commonly recognized that species exhibit different degrees of asymmetry, there have been surprisingly few attempts to characterize, quantify, and compare this feature across species. Previous attempts have been simply descriptive, or have had methodological errors associated with establishing a midline axis on an asymmetric object or use of non-homologous landmarks when comparing across taxa. We quantified skull asymmetry in 58 odontocetes using three types of data: i) 3D coordinates (28 bilateral landmarks), ii) 2D coordinates (18 bilateral landmarks), and iii) morphometrics (25 bilateral measurements). Skulls of four specimens per species (2 of each sex) were examined where possible. Coordinate data (i, ii) were subjected to Procrustes analyses to establish deviation of bilaterally homologous landmarks from positional averages within each skull. Distance data obtained from Procrustes analyses and morphometric data were then subjected to (separate) principal components analyses to establish: 1) which taxa have the most asymmetric skulls, and 2) where interspecific differences in asymmetry are found. Previous attempts to explain different degrees of asymmetry as a function of body size or skull apex height are not supported. Instead, skull asymmetry shows a clear phylogenetic signal. Basal

odontocetes (Physeteridae, Ziphiidae) are characterized by marked asymmetry around the external nares. Later diverging groups (Phocoenidae, Delphinidae) have relatively more symmetric skulls overall, but also exhibit comparably greater asymmetry in the marginal facial area (antorbital notches and processes, posterior maxillae) and rostrum. These trends were observed for all methods; 2D coordinate methods are the easiest to collect and give reliable results compared to the other two methods.

A Study of the Diet of Cape Fur Seals, *Arctocephalus pusillus pusillus*, in Plettenberg Bay, South Africa

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In response to public interest and claims from local fishermen of seals disturbing fishing operations, the diet of the Cape fur seal, *Arctocephalus pusillus pusillus*, in Plettenberg Bay, Western Cape, South Africa was investigated between March 2003 and March 2004 primarily using faecal (scat) analysis. A total of 485 otoliths was recovered of which 408 (84.12%) were identified, representing ten teleost prey species. Seven cephalopod beaks were found, representing two species. The most important prey species in the diet (based on IRI, total mass consumed and percentage frequency of occurrence) was found to be *Sardinops ocellatus*. Overall, 62.74% of the total mass of prey consumed was made up by small shoaling pelagic fish (*Sardinops ocellatus*, *Trachurus trachurus*, *Engraulis japonicus* and *Etrumeus whiteheadi*). The diet of Cape fur seals was found to be different in summer to all other seasons ($r = 0.03$, $p < 0.05$) with *S. ocellatus* constituting a smaller proportion of the diet relative to other seasons. Variation in the diet composition was possibly in response to prey abundance and distribution, suggesting that the seals are opportunistic feeders. No evidence was found to suggest the occurrence of significant biological interactions between Cape Fur Seals and fishing vessels operating out of Plettenberg Bay.

Habituation and Habitat Exclusion of Harbour Porpoises in a Simulated Gillnet Fishery with Pingers

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A large number of harbour porpoises are by-caught in gillnets. As a consequence, use of pingers is now mandatory in a wide range of EU gillnet fisheries. The purpose of this study was to investigate habitat exclusion and habituation to pingers in a simulated fishery where pingers were deployed and recovered repeatedly. The field work was carried out from mid April to mid June 2005 in a high density porpoise area of the Great Belt, Denmark. The presence of harbour porpoises was detected by acoustic data loggers (T-PODs). T-PODs were deployed in two impact areas (approximate size 0.6 km²) and two control areas. Distances from control areas to nearest pinger were 3 and 5 km, respectively. Two types of pingers (15 SafeWave 30-160kHz sweep, 155 dB re. 1 μ Pa@1m, and 55 Airmar 10kHz 132 dB re. 1 μ Pa@1m) were deployed in each their impact area. To simulate a real fishery the pingers were cyclically activated and deactivated for one month, each ON- or OFF period lasting between one and five days. The presence of harbour porpoises was significantly lower during periods with active pingers, evidenced by a decline in median echolocation click rates per day to about 1% of levels in control areas. In periods with inactive pingers the median click rates increased to about 40% of control levels. Pingers also affected the control areas, where median click rates decreased by 30% when pingers were active compared to inactive. Previous studies have shown that porpoises will habituate to a pinger that is continuously active for a long period of time. Our results indicate that porpoises do not habituate to pingers when these are activated and deactivated cyclically, resembling real fishery, and that habitat exclusion due to pingers thus is an issue of concern. Study funded by Aage V. Jensens Foundations.

Fecundity Patterns and Reproductive Senescence in the Hawaiian Monk Seal (*Monachus schauinslandi*)

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We evaluated the evidence for reproductive senescence in the Hawaiian monk seal (*Monachus schauinslandi*) and its potential influence on population dynamics. A decline in age-specific fecundity can arise from either true senescence or because females with relatively high fecundity die earlier. We therefore analyzed data pooled for all females as well as individual reproductive histories to determine if the observed patterns are consistent with senescence. The oldest known-age females are now 20-28 years old (varying among sites), allowing a first look at the entire reproductive lifespan of the monk seal. Age-specific reproductive patterns varied among three monk seal subpopulations examined. Onset of reproductive maturity was earlier and the maximum rate higher at Laysan Island than at the other two sites. All sites reveal a clear pattern for early and mature phases of reproduction, with well-defined ascending segments and discernible asymptote or peak for maximum fecundity of prime-aged females. Reproductive curves indicated senescence was operative at two of three sites, with declining fecundity beginning at age 15-18. Individual reproductive histories at Laysan are consistent with senescence rather than the alternative explanation whereby relatively more fecund females die younger. There appears to be a general decrease in the proportion of consecutive pups produced and, though not significant, the data also suggest a decline in overall reproductive rate of individual females as they age, roughly mirroring pooled age-specific patterns. The implications of reproductive senescence to actual populations are examined through sensitivity analysis and population projections initialized at current age/sex structures. The omission of senescence increased mean final abundance at Laysan, but was barely discernible at French Frigate Shoals, where the response was constrained by current low juvenile survival.

Marine Regulation Compliance and Harbor Seal Disturbance at Yellow Island, Washington

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Yellow Island is located in the San Juan Archipelago, between Orcas and San Juan Islands, Washington. It harbors 80-100 harbor seals (*Phoca vitulina*), which haul-out on two small islets off the west side. The Nature Conservancy (TNC) protects the island and imposes a 100-m marine buffer in compliance with NOAA regulations. However, it is unknown whether vessels violate this buffer zone and disturb seals. To evaluate the effectiveness of the buffer zone, we estimated vessel distance from the haul-out site and described seal recovery after a disturbance. Land-based observations were conducted from June to September of 2004. We simultaneously the two haul-out sites with a theodolite from a distance of 250 and 190m, respectively, at an altitude of 14.05m. We defined a disturbance as any activity that flushed seals into the water. Vessels disturbed seals on 50% of the 21 observation days. Stopped powerboats and kayaks always created a disturbance (n=7 observations each) whereas passing powerboats did not affect seals (n=221 observations). Distance from the haul-out site differed among vessel types (One-way ANOVA: $F_{2,18}=22.22$, $p<0.001$). It averaged $55.1 \pm \text{SD } 0.47$ m for kayaks, $100.5 \pm \text{SD } 0.65$ m for stopped powerboats and $301.8 \pm \text{SD } 0.71$ m for passing powerboats (we ln-transformed data and randomly selected seven passing powerboat observations). Disturbances resulted in full recovery during 38% of occurrences. Kayaks and stopped powerboats violated the buffer zone 100 and 57% of the time, respectively, and created a disturbance up to a distance of 214m; passing powerboats violated the zone 5% of the time. To decrease disturbances at Yellow Island, we recommend that TNC provide information to powerboat operators and kayakers on

areas inhabited by wildlife and restricted to boat use, and establish and enforce a buffer area of 250 m around the haul-out sites for slow-moving or stopped vessels.

An Online GIS Predictive Model for High School Students to Investigate Oceanographic Processes and Marine Mammal Distribution

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There has been too little effort to bridge the gap between the scientific and pedagogical realms, thus leading to a public that lacks the ability to hypothesize or understand and interpret scientific data. Using an on-line Geographic Information System (GIS), we created an inquiry-based curriculum for Gulf of Maine (GOM) high school students to investigate how oceanographic processes affect marine mammal distribution. This is the first education model combining GIS, whale and oceanographic research. Predictive models help scientists elucidate favorable temporal and spatial conditions for positive whale sightings and these models can also serve as useful platforms for educating the general public in the scientific process. We used 11,552 whale sighting data from 2002-2004 (collected from commercial, state, and research organizations), and geostatistically tested sightings with physical and biological phenomena (depth, bathymetric slope, 8-day composites of sea surface color and temperature) to create a GIS-based generalized linear model for whale habitat in the GOM. Years were analyzed separately and cross-validated with other years before presenting the data to students. The database also included ecological aspects of whale biology for investigations regarding habitat requirements. Students tested their own hypotheses about why and where whales are found in the GOM during the summer by using GIS to analyze the ecological, sighting, sea surface color and temperature, and bathymetric data. Preliminary results indicated habitat partitioning by whale species and strong correlations with temperatures and bathymetry, but not immediate chlorophyll concentrations (time lags are still being investigated). Local teachers have expressed great interest in this curriculum, as there are few opportunities for such hands-on research and application of critical thinking skills. An on-line GIS scientific curriculum offers classrooms the opportunity to participate in research without the burden of collecting data or purchasing their own expensive GIS software.

Unraveling the Behavior of Beaked Whales (*Ziphius cavirostris* and *Mesoplodon densirostris*) Using Sound and Orientation Recording DTAGs

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Several species of beaked whale including Cuvier's and Blainville's (respectively, *Ziphius cavirostris*, Zc, and *Mesoplodon densirostris*, Md) are known to strand in conjunction with naval maneuvers involving sonar. However, little is known about the normal behavior of these species or the reasons for the strandings. In on-going studies off the Canary Islands and Italy, we have attached suction-cup acoustic and orientation recording tags (DTAGs) to 9 Zc and 3 Md. The tags sampled audio at up to 192 kHz from mono or stereo hydrophones and attachments of more than 15 hours were obtained. Here we review the DTAG findings from Md and Zc and explore how this new information could be used to reduce the mortality from navy sonars. The tags revealed stereotypical dive behavior comprising long, deep dives (up to 1.5 hours and 2000 m) followed by protracted bouts of shallow dives. Distinctive click and buzz sounds, consistent with echolocation-mediated foraging, were made in deep dives with an average of 30 prey capture attempts per dive. These extreme foraging dives likely exceed the aerobic dive limit for both species and the acoustically-silent shallow dives may be needed to recover from lactate accumulation. Closing sequences of echoes from objects in the water

were frequently recorded on the tags during foraging dives. These, combined with the movement signatures recorded by the tag, enable the first study of prey selection and acquisition by echolocation in the wild. The clicks also likely serve to maintain the high degree of social coordination revealed by data from two contemporaneously-tagged Zc and by synthetic tracking of clicks recorded by stereo DTAGs. Based on the tag data and field experience, we examine the potential for passive acoustic detection of beaked whale clicks and discuss the feasibility of controlled exposure experiments to test behavioral reactions to sonar sounds.

Modeling the Effects of Predicted Sea Level Rise on the Terrestrial Habitat of Hawaiian Monk Seals (*Monachus schauinslandi*) and Other Wildlife in the Northwestern Hawaiian Islands

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Current climate models predict that global average sea level may rise considerably over the next 100 yrs, potentially affecting many species that rely on coastal habitats for foraging and reproduction. Many of the Northwestern Hawaiian Islands (NWHI) are small, low-lying, and likely vulnerable to predicted increases in sea level. The NWHI are home to several species of endemic, endangered or threatened organisms such as Hawaiian monk seals (*Monachus schauinslandi*). We tested the hypothesis that rising sea level during this century could significantly reduce the availability of habitat for monk seals and other wildlife at risk in the NWHI. Using a theodolite and Global Positioning System receivers, we surveyed Lisianski Island and selected islets at Pearl and Hermes Reef (PHR) and French Frigate Shoals (FFS) and created topographic models of them in a Geographic Information System. We evaluated the potential effects of sea level rise by 2100 under a range of basic scenarios, including tidal effects. Projected terrestrial habitat loss varied greatly among islands: 3% to 65% under a median scenario (48 cm rise), and 5% to 75% under the maximum scenario (88 cm rise). Spring tides may repeatedly inundate all land below 89cm (median scenario) and 129 cm (maximum scenario) in elevation. FFS and PHR, where virtually all land is less than 2 m above sea level, would be most severely affected. Higher islands such as Lisianski, Laysan, Necker, and Nihoa may provide longer-term refuges for species. The effects of habitat loss on NWHI biota are difficult to predict, but may be greatest for endangered Hawaiian monk seals, threatened Hawaiian green sea turtles, and the endangered Laysan finch at PHR. This study marks the first effort to detail the topography and evaluate sea level rise effects on species inhabiting the NWHI.

Relative Size (Age) Class of Humpback Whales in Different Social Roles on the Hawaiian Breeding Grounds, Estimated by Fluke Photogrammetry

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Humpback whale social organization on the breeding grounds consists of specific behavioral and social roles: 1) lone males (singers and non-singers); 2) male escorts (accompanying a female with a calf); 3) cows (with or without an escort); 4) adult pairs (male-male, male-female); 5) juveniles; and 6) newborn calves. Interactions between individuals in these roles drive social behavior patterns; however, variability in the behavior of different individuals occupying the same role complicates our understanding of how they function. The purpose of this study was to investigate the relative range of size (age) within specific social roles. From 2000-2003, the flukes of 45 whales were measured using photogrammetry techniques described by Calambokidis (2001). Multiple measurements of each whale were averaged. The results were: 1) singers ranged from 3.53 - 4.68 m (n = 25; M = 4.24; SD = 0.31); 2) escorts ranged from 3.52 - 4.62 m (n=7; M = 4.13; SD = 0.38); 3) cows ranged from 4.27 - 4.80 m (n = 5; M = 4.52; SD = 0.25); 4) pairs ranged from 3.38 - 4.96 m (n = 5; M = 4.23; SD =

0.61); 5) yearlings ranged from 3.31 - 3.35 m (n = 2; M = 3.33; SD = 0.03); 6) one calf (n=1) was 2.05 m. A range in fluke size existed within each group, and assuming a correlation with overall body size and age, this suggests that different aged whales may occupy the same social roles. Individual males in singer and escort roles showed the greatest variability, varying up to one meter. Cows had the largest mean fluke size, and fluke size variability in pairs reflected different potential size/age composition possibilities. We suggest that body size and age differences within social roles may account for the high variability in behavioral interactions observed during the breeding season.

Dodge-Lummus Island Turning Basin Project Protecting Dolphins and Manatees during Underwater Blasting: Preliminary Results

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In 1990, Congress authorized the deepening and expansion of the Miami Harbor, Port of Miami, Miami-Dade County, Florida. Part of the project included deepening of the DodgeLummus Island Turning Basin and Fisherman's Channel to -42 ft. The Port of Miami (Port) previously attempted to complete the project without underwater blasting. The contractor and subsequent surety company were unable to successfully complete the authorized work primarily due to the limestone bedrock that was resistant to dredging. In 2000, the Port approached the Jacksonville District, U.S. Army Corps of Engineers (District) to complete this dredging project. The District determined that blasting would be required as a construction technique and recognized that consultation with the National Marine Fisheries Service (NOAA Fisheries) and the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act was required. The District also determined that a population of bottlenose dolphins, *Tursiops truncatus*, a species protected under the Marine Mammal Protection Act of 1972 (MMPA), had been documented transiting through the Port and could be affected by the proposed blasting. The District submitted an application for an Incidental Harassment Authorization (IHA) under the MMPA in June 2002. This application was the first time that any district had applied to NOAA Fisheries to obtain an IHA. After a 30-day public review of the application, NOAA issued an IHA to the District. The construction project was delayed one year and the District initiated and obtained renewal of the IHA, which was granted by NOAA Fisheries in April 2005. Construction began in June 2005. A key determination made by NOAA was that marine mammals were unlikely to be seriously harmed by the detonations due to the District's conservative monitoring and mitigation measures that will ensure that neither dolphins, nor manatees would be within a pre-determined safety zone when the detonations occurred. This presentation reviews the consultation process; monitoring and mitigation measures implemented for this project to protect marine life; preliminary analysis of the results from marine mammal monitoring; an overview of acoustic and pressure measurement data collected during construction; and potential implications for future work using blasting as a construction technique in Florida by the Jacksonville District or elsewhere by others.

Stomach Contents of Mass-Stranded Short-Finned Pilot Whales (*Globicephala macrorhynchus*) from North Carolina

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The feeding habits of short-finned pilot whales in the western North Atlantic are poorly known. We examined the stomach contents of

short-finned pilot whales *Globicephala macrorhynchus* that mass stranded on the North Carolina coast in January 2005. Of the thirty-one stranded whales, thirteen had prey hard parts (cephalopod beaks and fish otoliths) in their fore stomachs. We used frequency of occurrence and numerical abundance to assess the relative importance of prey. We identified at least thirteen cephalopod species, representing nine different families. In addition to the cephalopod beaks, a large number of teleost otoliths were present (50% by numerical abundance). The otoliths were small, implying that the contribution of teleost prey to total biomass of prey was low. Our preliminary findings indicate that *Brachioteuthis riisei* (10%) and *Histioteuthis reversa* (7%), both oceanic species, are important cephalopod prey species regardless of the method of analysis used. *Taonius pavo* (5%) also represented a substantial part of the diet. Each of the remaining species accounted for <5% of numerical abundance or were present in less than three whales. *Loligo* sp., a neritic cephalopod, were present in large numbers (10%), but the specimens were small suggesting that this species does not account for a substantial proportion of prey biomass. These results differ from reports from the Pacific coast which indicate *Loligo* sp. is the dominant prey species for short-finned pilot whales. Our findings also suggest that there is a considerable difference between the diet of short and long-finned pilot whales (*Globicephala melas*) in the western North Atlantic. The latter feed predominantly on the long-finned squid (*Loligo pealei*) while the former feed on a variety of deep-water species. Our results indicate that these short-finned pilot whales fed primarily off the continental shelf prior to stranding.

Historical Distribution of Harbour Porpoises (*Phocoena phocoena*) and Other Small Cetaceans in Estonian Coastal Waters

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Harbour porpoises have inhabited central and northern Baltic Sea for thousands of years. First archaeological findings are dated from mid-Neolithic Age (5500 years ago). Most of prehistoric material is from late Neolithic and Bronze Age (4500 - 2500 years ago). First written records from Estonian coast are from the end of 1x century. Most of data about presence fall into period 1930 - 1940 and only few sightings are from period after 1950ies. Most of data originated from local newspapers, this indicates that meeting the cetaceans have been noteworthy for coastal inhabitants and rarely seen. Records are distributed spatially evenly along the coastline. Data show a seasonal variation of geographical occurrence. Most of records are from by-catch or intentional killing (70 %) and strandings (25%), only 5% are sightings.

Current Population Size and Distribution of the Breeding Caspian Seals (*Phoca caspica*)

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The Caspian seal (*Phoca caspica*) is the only marine mammal inhabiting the Caspian Sea, and is endemic. It is a sentinel species for the whole Caspian ecosystem and currently faces multiple threats from exploitation, habitat degradation, invasive species, disease, pollution, and climate change. However, the impact of these threats cannot be assessed until the present size of the population is known. To determine this a fixed wing aerial survey of Caspian seals was carried out over the winter ice-field in Kazakhstan in February 23-27, 2005. The survey encompassed at least 90% of the breeding seal

population. Total pup production was estimated at 19,452 (CV 12.4), with demographic models giving a total female population of 55,498, and therefore a total population of approximately 111,000 seals. Numbers of eagles and wolves, which are the main predators, were estimated to be 2,209 (CV 7.7) and 18 respectively. A hind cast for the Caspian seal population from 2005 to 1900 was carried out using this year's survey data and past hunting records. The pup production has fallen from approximately 300,000 in 1900 to approximately 20,000 in 2005 while the mean annual decrease since 1960 in the number of fertile females was estimated at 4%. An elasticity analysis indicated the principal cause of the decline in seal numbers to be excessive juvenile mortality, with impaired fertility playing a minor role. The contributory causes of mortality, particularly of juveniles, include commercial and scientific hunting, by-catch, canine distemper virus (CDV) and other pathogens, as well as loss to natural predators. The results of the 2005 survey should be able to assist in the new evaluation of the species' conservation status.

A Corrosion Casting Study of the Structure of Cetacean Kidneys

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Using a corrosion casting technique the precise vascular, tubular and collecting duct anatomy of cetacean kidneys was investigated. Kidneys were obtained from two stranded *Gogia* sp., two stranded *Tursiops truncatus*, and one stranded *Steno bredanensis*. After removal from the carcass, the kidneys were perfused with physiological saline. Mercor resin (Ladd Research, Williston VT, USA) was then perfused into the kidneys until the plastic emerged from the vein draining the organ. The kidneys were placed into a jar of hot (~50°C) water for 30-60 minutes until resin polymerization was complete. Once the resin was fully polymerized, the kidney tissues were digested in a sodium hydroxide solution, leaving a plastic cast of the perfused part of the kidney. The casts were examined and photographed under light microscopy. In the *Gogia* kidneys, within each reniculus the afferent arterioles, glomeruli, and efferent arterioles were found to be surrounded by a fine spherical network of the vasa recta. All kidneys strongly resembled a bunch of grapes, with the reniculi arranged in groups arising from separate branches of the renal artery, and drained by separate branches of the renal vein and collecting duct, consistent with published literature. In contrast to statements that each reniculus acts as an independent kidney, our results indicate that the cetacean kidney is actually composed of several lobes with each lobe consisting of multiple reniculi all fed by a single branch of the renal artery and all drained by a single branch of the renal vein and a single branch of the ureter. The renicular structure of cetacean kidneys may be an adaptation to diving, facilitating reperfusion after peripheral vasoconstriction during diving, or allowing parts of the kidney to be shut down or diminished in use to conserve energy, conserve water, or maintain electrolyte balance.

Using GIS Analysis and Adaptive Kernel Estimators to Detect Temporal and Spatial Variation in Home Range Areas of California Sea Otters (*Enhydra lutris nereis*)

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The use of adaptive kernel (AK) home range analysis is becoming an increasingly common method for estimating home range area and evaluating patterns of habitat use. We tested for temporal and spatial differences in home range size of California sea otters (*Enhydra lutris nereis*) using AK techniques, contrasting radio telemetry-based data collected from 29 animals in the 1980s and from 78 animals in the current population. Home range area has not changed significantly (at the population level) between the 1980's and the present, but there were striking spatial differences in home range size within the

current population for all age and sex classes. Males residing in the central and southern portion of the California range employed a very different strategy for survival than those males living in Monterey. Central and southern males moved extensively within the southern sea otter range over a period of 1 year, and generally established multiple core use areas (defined as non-contiguous kernel polygons defining 95% probability areas of occurrence). In contrast, northern males had much smaller home range sizes, averaging less than 1 km², and rarely had multiple core use areas. Female sea otters from all study groups exhibited multiple core use areas, with secondary-use areas generally established when they moved to give birth or wean pups. We discuss the implications of these differences in home range size and movement patterns, evaluating them in the context of corresponding differences in foraging strategy and survival.

The Oceanic Cetaceans of the Solor-Alor Islands, Indonesia: Implications for the Management of Indo-Pacific Marine Corridors

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The Solor-Alor region in the Savu Sea, eastern Indonesia, includes several important Indo-Pacific marine corridors such as the Ombai Strait, a transboundary passage shared with East Timor. This area is characterized by complex oceanography and exceptional bio-diversity and relative abundance of oceanic cetaceans ([pygmy] blue, [pygmy] Bryde's, sperm whales, orcas and numerous oceanic dolphin species). Furthermore, the region includes two traditional whaling villages, Lamalera (active) and Lamakera (inactive). A collaborative program has been conducted since 2001 to assess Solor-Alor's ecological significance for oceanic cetaceans. The program aims to (1) address the data gap on species diversity, distribution, relative abundance rankings, seasonality, preferred habitats, tourism potential and fishery interactions; (2) conduct basic ecological research on blue and sperm whales (photographic, acoustic, genetic and satellite telemetry); and (3) assess the degree of modernization and sustainability of the Lamalera traditional sperm whale fishery. During the five surveys (2001-2005) a total of 15 cetacean species were identified over 51 days and 367.0 hours, covering 2916.4 nm and 112 acoustic listening stations. A total of 16225 individual cetaceans were counted during 336 encounters. Species-specific results include species lists, relative abundance rankings, identification of corridor habitats and predator-prey interactions. Telemetry results from a sperm whale tagged for over 40 days indicate that movements extend at least 1,000 km into the NE Indian Ocean. Cetacean watching potential has increased, however this would not be an appropriate tourism activity without effective guidance. Community work with Lamalera includes CPUE monitoring, cultural heritage and ecological aspects. A large-scale Marine Protected Area (>1,000,000 ha) for the Savu Sea is under development by the Indonesian government. Continuation of cetacean programs in Indonesia are paramount to improve the protective management of vulnerable marine mammal species and habitats under district, provincial, national and EEZ jurisdictions; as planned under the Indonesia Marine Mammal Management Area initiative.

Genetic Pod Composition of Killer Whales (*Orcinus orca*) Stranded at Aidomari, Hokkaido on February 7, 2005

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The killer whale (*Orcinus orca*) is a cosmopolitan species ranging all

oceans of the world. Three distinct forms; residents, transients, and offshores, are recognized off the British Columbia and Washington State. These forms can be identified by dorsal fin shape, pigmentation pattern, food habits, behavior, and genetic characteristics. Although the species is also known from Japanese waters, virtually nothing is known on these animals. On 7 February 2005, 11 or 12 individuals of killer whales are entrapped by pack ice. The following day nine carcasses were secured; one large male (AKW1), five sexually mature females (AKW2, AKW4, AKW5 AKW6 and AKW9, three of them lactating) and three calves (AKW3, AKW7 and AKW8). Sequences of about 1,500 base pairs of mitochondrial DNA including full cytochrome b and partial D-loop regions, and four nuclear DNA microsatellite loci were determined for these individuals. MtDNA sequences obtained from nine individuals were completely identical. Among the microsatellites, one locus is polymorphic with eight alleles, and findings on two loci indicated none of the alleles of AKW1 was shared by any of AKW3, 7 and 8. Data for one locus indicated that AKW3 and AKW8 shared an allele only with AKW9, and AKW7 shared alleles with AKW2 and AKW6. AKW1 shared alleles with AKW4, AKW5 and AKW6. These four microsatellite data are understood as follows: fathers of the three calves are not included in this pod, whereas at least one adult female and one suckling calf are missing. Three adult females, AKW4, AKW5 and AKW6 could be siblings of the large male AKW1, or one of these three could be the mother of the AKW1. Further data accumulations on genetic structures of killer whales, as well as careful observations on the animals in the seas around Japan are necessary for clarifying their pod structure.

Past and Present Distribution of Marine Mammals in the Caribbean: A Historical Analysis of Causes and Consequences

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We analyzed 2,134 records of cetaceans, pinnipeds and sirenians for the Caribbean and Bermuda. Those records were classified based on geographical, temporal, and nature of the record (sightings, strandings, captures, etc.). 31 species of marine mammals have been recorded for the area in post-Columbian time. One of the species is now extinct, the Caribbean monk seal (*Monachus tropicalis*) and two others have shown significant reduction in their current distribution: the West Indies manatee (*Trichechus manatus manatus*) and the humpback whale (*Megaptera novaeangliae*). In the first case its decline can be attributed to a combination of both habitat destruction and hunting, while for the former it is overexploitation. The largest number of records correspond to humpback whales (502), although most of those records are exploitative in nature are for localities for which this species is no longer present. The odontocete species with the highest number of records is the boto (*Inia geoffrensis*) (224) followed by the pantropical spotted dolphin (*Stenella attenuata*) (195). With the exception of the Caribbean monk seal, the West Indies manatee, and the humpback whale, all other distributional changes over time seem to result from the way data was generated through human interactions with these animals either through exploitation or research. There are significant differences between the species composition of the Caribbean and the Gulf of Mexico. Yet it is hard to assign "species assemblages" for the Caribbean given the lack of long-term, widespread surveys for the area.

A Preliminary Examination of Sex Differences in Tactile Interactions Among Juvenile Spotted Dolphins (*Stenella frontalis*)

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The juvenile period may be an important time for spotted dolphins to practice social skills and to develop long-term social affiliations. Spotted dolphin juveniles spend a considerable amount of time in the presence of other juveniles, yet juvenile-juvenile interactions remain

relatively unexplored. Tactiles are an important display of affiliation and social bonding in dolphins, thus the study of juvenile-juvenile tactile interactions may provide a key to understanding the development of social behavior. Underwater observations were made on several juveniles in a Bahamian dolphin population. Two to four minute focal follows were performed on juveniles, and all interactions were videotaped. For each interaction observed, the gender of the juvenile that initiated the tactile, the gender of the juvenile that received the tactile, the regions of the initiator and receiver's bodies that came into contact, and the type of tactile used were scored. Juveniles were identified based on spotting pattern, and sex was determined by observation of the genital region. Nine male and 10 female juveniles were observed over 19 encounters. Overall, male juveniles had significantly higher percentages of tactile interactions involving their heads than female juveniles did. Male-to-male tactiles involved more head tactiles than female-to-female tactiles did. Males initiated significantly more tactiles with their heads and bodies than females did, while female juveniles initiated significantly more tactiles with their pectoral fins. Juveniles displayed a preference in body parts used to initiate tactiles: pectoral fins and flukes were used significantly more to initiate than receive tactiles. Heads, tails and pectoral fins were the three body parts used most to initiate tactile exchanges. Rostrums, melons, and flukes were the body parts used most in aggressive tactile exchanges. Swim formations were also scored: females always maintained the top position, and males the bottom, in all ventral-ventral formations (copulatory formations) observed.

'One for All and All for One': Intra-Group Dynamics of an Insular Spinner Dolphin Population

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Spinner dolphins (*Stenella longirostris*) occur throughout the Hawaiian Archipelago, but display two dissimilar social systems in different habitats across the island chain: classic fission-fusion societies off the main islands, and long-term stable, bisexually bonded communities with no obvious fission-fusion in the remote atolls of far-western Hawai'i, genetically distinct from dolphins at the main islands. We investigated intra-group dynamics of spinner dolphins at Midway Atoll based on nearest-neighbor association patterns across a 5-year photo-identification dataset (92 males and 53 females, 80% of all photo-identified individuals) using multivariate techniques and models provided by the population analysis software SocProg. Although long-term group stability represents an overall pattern for spinner dolphins at Midway, nearest-neighbor association rates differ between sexes, as does the persistency of nearest-neighbor grouping. Among males, there are significant preferential partnerships that persist over short sampling periods, as well as long-term companionships. The pattern for females is more dynamic, with some nearest-neighbor associations re-occurring across long time-scales, but with no short-term partner stability (with the exception of nursing females, where short-term nearest-neighbor adult-pairs are strong). However, the population model that best describes intra-group social dynamics is the same for male-male and female-female pairs: 'rapid disassociations + constant companions + casual acquaintances'. For male-female pairs it becomes more fluid ('rapid disassociations + two levels of casual acquaintances'). Female attractiveness, however, differs with season; the male-female nearest-neighbor grouping increases and is more persistent in summer, along with the increased frequency of sexual behavior and highest number of parturitions, but with little effect on male-male nearest-neighbor grouping. In general, despite stronger male-male bonds, the intra-group social pattern appears as a dynamic network similarly involving males and females – the dolphin

version of 'one for all and all for one', consistent with long-term group stability and likely promoting philopatry of both sexes.

The Recovery of Baltic Gray Seals: Results from 30 Years of Monitoring

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Counts of gray seals during molt has been the basis for population monitoring in Sweden since the mid 1970s. The situation for the seals in the Baltic was severe during the 1960s and 1970s. Hunting and a disease complex linked to environmental toxins, mainly PCBs decreased the Baltic gray seal population from an estimated 88,000-100,000 in the beginning of the 20th century to less than 4000 in the mid 1970s. However a ban on hunting and on the use of PCB and DDT in the early 1970s proved to be successful and stopped the decline. Due to differences in surveying methodology over time and between countries the total figures from the whole Baltic Sea area can't be used to estimate population trends. However the monitoring scheme in Sweden has been consistent and thus enables estimation of population growth rate. Between 1975 and 1985 the number of seals along the Swedish Baltic coast remained relatively constant with maximum numbers of counted seals about 1500. Not until the mid 1980s started the population to increase and in 1991, 2,100 seals were observed during molt. Between 1991-2004 the mean annual growth rate of the population was 7.49% (4.96%-10.01%) and the counted number of gray seals along the Swedish Baltic coast in 2004 exceeded 5,500. The same year a combined figure for the whole Baltic was approximately 17,600. However the number of counted seals is only an index of population size, since the proportion the counted population remains uncertain. But molt counts most likely provide at least a minimum estimate of population size. The rate of increase (7.49%) is slightly higher than the 6% estimated for the UK gray seal population, but less than estimates of the maximum potential increase rate of a healthy population with a stable age structure (approximately 10%).

Predicting Global Hotspots of Marine Mammal Biodiversity

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Quantifying the importance of specific key areas to a wide range of species is critical in the context of the preservation of marine biodiversity. We mapped worldwide patterns of marine mammal biodiversity based on predictions of individual distributions of 115 marine mammal species. Large-scale predictions of relative environmental suitability (RES) for each species were generated within a GIS framework using an envelope model and a global grid system of half degree latitude/longitude cells. The relative environmental suitability of each cell was defined as a dimensionless index ranging from 0.01 (low) to 1.00 (high) and was determined for each cell by relating all available data on individual species' habitat preferences to environmental cell attributes. We validated model outputs using independent survey and satellite tagging data for a subset of 14 species selected from a wide taxonomic and geographic range. This analysis indicated that predicted core habitats correlated strongly with high observed encounter rates for all but one species. We subsequently generated maps of global marine mammal biodiversity by overlaying RES predictions for all species, using a range of RES thresholds to define "core habitat". The resulting large-scale patterns showed strong bands of high biodiversity in temperate waters of both hemispheres, similar to those found by others for other top predator groups and zooplankton. Hotspots of marine mammal biodiversity in terms of core habitat were predicted to occur in, for example, New Zealand and Japanese waters, the Northern Gulf of Mexico, and around Baja California, and the Galapagos Islands. Our rule-based model utilizes

and synthesizes globally available marine mammal occurrence information within a single conceptual framework and can be a useful tool to prioritize areas that warrant intense research and management focuses.

A Voluntary Mechanism of Protection from Airborne Noise in a Harbor Seal

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We conducted two series of experiments designed to assess the effects of noise on hearing sensitivity in a harbor seal (*Phoca vitulina*). In the first series, temporary threshold shifts (TTS) were induced at octave-band noise levels of about 97 dB SPL (re 20 µPa) and above. Onset of TTS was determined to be at a sound exposure level of about 131 dB SEL (re 20 µPa)²s, and growth of TTS was determined using a modified exponential model to be between 1.5 and 2 dB/dB of noise. In the second test series, conducted more than one year after the first, no significant TTS was observed at noise levels of up to 106 dB SPL. Results of further experimentation showed that TTS onset had shifted to approximately 158 dB SEL, while growth of TTS and baseline hearing sensitivity remained essentially the same as in the earlier test series. Observations made during noise exposure showed that in the second series of experiments, the subject was able to open and close the opening to the external auditory meatus. Closure of the meatus during loud noise events may explain the nearly 30 dB difference in sound exposure levels needed to induce TTS, and suggests that some pinnipeds may learn to utilize protective mechanisms to reduce their exposure to environmental noise. This finding is important in light of concerns about the effects of anthropogenic noise on marine mammals.

Effects of Commercially-Available Acoustic Alarms, Designed to Reduce Small Cetacean Bycatch in Gillnet Fisheries, on the Behaviour of North Sea Fish Species

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World-wide many cetaceans drown incidentally in fishing nets. To reduce the unwanted bycatch in gillnets, pingers (acoustic alarms) have been developed that are attached to the nets. In the European Union pingers will be made compulsory in 2007, as long as their use does not reduce the fishermen's catch and does not disturb non-target fish species. In this study, the effects of seven presently commercially-available pingers on the behaviour of five North Sea fish species in a tank were quantified. The species tested were: sea bass (*Dicentrarchus labrax*), pout (*Trisopterus luscus*), thicklip mullet (*Chelon labrosus*), herring (*Clupea harengus*), and cod (*Gadus morhua*). The fish were housed as single-species schools of 9-13 individuals in a tank. The behaviour of fish in quiet periods was compared with their behaviour during periods with active pingers. The results varied both between pingers and between fish species. Sea bass decreased their speed in response to one pinger and swam closer to the surface in response to another pinger. Mullet swam closer to the bottom in response to two pingers and increased swimming speed in response to one pinger. Herring swam faster in response to one pinger, and pout and cod (close relatives) showed no behavioural responses to any of the pingers. Of the seven pingers tested, four elicited responses in at least one fish species, and three elicited no responses. Whether similar responses

would be elicited in these fish species in the wild, and if so, whether such responses would influence the catch rate of fisheries cannot be derived from the results of this study. Based on the limited number of fish species tested, the present study suggests, that the higher the frequency of a pinger, the smaller the chance that its sounds have an effect on the behaviour of fish.

HAL Meets Flipper: Modeling of Marine Mammal Vocalizations in High-dimensional Semantic Space

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The Hyperspace Analog to Language (HAL) model analyzes language in humans by encoding the complex statistical, grammatical, and semantic regularities in language input using a global lexical co-occurrence learning algorithm. HAL has been used to account for a broad range of cognitive phenomena and has been shown to be robust over a variety of languages (Burgess 1998). HAL and a Simple Recurrent Network (SRN; Elman 1990) were used to quantify contextual relationships in marine mammal vocalizations, primarily that of the bottlenose dolphin (*Tursiops truncatus*). Networks such as these are able to incorporate contextual relationships both before and after each "word," and are able to incorporate behavioral context with vocalizations. Some challenges to building these models will be discussed, and preliminary data will be presented. *References:* Burgess, C. 1998. From simple associations to the building blocks of language: Modeling meaning in memory with the HAL model. *Behavior Research Methods, Instruments, & Computers* 30:188-198.; Elman, J. L. 1990. Finding structure in time. *Cognitive Science* 14:179-211.

Skiff Surveys of Northern Sea Otters Within Tribal Boundaries in Alaska

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Since 1998, TASSC has worked with Alaskan Tribal Governments to count northern sea otters (*Enhydra lutris kenyoni*) in their Tribal boundaries to determine sea otter population trend. These surveys are conducted via skiff using standardized methods by traveling along the shoreline. One aspect of the skiff survey is the incorporation of local and traditional knowledge into survey design. Native peoples have information passed on to them by their fore-fathers who have hundreds of years marine mammal observation within their Tribal boundaries. From 2003 to 2005 TASSC worked with eight tribes in the following areas on these surveys: Cordova, Yakutat, Unalaska, Craig, Hydaburg, Port Graham/Nanwalek, Port Heiden and Chignik Lagoon. The surveys were conducted by trained Tribal members in proximity to their local communities. In 2005, approximately 1324.4 miles of coastline were surveyed. Cordova, Yakutat and Unalaska and Port Graham have the longest time series of data. Cordova began their surveys in 1998; Yakutat, Unalaska and Port Graham/Nanwalek began their surveys in 1999, 1999 and 2000 respectively. Results from Cordova, Unalaska and Port Graham indicate a gradual increase in the amount of sea otters sighted since the surveys began. Yakutat survey data shows a stable to a slightly decreasing trend. However, shoreline counts are influenced by Yakutat Bay being shallow enough where otters congregate in the middle of the bay. In Chignik Lagoon, surveys were conducted in the spring of 2003 and 2004, and the fall of 2004. The spring surveys show a stable trend over that time period. No trend can yet be determined for Craig, Hydaburg, or Port Heiden. During 2005, Craig surveyed 239.1 miles of coastline sighting 963 otters. Hydaburg surveyed approximately 112 miles sighting 437 otters. Port Heiden surveyed in the summer and fall of 2004, sighting 20 and 53 otters respectively.

Humpback Whale (*Megaptera novaeangliae*) Site Fidelity on Jeffreys Ledge and Mount Desert Rock: Biological and Physical Oceanographic Influences

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Identification research has allowed researchers to monitor humpback whale (*Megaptera novaeangliae*) populations and site fidelity in the Gulf of Maine for over 35 years. Recent sightings data have shown large fluctuations in the number of humpbacks sighted on Jeffreys Ledge and Mount Desert Rock (MDR) in the Gulf of Maine (GOM). These habitats are characterized by rocky submarine ridges close to basin edges in the GOM. This study examines possible correlations of humpback whale site fidelity and oceanographic parameters that have occurred on Jeffreys Ledge and Mount Desert Rock over the last six years. Humpback whale sightings were collected aboard commercial whale watch boats from 1997 to 2004 by Blue Ocean Society and Allied Whale naturalists and scientists. Humpback whale sightings were also collected on Allied Whale research vessels off MDR. Using Geographic Information System (GIS) and ArcMap, humpback whale sightings were compared yearly using the following physical and biological parameters: bathymetric slope, monthly average chlorophyll, and water temperatures. Preliminary results of this study suggest that annual trends in biological parameters, such as chlorophyll density coupled with slope topography, may impact humpback whale site fidelity on Jeffreys Ledge and MDR. Between the years of 2002 to 2004 humpback whale sighting data demonstrated a possible relationship between sight fidelity and slope topography on Jeffreys Ledge. In 2002 there was an observed shift in humpback distribution to the northeastern edge of Jeffreys, which borders a deep basin. Another interesting trend occurred in 2003 and 2004 included humpback distribution becoming increasingly dispersed along the southern areas of the Ledge. Also, during these years, the NAO (North Atlantic Oscillation) index remained in a predominantly negative state, which may imply that shifts in the NAO could affect humpback site fidelity.

Testosterone and Blubber: Assessing Male Sexual Maturity State and Mating Seasonality from Common Dolphin Blubber Biopsies

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In many free-living mammals, testosterone (T) is measured to assess sexual maturity state and seasonal mating behavior of males; however, in cetaceans obtaining the biological samples commonly used for these measurements (*i.e.*, blood, urine, and feces) is often impractical. In this study, we evaluated the utility of quantifying T in blubber, a tissue commonly obtained from biopsies of wild cetaceans, to estimate the maturity state of short-beaked common dolphins (*Delphinus delphis*). We measured T in small blubber samples (~150 mg, similar to the size obtained from projectile biopsies) from 85 male *D. delphis* killed in the California gillnet fishery. Right testis measurements (length and mass) were used to classify each specimen into one of three maturity states: immature, pubertal, and mature. We found that immature and pubertal animals had the lowest average blubber T concentrations (2.42 and 3.64 ng/g respectively) and mature animals had the highest (18.9 ng/g). Although the three concentrations were significantly different from each other ($p < 0.03$ for all three comparisons), the overlap in the range of concentrations indicates that blubber T cannot be used to definitively assess the maturity state of every individual. However, by fitting these data using binary and multinomial logistic models, we created reference criteria that will allow us to estimate the probability of a biopsied *D. delphis* (for which testis size is unknown) of being immature, pubertal, or mature from their blubber T concentration. We also found that plotting blubber T concentrations as a function of Julian date revealed seasonal patterns of T production that suggest a summer breeding season. The development of these techniques will ultimately allow us to further our study of cetacean population dynamics by using skin and blubber

samples collected from projectile biopsies.

Cytogenetic Characterization, Microdissection and Cross-Species Fluorescence In-Situ Hybridization (zoo-FISH) Studies of the Florida Manatee, *Trichechus manatus latirostris*

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Comprehensive cytogenetic studies are being performed on the chromosomes of the Florida manatee, *Trichechus manatus latirostris*, an endangered subspecies of the West Indian manatee. Cross-species fluorescent in-situ hybridization (zoo-FISH) studies were initiated using human genome reagents in an effort to understand the molecular nature of manatee chromosomes. This is an extension of the laboratory's earlier work, which developed the first manatee ideogram based on multiple high-resolution G- and Q-banded karyotypes from nine Florida manatees. Routinely, manatee white blood cells are collected and cultured for karyotype procedures. In addition, cartilage and kidney tissue cultures have been established following collection of tissue during necropsy shortly after euthanasia of an adult male with extensive boat strike injuries. These cryopreserved primary cell cultures have provided the high quality material needed for chromosome microdissection, *i.e.*, the physical isolation of partial or whole chromosomes using a microscopic needle. This technique is being used to compare the evolutionary conservation between human and manatee chromosome segments. For example, chromosome 23 has been collected repeatedly from multiple manatee cartilage cells using microdissection. The collected DNA was then amplified using PCR, labeled with fluorescent probes, and hybridized to homologous sequences within human chromosomes. Hybridization stringency conditions were optimization by varying temperature, salt and formamide concentrations. Preliminary results to date show hybridization of manatee chromosome 23 to the positive control, manatee chromosome 23 only, as well as to human chromosome nine. These studies will facilitate high-resolution genetic mapping of the manatee genome as well as intraspecific and interspecific comparisons to other, non-human, species.

Pigmentation Patterns in Bottlenose Dolphins: How to Distinguish *T. aduncus* and *T. truncatus* in South Australia

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Overall pigmentation pattern in the genus *Tursiops* is believed to be the generalised pattern from which more complex patterns developed in the family Delphinidae. It is a simple counter-shading of dark dorsal cape and lighter dorsal field overlay, with variation due to the extent and intensity of the latter. The present study investigates the pigmentation patterns on fresh carcasses of 17 *T. truncatus* and 25 *T. aduncus* from South Australia. Species identification was based on osteological and/or genetic features. Both species had blowhole and eye stripes (=bridles) and variable intensities in the flipper stripe. *Tursiops truncatus* generally had a much darker dorsal field overlay that contrasted with a white venter and ventral spotting was present in only one animal. A throat chevron and genital patch were present in all age groups and more clearly demarcated in sub-adults and adults than younger animals. All *T. truncatus*, including neonates and juveniles, had a flank blaze but this was not distinct in a few animals. *Tursiops aduncus* had a medium gray dorsal field overlay that graded

more evenly into an off-white, cream or pale gray venter. Ventral spotting was present in several adults. A very faint throat chevron was present in one animal and no *T. aduncus* had a flank blaze. Two *T. truncatus* with genetic contributions from both species retained the *truncatus* pigmentation features. Pigmentation patterns may relate to the behavior and ecology of *Tursiops* spp. in South Australia: *T. truncatus* is more distinctly counter-shaded and is likely to be a deep-water specialist whereas *T. aduncus* is less counter-shaded and inhabits shallow coastal waters. Flank blazes in *T. truncatus* may serve as identifying cues to other individuals and could indicate a more gregarious social organisation than *T. aduncus*.

A Tool for Identifying Areas of Humpback Whale Entanglement Risk in the Gulf of Maine

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Entanglement in fishing gear is a source of serious injury and mortality to humpback whales (*Megaptera novaeangliae*) and other cetaceans. NOAA Fisheries is currently considering measures to reduce entanglement risk from ground line that connects fishing equipment along the seafloor. However, successful gear modification depends on a better understanding of how whales use the lower reaches of the water column. Humpback whales in one southern Gulf of Maine (GOM) area have been shown to acquire abrasions along their jaw, suggesting that feeding sometimes extends to the sea floor. In this study, a jaw scuffing analysis was conducted to estimate the prevalence of this behavior and to identify other GOM areas where bottom feeding may occur. Between 2001 and 2005, high quality images were obtained of the heads of unique individuals in southern (41-42.5°N, n=77) and northern (42.6-44°N, n=20) habitats in the US and Canadian GOM. Individuals were categorized as having raw scuffing, healed scuffing, or no scuffing on the right side of the jaw. Animals using northern habitats were significantly less likely to exhibit jaw scuffing (35%) than those feeding in the south (62%, $G_{adj}=4.69$, $df=1$, $p=0.03$). Furthermore, none of the northern animals exhibited raw scuffing, presumably indicative of recent bottom feeding. These results are consistent with evidence that prey species known to favor the bottom (sand lance, *Ammodytes* spp.) occur primarily in southern areas in this region. Eliminating the ground line profile (via sinking line or other means) may be the only risk-averse option for such areas. Placing ground line at the bottom would also likely reduce risk for this species in northern GOM areas. However, the results of this study may also help to focus research on areas where alternate ground line profiles may be possible.

Freezer Paleostratigraphy: Re-Discovery of an Early Gray Seal Stranding From Block Island, Rhode Island, USA

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During an inventory and clean-out of the campus walk-in freezer in Spring 2004, a vaguely seal-shaped, burlap-wrapped bundle was discovered on a rear shelf, labeled "Harbor Seal, Block Island, March 3, 1980." The specimen had apparently been there since being recovered from Block Island, 16 km off the south coast of Rhode Island, by one of Professor Howard Winn's students 24 years earlier. When the specimen was thawed and unwrapped for necropsy several months later, however, it was very clearly a gray seal and not a harbor seal. Gray seals (*Halichoerus grypus*) had apparently been largely or entirely extirpated from southern New England by the mid-20th Century, and only began recolonizing the area around Nantucket, Massachusetts during the 1970's. The 1980 stranding was likely never examined closely at the time of recovery, since nobody expected to find anything but a harbor seal in the region. The earliest gray seal stranding record for Rhode Island in the modern era was in May 1986, also from Block Island. The newly discovered specimen backs up the stranding history for gray seals in the state by six years. The animal was a 130-cm juvenile male, and was in an advanced state of decomposition. No definitive

cause of death could be determined, although it was extremely emaciated with only a 2-mm thick blubber layer. There were no flipper tags observed, so it was not possible to determine if the Block Island animal originated from the small extant Massachusetts colony or from the larger population pupping on Sable Island off Nova Scotia, Canada, although the former may be more likely. No lower strata are present in the freezer, therefore no even older specimens will be forthcoming.

Neuronal Fiber Composition of the Corpus Callosum within Family Delphinidae

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Cetacean brains exhibit several unique features including significantly larger brain size relative to body size; highly convoluted cerebral and cerebellar cortices; and smaller callosal area relative to brain mass. Substantial evidence indicates that the corpus callosum is involved in communication and coordination between the cerebral hemispheres and maybe involved in the fusion of the sensory midline. The objectives of this study were to: 1) investigate the neuronal fiber composition of the corpus callosum within Family Delphinidae 2) determine if the reduction of the relative size of the corpus callosum is associated with a reduction in number of fibers or reduced fiber size and 3) determine if fiber density is related to brain mass or sex. This study utilized 10% formalin fixed whole brains collected during necropsies from *Orcinus orca*, *Tursiops truncatus*, and *Delphinus capensis*. Neuronal fibers were identified using standard histological methods for light microscopy and Luxol Fast Blue stain. Fibers from 10 regions along the midsagittal plane were divided into four categories based upon diameter. The initial findings of this study indicate that the corpus callosum of delphinids is not a homogeneous structure and there was variability in fiber size and number between the different regions in all specimens examined. This result may indicate the presence of topographic differences along the corpus callosum. In all regions the most frequent fiber size was in the 1.0-2.99 μ m category. Additionally, fibers greater than 5 μ m in diameter were the least frequent fiber size in all regions. The largest absolute fiber number and the largest number of fibers ranging in diameter between 1.0-2.99 μ m were located within the posterior one-third of the corpus callosum. These trends have been previously reported in studies of the corpus callosum in humans.

Nearshore Oceanography and Planktonic Prey (Family Porcellanidae) of Gray Whales in Clayoquot Sound, British Columbia, Canada

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Gray whales in Clayoquot Sound occasionally feed on dense patches of porcelain crab larvae. It appears that gray whales in this area switch from feeding on their primary prey of mysids to feed on porcelain crab larvae when dense patches are present. The irregular timing and extent of patches prompted interest in factors influencing larval distribution and abundance. Such factors could include oceanographic conditions which influence larval growth and survival, synchronous hatching of larvae timed to environmental cues and/or water circulation. Prey of foraging gray whales was determined using net tows and other cues. Timing of larval release in the porcelain crab, *Petrolisthes cinctipes*, was estimated by monitoring egg-carrying crabs. CTD/fluorometer casts and plankton net tows were conducted at repeatedly sampled locations to document temperature, salinity, chlorophyll fluorescence, distribution and density of porcelain crab larvae. Gray whales were present in the study area throughout the season with an average of 11.1 whales/day (SD = 8.56) documented. Gray whales fed primarily on mysids. Porcelain crab larval release peaked in early July. A subsequent increase in larvae in the plankton was not detected. Porcelain crab larvae densities were low throughout the season and gray whales were

not observed feeding on porcelain crab larvae. Variation in temperature and salinity is driven mainly by upwelling processes. Variation in chlorophyll *a* concentration up to five-fold occurred over periods of days. Spatially discrete phytoplankton blooms and thin vertical layers of chlorophyll fluorescence were documented. This study increases understanding of the oceanography of the relatively unknown nearshore zone of a wave-exposed environment.

Do Amazon River Dolphins See in Color? Behavioral and Molecular Approaches

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Cellular anatomical analysis of the retina of the Amazon River dolphin (*Inia geoffrensis*) reveals the presence of rods and cones, typically an indicator of color vision. In behavioral studies conducted at the Pittsburgh Zoo and Pittsburgh Plate Glass Aquarium, color vision was tested by exposing a single river dolphin to four floating targets of red, green, blue and yellow; the density of the targets was designed so that they would not appear distinct to monochromatic vision. A total of 846 tests over one year involved giving verbal, tactile and visual color-search commands. Results showed a 100% correct color match for red and blue, 87% for yellow and 86% for green. In a separate study, a molecular approach is being used to determine if two classes of cone visual pigments are present, using PCR for amplifying and characterizing dolphin visual pigment genes. Amplification of the *Inia* opsin gene was successful, and two opsin gene sequences were then targeted during sequencing. The next step will be to identify each opsin gene in *Inia* using TA cloning and sequencing. However, the behavioral results and preliminary molecular data strongly suggest that this species possesses color vision.

A Comparison of Cardiorespiratory Patterns of Nursing and Weaned Harbor Seal Pups

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Harbor seals, *Phoca vitulina*, are perhaps the most precocial phocid beginning active diving immediately after birth. Since their nutritional needs are met from nursing these dives are relatively shallow and short. Despite limited diving behavior during the nursing period, the development of cardiovascular control is rapid. However, at weaning this control is still not at adult levels. This study focuses on comparing the cardiorespiratory control of quietly resting nursing and weaned pups. We hypothesize that this control will be greater in weaned pups because they will be pushing their physiological limits in order to forage independently following weaning. Specifically, we expect weaned pups to have longer apneas (breath holds), more substantial bradycardias (decreases in heart rate), and the ability to maintain a lower heart rate more consistently during apneas than nursing pups. Data for this study was collected from harbor seal pups in Penobscot Bay, Maine during May and June of 2004 and 2005. Heart rate was monitored on resting seals with a Polar chest strap heart rate transmitter and a wrist recorder and respiration patterns were recorded with a video camera. Preliminary findings show that apnea duration and eupneic (restful breathing) heart rate were similar for both groups. However, apneic heart rate was lower in weaned pups. Furthermore a bimodal distribution in apneic heart rate shows that the percent of time spent in a low apneic heart rate (less than 100 bpm) was greater in weaned pups. These findings indicate that weaned pups have better cardiorespiratory control in comparison to nursing pups. This control, however, is not reflected in improved respiratory performance (*i.e.* longer apneas) while resting and may only be apparent when the need to forage necessitates the behavior that will push their physiological capacity.

Looks Are Important! Evidence of Species Recognition in Sympatrically Breeding Fur Seals

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Most fur seal species have discrete breeding ranges, but subantarctic and Antarctic fur seals breed sympatrically and produce hybrid offspring at three locations. Hybridisation in mammals is rare and natural selection predicts barriers to gene exchange between species. At Îles Crozet hybridisation between Antarctic and subantarctic fur seals is significantly less (~3%) than expected if random mating were occurring suggesting that there may be traits by which females choose conspecific mates. Male subantarctic fur seals exhibit unique features not found in other fur seals, *i.e.* conspicuous pelage with creamy ventral surface, dark dorsal fur and prominent sagittal crest. Other male fur seals are uniformly dark in colour with no sagittal crest. We examined determinants of male reproductive success and tested whether male pelage acts as a visual cue for species recognition. We collected genotypic and morphometric data from 31 adult males and genotyped 58 adult males, 96 females and 190 pups during the 2001/2002 and 2002/2003 breeding seasons. We performed a mate choice experiment in 2001/2002 by manipulating 8 male subantarctic fur seals to resemble other species. Similar treatment was given to a group of 8 control males and paternity analysis undertaken. In Antarctic fur seals but not subantarctic fur seals testes size was positively correlated with reproductive success. Pelage did not significantly influence the number of offspring sired but experimental male territories had significantly fewer females. Females may choose conspecifics based on visual cues when choosing a territory at the start of the breeding season rather than at time of mating. Territorial males were more successful than non-territorial males, but females were not always inseminated by their territorial male with many extra-territorial fertilisations. Clearly competition between males is high. Males with larger testes that produce more sperm may enhance their prospects of fertilising multiply mating females.

Phylogenetic Relationships Within the Subfamily Delphininae Determined Using Mitochondrial DNA Control Region Sequences and Nuclear AFLP Markers: A Comparison

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Molecular markers have contributed both clarity and contradiction to cetacean taxonomy and systematics at all levels. One group where relationships remain unclear despite past morphological and molecular studies is the subfamily Delphininae. In an effort to untangle the poorly defined relationships among members of this subfamily, we constructed molecular phylogenies utilizing the commonly sequenced mitochondrial DNA control region and compared this to a novel method, the amplified fragment length polymorphism (AFLP) assay. A 361 base-pair fragment of the mitochondrial control region from 338 haplotypes (a minimum of 5 individuals per ingroup species) encompassing twelve delphinine species and six outgroup taxa was used to build both bootstrapped (1,000 iterations) and non-bootstrapped neighbor-joining trees. Very few species in the control region tree were supported by bootstrap values above 50; in fact bootstrapping this dataset produced a large polytomy rather than a resolved phylogeny. The variation at this locus is so high that some *Delphinus delphis* and *Stenella clymene* haplotypes never cluster with the appropriate species. Therefore, determining relationships

among the species in this subfamily is nearly impossible using this highly variable mtDNA locus. For comparison, we assayed 128 individuals (minimum of 4 individuals per ingroup species) from twelve delphinine species and two outgroup taxa using 20 AFLP primer combinations (418 polymorphic markers). A bootstrapped (1000 iterations) neighbor-joining tree was built from the binary AFLP data using the Jaccard index. In contrast to the control region tree, the AFLP tree was considerably more resolved; seven of the twelve delphinine species exhibited strong bootstrap support. Both spotted dolphin taxa group together in all 1,000 iterations, and *Sousa* is a sister clade to all other ingroup taxa. Although the nuclear multi-locus approach does not render a completely resolved tree, it does offer new insight into relationships among the closely related Delphininae.

Biopsy Sampling in Tropical Dolphins: Individual and Group Behavioural Reactions

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Biopsy sampling in small cetaceans is extensively used to collect skin and blubber samples, for different topics including genetic, feeding ecology, toxicology, and immunology. However, despite rare lethal consequences, it is clearly needed to assess whether biopsy sampling impact dolphin behaviour (both on the short and long term). In 2005 (January-April), 82 biopsy attempts were made on five dolphin species in the waters surrounding the island of Mayotte (Mozambique Channel, Indian Ocean): spinner dolphin (*Stenella longirostris*, n=43), pantropical spotted dolphin (*Stenella attenuata*, n=21), melon-headed whales (*Peponocephala electra*, n=8), Fraser's dolphin (*Lagenodelphis hosei*, n=7) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*, n=4). Two techniques of biopsy sampling were used: scrubbing to obtain upper skin layer samples (only 16 attempts exclusively on spinner dolphins), and darting (stainless steel tips 8x25 mm) to obtain both skin and blubber samples. Only 15 attempts missed. For both species, 83% of the animals reacted negatively at different levels (100% of no-reaction concerned spotted dolphins), but most of the reactions were moderate. Immediate reactions of hit individuals consisted in body slap/dive (94%) and escape, generally accompanied by successive breaches (6%, which 84% were observed in scrubbed individuals). Short term reactions of groups/subgroups were observed irregularly (moderate increase of swimming speed/dive, 21%), and were correlated with group size and structure, and species. During the encounter of a group where biopsy sampling was undertaken, the behaviour did not change except for Indo-Pacific bottlenose dolphins. Approaches close to targeted individuals were more difficult. Over months, we did not find any change of behaviour of dolphins toward the research vessel (including for bottlenose dolphins). We concluded that biopsy sampling have a variable influence on dolphin behaviour, and that biopsy darting provoked moderated reactions vs. scrubbing. However, negative group reactions should be reduced as a precaution. Potential solutions are also discussed.

Coupling Energetics and Pharmacokinetics of Right Whales: Predicting Growth, Reproduction, and Dynamics of Persistent Lipophilic Toxicants (PLTs)

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Right whales have long lifespans, mature slowly, and pass toxicants to their young through milk. This results in a significant individual bioaccumulation of PLTs and the recycling of PLTs within the population through vertical transfer from mothers to their young. Since this vertical transfer happens during early stages of development, it could reduce the fitness of individuals and have negative population-level consequences. Nutritional stress can

mobilize toxicants stored in the blubber and further harm individuals. To help investigate the possible consequences of nutritional stress and PLT accumulation on right whale growth and reproduction, we constructed a compartment model with two linked sub-models. The first sub-model describes energetics; the second describes the pharmacokinetics of PLTs. Using the model we can predict the dependence of growth, reproduction and PLT bioaccumulation on environmental variables. Our model predictions match observations well and indicate that a 6% reduction in energy intake increases the birth interval from 3 to 5 years, and significantly increases the vertical transfer of PLTs. A 12% reduction increases the birth interval to 10 years. This suggests that a moderate decrease in food supply or an increase in the cost of food acquisition (e.g. due to feeding interruptions) may significantly reduce the fertility of right whales. Since there may be an energetic cost of exposure to toxicants, PLTs may impact fertility through energetics as well as through direct toxicity. Therefore, food supply, interactions with humans and pollution should be considered in any long-term management strategy.

Bermuda's Deep Diving Dolphins - Movements and Dive Behavior of Offshore Bottlenose Dolphins in the Northwest Atlantic Ocean near Bermuda

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Although Atlantic bottlenose dolphins (*Tursiops truncatus*) are widely studied around the world, little is known about the behavior of the offshore ecotype over deep water or near oceanic islands and seamounts. Using satellite-linked time depth recorders, the primary objectives of this study were to investigate the movement patterns and dive behavior of offshore bottlenose dolphins found near the Bermuda Pedestal, located 965 km east of Cape Hatteras, North Carolina. Six offshore dolphins were collected, temporarily restrained, tagged and released in summer 2003 (2 males, 1 female) (Wildlife Computers SDR-T16) and spring 2005 (2 males, 1 female) (Wildlife Computers SPLASH). In 2003, dolphins were tracked from 5 to 45 days and remained in close proximity to the island of Bermuda and its two neighboring banks where mean water depth was -1402.0 ± 1120.7 m. An adult female performed regular nightly dives beyond 450 m (the maximum range of the recorders) and dive durations exceeding five minutes during a 45-day track period. Preliminary results from 2005 show one dolphin remaining close to the island for more than 42 days while two other dolphins traveled over 250 km from Bermuda to Muir Seamount and through waters of depths greater than 4000 m before transmissions ceased. An adult female tracked for 12 days demonstrated maximum recorded dives to depths of 600 to 700 m and durations of 11 to 12 min, the deepest and longest dives ever recorded for this species. Results from this study suggest the existence of a potential seamount/island-associated population of offshore bottlenose dolphin near the Bermuda Pedestal while dive data indicate a possible diel dive cycle in search of mesopelagic prey during their nightly vertical migrations.

Presence of Ultrasonic Harmonics and a Frequency Modulation Repertoire in Male-to-Male Vocalizations by Captive Adult Florida Manatees

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Little is known about the full extent of acoustical communication in adult Florida manatees. Manatee vocalizations have been described as short and tonal but frequency modulation (FM) has not been extensively studied in the manatee repertoire and ultrasonic harmonics

have never been recorded. The goal of this study was to determine if FM and ultrasonic harmonics were present and potentially used in adult male-to-male communication of the Florida manatee. We examined 464 vocalizations occurring between four pairs of male manatees (total of five adult males) at the Cincinnati Zoo. We developed a dynamic classification system focusing on FM shifts at the beginning and ending regions of manatee vocalizations. Vocalizations self organized into three major categories (one-, two-, and three-region calls) based on the number of regions with differing FM patterns present in each vocalization. Regions within each vocalization were given individual classifications (Increase, Decrease, Level, or Hook) based on the modulation of the regions. These region classifications were strung together to create a compound subcategory classification for each call. Most modulations were simple linear modulations except beginning classification Hook which was seen in three subcategories. Fourteen distinct FM compound subcategories (three one-region, five two-region, and six three-region) were observed. Fifty percent of vocalizations were one of two previously reported vocalizations: Level (one-region call) or Increase-Level-Decrease (three-region call). Every vocalization contained between two and twenty-three harmonics, while two-thirds contained harmonics above 20 kHz; the highest reaching 62 kHz. We are in the process of trying to determine if manatees can control the use of harmonics to communicate. The presence of frequency modulated vocalizations suggests that manatees probably use FM at some level to communicate acoustically.

Beluga Whale and Bowhead Whale Distribution in the Northwestern Part of the Bering Sea in April of 2005

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Up to the present there is not much information about whales' spreading in the Bering Sea during the winter-spring period. The aerial survey was conducted on April 4-11 in an AN-26 "Arctic" aircraft-lab. The surveyed area was limited by the lat 61 N from the south, by lat 65 N from the north, by the shore-line from the west, by the Russian-US border in the east. The flights were performed on the altitudes ranged from 800 to 1000 meters. Total length of the transects equaled 7000 kilometers. Visual survey determined 162 groups of belugas (410 individuals) and 2 groups of bowhead whales (6 individuals). Twenty-three groups of belugas and all bowhead whales were photographed by a digital camera. The belugas were mainly observed alone the conditional border-line between the Anadyr Gulf and the clear waters of the Bering Sea with the largest concentration (more than 70% of total observations) in the area to the west of the Navarin Cape. Both bowhead whales groups were also observed in the same area. The belugas' habitats were attached to the narrow ice fractures and canals in the ice-fields; in the larger fractures they were not observed. The alone belugas were more often met (47% of all observations). The quantity of the belugas in groups varied from two to sixteen animals: the more numerous groups were not noticed. Among the observed groups the pairs prevailed (49% - 86 animals), groups of 3-5 animals made 32%, groups of 6-9 animals - 12%, groups of 10 and more - 7%. The results of the aerial surveys can be accepted as a basis for the method of belugas' wintering places in the Barents Sea accountability. This project is sponsored by the Government of Chukotka Region and USFWS 701815G329 grant.

Can the Mere Presence of Seals Affect the Catch of Herring in the Baltic Gillnet Fisheries?

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The gillnet fishery for herring in the Baltic Sea is subjected to intense

damages by grey seals, *Halichoerus grypus*. Damage consists of teared nets and damaged catch. Fishermen also suspect that seals scare away fish from fishing areas. In this study we investigated the affect the presence of seals might cause on the herring gillnet fisheries. Observers joined a professional fisherman fishing for herring in the north Baltic during six month in 2003 and 2004. Systematic observations for seals were conducted while gillnets were set and emptied. Presence of seals and the amount of catch on different nets were noted. When seals were observed while setting the nets the catch was significantly smaller then when no seals were observed, 8 kg herring/net*day compared to 25 kg/net*day. A complementary study was carried out in the same area and during the same time period. Herring caught in a net of commercial type were marked, without being removed from the net. The net was then reset and linked to the local fisherman's gear. The percentage of marked fish that were found damaged or missing the next day, was used as an indication that seals had visited the nets. 14 occasions of 19 rounds were considered as occasions with seal damages. The overall catch, including the commercial fisherman's, did decrease significantly during those occasions when seals had been present. The catch losses (difference in catch) were much larger than the few observed seals possibly could consume in that time period. The facts that catches decreases to almost nothing and that very few remains of herring is found left in the nets when seals are nearby indicates that the mere presence of seals affect the catch level. This supports the general opinion among fishermen that seals "patrol" along nets and thus scare fish away.

It's All in Your Head: The Evolution of Specialized Lipids in Odontocetes

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Mammalian adipose, including blubber of sirenians, pinnipeds, and mysticetes, is composed of triacylglycerols with fatty acids (FA) >14C. Odontocetes, however, are notable exceptions, depositing endogenous wax esters and short-chain FA in their specialized adipose depots (blubber, melon and mandibular fats). A combination of literature values and new data for 38 species leads to the hypothesis that echolocation was the driving force behind these changes in physiology, with blubber modifications representing secondary adaptations exploited by some groups. Phylogenetic relationships among extant odontocetes suggest that the evolution of acoustic lipids began in an odontocete common ancestor with deposition of waxes, which were then supplemented with 10:0-12:0 FA (physeterids, kogiids, platanistids, iniids). Ziphiids retained wax and replaced 10:0-12:0 with isolauric acid (*i*-12:0). Delphinids, monodontids and phocoenids retained some wax but substituted isovaleric acid (*i*-5:0) for *i*-12:0. Thus all odontocetes possess waxes and some form of short-chain FA in their acoustic fats, but this pattern is not mirrored in blubber. No species stores appreciable amounts of 10:0-12:0 or *i*-12:0 in blubber. In delphinoids, *i*-5:0 concentrations are high (25-60%) in acoustic fats, but levels in blubber are correlated with thermal habitat, potentially conferring advantages in cold water. *Globicephala* exemplifies this: both species have high (>30%) *i*-5:0 concentrations in acoustic fats, but cold-water *G. melas* (n=8) blubber contains twice the *i*-5:0 of warm-water inhabiting *G. macrorhynchus* (n=20). Like most mammals, blubber of most odontocetes is comprised of readily mobilizable triacylglycerols; waxes only dominate ziphiid, physeterid and kogiid blubber. It is hypothesized that animals dependent on triacylglycerols for seasonal/short-term energy (*e.g.* porpoises) retained these molecules in blubber, but species not reliant on blubber as stored energy (beaked and sperm whales) subsequently deposited waxes in blubber as a secondary adaptation for deep-diving. Such a mechanism would help explain why waxes are absent from blubber of other deep-diving marine mammals (pinnipeds).

Mysteries of Adaptation to Hypoxia and Pressure in Marine Mammals

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This paper reviews past and current work on diving behavior, effects of pressure, and the aerobic diving limit from the perspective of the Ken Norris Life Time Achievement Award. Because of the influence of Norris to marine mammalogy in general, and to my career in particular, I want to emphasize the important tradition of mentors and colleagues as keystones to a successful career in science, and ultimately to the success of science. These two related activities are illustrated by studies on marine mammals that were conducted in an endeavor to understand: 1) The behavioral traits associated with deep diving; 2) the mechanical and physiological effects of pressure during routine dives to great depth; and 3) the degree of oxygen depletion that they routinely endure while diving. The search for answers has resulted in numerous physiological and ecological experiments, along with accompanying theoretical analyses. Currently it appears that some deep diving mammals may suffer from bends, and some may resort more often than what seems physiologically possible to anaerobic metabolism while diving. Above all, the way divers manage their nitrogen and oxygen stores remains a mystery.

Assessment of State and Growth Prospects of Sea Otter *Enhydra lutris* Population in the Russian Part of Areal

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Contemporary abundance of sea otter (SO) in Russia takes about 27000 individuals (Kornev and Korneva, 2004). Own and literature data were used to assess state and development prospects of SO populations judging by population density, forage base condition and some environmental factors. The feeding was studied with carpological method on 2600 excrements; density was assessed from square of feeding area, taken as area inhabited and limited with the isobaths 50 m, with use of GIS computer program. SO population state is uncertain in Russian part of areal; there are 3 populations at least (Commander's, Kamchatka-Kurilian, Southern-Kurilian), bearing own internal structure — subpopulations. The role of density determining factors varies by populations. Commander's population, persisting as equibalanced, has the density of 3.3 specimens/km² approximately. This density is limited by trophic and spatial factors. Density of SO, inhabiting of the North Kurils and Southern Kamchatka, currently takes 3.8 specimens/km². In Paramushir and Shumshu, reckoned as favorable trophic, recreational and reproductive stations the density revealed is high — 5.1 specimens/km². In the South of Kamchatka SO densities are low (1.2 specimens/km²), also a northward distribution of SO being limited by physical and anthropogenic factors. In Central Kurils SO low density (0.6 specimens/km²) is determined by a small size of the islands, isolation and poor protective conditions. In the whole in the Southern Kurils a low density (1.1 specimens/km²) is determined by unfavorable ice conditions in winter and intense coastal fishery. The optimum density in Urup takes 3.1 specimens/km². Thus, in most part of areal in Russia SO populations exist within a carrying capacity. A further possible growth of SO abundance in Russia does not seem to be high, mostly at the expense of the Southern and partly Central Kuril populations and extension of the area up to its' historical range.

Observations of Bowhead Whale Mating in the Bering Sea

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Bowhead whale mating has been observed during spring migration from the Bering Sea to the Beaufort Sea and during late summer and early autumn in the Beaufort Sea. Some mating, particularly during

late summer and early autumn, probably does not lead to conception. Sizes of fetuses recovered from harvested whales, sightings of newborn calves in late spring, and a 13-14 month gestation period suggest that successful mating occurs mainly during March and/or April. During the few surveys conducted previously in early spring in the Bering Sea, only small groups of mating whales have been observed; no one has encountered large numbers of mating bowheads, which would confirm the timing of the main mating period. During an aerial photogrammetry study of bowheads in the Bering Sea (9 April to 2 May 2005), we encountered an unusually large aggregation of several hundred to a thousand or more bowheads. They were sighted on 13 and 14 April ~50 km north of St. Lawrence Island, concentrated along narrow leads and pockets of open water in heavy pack ice. Although northward migration toward Barrow was well underway, most of these whales were engaged in mating or resting, and few were actively traveling. We obtained ~240 vertical aerial photographs of these whales on the two days. Most whales were large and presumably mature. The observed behavior, high concentration of animals, and timing indicate this was an important mating event, a phenomenon that has apparently gone unnoticed until now because of the remote location. If the observed group was successfully mating (*i.e.*, fertilization occurred), gestation is ~13 months assuming a peak in calving of about mid-May based on observations of calves of various sizes passing Barrow in mid-to-late May and early June.

Plasma Glucose Regulation in a Fasting Animal: The Effect of a Glucagon Challenge in Weaned Northern Elephant Seal Pups

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Fasting is rare in young mammals due to the high energy demands of growth; however some species, including northern elephant seals (*Mirounga angustirostris*), fast during development. Pups fast for 2-3 months postweaning during which body reserves are catabolized to meet metabolic demands, including the supply of fuel substrates to glucose dependent tissues. Net glucose catabolism appears to be low and it has been suggested that elephant seals do not regulate plasma glucose levels using the standard mammalian insulin-glucagon model (Kirby and Ortiz, 1994). Previous studies demonstrated that insulin levels decrease during the postweaning fast, while glucagon increases dramatically (Ortiz *et al.* 2003). These shifts should stimulate gluconeogenesis; however, Champagne *et al.* (2005) found a reduction in gluconeogenesis during this period. To further understand the roles of insulin and glucagon in regulation of plasma glucose throughout the postweaning fast, 9 weaned pups were challenged with a physiological glucagon dose (2,000-3,000ng) to elevate plasma glucagon levels to levels observed in previous studies. A bolus of glucagon was injected intravenously and blood samples were taken over 90 minutes in early (2 weeks) and late (7-9 weeks) stages of fasting. Plasma glucose and plasma insulin significantly decreased across the fast (glucose: $t=-2.3$, $p=0.047$; insulin: $t=-3.4$, $p=0.01$). In contrast, and contrary to previous studies, no significant change in plasma glucagon concentration was observed ($t=0.7$, $p>0.05$). After injection of glucagon, plasma glucagon immediately increased 2-3 fold; after 20-30 minutes, glucagon returned to pre-injection levels ($t=-0.3$, $p=0.77$) with no glucose response ($t=0.044$, $p=0.97$). This study induced acute hyperglucagonemia in weaned pups and found no gluconeogenic response. The glucagon doses used may have been too conservative to alter hepatocyte receptor binding. Whether a gluconeogenic response follows larger glucagon doses requires further investigation.

Ventral Pouch Flow Dynamics in Feeding Rorqual Whales: A Kinematic Analysis

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Most rorquals (Balaenopteridae) capture prey intermittently by lunging

into masses of prey organisms. They employ their unique filter-feeding anatomy to controllably engulf prey and seawater. A roughly cylindrical volume enters the buccal cavity and flows into the ventral pouch. Due to the present impossibility of directly investigating internal flow dynamics in wild rorquals, I have used indirect observations and measurements to study aspects of these flow movements. Field observations and video capture of surface-feeding rorquals took place in the Gulf of St. Lawrence, Canada. Only lunging techniques that oriented their ventral pouches above the sea surface could be used in this analysis. As lunging rorquals broke the surface their engulfed volumes of water often generated conspicuous waves in the outer walls of their ventral pouches. The movement of these waves provided signatures of internal flow movement. Two-dimensional kinematics of the waves was analyzed from video of three species of rorquals. Individual still frames were extracted from video sequences and digital landmarks were placed on the anterior margin of individual waves. This allowed flow movement, relative to the animal, to be calculated over known time intervals. The flow initially traveled back into the pouch before rebounding off the posterior terminus and traveling back toward the rostrum. Flow velocity was quantified and the momentum of the rebound is thought to help initiate ram filtration through the baleen plates. Results showed that minke whales (*Balaenoptera acutorostrata*) have the fastest rebound velocity, followed by finback whales (*B. physalus*) and blue whales (*B. musculus*), respectively. Previous studies concerning the function of the ventral pouch have mostly come from morphological investigations of postmortem specimens. This study is the first, to the best of my knowledge, to quantify ventral pouch flow dynamics in wild rorqual whales.

Seals Have a Good Nose for Finding Feeding Grounds

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As food resources at the open sea are patchily distributed, it has been particularly unclear which environmental information seals may use to locate attractive feeding grounds. Elevated atmospheric concentrations of dimethyl sulfide (DMS), produced by phytoplankton in response to zooplankton grazing, have been demonstrated to be an indicator for productive areas. To find out whether seals can smell DMS we determined the detection threshold for DMS in two male harbor seals using a go/no-go response paradigm. Stimuli were presented using sealable glass syringes containing a piece of filter paper. Filter papers were moisturized inside the syringes with either 2 µl DMS-solution (dist. water) as the olfactory stimulus or 2 µl distilled water as the control stimulus and vaporized for one hour. Defined gaseous DMS-concentrations from 50 to 1x10⁻⁷ µg(DMS)/l(air) were obtained by total vapour saturation. Syringes were discharged at a constant flow (4 ml/sec) using an electronically controlled discharging apparatus. At the human threshold concentration of 1 µg/l seals detection performance was still 100% correct, while the DMS concentration typical for marine productive areas (0.0005 µg/l) was detected with ≥85% correct decision. Compared to humans, interpolated detection thresholds of 1.25x10⁻⁶ µg/l and 8.06x10⁻⁷ µg/l (seal 1 & 2) indicate that the olfactory sensitivity to DMS in seals is several orders of magnitude higher. These results provide first evidence of a high olfactory sensitivity in seals. Well tuned to the DMS-concentration found in the marine habitat it provides the sensory basis for the identification of profitable feeding grounds.

Spatial Distribution of Ringed Seals (*Phoca hispida*) in Their Fast-ice Breeding Habitat in Kongsfjorden, Svalbard, Norway

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Most ringed seals breed in land-fast ice areas where they are thought to defend underwater territories with associated breathing holes and lairs. Prime breeding areas occur where enough snow accumulates to

enable construction of birth lairs and where the ice remains stable late into spring. The ice is variable with respect to these important characteristics and it is logical to assume that there might be competition, and hence segregation, of various age- and sex groups within an area. In this study we investigated the spatial distribution of 94 ringed seals (33 adult females AF, 19 adult males AM and 42 sub-adults SA) that were shot for a broad range of scientific studies in Kongsfjorden in late spring 2004. GPS positions of the collection points for each animal indicate that AF are found significantly deeper in the fjord compared to AM or SA (ANOVA, *Post hoc* Tukey $p < 0.01$), where glacier-ice pieces permit snow accumulation and islands protect the ice from wave and current action. The inner, most stable ice, had a significantly different age and sex composition (AF:59%, AM:24%, SU:17 %) than outer parts of the fjord (AF:12%, AM:17 %, SU:71%) ($\chi^2=151.50$, d.f.=93, $p < 0.01$). In the inner area, the AM:AF sex ratio was 1:2.4, and AM with more neighboring AF (5-6) were significantly older than AM with fewer (0-3) (18±1 yrs (SE) vs 12±1 yrs, Mann Whitney U-test, $p=0.01$). AF occupy the most stable fast-ice areas, while the SA are found in the least stable areas. AM are found in both areas, probably as a consequence of competitive exclusion of some of them. The sex ratio in prime breeding areas suggests a slightly polygamous mating system and age seems to be an important determinant for male mating success.

Feeding Ecology of Eastern North Pacific Killer Whales (*Orcinus orca*) from Fatty Acid, Stable Isotope, and Organochlorine Contaminant Profiles of Biopsy Samples

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The feeding ecology and foraging range of eastern North Pacific killer whale (*Orcinus orca*) populations were studied using chemical profiles of their skin and blubber from remote biopsy samples. In particular, biopsies from the three currently recognized killer whale ecotypes, (*i.e.*, “residents”, “transients”, and “offshores”) were analyzed for fatty acids (FA), carbon and nitrogen stable isotopes (SI) and organochlorine contaminants (OCs). Results from these analyses indicated that FA and OC profiles were sufficiently different among the three groups to allow classification of individuals by ecotype based on multivariate discriminant function analysis. For each ecotype, FA, SI and OCs were consistent with the reported prey specializations (*i.e.*, fish for residents and offshores; marine mammals for transients), with the exception of unusual OC concentrations (high) and ratios found in the blubber of offshore whales. The OC results for offshores were suggestive of a diet that may include high trophic level or highly contaminated fish (*e.g.*, shark or tuna species). Moreover, contaminant ratios ΣDDT/ΣPCB and p,p'-DDT/ΣDDT measured in offshore whales sampled in Alaska were indicative of a “California signature” owing to high relative concentrations of DDTs compared to PCBs, as well as “old-source” DDTs. Thus, North Pacific offshore whales seemingly forage over a large range (Alaska to California) that is consistent with the limited number of photographic resightings of individual whales between these areas. Additionally, mean SI values of various regional groups differed considerably among locations, suggesting that prey preferences of proximate neighbors can be substantially different. Finally, a SI predator-prey model was utilized to corroborate prey composition estimates obtained from observational data. Four regional killer whale groups (West Coast residents, Gulf of Alaska residents, Prince William Sound transients and eastern Aleutian Island transients) had measured SI values that agreed well with values predicted by the diet model.

Using Isotopes to Investigate the Foraging, Migratory, and Reproductive Ecology of Northeast Pacific Sperm Whales (*Physeter macrocephalus*)

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The foraging, migratory, and reproductive ecology of *Physeter macrocephalus* is not fully understood. These elusive and deep diving animals are difficult to observe in their natural habitat, making it hard to gather substantial and unbiased information about their lifestyles. Isotopic analysis of tooth annuli provides a life-history record of ecological information, which may exceed several decades for large odontocete whales. We analyzed teeth from several adult female and sub-adult male individuals, which were collected during a mass stranding event on the central Oregon coast in 1979. Inter and intra-annual variations in carbon and nitrogen isotope values allow us to assess seasonal and/or ontogenetic shifts in diet as related to trophic level or foraging habitat. In addition, isotopic data may be used to assess reproductive behavior, such as the length of lactation (*i.e.*, weaning age) and female fecundity. This natural preservation of data gives us valuable insight into the complex ecology of these creatures.

Whale-Watching: Russian-Style

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It is likely that up to 5 years ago nobody on the Russian coast of the Black Sea knew what Whale-watching (Ww) was. For the last 3 years, the operation of Ww-tours has become a widespread small business, and is currently becoming popular among the tourists. In almost every resort town between Tuapse and Adler it is possible to find a man, occasionally a company, that would be ready to provide a Ww service. Typically, it is fishermen or small motor-boat owners, who operate these tours. We are aware of a case of a diving club regularly organizing Ww-tours; and we suspect it is not the only one. In the mentioned resort region, all three Black Sea species of dolphins (*Tursiops truncatus*, *Delphinus delphis*, *Phocoena phocoena*) can be seen, and some of these populations are likely to be local. Between Adler and Sochi, reproductive herds of bottlenose and common dolphins are observed daily during the reproduction season – in late spring and summer. All dolphins in the region are under the pressure of commercial and fishing traffic (at least, from May to October). Non-professionally organized and unlimited Ww presents an additional significant disturbance. Ecotourism is still poorly regulated in the Russian Federation, and regulations controlling Ww activities do not exist at all. Since it will take many years for the development of ecotourism legislation, we consider it expedient to minimize Ww-impact by creating an educational package that can be distributed privately among Ww-operators. The main, elucidatory, part of the package would consist of a list of well-grounded recommendations (policies) on Ww that tour-organizers would be requested to follow. We expect higher effectiveness and “successful usage” of the package if it also contains popular educational information that can be used as a base for lectures for the tourists.

Photo-Identification of White Sea Belugas (*Delphinapterus leucas*)

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Observations on the Solovetsky breeding aggregation of belugas (Beluzhy Cape, Bolshoy Solovetsky Island, White Sea, Russia) were conducted since 1995 (sponsored by the International Fund For Animal Welfare (IFAW)). Within this project in 2003 we've conducted the study aiming to determine levels of the seasonal site fidelity and annual return of the photo identified of belugas. Effort was conducted from June to August in 2003 and 2004. Opportunistic photos taken in previous years were also incorporated in analysis. Photographs

were taken from the fixed location at the shore using tripod-mounted photo-sniper (Zenit-EC) with 300 mm lens (Tair-3-FS) and Zenit (Zenit-E) with the 500 mm lens (CM-5A). Adult animals were photographed from the distance less than 20 m. In 2003 24 individuals were identified and the PhotoID catalog was created. Photographs of only left and right flanks of the whales were used for the catalog as belugas rarely expose other parts of the body. Catalog contains mainly photographs of the left side, as belugas surface mainly “from right to left”. We hypothesize that this could occur due to the current direction. Nevertheless catalog also holds some images of the right sides. Analysis of the photos revealed that individuals observed within the aggregation show different site fidelity and annual return pattern. Some animals were photograph only ones within the season but known to visit the aggregation every summer. Others observed/photographed multiple times throughout the season were not documented neither in previous nor in following years.

Breaching by Humpback Whales During Migration off the East Coast of Australia

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Humpbacks are well known for the frequency with which they engage in aerial, high-energy behaviours such as breaching. A clear role has not yet been defined for breaching, but it is thought to have multiple functions. Whilst breaching and other behaviours of humpback whales have been studied extensively in the breeding areas, few studies have studied breaching behaviour of humpbacks during migration. This work examines the context and function of breaching by humpback whales during migration past the east coast of Australia. Humpbacks were tracked using a theodolite and extra behavioural observations were entered into “Cyclopes” (a theodolite tracking programme), with special attention to breaches. Of the total number of pods observed 16% of them breached, 480 breaching pods were tracked using the theodolite and were used for behavioural assessment. Of the 480 pods, 275 did not appear to interact in any way with other whales. Of the other 182 pods, 153 pods were involved in distant interactions with other pods where the movement or behaviour of the other pod appeared to be influenced by the breaching pod. The remaining 23 pods joined with other pods. Rates of breaching per pod and per whale significantly decreased with the number of other pods ($p < 0.0001$; $p < 0.0002$) and whales ($p < 0.0051$; $p < 0.0112$) in the study area. Breaching rates significantly increased with increasing pod size ($p < 0.01$). There was no significant diurnal variation of breaching rate, but peaks were observed early morning, midday and late afternoon. Nor were there significant effects of seasonality or sea state. Breaching therefore is more closely related to social influences, rather than temporal or environmental. However, a more clearly defined role is not apparent and breaching may possess multiple social functions.

Stranding and By-Catch Records of Finless Porpoise (*Neophocaena phocaenoides*) in Taiwan

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Two subspecies of finless porpoise (*Neophocaena phocaenoides*) occur in both sides of Taiwan Strait: *Neophocaena phocaenoides phocaenoides* and *Neophocaena phocaenoides asiaorientalis*. However, finless porpoise has not been reported from eastern Taiwan. A total of 72 finless porpoise specimens, 40 *N. p. phocaenoides*, 11 *N. p. asiaorientalis* and 21 unidentified *N. p.*, have been collected since 1994. 91% of the *N. p. asiaorientalis* specimens were collected from western Taiwan Strait, and only one from eastern Taiwan Strait. Sex composition of specimens includes 31 females, 26 males and 15 sex-indeterminate individuals. The neonatal lengths of *N. p. phocaenoides* ranged from 75 cm to 83 cm. The body lengths of the

sexually matured *N. p. phocaenoides* ranged from 137 cm to 171 cm. The 11 *N. p. asiaorientalis* include one calf, 7 immatures, and 3 no-measurement. Their body lengths ranged from 90.5 cm to 117.5 cm. The source of 72 specimens include: 53 % of the specimens were from by-catches and 47% were from stranded individuals which had either been floating on the sea or died of unknown cause prior to landing. The fishery types of by caught porpoise included gill net (54.1%), set net (5.4%), long-line (5.4%), and unreported method (35.1%). Stranded and by caught finless porpoises occurred in all months of the year except September. Conspicuous difference was found in the number of records per season, with 49% occurring in the spring and 34% in the winter. The high season of gill net fishery was from December to January in Taiwan Strait. Whether the above-mentioned seasonal difference in the stranding and by-catch records for finless porpoise reflects its natural population dynamics or the seasonal efforts of gill-net fishery in this region remains to be clarify.

Human Disturbance and the Hauling Out Behaviour of Steller Sea Lions (*Eumetopias jubatus*)

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There is considerable interest in assessing and mitigating disruptive effects of humans on the behaviour of marine mammals, especially for species with uncertain or decreasing population trends. In an effort to understand the causes of their population decline, field studies of Steller sea lions have increased in intensity over the last decade. Consequently, disturbance due to scientific research has also increased at rookeries and haulouts. We measured short-term effects of human disturbance on Steller sea by documenting numbers of sea lions using terrestrial sites for 2-3 week periods in southeast Alaska and British Columbia during summer (n = 8 sites) and winter/spring (n = 6 sites). Observation periods were scheduled to span research disturbances to collect scat samples at haulouts, and to brand pups at a rookery. Pre- and post-disturbance periods revealed large daily variation in numbers of sea lions on land within and among study sites, related in part to environmental conditions. Disturbances resulted in significantly fewer sea lions using haulouts during the post-disturbance period and an increase in variation in the numbers of animals on land. Numbers did not return to pre-disturbance levels at 4 of ten disturbed sites suggesting a departure of animals at the time of the disturbance. At the remaining 6 sites, it took an average of 4.3 days for the daily mean numbers of sea lions to reach 100% recovery. Other disturbances from both natural (birds and sea lions) and unnatural (boats and aircraft) sources were frequent events and typically resulted in up to 20% of the animals leaving the haulout at the time of the disturbance. Recognizing that research activities can affect sea lion hauling out behaviour is the first step in assessing tradeoffs between obtaining information necessary for monitoring and conserving the population, and the cost to the animals of obtaining it.

Spatial and Temporal Trends of Brominated Flame Retardants in Dolphins from the Western North Atlantic Ocean and Eastern Gulf of Mexico

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The brominated flame retardants (BFR) polybrominated diphenyl ether (PBDE) and hexabromocyclododecane (HBCD) are current-use

products with environment release rivaling that of polychlorinated biphenyls (PCB) during peak production. PBDEs are toxicologically similar to PCBs while little is known about HBCD toxicity. PBDE concentrations are ten-fold greater and increasing more rapidly in Americans than in Western Europeans suggesting large spatial and temporal exposure differences. The objective this study was to determine if temporal or spatial differences exist in marine mammals living along the US East and Gulf coasts. Several coastal bottlenose dolphin (*Tursiops truncatus*) populations are highly resident and may be indicators of local or regional BFRs contamination. To examine spatial variability in dolphin populations, blubber was collected from juvenile and male dolphins from Sarasota Bay, FL (n = 23, surgical biopsies), Tampa Bay, FL (n = 5, dart biopsies), St. Joe Bay, FL (n = 8, post mortem samples from animals involved in an unusual mortality event), Charleston Harbor, SC (n = 12 dart biopsies), Holden Beach, NC (n = 4, surgical biopsies), and Cape May, NJ (n = 3, surgical biopsies). Several studies show lipophilic pollutant concentrations are not significantly different between juveniles and males. BFR temporal trends were assessed in blubber from juvenile and male Atlantic white-sided dolphins (*Lagenorhynchus acutus*) stranding from 1989-2003 near Cape Cod, MA. PBDE and HBCD concentrations were determined using gas chromatography mass spectrometry (GC/MS) and liquid chromatography MS/MS, respectively. Preliminary data indicate higher BFR concentrations in urban Sarasota Bay and rural St. Joe Bay than other areas suggesting factors other than proximity to urban areas affect BFR levels. White-sided dolphin HBCD and PBDE concentrations were not significantly related to collection date suggesting a slower response to increasing environmental BFR levels than in humans. The presence of BFRs in all dolphin samples examined indicates that contamination is wide-spread.

Behavioral Observations of a Possible Resident Population of Rough-Toothed Dolphins (*Steno bredanensis*) off the Coast of Utila, Honduras

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Observations conducted off the island of Utila, Honduras during June and September 2004 suggested that a resident group of rough-toothed dolphins (*Steno bredanensis*) may inhabit the waters near this island. Rough-tooth dolphins were frequently encountered during both months in water ranging in depth from 6-122 meters. During these encounters, data were collected using field notes, digital video and still photography, and hydrophone recordings. Group size ranged from 5-20 animals, 8-12 animals being most common. Sixteen dolphins were identified using photo-identification techniques, and were frequently re-sighted. The frequency of sightings, re-sightings of dolphins from one encounter to the next, the similarity of group composition across sightings, and the strong associations of re-sighted animals suggest that this may be a resident social group of rough-toothed dolphins. This possibility is supported by anecdotal reports by local dive boat operators that rough-toothed dolphins are seen year-round (a possibility that we are currently investigating). The dolphins engaged in a variety of behaviors during these observations, including traveling, milling, feeding, and playing. Social behaviors were common within each of these behavioral contexts, and often involved tactile behaviors, including pectoral fin rubbing and side rubbing. Play was often social and two instances of adult-calf cooperative play were observed. Dolphins frequently approached the research vessel and engaged in bow-riding. On other occasions, they followed the boat, surfed in its wake, and once oriented and echolocated on a slow-moving propeller. They also approached and examined the hydrophone on several occasions. Recorded whistles were categorized according to frequency contour, and whistle type seemed to be related to group behavior. Future observations of these animals will help to determine the nature of their social relationships, their behavioral repertoire, the extent of their home range, and the effect of seasonality on site fidelity.

Time to Eat: Measuring At-Sea Feeding Events to Understand Foraging Behavior of the Northern Elephant

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Understanding the foraging ecology of marine predators presents a unique challenge as most feeding occurs underwater and therefore outside the scope of observational studies. For the northern elephant seal, a great amount of information has been gathered on at-sea behavior through the use of satellite telemetry and time-depth recorders. However, there are limitations when using these technologies to understand foraging ecology. Dive records and satellite locations lead to assumptions about where prey are found, but definitive evidence of feeding is crucial to truly understand foraging. Stomach temperature telemetry can provide direct measures of feeding in free-ranging animals and make it possible to elucidate the foraging behavior of marine mammals. This research combined data collected from dive recorders, satellite transmitters, and the first recorded stomach temperature measurements from 13 adult females to investigate the foraging behavior of northern elephant seals. Specifically we examined when animals locate prey along the foraging migration, the accuracy of using dive types to identify foraging, and how foraging behavior differs between females using different foraging areas. Females traveled throughout the north Pacific and along coastal areas north to Vancouver Island, with dive recorders reflecting patterns previously described for this species. Stomach temperature was recorded for 1.3 to 21 days with zero to 71 feedings per record. Animals varied in the time of first feeding and the number of feedings prior to reaching foraging grounds. Feeding events were associated with multiple dive types, but the strongest relationship was with dive types previously hypothesized as foraging dives. Although much is known about diving and movement patterns in this species, this is the first study to directly measure at-sea foraging. Measuring feeding events is a significant step, not only towards understanding the ecology of the northern elephant seal but also to address foraging ecology of other marine predators.

Sea Otter Behaviour: Looking for Answers...Did Killer Whales Cause the Western Alaska Sea Otter Decline?Kuker, Katie J.^{1,2}; Barrett-Lennard, Lance G.^{1,2}⁽¹⁾ Department of Zoology, University of British Columbia, 6270 University Boulevard, Vancouver, BC V6T 1Z4, Canada⁽²⁾ Vancouver Aquarium Marine Science Centre, PO Box 3232, Vancouver, BC V6B 3X8, Canada

In response to predation risk, animals make trade-offs between fitness-enhancing activities such as feeding, mating or parental care, and defensive behaviours aimed at alleviating the perceived threat, which might include hiding, increased vigilance or fleeing. However, predation risk can vary in both space and time, thus exposure to previously unfamiliar predators forces organisms to learn to recognize such novel dangers, and acquire anti-predator responses. Estes *et al.* (1998, *Science*, 282: 473) hypothesized that because of a decline in food supply killer whales (*Orcinus orca*) have turned to alternative less nutritious prey sources, such as sea otters (*Enhydra lutris*), causing a drastic decline in sea otter populations in Alaska during the last 15 years. In the waters of British Columbia, Canada, sea otter populations are stable and there is no evidence to suggest that killer whales prey upon the species. The overall objective of this project will be to compare the behavioural response of sea otters to killer whales in Alaska and British Columbia by conducting field observations of sea otters in the presence of killer whales and experimentally-induced predator cues. We predict that if killer whales do in fact prey on sea otters in Alaska, then sea otters will be more vigilant and allocate more energy towards anti-predator behaviour in Alaskan waters compared to British Columbia. Here, we present preliminary results describing sea otter vigilance behaviour in Nuchatlitz, our control site off the west coast of Vancouver Island. Since sea otters are a keystone species, killer whale predation (if it occurs) is of significant interest because it has the potential to alter marine community structure.

Physiological Responses to Short-Term Low Energy Intake Are Seasonally Dependent in Steller Sea Lions (*Eumetopias jubatus*)

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It has been suggested that population declines of Steller sea lions in western Alaska may be related to changes in prey availability or quality. Our study investigated the physiological effects of seasonal prey restriction and prey composition on sea lion body mass, body composition, metabolism, and blood chemistry. We fed captive Steller sea lions restricted iso-caloric amounts of Pacific herring (*Clupea pallasii*) or walleye pollock (*Theragra chalcogramma*) for 9 days, four times a year. At these levels of restricted intake, the sea lions lost body mass at a significantly higher rate in winter (1.6 ± 0.14 kg d⁻¹) than in summer (1.2 ± 0.32 kg d⁻¹). Decreases in body fat mass and standard metabolic rates were similar among all seasons and for both diets. Generally, the majority of the body mass lost while eating pollock was due to decreases in lipid mass, whereas the most of the mass lost while eating herring derived from core tissues; however this trend was reversed in summer. Metabolic depression was not observed during the trials, despite the constant loss of body mass. During food restriction periods, serum levels of cortisol and blood urea nitrogen increased (217.6%, 11.4, respectively) and total triiodothyronine decreased (-35.6%), with the greatest changes in these parameters observed in winter. Serum cortisol levels correlated negatively with both body mass and body condition suggesting that cortisol may play an important role in body fat regulation in Steller sea lions. The mean ghrelin level in Steller sea lions correlated negatively with body mass. Surprisingly, leptin levels did not correlate with body fat. Our findings support the hypotheses that both season and quality of prey influence the effect that restricted energy intake has on Steller sea lion physiology, and that wild sea lions may be more vulnerable to food restriction in the winter.

Linking T-POD Performance in the Field to Laboratory CalibrationsKyhn, L.A.^{1,2}; Tougaard, J.¹; Wahlberg, M.²; Beck, N.I.¹⁽¹⁾ National Environmental Research Institute, Fredrikborgvej 399, DK-4000 Roskilde, Denmark⁽²⁾ Aarhus University, Department of Zoophysiology, C. F. Møllers Alle Building 131, DK-8000 Aarhus, Denmark

The T-POD (Time-PORpoise Detector, Chelonia, U.K.) is a self-contained acoustic data logger used for detecting and monitoring the presence of vociferous dolphins and porpoises. It has become a standard tool in many environmental impact assessments and monitoring programs. Yet, little is known about the variability in sensitivity and detection range of T-PODs. In this study the threshold of ten T-PODs were determined in a small tank using 100 μ s long 130 kHz pulses mimicking the sonar signal of harbour porpoises. The threshold of the T-PODs was defined as the sound pressure at which only half of the transmitted pulses were recorded by the T-POD. The threshold was measured at four angles of incidence in the horizontal plane. The mean threshold ranged from 114 to 123 dB re 1 μ Pa (pRMS). Following threshold determination the ten units were deployed at short inter-T-POD distances for 8 days in an area with high occurrence of harbour porpoises (Great Belt, Denmark). The mean number of clicks recorded per day ranged from 780 to 1,450 with a linear relationship between T-POD threshold (in dB) and the number of recorded clicks ($r^2 = 0.73$). The daily frequency (% of the day with clicks) decreased with increasing thresholds ($r^2 = 0.44$), whereas intensity (mean number of clicks per minute for periods with clicks) was not correlated strongly with T-POD sensitivity ($r^2 = 0.11$). The relationship between threshold and click detection was close to but not identical to an expected 6 dB slope, showing that other factors besides the threshold affects T-POD performance in the field. This study shows that individual threshold calibration of T-PODs is necessary to obtain comparable results from monitoring odontocetes with this tool. *Study funded by Aage V. Jensens Foundation.*

Sex- and Age-Specific Survival of California Sea Lions at San Miguel Island, California

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Although behavioral aspects of California sea lion life history have been well described, there have been no comprehensive studies to estimate their life history parameters. To develop sex and age-specific survival rate estimates of California sea lions, we initiated a long-term branding study at San Miguel Island, California. From 1987 to 2001, we branded 6543 sea lion pups typically in late September to early October and re-sighted them during the following reproductive seasons (15 May-15 Aug). Using sex-specific Cormack-Jolly-Seber models, we evaluated possible year, cohort, and age effects on survival. Probability of sighting was a function of year, age, location, previous re-sighting history and reproductive status. Survival was age-specific but time invariant except for pups. The effect of age on survival followed a typical "dome" pattern. Survival was lowest for pups and yearlings and highest for prime age animals (3-10). Female survival during the prime ages was higher than male survival. Pup survival was dependent on weight at time of branding. The odds of survival ($S/(1-S)$) doubled with a 5 kg increase in female weight and a 6 kg increase in male weight. Pup survival varied widely between years with low survival during El Niño events and low survival in recent years from hookworm infections. Using generalized additive modeling (GAM) we were able to demonstrate that annual variability in pup survival could be explained by changes in local sea surface temperature and a declining trend since the mid 90s. The decline in pup survival has occurred concurrently with a reduction in population growth rate suggesting that the sea lion population is partially regulated by a density dependent response in pup survival.

Stomach Temperature Changes Do Not Indicate Meal Size or Feeding Frequency

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Stomach temperature has been proposed as an indicator of both timing and magnitude of food intake by warm-blooded marine predators feeding on cold-blooded prey. Attempts to calibrate temperature change as a quantitative measure of meal size have been based on temperature changes in response to individual meals fed in isolation. This is different to the normal feeding behaviour of patch foraging marine predators that often eat large numbers of small prey and is unlikely to accurately represent the conditions in a wild marine mammal's stomach. We investigated the patterns of stomach temperature change in three captive grey seals to derive realistic relationships between observed stomach temperature profiles and mass of food ingested. Seals were fed a Wildlife Computers' stomach temperature pill and then given a series of meals (herring at 10°C) on schedules similar to feeding patterns observed in the wild. Area under the curve (AUC) and the total duration of the temperature variation (TV) were recorded. Sensor placement effects were tested by feeding two sensors to one seal. Temperatures differed significantly, but profiles were parallel. Temperature profiles were clearly influenced by recent feeding history. After periods of fasting (>12hr), first meals always produced precipitous drops in temperature followed by exponential increases to an asymptote and both AUC and TV were closely correlated to meal mass. Asymptotes were always higher than prefeeding stomach temperatures. However, in second and subsequent meals, declines became progressively less rapid and smaller. This was apparent even when 1kg meals were eaten 4hr apart and temperatures had reached asymptotes between feedings. Fourth meals in sequences had no discernible effect on the stomach temperature. Clearly, stomach temperature is neither an accurate method for estimating meal size nor a reliable indicator of timing or frequency of feeding events in free ranging pinnipeds eating multiple prey items.

Spring Diet of Ringed Seals (*Phoca hispida*) in Spitsbergen, Svalbard, Norway

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Gastrointestinal tracts from 267 ringed seals from 5 different areas in Spitsbergen were collected during 2002-2004. All seals were collected during spring while hauled out on land-fast ice. 11.2% of the stomachs, 66.3% of the small intestines and 99.6% of the large intestines had identifiable remains. Hard parts of ingested prey were washed through a set of sieves with mesh size from 0.5 to 2.0 mm, and identified to the lowest possible taxon. Fish otoliths and crustacean exoskeletons from stomachs and small intestines with no or low signs of erosion were measured for pre-ingested prey size and biomass estimations. Fish remains were found in all the seals, while 36% also had ingested various invertebrate species. Polar cod (*Boreogadus saida*) dominated the diet, with a frequency of occurrence (FO) of 100%, and it comprised 73% of all ingested prey (Relative FO). Based on measurements of otoliths (N=7007) ringed seals were found to prey on polar cod with an average length of 105.6 mm (range: 44.4-229.2 mm). No difference was found between sex and age-groups of ringed seals with respect to size of ingested polar cod. *Lumpenidae* was the second most frequent prey (FO=53.9%) followed by *Gadidae* (FO=28.5%). 11 other fish taxa were identified in total. Invertebrate prey species comprised 1.1% of all prey species (Relative FO). The most frequent was *Sabinea septemcarinata* (FO=19.9%), followed by *Themisto libellula* (FO=9.0%) and *Sclerocrangon* spp. (FO=6.7%). Ringed seals from one of the areas had a diet that deviated from ringed seals from the other areas. Here polar cod had low relative FO, and the diet was dominated by other fish species such as *Lumpenidae* spp. and various sculpins (primarily *Gymnacanthus tricuspidis* and *Myoxocephalus scorpius*). This area is located on the west-coast of Spitsbergen and is influenced by an inflow of warmer Atlantic water.

Essential Minerals Concentration in Teeth of the California Sea Lions *Zalophus californianus californianus* and Relation to Dental Wear

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Excessive tooth wear in marine mammals, has been attributed to the age, feeding habits, behavior (as the maintenance of breathing holes in the ice) and the bad alignment of the jaw, among others. The presence of advanced wear in some California sea lions, including young animals (< 5 years), arise the question whether variations of the tooth chemical composition (whereas some minerals would be in anomalous concentrations) could make some teeth more susceptible to wear. In this study the concentration of essential minerals Ca, P, K, Na, Fe, Mg and Zn in the dentition of *Zalophus californianus californianus* are presented for the first time. To address our question, concentrations of the essential minerals were compared among California sea lions teeth with different degrees of wear. We used canines and molars in 45 skulls from 15 locations; each piece was digested in perchloric acid and the samples analyzed in the atomic absorption spectrophotometer converted to micrograms units. An index of tooth wear (*Id*) was created, involving the average wear of the teeth and age of individuals (determined as the number of growth layers). No significant differences were detected in the index of wear among the sexes ($t_{0.05(2),69} = -1.37$; $p = 0.17$), localities ($F_{3,43} = 0.126$; $p = 0.94$), neither periods of sample collection ($F_{3,70} = 0.518$, $p = 0.671$), except for age ($H = 14.53$; $df = 6$; $p = 0.02$). A tendency to increase the index of wear was evident with age up to the 7th year to later diminish accordingly. The Ca concentration of the teeth showed a negative linear relation to the age of the animals ($r^2 = 0.072$; $r = -0.269$; $p = 0.026$) but the concentration of the minerals analyzed did not explain the excessive wear observed (correlation $p > 0.09$; ANOVA $p > 0.15$).

Assessing the Importance of Frontal Zones on the Distribution of Upper Trophic Level Predators off Cape Hatteras

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Discovering the associations between habitat variables and upper trophic level predator distributions is the first step in developing predictive habitat models. We are investigating the spatial distribution of upper trophic level marine predators, including marine mammals, sea birds and sea turtles, off Cape Hatteras, North Carolina, in relation to the positions of the shelf break and Hatteras fronts. These species aggregate along frontal systems and bathymetric gradients on broad spatial scales, but little is understood about the relative importance of these two habitat features where they overlap in time and space. To assess the influence of these features on the distribution of upper trophic level species, we conducted transect surveys for marine mammals, sea turtles and sea birds concurrently with fine-scale oceanographic sampling in August 2004 and January-February 2005. We derived the positions of the Hatteras front from temperature, salinity, and pressure data collected by a Scanfish and ship-mounted Acoustic Current Doppler profiler (ADCP). A Scanfish is a towed, undulating vehicle that measures hydrographic properties with high spatial resolution. We determined the distributions and relative abundance of seven species of cetaceans and twenty species of sea birds (cetacean sightings, $n = 55$; seabird sightings, $n = 870$). We are using several complimentary statistical tests to investigate the strength of the relationship between habitat variables and species distributions: simple and partial Mantel's tests and classification and regression trees (CART's). We are using simple Mantel's test to determine whether there is a significant correlation between marine mammal and seabird sightings and the positions of the front, and partial Mantel's to assess the relative explanatory power of bathymetry, temperature, salinity, distance to front and distance to convergence zone. Subsequently, we are also using classification and regression trees (CART's) to determine predictive habitat areas for these species.

Behavioral Observations of Diurnal Rest in a Rehabilitated West Indian Manatee (*Trichechus manatus*)

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Numerous studies have investigated sleep in Cetaceans, Otariids and Phocids. However, relatively few studies have concentrated on sleep in Sirenians, especially the West Indian Manatee (*Trichechus manatus*). The diurnal behavior of a 3 year old rescued manatee has been recorded continuously using visual observations. Behavioral episodes were grouped into 3 major categories: "active", "relaxed" and "rest". On average, rest episodes accounted for 20% of total observation time. Active episodes accounted for 37% and relaxed episodes accounted for 17 % of total observation time. The manatee was out of sight in 26% of the total observation time. Rest episodes varied in duration (5-83 min) with a mean of 22 min ($n=26$). In all such occurrences, the manatee was laying on the bottom of the pool. Respiratory pauses differ significantly: 116 s for active, 129 s for relaxed and 163 s for rest episodes respectively. Most of the long respiration pauses (>240 s) occurred in rest episodes: 82% ($n=51$). Furthermore, irregular breathing patterns occurred mostly in rest episodes (86% of all occurrences, $n=21$). Eyes states were recorded when visible. In addition, separate head, lips and body jerks as well as serial lips movements were observed during relaxed and rest episodes. This study addressed behavioral characteristics of the diurnal rest in a rehabilitated West Indian Manatee; however more observations are needed, especially during night time to fully understand the patterns and characteristics of rest in the West Indian Manatee (*Trichechus manatus*).

Distribution, Seasonal Occurrence and Habitat Use of Antillean Manatees in the Drowned Cayes Area of Belize, Central America

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The Antillean subspecies of the West Indian manatee (*Trichechus manatus manatus*) is listed as vulnerable to extinction by the IUCN (IUCN, 2005) due to greatly reduced numbers and highly fragmented populations throughout its range (Lefebvre *et al.*, 2001, UNEP/CEP, 1995). Belize, Central America has long been recognized as a "stronghold" for this species (O'Shea and Salisbury, 1991). Aerial and boat surveys (Morales-Vela *et al.* 2000; Sullivan 1999, Auil 1998) have documented that the Drowned Cayes area, which encompasses the Swallow Caye Wildlife Sanctuary, is consistently used by manatees. We devised a point sampling survey design for a small boat platform to quantify manatee distribution and habitat use. Fifty-three permanent points were randomly sampled by conducting 30-minute scans during the dry and wet seasons from 2001-2004. Researchers and a varying number of short-term volunteers recorded the number of manatees sighted, as well as recorded sighting conditions associated with each point scan. Bottom and mangrove shoreline characteristics were used to classify points into habitat categories to be used in the statistical analysis. Logistic regression was used to examine the impact of sighting conditions on sighting probability and chi-square analysis was used to examine the influence of micro-habitat characteristics. The ratio of volunteers to researchers was the only variable in the sighting conditions analysis that had a significant negative influence on the probability of sighting a manatee. There was no significant difference in sighting probability between the wet and dry seasons. Manatee sighting probability was highest in grassflat habitats (0.56 per scan) and lowest in reef habitats (0.15 per scan). The presence of a resting hole and of shoreline protection appeared to influence sighting probability, with effects depending on particular habitat types. These results will be used to develop a predictive model of manatee habitat use.

Seasonal Changes in the Abundance of Mysticeti and Euphausiids in the Ballenas Channel-Bahía de los Ángeles Region, Gulf of California, México, 2003-2004

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In the Gulf of California, the Ballenas Channel-Bahía de los Ángeles region is a very important area for the feeding ecology of whales due to its high productivity. During 2003 and 2004 eight field trips (four/year) were made to this region to study the possible relationship between the distribution and abundance of whales and euphausiids. We carried out line transect surveys in small boats (145 days and 954.18 hours of effort) and zooplankton surface net samplings (73 samples in 2003, 106 samples in 2004). Four whale species were sighted: fin whale (*Balaenoptera physalus*) and Bryde's whale (*B. edeni*) in both years, humpback whale (*Megaptera novaeangliae*) only in 2003 (winter) and gray whale (*Eschrichtius robustus*) only in 2004 (winter-spring). Gray whales were observed feeding on amphipods. In both years, the maximum relative abundance (number of animals/hour of search effort) of whales was during summer (1.25 for 2003 and 1.47 for 2004) and the minimum during autumn (0.13 for 2003 and 0.30 for 2004). Abundance in 2004 (1.13) was almost double than in 2003 (0.54). *B. physalus* was the most abundant whale throughout 2003 and 2004 (0.37 and 1.03, respectively). *B. edeni* was absent only during autumn. The euphausiid *Nyctiphanes simplex* (larvae) was present in almost all zooplankton samples. As in whales, the minimum abundance (mean number of animals/m³) in both years was during autumn (0.31

for 2003 and 10 for 2004) whereas the maximum for both years was during spring (3902 in 2003 and 51 in 2004). On 38 occasions, during spring and summer, *B. physalus* was sighted feeding on surface aggregations of *N. simplex* near the coast. The Mexican government has considered creating a biosphere reserve in this region; therefore its management program should take into account the seasonal changes in abundance and feeding behavior of whales.

Spring Migration and Characterization of Summer Feeding Areas of South African Right Whales

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During September 2001, 21 right whales off South Africa were tagged with implantable Telonics ST-15 Argos radio tags. Eighteen tags (86%) reported data. Whales left the coast individually and traveled up to 8,900 km and 161 days (total = 48,500 km). Movements revealed summer coastal feeding for some tagged whales, while others migrated to near the Atlantic ice edge (54°S and as far west as the South Sandwich Islands) and/or the historic sub-tropical Tristan and Pigeon whaling grounds. Three whale tracks converged over the Meteor Seamount while headed south. Whales traveled with considerable variation in individual speeds and dive habits. This is the first identification of the summer feeding areas for this right whale stock. Characterization of the summer feeding habitat and home range estimates were made. These data contribute significantly toward the interpretation of historic whaling records. Re-sightings of previously tagged whales have occurred off South Africa in each of the succeeding years.

New Insights from Age Determination on Toxic Element Accumulation in Small Cetaceans from the Atlantic and Mediterranean Waters

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Mediterranean striped dolphins (*Stenella coeruleoalba*) have been reported to exhibit much higher concentrations of mercury (Hg) than those from the Atlantic, but on the basis of body length only. Mediterranean striped dolphins are yet smaller than Atlantic ones, which may affect previous observations. Hence, the present study aimed at comparing Hg but also cadmium (Cd) accumulation with age in small cetaceans from the Mediterranean and Atlantic waters. The selected species were those that are commonly abundant in the two areas, that is, striped and bottlenose dolphins (*Tursiops truncatus*). Metal analyses were assayed in their storage tissue for dolphins (n = 55), i.e. the liver for Hg and the kidneys for Cd, as well as in some whole prey (9 species), in order to infer about metal exposure through the diet between areas. As expected, Mediterranean prey exhibited the highest Hg levels, as a consequence of the Hg enrichment of the Mediterranean Sea. Moreover, Mediterranean bottlenose dolphins displayed higher Hg levels than Atlantic ones (p = 0.032), whereas, and surprisingly, Mediterranean striped dolphins did not (p = 0.691). As Myctophids displayed the highest Hg levels (105 ± 80 ng.g⁻¹ w.wt.) among Atlantic prey, only an offshore dietary behaviour for Atlantic striped dolphins could explain their high Hg levels. Therefore, Hg levels suggested that Mediterranean striped dolphins would rather feed over shallower waters. Concerning Cd, no evident trends were found between areas, except for 3 bottlenose dolphins that belonged to a resident group from the Arcachon Bay. The particularly low Cd levels exhibited by these individuals were clearly due to the limited occurrence of cephalopods in this area. These results suggested that metal measurements could be used as additional tracers to better understand long-term feeding preferences of upper-level predators. Moreover, this study highlighted the need to consider age to compare

metal levels between populations.

Linking Foraging Ecology of Bowhead Whales to Spring Productivity in an Arctic Ecosystem

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A fundamental concept in marine ecology is that the fitness of a predator depends on the spatial and temporal synchrony with the production of its prey. This is especially true in seasonal polar environments, where predictable changes in temperature and solar radiation only allow for short production periods. Twelve bowhead whales (*Balaena mysticetus*) were instrumented with archival Time-Depth or Time-Depth-Fluorescence Recorders in Disko Bay, West Greenland, between 2002 and 2005. Instruments collected *in situ* measurements of depth, surface and water column fluorescence, and water temperature during the spring primary production bloom. Seventeen additional whales were instrumented with satellite transmitters providing concurrent and detailed information on movements and area use. Simultaneous data were collected on zooplankton density, taxa, and biomass at 30 standard stations and were used to characterize the horizontal and vertical structure of the prey base for bowheads. After the retreat of annual winter sea ice, bowhead whales used a limited area (<5,000 km²) and made characteristic foraging dives just below the euphotic zone to 40-70 m targeting recently ascended calanoid copepods. Bowheads demonstrated remarkable flexibility in diving with maximum dive depths reaching >400 m. Spatial distribution of zooplankton biomass was negatively correlated with the presence of bowhead whales, yet the relationship was confounded by effects of local bathymetry and timing of sea ice breakup. Fluorometric data were used to characterize the springtime primary production by interpolating fluorescence measures collected every second from diving whales. Data were also spatially coupled with remotely-sensed images of chlorophyll-a obtained from MODIS EOS-Terra and Aqua satellites. This approach provided a foundation for a 3-dimensional characterization of springtime production in bowhead habitat and facilitated the quantification of links between bowheads and their prey. High-resolution dive and oceanographic data collected from marine mammals provide important inputs for ecological studies of environmental forcing factors on top predators.

Diel and Spatial Patterns in the Singing Behavior of Humpback Whales off Oahu, Hawaii

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The singing behavior of male humpback whales on the winter breeding grounds is still a poorly understood phenomenon. Previous work indicates that the chorusing levels of singing whales off west Maui are higher at night than during the day. However, the cause of this variation is not yet known. To investigate whether more whales sing at night or whether the same number simply move closer to near-shore recorders following sunset, the abundance and location of singing whales off Kaena Point, Oahu was examined. A bottom-moored recording system was used to establish that the same diel pattern observed off Maui in fact also occurs off Oahu. The location of singing whales, both during the day and at night, was determined by localizing singers along a preset transect track using a towed hydrophone array. More whales were found singing along the coastline at night than during the day. However, there was no indication of a shoreward migration of singers that could account for the higher chorusing levels received by the moored recorder. These results suggest that, at night, more males sing and that singing displays may therefore be a more effective behavioral tactic than direct competition for females in a pod. Also, more singers were found along the northern part of the coastline, which is dominated by a shallow bank, indicating that singers were selective with respect to where they chose to sing.

Combining Novel and Traditional Techniques to Accurately Quantify Salmon Species in Harbor Seal Diet and Its Implications for Management and Conservation

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Harbor seal populations along the west coast of the US have dramatically increased since passage of the MMPA in 1972. During this same period, numerous marine and anadromous fish populations have declined. Researchers have investigated relationships between predator and prey populations for many years to determine their role in management and conservation. We present multiple techniques to quantify impacts of harbor seals on depleted (or ESA listed) salmonid populations in the Duckabush and Dosewallips River systems in Hood Canal, Washington. In 1998-2001, we conducted fecal (scat) collections and behavioral observations of harbor seals during summer and early fall. Scat analyses indicated 13.0% of seal diet was composed of salmon. Salmonid remains recovered from scats can be identified to family based on morphology; however species identification is not possible. Concerns about the conservation status of salmonid stocks have made species identification critical. Thus, genetic markers based on Single Nucleotide Polymorphisms (SNPs) were used to identify the species-of-origin for salmonid bones recovered from scats. A total of 171 bones were analyzed and 126 (73.7%) were successfully identified. Comparison of salmon species compositions from genetic identification of prey remains indicated significant differences from those identifications obtained during behavioral observations. The percentage of bones genetically identified as pink salmon in 1999 and 2001, was 0% and 9.5%, however, in both years, a large proportion of observed predations were identified as pink salmon. Conversely, the proportion of cutthroat trout based on genetic identification was 4.8% and no predations on cutthroat were observed. These results suggest, when conservation and management of specific prey species is important, a combination of food habits analysis techniques and incorporation of new technologies is necessary. Foraging strategies of individual seals, relative abundance of salmon species available to harbor seals and salmon life histories are also valuable when exploring predator-prey relationships.

Environmental Composition of Habitat Used by Juvenile Steller Sea Lions (*Eumetopias jubatus*)

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The decline of the western stock of Steller sea lions (*Eumetopias jubatus*) over the past three decades may have been attributed to the synergistic effects of fisheries and environmental perturbations, which may have altered distribution or abundance of prey. Previous studies have indicated that prey occurrence and diet diversity were related to population decline within metapopulation regions of the western stock of Steller sea lions in Alaska. The objective of this study, therefore, was to examine diversity of habitat used by Steller sea lions with respect to population trajectories. Habitat use was assessed by deploying satellite-depth recorders and satellite relay data loggers on juvenile Steller sea lions ($n=50$) over a five-year period (2000 to 2004) within four regions of the western stock. Areas used by sea lions during summer months (June, July, and August) were demarcated using satellite telemetry data and characterized by environmental variables (sea surface temperature and chlorophyll-*a*), which possibly serve as proxies for environmental processes or prey. Shannon's Diversity Index (ShDi), a measure of composition that indicates how evenly the proportions of environmental patch types are distributed (ShDi=0 when area contains only 1 patch), was quantified for each

area using a spatial pattern analysis computer program. Although there was considerable interannual variability within and among all areas, indices of diversity of sea surface temperature for the Eastern Aleutian Islands (range = 1.39-1.70) and Central Aleutian Islands (range 1.04-1.30), which are areas of population stability or increase, were consistently greater than indices for the Western Aleutian Islands (range 0.69-1.38) or the Central Gulf of Alaska (range 0.94-1.27), which are areas of decline. Additional pattern metrics of composition and configuration will further our understanding of sea lion behavior and distribution with respect to environmental heterogeneity.

Necessity is the Mother of Invention: Better Disentanglement through Trial, Error and Creative Design

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Serious injury and mortality caused by incidental entanglement in commercial fishing gear has been recognized as an impediment to the recovery of the North Atlantic right whale. Disentanglement techniques attempted by the Atlantic Large Whale Disentanglement Network have proven useful on other species, especially humpbacks, but have been substantially less effective on right whales, eliciting ongoing experimentation and development of tools and techniques. Here we report on the breadth of disentanglement innovations with a detailed look at the strengths and weakness of six from their use in the field: the development of a disentanglement network, the use of telemetry buoys, sedation, tail harnesses, grapples and aerial support. Each was created in response to specific challenges encountered during different stages of disentanglement operations, including: relocating entangled whales; assessing and documenting entanglements; attaching a control line; and slowing or stopping an animal. New jam-grapple designs have allowed for greatly improved access to entangling gear and have improved recovery of removed gear for research. Sophisticated aerial support and tracking, incorporating digital imaging and telemetry, have improved assessment and planning and increased disentanglement opportunities and human safety. A network of strategically stationed trained responders has increased the scope of response, both geographically and technically. Sedation and tail harness designs, so far, have not substantially aided entangled whales directly, but investigations toward their potential application rely on knowledge gained during disentanglement attempts. Continuing research focuses on improving disentanglement capabilities, while maintaining a high level of human safety, provides more detailed information on the causes and effects of entanglement on marine wildlife, and may aid disentanglement efforts worldwide until reliable preventive measures are found.

Paternity Assessment in the Western Gray Whale Population Using Microsatellites

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For the past nine years we have studied the critically endangered western gray whale population at the only known major feeding ground off Sakhalin Island, Russia. While the continued survival of this population is jeopardized by many factors, the low number of reproductive females documented in the population is considered a particularly significant constraint affecting recovery. Because the breeding grounds remain unknown, however, understanding of the

population's mating system and male reproductive behavior is limited. We focused on identifying breeding males and the distribution of their reproductive success. We used eight polymorphic microsatellite markers amplified from biopsy samples collected from 32 mother/calf pairs and 39 potential adult males. After removing the mother's contribution to the calf's genotype, candidate males were eliminated as potential fathers if their genotypes did not match those of the calf for at least one allele per locus. When more than one male remained after exclusion, a likelihood of paternity was assigned to non-excluded candidate fathers based on the population's allele frequencies. Putative fathers were identified for 10 calves, while paternity remained ambiguous for one additional calf, for which two males were assigned as putative fathers with the same likelihood of paternity. No putative fathers were identified for the remaining 21 calves. Reproductive success was evenly distributed among putative fathers, with nine males designated as putative fathers for the ten calves with assigned paternities. We propose several different hypotheses to explain the "missing" fathers; however, resolution of these questions will require further studies. While continued monitoring of the population on the feeding ground, which represents critical habitat for pregnant and lactating females, should be emphasized, these results also highlight the importance of locating the population's breeding and calving grounds.

Reproductive Effort in Primiparous Grey Seals (*Halichoerus grypus*): The Costs of First Reproduction in a Capital Breeding Mammal

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Primiparous females are thought to perform more poorly than multiparous females, however, direct comparisons of reproductive effort have never been made for any species of wild mammal. We compared milk composition, maternal energy expenditures and pup growth and energy deposition over the course of lactation between known age (marked by permanent brands) primiparous (n=15), second parity (n=5) and multiparous (n=15) grey seal females using hydrogen isotope (²H₂O, D₂O) dilution. There were no significant differences in milk composition between the groups at day 3 or at day 10-13 postpartum. Although multiparous females were significantly heavier at parturition (p<0.001), mobilized larger absolute amounts of body energy stores (kg/day, p<0.001), had significantly higher levels of daily energy expenditure (DEE, MJ/day, p<0.001), milk energy output (MEO, MJ/day, p<0.001) and pup mass gain (kg/day, p<0.001) than primiparous and second parity females, there were no significant differences in the proportion of body energy stores mobilized to support the costs of lactation between the groups (p=0.865). On average, the difference in DEE between primiparous (97.1±6.62 MJ/day) and multiparous (135.6±6.16 MJ/day) females was proportional to the difference in average body mass at parturition between the two groups, however, the proportion of DEE devoted to MEO was significantly higher in multiparous (71.3±2.97%) compared to primiparous females (62.0±3.38%, p=0.05), indicating that primiparous females were less efficient at transferring energy into milk production. While pups of multiparous females were significantly heavier at both day 3 and day 12 (p<0.001) than pups of primiparous and second parity females, there were no significant differences between the groups in the body composition of pups at day 3 (10.5±0.69% fat, 22.3±0.20% protein) or day 12 (35.8±0.75% fat, 15.1±0.22% protein). In contrast to results from laboratory species, our results demonstrate that primiparous grey seal females do not invest proportionally more energy during lactation than multiparous females.

High Definition Imagery Analysis as a Method of Assessing Behavior and Human Impacts on the North Atlantic Right Whale (*Eubalaena glacialis*)

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Monitoring negative anthropogenic effects on the North Atlantic right whale (*Eubalaena glacialis*) and evaluating current regulations and management strategies is essential in order to reduce potential contributing factors to the decline in population survival of this species. Since 2002, a systematic research effort in collaboration with Fuji Film U.S.A. Inc. and the Advanced Imaging and Visualization Laboratory at the Woods Hole Oceanographic Institution has employed high performance digital imaging capabilities with the use of the Fuji Airship as an aerial monitoring platform. This opportunity has allowed for ongoing aerial data collection off coastal waters of the northeastern and southern United States in cooperation with the National Oceanic and Atmospheric Administration (NOAA) aerial monitoring programs. Preliminary findings of HD imagery collected during the aerial surveys have not only provided increased sightability effort in high-priority areas of right whale habitat use, but has provided the Atlantic Large Whale Disentanglement Network with real-time video documentation and time-series imaging of large whale entanglements. Data analysis to date of baleen whale movements in and around shipping lanes has provided insight on the frequency of surface activity within close proximity of large vessel passage. In addition, compliance of whale watching guidelines was evaluated using range markers to compliment imagery taken while monitoring whale watch and recreational boat interactions in relation to the presence of humpback whales (*Megaptera novaeangliae*). Photogrammetry efforts included both stereo imaging and single camera systems. With the effective application of this pilot study and valuable potential for a multi-year effort, the development and analysis effort will continue to provide high quality data to the marine mammal community and contribute to managing the reduction of protected species mortalities.

Assessing Contaminant Susceptibility in the North Atlantic Right Whale: Molecular Characterization and Functional Analysis of the Aryl Hydrocarbon Receptor

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The North Atlantic right whale (NARW, *Eubalaena glacialis*) is among the most endangered species with approximately 350 living individuals, and a prognosis of extinction within 150 years. Vessel collisions and fishing gear entanglement are the leading causes of direct mortality; however, habitat degradation and compromised health condition are implicated as factors contributing to the species' decline. To investigate the hypothesis that NARW are highly susceptible to chemical pollutants such as polycyclic aromatic hydrocarbons (PAH) and PCBs, we cloned and sequenced a cDNA encoding the aryl hydrocarbon receptor (AHR), a transcription factor that binds PAH/PCBs and regulates gene expression, including cytochrome P-450. PAH/PCBs may exert physiological effects by disrupting AHR-dependent gene expression patterns or generating reactive chemical by-products. Variations in AHR sequence are known to control species-specific chemical sensitivity. A cDNA encoding a predicted 850 amino acid protein (95.8 kD) was identified by RT-PCR and RACE using RNA prepared from skin/blubber biopsies of free-ranging NARW. An AHR cDNA was also cloned from a sympatric species, humpback whale (*Megaptera novaeangliae*). Pairwise ClustalW analysis of the predicted amino acid sequence revealed 94-96% identity among whale (including beluga) AHRs, 82-84% identity with human, harbor seal and Baikal seal AHRs, and 68% identity with the murine form. Velocity sedimentation of *in vitro* expressed proteins using sucrose gradients showed specific binding of [³H]TCDD (2,3,7,8-tetrachlorodibenzo-*p*-dioxin), the prototypical AHR ligand, to both mysticete AHRs. Saturation binding assays using dextran-coated charcoal are being

performed to compare the binding constants of right, humpback and beluga AHRs with those of other mammalian species. Phylogenetic analyses, combined with biochemical characterization, may explain functional adaptation of this cellular regulator among marine mammal species. Further characterization of cetacean AHRs will aid in assessing impacts of chemicals on the marine environment and endangered species. [Supported by NOAA Right Whale Grants Program & Northeast Consortium]

Spatiotemporal Prediction of Fin Whale Distribution in the Ligurian Sea (NW Mediterranean Sea)

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Prediction models were developed for fin whale (*Balaenoptera physalus*) of the Ligurian Sea. An effort of 6,160 km distributed on thirty dedicated surveys was carried out between French mainland and Corsica from February 2001 to February 2004. Surveys were conducted on a monthly basis, using the same platform and the same protocol. Using multiple logistic regression, presence of fin whales was related to predictor variables as topographic variables (Depth, Contour Index, distance to the shore) and oceanographic parameters from remote sensing (Sea Surface Temperature, Chlorophyll and Net primary production). Simultaneous primary production or averaged on two previous months, water temperature and distance to the coast were selected by stepwise procedure as influent on whale distribution. Monthly and weekly time scale of variables were tested. Model predicted correctly 68% of the sampled cells. The model predicted successfully the spreading between June and August and spatial shift of whale distribution from a year to another. Cross validation of the predicted distribution was done with two external data set obtained from a survey in the Marine Protected Area. The selected model predicted correctly 73% of the presence and 79% of the absence of the external data set. Reliable prediction were obtained for fin whale, providing promising results for the development of future applications. This project will contribute to understand fin whales distribution and links with environmental parameters in an area or whales are well known to concentrate each summer. Prediction of weekly distribution of fin whale in relation to environmental parameters represent a very useful conservation tool to prevent collisions between ship and whales or as conservation tool in the Marine Protected Area.

Heavy Metal Toxicology in Bottlenose Dolphins Stranded and By-Caught in South Australia, 1989 – 2004

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Markers of heavy metal pathology were investigated in an opportunistic sample of 38 Indo-Pacific bottlenose dolphins, *Tursiops aduncus*, stranded or by-caught in South Australia between 1989 and 2004. The ability of pathological markers to withstand the effects of post-mortem decomposition was investigated in the present study in order to determine the best pathology markers for ecotoxicology studies using decomposed specimens. Robust markers of pathology that were resistant to decomposition effects included quantification of metallothioneins, measurement of histological renal parameters, and changes in bone density. These parameters were compared with concentrations of metals (zinc, cadmium, mercury and lead) and selenium in *Tursiops aduncus* tissue (liver, kidney and bone) in order to make inferences of the health of South Australia's most publicly cherished species, the dolphin. Two dolphins in the present sample of 38 displayed indications of metal-induced pathology and evidence was put forth to suggest that zinc may have a role in the pathology observed in these animals.

Some Features of Interactions Between *Delphinapterus leucas* and *Tursiops truncatus* Kept Jointly in Captivity

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Observations of two Beluga Whales (BW) and three Black Sea Bottle-Nosed Dolphins (BND) of different sex and age (3-15 years) kept in captivity revealed the following types of their behavioral reactions and communications. 1. Self-defense or defense. Two BW of different sexes, and two BND of the same sex form a cross by placing their rostrums to each other. Hence, their grouping becomes a patch on water surface. Besides, it becomes more difficult for the underwater enemies to identify dolphins; weak and sick animals get support and potential safety. 2. Sexual interaction. The behavior of BW and BND which imitates mating (simultaneous motion of the female and underlying male) does not always play the role of a sexual act or erotic game. It often serves as means of social interplay and hierarchy structuring. This phenomenon also occurs in pairs of different species, both of the same or different sex. 3. Simultaneous movements by all dolphins. It involves synchronous motion of the animals by pairs, or by groups of three or four, in any directions; individuals may join already moving groups. Meanwhile, some animals may jump from water directing the movement of the pod. In addition, the animals which permanently stay in an enclosed space may also cooperate among males (BND and BW), e.g., it would be as if two males of different species capture and guard the female. The following conclusion was made: not only the successful formation of a shoal but also the establishment of positive contacts between individuals of different sexes, species, and ages are possible in captivity. This fact has both scientific and practical value: it becomes possible to use the examined phenomenon of positive interactions of animals for improving their keeping and training, including the situation when the expenses for the tanks have to be reduced.

Floating time-depth recorders provide elusive data linking dive shape to prey type

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Typically, simple time-depth records are used to describe the foraging tactics of marine predators. However, ascribing function to dive shape is a classic problem facing ecologists. In 2003/2004, a study to better understand the fine-scale, winter-foraging tactics of juvenile Steller sea lions (*Eumetopias jubatus*, SSL) was prompted by the low survivorship of juveniles in western Alaska. A variety of tracking (VHF, satellite and acoustic telemetry) and simultaneous prey quantification techniques (hydroacoustic surveys) enabled real-time tracking of 15 sea lions and their prey. Difficulties associated with recapturing individuals led to the design of a floating tag encasing a time-depth recorder (Wildlife Computers), which could be retrieved, once moulted. Floating tags were deployed on 10 juveniles in October 2003-February 2004 in southeast Alaska. These archival tags sampled depth every 2s, temperature (4s) and light levels (30s), and would record the most detailed dive behaviour for juvenile Steller sea lions to date. Satellite-relayed dive loggers were deployed on 6 of the same individuals to measure coarser scale diving behaviour (max. depth, duration) and locations. Two of the TDRs were recovered in April 2004 and 2005, providing ~2 and 6 months of data respectively. The dive behaviour of SSL1, a 1.5 year old (yo), suckling, male, was typical of a shallow, mixed benthic and pelagic forager. Resights by ADF&G biologists indicate that the tag also spanned weaning. SSL2 (an independent, 2.5 yo female) was followed at sea on 12 occasions, and showed ontogenetic increases in maximum dive depth (158 m to 249 m) from November to April. Dive shapes indicate that SSL2 was predominantly a pelagic forager, and concurrent hydro-acoustic

surveys in her foraging areas identified herring. Corresponding dives showed characteristic wiggles, potentially indicating ambush predation from depth. This study provides significant new insights into prey-related foraging tactics by actually linking dive shape to concurrent prey type and accessibility.

Mitochondrial Differentiation Among Antarctic Killer Whales

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A recent study documented the presence of three morphotypes of killer whale (*Orcinus* spp.) in the waters around Antarctica, concluding that they may be in fact distinct species. One of the forms (Type A), which appears similar to killer whales from other parts of the world, occurs in open water and is thought to prey primarily upon baleen whales. The other two forms (B and C) frequent the pack ice in Antarctica and are thought to favor pinnipeds and fish, respectively. The latter two forms are smaller than Type A and have distinct differences in color pattern. We generated complete sequences of the mitochondrial control region from biopsy samples of all three forms, including six of Type A, 17 of Type B and 18 of Type C. All samples were from the waters around Antarctica except for two Type B samples from the Falkland Islands. These sequences were also compared to sequences from killer whales in other regions. Across the control region, Haplotypes from types B and C show three fixed differences (two base substitutions and a single-base indel) from Antarctic Type A killer whales, as well as from killer whales from other parts of the world. Types B and C had three haplotypes each, with far less divergence within and between them than was seen in Type A killer whales. A single fixed base substitution differentiated the haplotypes of the Type B killer whales from those of Type C. These results should be considered preliminary, given the limitations of the sampling and the single-marker analysis, but are consistent with reproductive isolation of the different forms. Furthermore, the low levels of sequence divergence indicate that the considerable morphological and ecological differentiation of these types may have proceeded relatively rapidly in evolutionary terms.

The Cost-Benefit Analysis of Whale-Watching Enterprises in the East Coast of Taiwan

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Whale-watching in Taiwan was initiated by one boat at one remote harbor in 1997. It expands rapidly to six harbors at 3 counties along the east coast: Ilan, Hualien and Taitung in the past 8 years. It reached a high point with 32 whale-watching boats and carried about 240,000 tourists out in 2004. However, its growing rate reached a plateau in the past 2 years. The relationships among operators has involved into a deteriorated competition. Through the analysis of cost and benefit of whale watching enterprise, we hope to find a balanced cruise price, and hope to help operators to increase their efficiency in running cost and help government on the new policy making. We collected the information about the cost-benefit and management methods by questionnaires and interviewing operators. In addition, we obtained the data of tourist numbers from the coast guard which is in charge of harbor security of all harbors in Taiwan. The analysis shows that the most important influences of whale watching industries include (1) size of the boat, (2) tourists numbers, (3) prices of whale-watching boat, (4) total cost, (5) fluctuant cost, and (6) the profit of whale watching operators. Although the number of boats has reached 13 (highest) in Ilan, the expanding pressure is predicted high due to its easy access to Taipei. Although there are only 2 boats left in Taitung, this enterprise is facing great challenge because of its high cost. For future survival of whale-watching business, we suggest that whale-watching in Taitung and Hualien need to be directed toward ecotourism style, tour quality should be more valuable than tour quantity.

The intention of operators at Ilan to obtain of whale-watching award (an ecolable issued by Taiwan Cetacean Society) probably will be low unless their business drops in the future.

Distribution of Cetaceans in the Waters off Eastern Taiwan

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We quantitatively examined the cetacean distribution in the waters off eastern Taiwan by compiling sighting data between 1996 and 2003 from various survey reports using a geographic information system (GIS) approach. A 500 m x 500 m grid system was used to produce distribution maps. At least 16 cetacean species were found in the waters covered approximately 15,856.8 km². A total of 895 sightings were made and six dominant species, i.e., Risso's dolphin (*Grampus griseus*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin (*S. attenuata*), Fraser's dolphin (*Lagenodelphis hosei*) and bottlenose dolphins (*Tursiops truncatus* and *T. aduncus*), those comprised 86.3% of the sightings. Distribution maps of these species were generated and a species richness map was created. Six environmental factors, i.e., bottom depth, bottom depth gradient (slope), contour index (CI), the nearest distances to coastline of Taiwan, river-mouths, and the steepest regions (slope > 20°) in the waters, were used to characterize the distributions of species and hotspots. Although there are many overlapping areas, each species has its distinct physical habitat characteristics. The bottom depth is the 'best' variable to differentiate the dominant species, though other environmental variables also help. The species richness map shows that most of the grids have only one or two species. We defined a grid with three species occurring as the hotspot. Using this criterion, only ten grids qualified. These hotspots accumulated at the middle section of east coast. This paper provide biogeographic information that has great potential to enhance conservation planning of cetaceans, e.g., a marine protected area.

Vocalization Repertoire of the Three Strayed Rough-Toothed Dolphins (*Steno bredanensis*) in the Danshui River, Taipei, Taiwan

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Three rough-toothed dolphins (*Steno bredanensis*) were reported swimming into the Danshui River in Taipei on Feb. 10, 2004. A total of 21hr 10min 41sec sound and behavior recordings were made from Feb. 17 to Mar. 4 when these animals were still in the river. Two of the dolphins were caught and released on Mar. 5, while the other one was missing prior to that, and later found dead-stranded on the riverbank. Recordings were made with dolphins presenting within 100-200m of the observation motor boat. There were other entertainment boats operating on the river, and the dolphins' responses to heavy engine noise were relatively negative. Regular clicks were found consistently in most of the recording sessions (more than 70% of total recording time). Four major types (types A to D) of whistles were identified, which constitute over 81% of the whistles recorded. The predominant whistle type (more than 62%; type C) and its variations usually occurred in a long series that lasted for 1 to more than 10 min, a situation not observed in other types of whistles. And the composition of whistles recorded changed during the observation period. Besides, the inter-pulse intervals of the pulse-like sound (including commonly described bursts or buzzes) were used as reference for the animals' behavior state. The fall of the amount

of rapid pulses toward the end of the observation period may be the sign of starving and their possible poor body conditions.

Evaluating the Effect of Pelagic Trawl Pingers on the Behaviour of Bottlenose Dolphins (*Tursiops truncatus*)

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Large numbers of dolphins and porpoises are bycaught in fishing gear worldwide, posing serious threats to several populations and species. Several mitigation measures, including acoustic deterrent devices ("pingers"), have been used in attempts to reduce this bycatch. In order to reduce the number of dolphins caught in pelagic trawls fishing for albacore tuna in Irish waters, two models of pinger are being tested. Standard "continuous pingers" (CP) produce a continuous, high intensity sound at 20-160 Hz and 165 dB. A new prototype responsive pinger (RP) produces an alarm activated by the reception of dolphin vocalisations, and also logs these vocalisations. Prior to this study, both models had been tested in a controlled environment, but had not been tested in the field. This study compared the responses of common bottlenose dolphins (*Tursiops truncatus*) to both pinger models in the Shannon estuary, southwest Ireland. A sampling programme incorporating a range of spatial and temporal scales was designed, such that factorial analysis of variance could be used to compare response variables between control and test periods. We used a combination of visual surveys and acoustic monitoring (using TPODs). At a number of locations, an RP and CP-TPOD pair were deployed for replicate 24-hour periods. Land-based observations were carried out during daylight hours, documenting the occurrence of dolphin groups in the vicinity of the gear, their closest approach distance and behaviour. TPODs and the RP collected acoustic data on the vocalisation activity of dolphins within range. Boat-based approaches were also carried out, using a similar study design. Observable behaviour and vocalisation activity is expected to differ between control and test periods, and also between the two pinger types. No results are available at the time of writing. When available, the findings will be used to improve the reduction of dolphin bycatch in tuna trawl fisheries.

Geographic Variation in Whistles of Bottlenose Dolphins (*Tursiops aduncus*) in Southeastern Australia

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Geographic variation in delphinid vocalisations may be affected by evolutionary or environmental factors. Several mechanisms have been suggested for the development of dialects in delphinids, including cultural drift, call innovation, cultural diffusion and environmental effects. Cultural drift is the consequence of 'mistakes' during vocal learning which translate through generations. Innovation involves change, whereas diffusion results from new sounds appearing due to immigration of conspecifics. Environmental effects include sound propagation and ambient background noise. Complexity underlying geographic variation in call structure is analysed in relation to calls from two populations of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Southeastern Australia. These populations are largely genetically distinct and geographically isolated. Ten variables were measured from the fundamental frequency of 200 whistle contours from each dolphin population, recorded in four behavioural contexts. Principal component analysis revealed significant differences between the populations, with Port Stephens dolphins having less complex whistles of a higher frequency than those in Jervis Bay. Three call characteristics were significantly different in the different behavioural

contexts and five differed between sites; however there was no interaction between site and behaviour. Ambient noise was significantly different between Port Stephens and Jervis Bay, but the difference in mean frequencies of whistles does not appear to be explained by the variation in ambient noise. The genetic difference and degrees of isolation suggest that cultural drift may play a role in the differences. Cultural diffusion may also contribute, although populations seem relatively stable with little movement between them.

Changing Harp Seal Predation on Salmon in Newfoundland and Labrador Rivers: Insights Based on Local Ecological Knowledge

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Causes for declining Atlantic salmon stocks in eastern Canada are unknown but many resource users consider predation by seals in rivers and estuaries to be a potential problem. During the 1990s, the Department of Fisheries and Oceans (DFO) received reports from resource users of increased harp seal/salmon interactions on several Newfoundland and Labrador rivers. In 2005, a series of semi-directed interviews (n=30) were conducted with resource users on 10 of the rivers reported to have potential seal predation problems. Respondents were requested to comment on any changes in relative abundance, timing of migration, habitat use and foraging behavior of harp seals frequenting the rivers and estuaries during the past 5 years, during the 1990s, and prior to 1990. The relative abundance of seals increased during the late 1990s on 7 rivers and in early 2000 for the others. Starting in the mid 1990s most respondents noted that seals increased their residency time in rivers and estuaries by 1-3 months. In 9 river systems increased seal sightings were concurrent with the migration and/or spawning of pelagic forage fish (e.g., capelin) in the area. The feeding activity of seals on forage fish often overlapped temporally and spatially with either an adult or smolt salmon run, when historically, seals were largely absent from the area at that time of the year. The consistency of these observations provided by the respondents suggests that the potential for seal predation on salmon has increased during the last decade. These data are also consistent with what is known about larger-scale ecosystem and oceanographic changes taking place in the northwest Atlantic during the 1990s. Directed field studies on harp seal foraging in coastal areas are needed to determine the importance of changing seal predation and are the focus of a second component of this ongoing research.

Evaluating Cetacean Hybrids: The Utility of Multiple Sources of Data to Investigate the Origin of an Intermediate Cetacean Species, *Stenella clymene*

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The evolutionary role and significance of hybridization is a controversial topic in cetacean systematics and taxonomy. Processes of speciation are typically subdivided into three categories (allopatric, sympatric and parapatric). However, novel species can also arise through natural hybridization, or the reticulation of divergent lineages resulting in what are perceived as a unique gene pool. Based on morphological, behavioral and mtDNA data, the Clymene dolphin (*Stenella clymene*) has been suggested to have originated as a result of hybridization. However, this has not been evaluated in a rigorous systematics context. The Clymene dolphin is closely related to congeneric (and proposed parent species) *S. longirostris* and *S. coeruleoalba*. Cranially it resembles *S. coeruleoalba* but is similar to

S. longirostris in coloration, body form and highly-derived “spinning” behavior. Mitochondrial DNA data placed *S. clymene* among the sister taxa of *S. coeruleoalba*, but distantly related to *S. longirostris*. Here we evaluate the hybrid origin of *S. clymene* using a combination of molecular (nuclear, mtDNA, and Y-chromosome) and morphological character information and a two-tiered approach. First, we examine multiple molecular markers in 333 samples from the three putative parent/daughter species (*S. coe*, *S. cly* and *S. lon*). Second, we investigate the phylogenetic relationships of these species within a representative taxonomic sampling of 125 individuals within the Delphinidae family. Operational taxonomic units and phylogenetic relationships are assessed for all loci with population aggregation analysis and maximum parsimony analysis, respectively. Sister relationships and measures of nodal support are contrasted across data partitions in order to detect a reticulation event within the genus *Stenella* or other taxa. Our approach provides a robust and comprehensive method to evaluate reticulation as a process of speciation, and a framework to investigate similar issues concerning hybrid origin among all marine mammals.

Fine Scale Foraging Behavior of Female Northern Fur Seals (*Callorhinus ursinus*)

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The decline of the Pribilof Island population of northern fur seals (*Callorhinus ursinus*) since the late 1970s is not well understood. It has been speculated that changes in prey availability due to competition with commercial fisheries may be contributing to their decline and/or impeding their recovery. Previous studies have successfully used radio and satellite telemetry to identify movement patterns and at sea locations of fur seals % however, the resolution of data has been too coarse to identify critical foraging habitat and assess the spatial overlap with fisheries in the eastern Bering Sea. Our objectives were to use the newly-developed dead reckoning technology to determine the four-dimensional pelagic habitat and foraging behavior of northern fur seals on a finer spatial scale and at a higher resolution than is currently available. Five lactating fur seals were tracked from St. Paul Island from July to October 2005. Each animal was equipped with a VHF radio transmitter, Argos satellite tag and a Driesen & Kern dead reckoner tag. We obtained detailed records of fur seal diving patterns and used them to describe how foraging patterns vary with month and topography. These results provide a better understanding of fur seal foraging behavior and will ultimately provide an improved assessment of critical habitat and the degree of overlap with fisheries. Studying fur seal foraging behavior at a fine scale is a necessary step towards addressing the question of potential interactions between northern fur seals and commercial fisheries operating in the vicinity of the Pribilof Islands.

Developmental Patterns of Myoglobin Concentrations in Harp (*Phoca groenlandica*) and Hooded (*Cystophora cristata*) Seals

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Pinnipeds rely primarily on oxygen stores in their blood and muscles to support aerobic diving, therefore rapid development of oxygen stores is crucial for pups to make the transition from nursing to independent foraging. Early work on several pinnipeds has shown that blood oxygen stores develop quickly, while muscle development proceeds at a much slower pace. This suggests that muscle maturation may influence the behavioral ecology of young pinnipeds. To investigate the pattern of muscle development in shallow and deep diving phocids, muscle samples from 23 harp seals (9 neonates, 5 weaned pups, and 9 adult females, maximum dive depth 370m) and 38

hooded seals (7 neonates, 17 weaned pups, and 14 adult females, max depth >1,000m) were collected in Norway in 1999 and 2000 and in Canada in 2005. To relate the pattern of muscle development to muscle function, we measured myoglobin concentration ([Mb]) in ten muscles from across the entire body. Adult [Mb] ranged from 2.8 - 9.7 g% and 3.7 - 9.9 g% in harp and hooded seals respectively, with values increasing from the *sternothyroideus* muscle in the cervical region to the *psaos* muscle in the lumbar region. In addition, adult [Mb] was 3-4 times higher in swimming vs. non-swimming muscles. While neonate and weaned pup muscles exhibited a similar pattern across the body, [Mb] for all muscles was significantly lower than in adults in both species. However, in neonates and weaned pups there was little difference in [Mb] between swimming and non-swimming muscles (1.9 - 3.1g%), nor were there differences with age, suggesting that little development occurs during the nursing period. Such large changes in [Mb] between muscles and age classes suggest equally large changes in muscle structure and function postweaning. Future research will investigate concurrent changes in enzyme profiles, fiber types and mitochondrial and capillary densities.

Genetic and Electroretinographic Examination of Pinniped Visual Pigments

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We evaluated the rod and cone photopigments of seven pinniped species and two other marine carnivores (sea otter, polar bear). Rod, middle/long-wavelength sensitive (M/L) cone, and short-wavelength sensitive (S) cone opsin (if present) sequences were obtained from retinal mRNA. Pigment spectral sensitivity was inferred through the evaluation of known spectral tuning residues. The rod pigments of six of the pinnipeds were spectrally similar to those of the sea otter and polar bear with maximum sensitivities (λ_{\max}) of 499 or 501 nm. The M/L cones of all the pinnipeds, polar bear, and sea otter had inferred λ_{\max} of 545-560 nm. The spectral tuning of these M/L pigments is thus very similar to that observed in many terrestrial carnivores. Only the rod opsin sequence of the elephant seal had a spectral sensitivity characteristic of adaptation for vision in the marine environment, with an inferred λ_{\max} of 487 nm. In contrast, no evidence of S cones was found for any of the pinnipeds, a feature also common to all cetaceans and sometimes attributed to adaptation for vision in the marine environment. The polar bear and sea otter had S cones with λ_{\max} of ~440 nm. Electroretinogram flicker photometry was additionally used to examine the *in situ* spectral sensitivities of a subset of these pinniped species. Despite the use of conditions previously shown to evoke robust cone responses in many other mammals, no responses could be elicited from the cones of the pinnipeds. By contrast, the rod photoreceptor responses recorded for all three species were as predicted by the genetic data.

The More the Merrier - Climate and Density Dependent Haul-Out Dynamics in Walruses

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Systematic records of Atlantic walruses (*Odobenus rosmarus rosmarus*) lying on haul-out were collected during July and August 1998-2000 in Young Sound, Northeast Greenland (74°18'N; 20°15'W). The purpose was to quantify the haul-out dynamics of walruses using the area and

investigate to what extent density dependent effects and climate influenced this dynamic. We used time series analyses (autoregression and spectral analyses on walrus abundance from four daily counts in July-August) focussing on three weather parameters previously shown to be of importance for walrus lying on haul-out: wind speed, air temperature and sea-ice cover. The results indicated that the importance of these parameters was subjected to intra- and inter-annual variations over the three years suggesting different mechanism for the dynamical patterns between and within years. Density dependent effects previously ignored in haul-out dynamic models for pinnipeds were shown to be of highly statistical significance in all years explaining 57.6% of the total variance for the full three years model compared to less than 1% explained by the weather parameters. A strong positive correlation between density at one time and previous densities of individuals hauled out does not surprisingly suggest a crowding effect.

Comparing Summer Distribution of Beluga Whales (*Delphinapterus leucas*) Using Traditional Ecological Knowledge and Satellite Telemetry

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Traditional Ecological Knowledge (TEK) consists of the collective ecological knowledge, experience and values of subsistence communities. In northern communities, TEK is increasingly being incorporated into resource management and policy decisions. In contrast, western science relies on hypothesis testing under specified conditions to obtain information on natural processes. Both approaches provide important ecological information, but few studies have compared the two knowledge sources. Here we compare information on movements and aggregation of beluga whales obtained from TEK interview records (N=3,253) and satellite telemetry of 30 whales tagged from 1993 to 2003 at three locations in eastern Hudson Bay, Canada. TEK records were converted to points using the vertices of the original polylines; telemetry locations, spanning 10 to 285 days, were classified according to traditional Inuit seasons. Using 28,004 filtered telemetry locations and 233,956 TEK points, the zones of intensive utilization for summer distribution were determined using a kernel estimator. Estuarine centres of aggregation in the summer are evident in both datasets. The intensive use of the offshore area seen in the telemetry data, where 76% of the locations are greater than 15 km from mainland Quebec, is not evident in the TEK, where only 17% of the records account for offshore use. The difference in summer distribution was tested with Morisita's Index of Similarity. A coefficient of 0.3 confirmed the dissimilarity between summer distribution of TEK and telemetry. The minimal offshore TEK records are related to limited travel routes to key offshore islands. Location and movement data from the telemetry study are limited by small sample sizes, and short deployments, while TEK is limited by distances traveled from communities and coastal travel habits. Although both data sets can provide complementary information, they also suffer from weaknesses that need to be recognized when applied to resource management issues.

Individual Influence on Group Movement: Initiation and Leadership in the Bottlenose Dolphin

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For many social species, only a few individuals initiate and guide movement during group travel. As a result, habitat use patterns are under considerable influence from a fraction of the group members present. While much is known about the coastal form of the bottlenose dolphin (*Tursiops truncatus*) we have yet to fully understand the forces guiding individual movement. To determine individual influence

in bottlenose dolphin groups, we examined movement initiation and positional leadership in a Lower Florida Keys (LFK) residential population. Data were collected through focal follows where identity of individuals leading and initiating movement were recorded for traveling groups. The most forward position was considered the lead. Successful direction changes were defined when the majority of the group followed direction change initiated by an individual. Photo-identification was used for individual identity verification. Preliminary results indicate that within the LFK population, a small number of individuals are responsible for the majority of group leadership (5 of 28 individuals, over 21 follows). Lead animals are also the primary control for movement direction. For follows examined (n=13) group members continued to follow lead animals on 75% of the cases where non-leaders attempted to change group direction. In addition, group members always followed direction changes initiated by leaders. Leadership appears to be stable over time as the same "leaders" have been recorded repeatedly within and between years (2001-2004). Both females (n=3) and males (n=2) have been identified as leaders. All female leaders noted were mothers with calves. This study represents the first reported example of leadership in a cetacean. These findings provide an interesting example of behavioral convergence between terrestrial and marine mammals. Results offer further insight into the social structure of bottlenose dolphin groups by increasing our understanding of the importance of individuals within groups for this species.

Bottlenose Dolphin Distribution in the Pelagic Islands: Integration of Remote Sensing Data with Sightings

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In the framework of the LIFE project NAT/IT/000163 a methodology integrating satellite remote sensing with conventional in-situ data has been developed to obtain ecological information relevant to the preparation of the Bottlenose Dolphin (*Tursiops truncatus*) Action Plan for the Pelagic Archipelago. In accordance with the local climatologic distribution of superficial currents, the Archipelago of Pelagie is locally interested by different current regimes and characterized by water of different origin. Main differences occur between areas interested by jets from West to East across the Sicilian Channel (in proximity of large bottom slopes) and areas subject to a coastal regime over flat and shallow bottom. Water characteristic depends on the regimes in these different areas. Intensification or attenuation of local phenomena (as pulses of coastal gyres and intensification of jets) have been daily monitored using MODIS satellite data to describe the main dynamics of the area. Sea surveys for dolphin monitoring has been regularly conducted in 2004 and 2005, enabling close approaches for photo-identification. Maps based on measurements of Sea Surface Temperature (SST) and surface chlorophyll concentration by satellite and in-situ observations were produced. Datasets have been integrated with sightings of dolphins in order to find correlations between sightings and physical and biological aspects of the marine environment of the Archipelago of Pelagie. Results for the research seasons 2004 (June-September) and 2005 (January-September), regarding the relationship between dolphin distribution and satellite data, will be presented.

Radio-Tracking System for Monitoring Captive-Released Manatees (*Trichechus manatus manatus*) Along the Northeast Coast of Brazil

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The Aquatic Mammal Center/IBAMA and Aquatic Mammal Foundation have an on-going program for the rescue, rehabilitation,

and release of manatees along the northeast coast of Brazil. Between 1994 and 2004, a radio tracking system was developed and used to monitor thirteen released manatees. Tracked individuals ranged along 1,500 kilometers of coast between Bahia and Rio Grande do Norte. The most frequently used tag type consisted of a very high frequency (VHF) radio-transmitter in a floating housing, which was tethered to a belt around the base of the manatee's tail. This system allowed the manatee to be followed by field trackers stationed along the coast or using a mobile tracking unit. Monitoring was conducted daily to determine location, behavior, and associated habitat features. Technicians tracked manatees during the early years, but in later years, field trackers selected from local communities performed the monitoring. A total of 8,138 tracking days were recorded (57,781 hours) with a median daily effort of 7 hours (maximum=18). Twenty-six transmitters were used and the total median life of the equipment was 412 days (minimum=22; maximum=1,057). The median following effort/animal was 71.5% (261 days/year). The tracking efficacy (location days/monitoring days x 100) was defined as the tracking system's performance index. The median annual tracking efficacy was 86.6%. The tracking system proved to be appropriate for monitoring captive-released manatees by field trackers and by the mobile tracking unit. The selection and training of people from local areas to work as field trackers was important for educating communities, and conservation efforts for the species in Brazil. However tracking with VHF tags was less effective for manatees that migrate long-distances and those that remained offshore. For these animals, we recommend using satellite-monitored Argos tags, which allow for remote tracking, reduced field effort and to help ensure the successful adaptation of individuals to the wild.

A California Sea Lion (*Zalophus californianus*) Uses a Transitive Logic Rule Across Sensory Modalities to Solve Novel Transfer Problems

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Problem solving requires that animals be able to integrate information from within and between sensory modalities to make sense of their environment. The ability to form transitive associations may help an individual to respond appropriately when presented with a novel situation. A test of associative transitivity requires an animal to follow a rule of logic such that if one has learned that 'square is related to triangle' and that 'triangle is related to circle' then one can infer that square is related to circle (if $A=B$ & $B=C$, then $A=C$). In the past, associative transitivity was demonstrated in a sea lion within the visual modality. However, since the environment is comprised of multimodal stimuli it is necessary to investigate whether transitivity can be demonstrated across the sensory modalities. The current study examined cross-modal transitivity by investigating auditory-visual relations in the same sea lion. The animal had previously learned to discriminate two classes of visual stimuli in a matching-to-sample paradigm. Next the subject was taught using food reinforcement to associate a different acoustic stimulus with one member of each visual class. Finally, the subject was tested to determine if untrained transitive relationships would emerge between each of the acoustic cues and the remaining members of each visual class. The results show that the sea lion immediately solved novel transfer problems, with new transitive relations emerging between acoustic and visual stimuli that were separately related to a common visual mediating stimulus. This is the first demonstration of cross-modal transitivity in a nonhuman. The sea lion's ability to pass a cross-modal transitivity test allows for a more complete understanding of how this cognitive ability may function in an animal's natural environment.

Angiomatosis in a New Species of Dolphin, *Delphinus capensis*, from Central California

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Angiomatosis is a disease, apparently unique to the dolphin, characterized by proliferation of small thick-walled blood vessels diffusely throughout the lungs, without inflammation, exudation or alveolar hemorrhage. Similar vascular proliferation commonly occurs in lung-associated lymph nodes, and may also be accompanied by the formation of hemangiomas in the lymph nodes and lung. Marked thickening and opacification of the visceral pleura is present in more severe forms of the disease. In severe instances of the disease there may be right ventricular hypertrophy, suggesting pulmonary hypertension, a life-shortening condition. The etiology of this disease remains undefined. Initial observations (1999) were limited to Atlantic bottlenose dolphins, *Tursiops truncatus*, in the western Gulf of Mexico, but have increased in incidence and severity over a span of a few years, reaching an incidence of 100% of mature animals. Since publication of the initial report, incidence remains high, but severity appears to be diminishing. If the apparent limitation to bottlenose dolphins in the western Gulf of Mexico is a valid finding, it has implications for etiology. However, unpublished observations (personal communications) suggest that it may occur in other dolphin species and other waters as well. We have observed lesions of angiomatosis in another species, the long beaked common dolphin *Delphinus capensis*, from the central California coast. In three observed cases, the lesions were never more than mild, but were very consistent with the disease in *T. truncatus*, including lymph node involvement. This observation confirms that angiomatosis is not limited by dolphin species or by geography.

Calculating Length Frequencies of a Crustacean Prey in Marine Mammal Diets Using Carapace Measurements

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Krill carapaces measurements have been used to reconstruct krill length frequencies in Antarctic fur seal diet. The discriminant function currently used to determine sex, and the sex-specific allometric equations for calculating total length from carapace length, were derived from South Georgia krill populations. The equations have been applied to fur seal diet studies in the South Shetlands but until now have not been validated using locally sampled krill. This study reports on a three year study validating the use of discriminant functions to determine sex of krill based on carapace length and width and independently derives sex-specific regression models for krill collected in the South Shetlands. Allometric equations derived from South Georgia krill overestimated total length. Applying a discriminant function derived from mature krill in years following significant recruitment events with large proportions of immature krill resulted in significant bias towards male krill and an overestimation of krill length. We propose some standard guidelines for applying discriminant functions, allometric equations and for interpreting results.

Remote Determination of Harp Seals Sizes in the White Sea by Data of Air Surveys of 2003-2004

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Application of the modern digital photo cameras during the air surveys of harp seals gives an opportunity to determine remotely their sizes.

It is possible to obtain during one day several hundreds of photographs of seals to determine their sizes and to investigate large areas of their distribution. Thus, it is possible to obtain some biological characteristics of the population (a structure of the size-age and sex composition). A method of measurement and results of the remote determination of harp seal sizes by materials of the air surveys on the breeding and moulting grounds in the White Sea in 2003-2004 are presented in the given paper. Air surveys were carried out from the board of the aircraft-laboratory AN-26 "Arktika", where a digital photo camera NIKON D1X was installed. Photo survey was carried out at the altitude of 150-200 m with the focus distance of the objective 35 and 85 mm. The obtained photos were input into the aircraft computer for the subsequent office studies. By data of measurements, tables and graphs of harp seals distribution by sizes were obtained. The graphs present a size structure of harp seal sampling on the whelping and moulting grounds in the White Sea; pups and adult animals are prominent. Total range of seals' sizes is from 80 to 200 cm; mean sizes of pups on the whelping grounds are 100-110 cm, those of adults – 165-175 cm. An absolute error in determination of the body length constituted for seal pups 10-15 cm and that for adults – 15-20 cm. Methods of remote determination of the body sizes of seals widen the possibilities of both the air survey and the biological analysis of the harp seal population.

Proximity to the Edge of the Continental Shelf is Unrelated to Prey Composition in a Benthically Foraging Otariid, The Female Australian Fur Seal

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The Australian fur seal (*Arctocephalus pusillus doriferus*) is a temperate latitude species with a breeding distribution restricted to Bass Strait, between the south-eastern tip of the Australian mainland and Tasmania. Recent studies of the foraging behaviour of female Australian fur seals indicate that they begin diving soon after leaving the colony, dive throughout the foraging trip at all times of the day or night with no bout structure, and feed demersally in the shallow continental shelf waters of Bass Strait. This foraging behaviour is in stark contrast to that of other female Arctocephaline (Southern Hemisphere fur seals) species and akin to that observed in sea lions. These studies, however, were conducted at one colony (Kangaroo Island) located in central northern Bass Strait and it was suggested that the observed foraging behaviour may be due to the distance of this colony from the continental shelf-edge (180 km) making it inefficient to forage beyond it. The diet of lactating Australian fur seals was compared between two colonies to test if differing proximity to the continental shelf edge resulted in differences in foraging behaviour. The two breeding colonies studied, Kangaroo Island and The Skerries, were 180 km and 25 km from the nearest shelf edge, respectively. We analysed a total of 917 scat samples collected at the two colonies between 1997 and 2001. From faecal analysis 45 primarily demersal on-shelf species of fish and cephalopod were identified. Only four species had a frequency of occurrence greater than 10%, redbait (*Emmelichthys nitidius*), jack mackerel (*Trachurus* spp.), red rock cod (*Psuedophycus bachus*), Gould's squid (*Nototodarus gouldi*). No seasonal, annual or spatial differences were found between the two colonies indicating that proximity to the shelf edge does not influence diet.

Non-Invasive Monitoring of Testosterone in an Endangered Species, the Steller Sea Lion (*Eumetopias jubatus*)

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Inherent difficulties exist in obtaining blood samples for hormonal

analysis from large free-ranging marine mammals. The use of feces as a medium offers a unique opportunity to provide an approximation of an animal's circulating concentration of hormones through non-invasive methods. In this study, an adult captive male Steller sea lion housed under ambient conditions at the Alaska SeaLife Center (Seward, AK) was monitored for both fecal and serum testosterone concentrations from May 2002 to June 2003. The objective of the investigation was to determine if the use of feces was applicable to monitoring testosterone for Steller sea lions (*Eumetopias jubatus*). A commercially available radioimmunoassay was validated for fecal testosterone in this species. Serum testosterone concentrations ranged from 0.07-1.74 ng/ml. Fecal testosterone values ranged from undetectable levels to 80.2 ng/g dry weight. Changes in serum testosterone were closely tracked by fecal testosterone, exhibiting a similar temporal trend in concentration patterns. In addition, fecal samples collected from the male Steller sea lion from November 2001 to January 2005 were analyzed. Samples were divided into seasons by the breeding (March to August) and non-breeding (September to March) seasons of the free-ranging population. Despite the captive state of the animal, fecal concentrations were significantly higher during the breeding season than non-breeding season ($P=0.02$). These data support the use of feces as a reliable medium for non-invasive monitoring of testosterone for this endangered species. This method eliminates handling stress and allows for a viable alternative in sample collection when serum may not be possible to obtain.

Persistent Organic Pollutants in Bottlenose Dolphins (*Tursiops truncatus*) in Biscayne Bay, FL

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Biscayne Bay, FL is a shallow, subtropical embayment surrounded by the Miami metropolitan area to the north and connecting to Florida Bay to the south. While various studies have determined contaminant concentrations in water and/or sediments, few have done so in tissues of organisms from Biscayne Bay. Bottlenose dolphins (*Tursiops truncatus*) are long-term residents in Biscayne Bay and are apex predators in this estuary. They are therefore vulnerable to bioaccumulation of persistent organic pollutants (POPs). Remote biopsy samples were collected from 46 individual dolphins in the bay, with 35 individuals matched to the NOAA Biscayne Bay photo-identification catalogue. Blubber samples were analyzed by gas chromatography/mass spectrometry for 68 polychlorinated biphenyl (PCB) congeners, six polybrominated diphenyl ether (PBDE) congeners, and organochlorine pesticides including DDT and metabolites, chlordanes, dieldrin, and mirex. Sex was determined from skin samples using molecular techniques. Age class was assigned to known individuals based on sighting histories. POP concentrations (wet weight basis) were significantly higher in adult males and juveniles relative to adult females ($t = 4.37$, $p < 0.05$). In males and juveniles, the Σ PCBs were present in the highest concentrations [19,200 ng/g (35,000 ng/g)]; [geometric mean (1 SD)] followed by the Σ DDT's [2910 ng/g (2030 ng/g)], Σ chlordanes [1040 ng/g (1460 ng/g)], Σ PBDE's [375 ng/g (460 ng/g)], and other pesticides. Preliminary data analyses indicate variance in POP concentrations between samples is largely explained by geographic location within Biscayne Bay. Animals with sighting histories primarily in the northern, more developed area appear to have higher POP concentrations than animals with sighting histories in the southern, less developed area. Differences in POP concentrations exist on a small geographic scale and likely indicate differences in habitat use and forage base POP concentrations.

Blue Whale (*Balaenoptera musculus*) Acoustic Results from the 2003-2004 International Whaling Commission-Southern Ocean Whale and Ecosystem Research

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From 19 December 2003 to 8 March 2004, the International Whaling Commission conducted acoustic and visual surveys in area V. In January and February 2004, the research vessel Shonan Maru was in the Ross Sea in heavy ice, but with Antarctic-type blue whales present, allowing the opportunity to make long term recordings. Recordings were made at night using DiFAR sonobuoys and data were recorded to hard drive in hour-long files. Over 8500 blue whale calls were recorded in 48 h of the 60 h of recordings. Both the diagnostic 28-Hz Antarctic-type calls and frequency-modulated downsweeps were recorded. As in Rankin *et al.* (2005), long sequences of 28-Hz calls were not recorded, rather sporadic calls from different animals (based on relative loudness) were observed and FM downsweeps were the most common calls (5,000 or 59%). A comparison of two days one month apart reveal interesting differences in the relative abundance and proportions of call types. During 9.5 hours of recording on 19 January, 710 total calls were recorded of which only 20% were 28-Hz calls. From 10 hours on 17 February, almost four times as many calls were recorded (2559 total) and 38% of these were 28-Hz calls. Additionally, the number of calls/hour increased from 74.7 to 255.9. Although most published studies have addressed the low-frequency stereotyped calls of blue whales, more attention is being paid to the higher frequency, FM downsweeps that have been documented for blue whales in different geographic areas. These calls appear to be more variable in frequency and duration among different individuals and, based on the temporal change in relative proportion, probably serve a different purpose. Longer term recordings are necessary to determine if this pattern holds over time and the Ross Sea has been shown to be a locale where blue whales may be reliably recorded.

**Transient Killer Whales in Hood Canal – The Sequel:
Ramifications of a Second Extended Foraging Event by
Mammal-Eating Killer Whales on a Population of Harbor
Seals in Washington State, USA**

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Harbor seals in Hood Canal, Washington have been subjected to two distinct extended foraging events by mammal-eating killer whales in the past three years. Eleven killer whales were present for an unprecedented sixty days from 2 January – 3 March, 2003. On 24 January, 2005, six different mammal-eating killer whales arrived in Hood Canal and have remained there for >150 consecutive days. The individuals present in 2005 include two adult females and four of their offspring and, like the whales in 2003, are considered part of the West Coast Transient population of killer whales. A Monte-Carlo simulation of killer whale consumption, based on bio-energetic models, was conducted to understand the potential impact of the extended foraging events on the seal population. The estimated median output for 2005 is 835 seals consumed (2.5% = 593, 97.5% = 1204) after 150 days. This compares with a median output of 997 seals consumed (2.5% = 708, 97.5% = 1435) by the whales in 2003. In both instances, the predicted consumption represents greater than 80% of the estimated pre-whale harbor seal population. Yet, subsequent aerial surveys and ground counts have not exhibited a noticeable decline. We have conducted boat based observations (n > 10) of the whales in 2005 to determine a total estimated seal consumption to validate the results of the bio-energetic models. Comparison of final seal consumption estimates based on bio-energetic models and those estimated from observed predation rates in 2005 suggests a similar

outcome. The discrepancy between predicted consumption and observed population changes may be attributed to changes in seal haul out behavior. The extended foraging events in Hood Canal have provided unique insight into the behavior of mammal-eating killer whales and their potential impacts on pinniped populations, an issue that remains critical in the management and conservation of the North Pacific.

**A Comparison of the Population Dynamics of Two Harbour
Seal (*Phoca vitulina*) Populations in the North Sea**

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The rapid growth of the harbour seal populations in the North Sea were dramatically interrupted by the 1988 and 2002 phocine distemper epidemics. Rates of population increase and intensity of epidemic mortality varied between areas and over time. Data from aerial surveys of the Wadden Sea (Netherlands, Germany and Denmark) and The Wash (England) are used to investigate these differences, and to assess the relative importance of stochastic inter-annual variation in growth rates and uncertainty in the observation process. Traditional, frequentist, regression models and Bayesian alternatives that explicitly account for the two sources of error are compared. The two sets of models produce consistent results, highlight the significance of the observed differences and emphasise the importance of including "observation error" in such models. Populations in both regions grew throughout the study period (1970-2004). Between epidemics the growth rates (1989-2002) in both areas were approximately double the pre-epidemic rates and growth rates in the Wadden Sea were approximately double those of the Wash in both pre and post-epidemic periods. Populations in both regions fell by approximately 50% in the 1988 epidemic, but in the 2002 epidemic the decline in the Wash population was less severe, declining by 18% while in the Wadden Sea the decline was similar to the 1988 event. Models of population growth in the two areas were linked to allow for animal movement, and the plausible strength of the connection between the areas assessed under various assumptions. The results are discussed, and both their implications and the limitations of this approach are considered.

**Preliminary Analysis of Genetic Structure of Humpback
Whales (*Megaptera novaeangliae*) from Antarctic
Feeding Areas I, II, and III**

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In the Southern Hemisphere, humpback whales feed in circumpolar waters around Antarctica, where feeding grounds remain poorly defined along six longitudinal geographic Areas (I-VI) traditionally recognized from historical whaling data. Despite evidence of occasional interchange between feeding Areas, there are few data to determine the extent and significance of these events. The relationships and genetic structure of Antarctic feeding grounds remain mostly

uncharacterized in these regions. In this study, we present preliminary results of an analysis of nuclear genetic markers conducted on samples from feeding aggregations distributed throughout three Antarctic IWC feeding Areas (I, II, and III). A total of 91 individual whales were sexed, and genotyped at ten microsatellite loci. For all sites, the sex ratio of collected samples was biased toward females, possibly due to sampling effects. However, this bias was particularly high around South Shetland Islands (20:3). Genetic variability was similar to the observed on Southern Hemisphere breeding grounds ($H_e = 0.74$). An analysis of molecular variance (AMOVA) using Fst showed that most of the genetic variation was attributed to differences within sites. Small but significant differentiation was found among different clusters of sampling sites that only partially correspond to IWC divisions. Given the limitations on the quantity of analyzed data, the results presented here are not conclusive, but represent a first step toward evaluating the boundaries of current humpback whale feeding Areas in the Southern Hemisphere.

Novel Collaborations and Techniques Used to Rescue and Rehabilitate Two Melonheaded Whales (*Peponocephala electra*)

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In August 2003, the Hawaiian Islands Stranding Response Group (HISRG), the Hawai'i Institute of Marine Biology (HIMB) and the U.S. Marine Corps Base Hawai'i (MCBH) rescued two adult male melonheaded whales (*Peponocephala electra*) on the northeastern shore of Oahu, Hawai'i. The animals were placed in a temporary holding pool for assessment and stabilization at the HIMB facility on MCBH. Under the direction of the veterinary staff and husbandry personnel, volunteers provided continuous supervision and care. During the rehabilitation, both animals swam in a counter clockwise direction; remaining on their right side while keeping their left side at the surface of the water. Persistent efforts to right the animals were unsuccessful. The first whale, apparently the older of the two, was euthanized after five days due to several 'syncopy' like events and severe tachycardia. Gross necropsy and histology revealed right sided heart failure as well as slight scoliosis associated with irregular body posturing. The increasingly apparent scoliosis of the second whale led to treatments of chiropractic manipulation as well as various efforts during feeding to alter its body position. An increase in mobility during feeding and relaxation of concave paraspinal muscles was observed post treatment. The second animal was euthanized 29 days after stranding due to intractable pancreatitis. Behavioral observations and novel approaches used in the rehabilitation of these animals may facilitate responses to other strandings of this species. This stranding also provides important insight into the biological status of the wild melonheaded whale population in Hawai'i. The stranding response was only possible through the unique collaborative efforts of the federal and state government agencies, the U.S. Marine Corp at MCBH, and local volunteers.

Distribution of Bottlenose Dolphins in Laguna de Términos, Campeche, México

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The bottlenose dolphin (*Tursiops truncatus*) lives in coastal and open waters from temperate and tropical oceans worldwide. In the southern Gulf of Mexico, they are found in great numbers in Laguna de Términos, a tropical coastal lagoon home to more than 2000 dolphins (about 600 annually), of which less than 100 are residents. To investigate how dolphins use this lagoon, boat surveys looking for them were made from January 2004 to July 2005 to obtain 2 surveys per season ("nortes", dry, and rainy) per year (totaling 12 surveys). Once a herd

was sighted, its position and size (number of dolphins) was recorded, resulting in a specific distribution pattern for each survey. The lagoon was divided into 3 and 12 areas of similar size to inspect for differences in these distribution patterns by survey and area as 1) presence/absence, 2) number of herds, and 3) number of dolphins. When comparing means of each distribution from 2004 no significant differences were found among surveys and areas (t , $p > 0.05$), while an analysis of variance gave significant results between "nortes" surveys for the number of animals (F , $p < 0.05$). A similarity test of the presence/absence of dolphins for 2004 showed similarities in the distribution from surveys of different seasons and between areas with always presence or always absence. A correspondence analysis for 2004 showed no clear association patterns between surveys nor areas. However, areas with fewer or no herds were further apart, while areas where animals were always sighted were grouped closer. In summary, dolphin distribution and numbers were, on average, constant during 2004, with differences between surveys and areas but not between seasons. Dolphins were found frequently in certain areas, suggesting that these habitats have certain characteristics, which need to be determined. Work supported by CONACyT-Gobierno Edo. de Campeche, PAPIIT, UNAM, and ICMYL, UNAM.

Beaufort Beluga Movement and Diet Related to Foodweb Mercury Levels

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Beaufort Beluga whales have some of the highest mercury (Hg) levels among Canadian beluga whale populations. Ultimately it is the prey that Beluga feed on that determine Hg levels; however, little is known about Beaufort Beluga habitat use, migration patterns, foraging behaviour, and diet. Here we evaluate foraging behaviour and try to determine diet to calculate Hg trophic level transfer. Two approaches are used to characterize beluga diet; i) a spatio-temporal approach to determine feeding regions and migratory paths using satellite telemetry, and ii) a bio-chemical approach to quantify seasonal diet by comparing stable isotopes and fatty acid signatures in beluga tissues with potential prey items. Together this will provide the geographical and trophic related sources of Hg uptake. For the first time an annual summary of Beaufort beluga satellite positions collected (2004-2005). Based on seasonal movement, prey items were collected from the summering grounds (Mackenzie Delta/Beaufort Sea) and wintering grounds (Bering Sea). In the summering grounds stable isotopes $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ and fatty acids were measured in biota including estuary fish species such as Pacific Herring, Arctic Cisco (*Clupea pallasii*, *Coregonus autumnalis*), the marine fish species Arctic Cod (*Boreogadus saida*), benthic invertebrate such as decapods (*Eualus gaimardii*) and zooplankton (*Calanus* spp.). Trophic levels were determined and used to calculate food web magnification factors (FWMFs) of Hg to beluga on summering grounds and will be compared with results for the wintering region. Arctic Cod Hg levels were higher than in most estuary species (e.g., Pacific Herring), which was supported by a higher trophic position. Preliminary results from fatty acid analysis show Beluga signatures are similar to Arctic Cod and some estuary species, but different from benthic invertebrates. Understanding beluga foraging behaviour, diet, and Hg sources will assist in conservation efforts in a region undergoing considerable economic development and climate warming.

Urogenital Carcinomas in California Sea Lions: Herpesvirus, Sex, Pollutants and Genes

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Urogenital cancer is endemic in the population of California sea lions (CSL) along the Pacific coast of California, accounting for about 18% of subadult and adult CSL strandings. A gamma herpesvirus, designated OthV-1, has been identified using molecular techniques in 100% of urogenital carcinomas examined in 3 separate studies. In contrast, in the most recent study, sea lion papillomavirus DNA was not detected in any urogenital cancers nor was OthV-1 DNA detected in 13 different sea lions tumors. Recent field studies demonstrated that OthV-1 DNA could be detected in prepuce swabs from 43% of wild adult male CSL, and in vaginal swabs from 22% of wild adult females, but in <1% of pharyngeal swabs from adults. It was detected in 5.8 % of pups and juveniles, and one newborn pup from a positive female. Post mortem studies confirmed the 100% detection of OthV-1 in urogenital carcinomas and localization in the urogenital tract of both males and females. Serial vaginal swabs from stranded adult females have shown that viral detection may be constant or intermittent; both onset and cessation of detection occurred during rehabilitation. Investigation of urogenital flora in male and female CSL with and without cancer revealed a statistical association between cancer in females and the presence of Beta hemolytic *Streptococcus* sp. Concurrent studies directed toward the role of contaminants showed a significant association between urogenital tumors and contaminant levels, specifically PCBs, and marginal association with DDTs. Immunogenic studies showed a positive association between urogenital cancers and the major histocompatibility complex type II gene *ZaCa DRB*. These data taken together support the concept that urogenital carcinomas in CSL are the result of complex interactions between a venereal herpesvirus, bacterial flora, and persistent organic pollutants, acting against the genetic background of the affected CSLs.

A Genetic Analysis of Coastal and Offshore Bottlenose Dolphins, *Tursiops truncatus*, off the Western United States

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Bottlenose dolphins (*Tursiops truncatus*) are found worldwide in temperate and tropical regions, often with coastal and offshore forms. In US Atlantic waters, these two ecotypes have been distinguished based on morphology, hematology, parasite load, diet, habitat, photo-identification, and in some locations, genetic analysis. Off California, a morphological and photo-identification study has been conducted on bottlenose dolphins and on that basis, there are two stocks that are managed separately: a coastal stock, estimated at about 200 individuals, and an offshore stock of 3,000 animals. Because the coastal form is exposed to many more anthropogenic risks, we examined the level of genetic differentiation between the forms. We biopsy sampled seventy-three animals from coastal (located within 1 km of the shore, n=28) and offshore dolphins (n=45). We examined both mitochondrial DNA (402 bp sequence from the control region) and five microsatellite markers. Coastal dolphins were found to have less genetic variability than the offshore dolphins at both the nuclear and mitochondrial sites. Five haplotypes were identified for 26 coastal animals (gene diversity=0.7754±0.0397), while 26 haplotypes were identified for 42 offshore animals (gene diversity=0.9628±0.0172). There were no shared haplotypes. Gene diversity for the microsatellite loci was 0.9993±0.0018 for the offshore population (n=45) and 0.9825±0.0065 for the coastal population (n=28). Significant genetic differentiation was found between the two populations for the mtDNA (Φ_{ST} =0.2531, p<0.005) and microsatellite loci (F_{ST} =0.2369, p<0.005). These results indicate strong differentiation that is consistent with long-term separation. This reinforces the decision to manage these groups separately and to closely monitor the small coastal population,

which is subject to threats of human encroachment and pollution.

ABR Study on the Potential Impact of Offshore Wind Turbine Related Sound on the Sound Detection of Harbour Porpoises in the North Sea

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An auditory study has been conducted on a harbour porpoise at the Dolfinarium Harderwijk, The Netherlands. The aim of the study was to assess the potential masking effect of operational sounds of offshore wind turbines on the perception of important signals by the animal, especially potential communication signals of harbour porpoises. The measurement of ABR's was chosen as method for achieving the data. A male harbour porpoise was trained to participate in the study, which involved an active participation of the animal. Due to its dimensions and material the research pool provided a difficult acoustic situation for conducting the study. ABR's were evoked with two types of acoustic stimuli, click type signals and amplitude-modulated signals. The masking noise resembling the underwater sound emissions of an operational wind turbine was simulated. At first the animal's hearing threshold was measured at frequencies between 0.7 and 16 kHz. Subsequently these measurements were repeated at frequencies between 0.7 and 2.8 kHz in the presence of two different levels of masking noise. Absolute hearing thresholds were established for frequencies between 2 and 5.6 kHz whereas at 8 kHz and above the resulting data are likely to represent masking threshold information. The resulting data show a masking effect of the simulated wind turbine sound at a level of 128 dB re 1µPa at 0.7, 1 and 2 kHz. This masking effect varied between 4.8 and 7.3 dB at those frequencies. No significant masking was measured at a masking level of ~115 dB re 1µPa. The available data indicate that the potential masking effect would be limited to short ranges in the open sea, but limitations exist to this conclusions and all estimates are based on existing turbine types, not taking into account future developments of larger and potentially noisier turbine types.

Estimating Unregulated Takes of North Pacific Minke Whales from Surveys of Japanese Markets

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We investigated the temporal and geographic distribution of North Pacific minke whale products purchased on Japanese markets from 1998 to 2004. A sample of 232 NP minke whale products, identified to species by analysis of variation in mtDNA, was reduced to 188 unique market individuals by additional analysis of microsatellite genotypes and sex. Market individuals were classified into one of four mtDNA haplogroups, one of which is characteristic of the O stock (O-type) targeted by the Japanese scientific hunt, and three of which are characteristic of the depleted J stock (J-type) thought to be confined to the East Sea/Sea of Japan. The overall proportion of J-type individuals was higher than expected, representing 44% of all market individuals. Contrary to expectation, we found no significant change in this proportion after the 2001 change in regulations controlling the sale of by-catch in Japan, despite a four- to five-fold increase in the reported bycatch, compared with a two-fold increase in the scientific catch, since that time. We conducted mixed-stock analysis and logistic regressions (using a catmod procedure) of market individuals using haplogroup frequencies reported for the JARPN

program ($n = 368$ for 1994-98) to represent the *O* stock, and haplogroup frequencies for Korean market individuals ($n = 187$ for 1999-2004) to represent the *J* stock. The mixed-stock maximum likelihood estimate of 45.5% (SE = 4.3%) for the *J* stock proportion, and the known scientific take of 740 individuals from the *O* stock from 1997 to 2003, were used to calculate a minimum total take of 616 *J*-type minke whales over this period. This was significantly higher than the reported bycatch of 441 minke whales for the same period. The evidence for a large number of unreported takes suggests that the commercial sale of 'bycatch' could be acting as a cover for illegal hunting or intentional 'net whaling'.

Ontogenetic Changes in Body Size and Shape of Antarctic and Subantarctic Fur Seals: Constraints Imposed by Lactation Duration?

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Pre- and postweaning functional demands on body size and shape of animals are often in conflict, especially in species where weaning involves a change of habitat. The rate and magnitude of morphological changes that offspring undergo to adjust to those changing demands can help elucidate trade-offs involved. Lactation imposes limits on the time available for making such changes. All other factors being equal, short lactations are expected to be associated with faster rates of development and attainment of adult traits than long lactations. We present the growth pattern and allometry of two closely related fur seal species with large differences in lactation duration, at Crozet Islands, a sympatric site. Longitudinal measurements were collected from Antarctic (*Arctocephalus gazella*) (120d lactation) and Subantarctic (*A. tropicalis*) (300d lactation) fur seals during lactation. Neonate body mass was not different among the two species, but standard length and flipper size were larger in *A. gazella*. Rates of growth in standard length, and flipper dimensions were higher in *A. gazella* than in *A. tropicalis* pups, which show a higher rate of growth in girth. The scaling of flipper span squared on flipper surface area showed more similarities between female pups and adults among *A. gazella* than among *A. tropicalis*. The scaling of the position of foreflippers along the body with standard length showed a similar trend, suggesting that *A. gazella* pups acquire adult body shape faster than *A. tropicalis*. Our results indicate that preweaning growth involves significant changes in body shape of fur seal pups, involving the acquisition of a long, slender body with relatively large flippers in *A. gazella* vs. a stockier body with shorter flippers in *A. tropicalis*. We suggest that the two growth patterns reflect the constraints imposed by an early, compared to a late, transition to an aquatic mode of life.

Association Between Behavior and Sleep in Bottlenose Dolphins

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Previously electroencephalogram (EEG) was recorded in dolphins using traditional tethered equipment. In this study we employed a digital recorder to register EEG in dolphins freely swimming in spacious pools to avoid the restraint imposed by recording cables. The aim of this study was to examine the association between behavior and sleep in Black Sea bottlenose dolphins. EEG was successfully recorded for 4 and 6 continuous days in dolphin 1 and 2, respectively, and synchronized with videos. In both dolphins, episodes of unihemispheric sleep ranged from 26-98 min, alternated between two hemispheres, and were evenly distributed across the 24-h period. In dolphin 1, 85%

of sleep was recorded during floating at the surface and was accompanied by nearly continuous paddle movements of the pectoral fins and tail fluke. The remaining sleep occurred during slow circular swimming. On the other hand, episodes of floating at the surface in dolphin 1 equally represented waking and sleep (56 and 44% of the floating time, respectively) while 87% of circular swimming was indicative of waking. In contrast to dolphin 1, 90% of sleep in dolphin 2 occurred during slow circular swimming and only 6% while floating. In dolphin 2 87% of floating and 70% of swimming episodes represented waking. For the first time, we documented unihemispheric sleep in a dolphin while quietly lying on the bottom of a pool. Sleep on the bottom comprised 4% of the total sleep time in dolphin 2. These episodes lasted 150-212 sec and were interrupted by arousals when the dolphin surfaced to breathe. The data collected here using a portable recorder indicate 1) considerable plasticity of sleep behavior in dolphins, particularly their ability to sleep while swimming, floating on the surface and lying on the bottom, and 2) the absence of strict correlation between behavior and sleep.

The Use of Mini-Loggers, Small, Archival, Pressure Tags, To Profile and Thus Better Understand the Dynamic Nature of Fixed-Fishing Gear as it Pertains to Entanglement Threat: A New Tool to Assess Entanglement Risk of Large Whales in Fixed-Fishing Gear

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Suspended fishing gear poses a potential threat of entanglement to large whales. To quantify the threat we need to know how whales use the water column, and where the gear lies with respect to whales. Many researchers use tags to track the whale's use of the water column. Here we use Star-Oddi mini-loggers, small, neutrally-buoyant pressure sensors, in a novel approach to tag fixed-fishing gear. By tagging gear we quantitatively profile the entanglement threat it may pose. Loggers have the distinct advantage because they profile gear over time, thus providing a better understanding of the dynamic nature of gear, and the effect of tides, currents, and surface influences on line height and entanglement risk. This approach is logistically simple, not constrained by limited visibility, increased pressure, strong currents, and weather. They allow for greater coverage of different line types, gear configurations, and sets. Lastly, loggers are cost effective compared to other means of gear profiling. A set of loggers, which can be used for years, costs half that of a Remotely Operated Vehicle used for one day. Using loggers we have profiled buoyline, and groundlines (line that connects a series of traps). Over 500 days of logging, 58 different sets, covering 20 gear configurations, by 12 fishermen, have been accomplished. Groundline profiling of inshore lobster gear indicates that floating groundlines arc as much as 20 feet off the bottom, but average 8 feet. Offshore lobster gear groundline arcs as high as 40 feet and averages 17 feet. By animating line profiles over several tidal cycles, we have successfully demonstrated to fishermen, conservationists, and researchers that there exists a great deal of variation in fixed-gear profiles due to different configurations, environmental conditions, and how the gear is set. All these factors need to be considered when estimating entanglement threat of fixed-gear.

Pattern Swimming in Walrus in an Aquarium Setting: Evidence for Micro-Territories?

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Recently there has been a great deal of attention paid to stereotypic behaviors of animals in captive settings. A frequent assumption is that patterned swims are chronic stereotypic behavior patterns that are hard to disrupt. A social group of four mature Pacific Walruses

(*Odobenus rosmarus divergens*), 3 females and 1 male, housed at the New York Aquarium at Coney Island was observed for 3 hours/week for 6 weeks before, after, and between feeds and their swim patterns were observed. Walrus used particular straight swims "paths" ($\chi^2(4,971, 18) = 2900, p < .0001$) and of the six preferred paths, each was preferred by one walrus and avoided by another. A lag-sequential analysis of path use indicated clear "routes" for each walrus (all routes reported $p < 0.001$). Only the male walrus shared his preferred routes, sharing one preferred route with one female and one with another. The establishment of these individualized routes or "micro-territories" may be interpreted as an efficient use of space by the animals or as stereotypic swim patterns. A separate but related study tested whether non-food object enrichment would affect the walrus' general behavior and their preferred routes. The walrus were observed between feeds for 15 minutes per day for 20 days in the presence of 4 enrichment objects or in the absence of any objects. Results showed that enrichment affected the general behavior and disrupted the swim routes of the walrus even when there was little or no direct object interaction (Loglinear analysis, adjusted residuals for all reported behaviors $> 2.0, p < .05$). These findings, when considered jointly, suggest that the pattern swims in these walrus should not be considered a chronic stereotypy, but rather either an acute stereotypy or a mechanism to efficiently manage continuous movement within an enclosed space.

Antibiotic Resistant *Escherichia coli* Found in Florida and South Carolina Wild Bottlenose Dolphins

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The widespread use of antibiotics in humans, pets and agriculture continues to generate much discussion about the effects of antibiotic use on the development of multi-drug resistant bacteria. A large majority of administered antibiotics are excreted unchanged, and ultimately deposited into the aquatic environment. Most antibiotics tested have been shown to be persistent, with low rates of biodegradation and high sorption rates to sediment. In addition to antibiotics themselves, resistant bacteria pass through sewage treatment plants and other non-point sources into the marine ecosystem and readily transfer resistance genes, thus creating the potential for establishment of resistant bacteria within aquatic wildlife. The current study assessed the prevalence of antibiotic resistant gastrointestinal *Escherichia coli* in wild bottlenose dolphins (*Tursiops truncatus*) from the Indian River Lagoon (IRL), Florida, and Charleston Harbor area (CHS), South Carolina. As part of a larger health assessment, rectal swabs were collected with Amies culturettes from dolphins in the summers of 2003 and 2004. *E. coli* isolates (15-20 per animal) were cultured on selective media and evaluated for resistance to 25 antibiotics using Dade-Behring Microscan custom panels. In 2003, 133 of the 716 *E. coli* isolates were resistant to one or more antibiotics. The most common antibiotics to which bacteria were resistant were Ampicillin, Amoxicillin, Penicillin, Cephalothin, Cefoxitin, Erythromycin, Trimethoprim, Sulfathiazole, and Oxytetracycline. The number of antibiotics an isolate was resistant to ranged from 1 to 11 (average = 3.7). For animals sampled in 2003, significant differences ($G_{adj} = 7.43, p < 0.01$) were observed in the percent of animals harboring *E. coli* resistant to one or more antibiotics between IRL (20%, n=15) and CHS (65%, n=23). These results warrant further investigation to better understand environmental pathways by which aquatic mammals acquire resistant bacteria, genetic mechanisms of resistance, and potential health implications on hosts, ecosystems and humans.

Spatial and Temporal Modeling of North Atlantic Right Whale – Ship Encounter Probabilities to Advance Vessel Traffic Management

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The risk of an interaction between a North Atlantic right whale (*Eubalaena glacialis*) and a commercial ship is asymmetric; the small population of right whales and large number of ships makes the risk several orders of magnitude greater for a whale than a ship. Researchers have dedicated a significant amount of effort to understanding right whale distribution; much less is known regarding vessel traffic. This is a critical gap given that ship strikes are the leading anthropogenic cause of known right whale mortality. Through NOAA and Canadian funding, we are engaging in cross-border collaboration to develop statistical and GIS models to quantify the probability of an interaction between a right whale and a vessel along the North American Atlantic coast spatially (at approximately 10 nmile resolution), temporally, and by vessel characteristics. We employ data from the Right Whale Consortium database and ship position data using a combination of spatial datasets (ICOADs and ECAREG), port arrival and departure data, and the Lloyds ship database. For illustrative purposes, we use several spatial and temporal vessel-related variables with right whale sightings and sightings/unit effort data to model probabilities in a region defined by 40-45° N and 75-60° W where right whale deaths from ship collisions are known to be highest, presumably due to relatively high right whale seasonal abundance and concentrated ship traffic near key ports. The results are used to identify areas and probabilities of interaction and to highlight how such information could be used to create practical vessel management solutions that reduce the likelihood of ship strikes, by NOAA in support of the Advanced Notice of Proposed Rulemaking (2004), and in similar Canadian initiatives relevant to the Species at Risk Act and North Atlantic Right Whale Recovery Plan due in 2007.

Stable Isotope Analysis Utilized to Create Multi-Annual Records of Right Whale Migration Patterns

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Although the seasonal habitat use of North Atlantic right whales (*Eubalaena glacialis*) is well described, there is evidence suggesting areas outside of known habitats under dynamic management are important to the species. We used carbon, nitrogen, oxygen, and hydrogen stable isotope analysis of right whale baleen from fifteen individuals and zooplankton collected in five feeding habitats to generate a continuous multi-year record of right whale movement patterns. Since animals incorporate the isotopic signature of both their food source and the ambient environment into their tissues, analyzing a metabolically inactive tissue such as baleen provides a long-term history of foraging and habitat use. In concordance with Schell *et al.* (1989), Best and Schell (1996) and Wetmore (2001), we demonstrate that the oscillations of baleen carbon and nitrogen isotope signatures reflect a whale's movement through isotopically distinct foraging areas. Using right whale sighting records and habitat-specific zooplankton isotope data, we were able to determine the isotope signature of baleen formed in major feeding areas, with each region having a unique multi-isotope tag. Plankton from southern offshore areas such as the Great South Channel are enriched in carbon (-19‰) and depleted in nitrogen (6.2‰) relative to northern habitats such as the lower Bay of Fundy which is more depleted in carbon (-21.5‰) and enriched in nitrogen (8.2‰). Baleen formed in these areas is predictably enriched 1‰ (carbon) and 3‰ (nitrogen) relative to zooplankton prey. Our results demonstrate the high resolution that stable isotope data afford when used to track right whales through space and time. Further investigation of zooplankton and right whale baleen with stable isotope analysis could allow us to determine right whale occurrence outside of currently recognized habitat areas.

Recovery of Seagrass Beds Grazed by Dugongs

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At Chambery, Manapla in the Central Philippines, where the seagrass bed supports a possibly isolated population of dugongs, grazing tracks were monitored for recovery. Recovery rate was measured by obtaining biomass samples from actual grazed areas and compared to non-grazed areas. The seagrass bed is said to have recovered if the biomass obtained from the grazed area is similar to the biomass obtained from a non-grazed area. Monitoring was done every month for a minimum of four months. Dugong grazing tracks were found between 2-5 m deep. The tracks were easily recognized by their scalloped edges. They vary in size from small strips (0.5 m x 2.8 m) to very narrow (0.12 m) serpentine tracks to large oval tracks of several meters. The seagrass composition of dugong varied from monospecific, usually *Halophila ovalis*, to multispecific with *H. ovalis*, *H. minor*, *H. spinulosa*, *Halodule uninervis* and *Syringodium isoetifolium* and *Cymodocea serrulata* in various combinations. Our initial findings show that the recovery of a feeding track depends on its size. Narrower tracks were observed to have some growth after one month while large feeding tracks remained bald after one month. We are still on the third month of monitoring. Apart from monitoring recovery in terms of biomass, other parameters were measured to characterize the seagrass growth in grazed areas. These are rhizome diameter and length, leaf and petiole length, leaf width and number of reproductive structures.

Serological Survey of Pre-Weaned New Zealand Fur Seals (*Arctocephalus forsteri*) for Brucellosis and Leptospirosis

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AIM: To conduct a longitudinal serological survey for *Brucella* spp. and *Leptospira* spp. in pre-weaned New Zealand fur seals (*Arctocephalus forsteri*) in a colony on the Otago Peninsula. **METHODS:** Seal pups were repeatedly captured on a monthly basis from February through to July 2001. Pups were tagged at first capture and a blood sample was taken at each capture event. A total of 163 sera were collected from 118 seal pups. Where sufficient volume was collected, the sera were tested for leptospirosis using the microscopic agglutination test (MAT), and for brucellosis using the competitive enzyme-linked immunosorbent assay (ELISA) for *Brucella abortus*. **RESULTS:** None of 128 sera from 101 seals tested positive to the ELISA test for *B. abortus*. All tests for *Leptospira interrogans* serovars Grippotyphosa, Copenhageni, Bratislava and *Leptospira borgpetersenii* serovar Ballum were negative at a cut-off of <1/100 dilution. Positive or suspicious titres were found to *L. interrogans* serovars Canicola and Pomona and *L. borgpetersenii* serovar Hardjo. The highest titres (12,800) were found to serovar Pomona. The titre to serovar Pomona in one seal rose from <1/50 in March to 12,800 in April and was <1/50 when re-sampled in July. The titre to serovar Pomona in another seal dropped from 12,800 in May to <1/50 in June. These seals also had titres to serovar Hardjo, which rose or fell in the same manner. All suspicious or positive titres occurred in late April and early May, when the pups were approximately 4 - 5 months old. In June and July, all seals tested were negative. **CONCLUSIONS:** There was no serological evidence of *Brucella* in the pre-weaned fur seals at the colony. The titres to serovars Pomona, Hardjo, or Canicola suggest that a *Leptospira* sp. was present at the colony, however isolation or visualisation of the organism is required to confirm this. Care should be exercised when handling New Zealand fur seals to prevent human infection or inadvertent transfer of leptospirosis to another marine mammal species.

Investigating Tooth Mineral Composition: What Can We Infer About Phocid Life History from Cementum Growth Layer Groups?

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Tooth cementum provides an ideal long-term recording structure as it is continually deposited in annual incremental growth layer groups (GLGs), and never remodelled. Previous studies have indicated that changes in the characteristics of these GLGs could reflect reproductive events. However, these changes have yet to be quantified. This study combined the use of a scanning electron microscope (SEM) and mass spectroscopy to determine whether individual life history events could be quantified. Canines from three female grey and four female harbour seals were used, along with teeth from one male of each species. Analyses were made using a Hitachi S-4300 SEM connected to the Gatan Mono CL2 system. We recorded atomic percent by mass of carbon, phosphorus, and calcium, and investigated changes in carbon in our analyses. For the grey seals Kruskal-Wallis tests supported significant changes in percent by mass of carbon in two of the females and the male across GLGs. In addition, all individuals showed a marked increase in the amount of variability around the mean (standard deviation). These results indicate clear changes in mineral composition in all grey seals: in females this occurred between the ages of three and seven, and at age seven in the male. In harbour seals the Kruskal-Wallis tests did show that two of the females had a significant change in the mean percent by mass of carbon; in both cases this was at age four. However, there was no marked increase in variability around the mean across the GLGs. This novel approach to quantifying reproductive events using tooth GLGs could provide further insights into individual life history. However, further investigations need to be completed to examine the full range of potential factors responsible for differences in mineral composition across tooth GLGs.

Biosonar Use of Foraging Beaked Whales

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Odontocete echolocation has been studied intensively in captive specimens, but little information exists on how echolocation is used by free-ranging toothed whales to find food. To study this, we deployed ultrasound and orientation recording Dtags, sampling stereo-hydrophones at 192 kHz with 16 bit resolution, on the beaked whale species, *Z. cavirostris* and *M. densirostris*. The tagged whales emitted ultrasonic echolocation clicks at center frequencies around 45 kHz during foraging dives to depths of more than 1000 meters. Echoes from the seafloor and from prey items were recorded along with the outgoing clicks, providing the first data on how toothed whales echolocate for food and respond to incoming prey echoes in the wild. It is shown that these free ranging animals in some ways operate their sonar differently than dolphins trained to echolocate steel spheres. The beaked whales do not implement automatic gain control on the transmission side, and long, stable click intervals are not adjusted to the decreasing echo delay from incoming prey until the target is within a body length of the whale after which the click rate is increased rapidly like the buzz of echolocating bats. The whales ensoundify many more objects in the water column than they attempt to capture. Therefore, stable click production when searching for food may serve to facilitate processing of such complex, multitarget, auditory scenes in a selective foraging scheme to maximize energy returns during deep diving. The whales implement different, but stereotyped movement patterns before and during prey capture showing that prey types are re-recognized and classified on the basis of acoustic cues in the returning echoes, and that certain motor-outputs are implemented as a consequence of this information.

Can Economics Assist in the Allocation of a Marine Mammal and Turtle Take Limits Across and Within Fisheries?

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NMFS is assembling two Take Reduction Teams (TRTs) to develop plans to reduce the annual mortality of pilot whales, common dolphins, and Atlantic white-sided dolphins to below the allowed potential biological removal rate (PBR) or zero-rate mortality goal (ZMRG). Because these gear types (long-line and trawl) take sea turtles, the teams are also being asked to develop take reduction methods for loggerhead turtles. These two independent teams take animals from the same stocks; however, there is only one PBR for each stock, and both plans must jointly reduce the annual mortality of shared stocks. In addition, there are several sub-fisheries within each gear type. The question is how should PBR be allocated across and within fisheries. Economics suggests an efficient allocation would be achieved when marginal values of individual marine species are equal across fishing groups. Information on the marginal value of specific marine species to the different sub-fisheries can provide a starting point for management discussions. The ability of a fishery to bear the regulatory costs of gear restrictions and the incentive for illegal activity are, in theory, related to the marginal value of each protected species in the production of fish. The purpose of this talk is to review an economic model that may be applicable to the efficient allocation of PBR across and within fishery gear types, and to illustrate with an empirical example how this information might be of use to the Take Reduction Teams when discussing regulatory options.

GIS Modeling of Shipstrike Risk in New England Shipping Lanes

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Shipstrike is one of the most common anthropogenic causes of cetacean mortality. Finback (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), and right whales (*Eubalaena glacialis*), all endangered species, appear to have the highest incidence of hits in US Atlantic waters. However, the geographic location of a strike is rarely known or goes unreported, making protective measures difficult. Therefore, it is useful to model areas of high predicted shipstrike risk. Using data from 1978-1985 from the Cetacean and Turtle Assessment Program, we created a simple model where predicted risk is a function of relative sighting density and proximity to shipping lanes. Monthly sightings and sighting effort from pooled years were aggregated into seasons (January–March, April–June, July–September, and October–December). A sightings-per-unit-effort (SPUE) index was then calculated as whales/1000 km of effort by species per 5x5-minute cell. Northeastern US shipping lanes between Portland, Maine and Massachusetts were superimposed on SPUE data using ArcGIS (9.0). The shipping lanes and a 5-nm buffer around the lanes were weighted as having a risk 10 times and 5 times greater than the risk outside the lanes, respectively. Results varied between species, and although dependent on relative risk weighting, suggest that all three species have a high risk of shipstrike in and near the Boston lanes, particularly between April and June. During this season, finbacks and humpbacks had the highest SPUE rates directly in the shipping lanes, while the highest right whale SPUEs were east of the Boston lanes and the 5-nm buffer. A more complex model will benefit from data on actual observations of shipping traffic. Therefore, we are currently modeling shipping traffic in the Gulf of Maine using data from the Army Corps of Engineers' Waterway Network database to address this issue.

From Lekking to Territoriality: How Heat Stress, Habitat Availability and Population Density Shape the Mating System of the South American Fur Seal (*Arctocephalus australis*) at Punta San Juan, Peru

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The form and degree of polygyny in otariids is determined by female spatial and temporal distribution, both of which vary as a function of climate, topography and population density at the breeding colonies. We studied the reproductive behavior of S.A. fur seals (FS) at Punta San Juan (PSJ, 15°22' S) during the 1990-1994, 1997 and 2004 seasons and were able to correlate changes in mating patterns with changes in beach topography and breeding densities. FSs at PSJ suffer heat stress, requiring females to move their pups near tide pools daily during the peak of heat and males to defend territories around these tide pools. Through 1990-94, under high density conditions, pupping and mating were spatially segregated. Females pupped in safer (*i.e.*, away from other aggressive, heat-stressed females) dry areas, while males clustered in small territories in the intertidal areas regularly visited by females for thermoregulation and where most mating occurred. The system closely resembled a lek, although the "arena" contained resources used by females. The 1997/98 ENSO caused a considerable reduction in FS at PSJ, and an earthquake lifted the beach in 1996 enlarging the intertidal area. Following this, many females still pupped in dry areas, but remained longer around the intertidal zone and males defended larger territories. From 1998-2003, the study beach was abandoned. In 2004 when fur seals again returned, at significantly lower densities, females remained in the intertidal zone through the day, the few males present defended larger territories, and all pupping and mating took place in the same areas. The mating system now resembles typical otariid resource defense territoriality. The observed changes in mating behavior followed mating system theory in accordance with changes in location of pupping sites and movements resulting from changes in beach structure and breeding densities following natural environmental events.

A Multi-Stakeholder Process to Develop Whale Watching Regulations for Churchill, Manitoba, Canada

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Fisheries and Oceans Canada (DFO) is proposing to amend the current Marine Mammal Regulations in the near future to include marine mammal viewing. Public consultations regarding suggested amendments are in progress. On a national scale, the proposal suggests broad regulations designed to guide marine mammal viewing activities common to all regions. On a regional scale, the proposal could include unique guidelines for areas and species that deserve special consideration. In Churchill, Manitoba, located at the mouth of the Churchill River on Hudson Bay, a summering population of beluga whales (*Delphinapterus leucas*) is the subject of whale-watching activities. Commercial viewing platforms include one main vessel, several other inconsistent vessels, two kayaking outfits, and limited snorkeling from small zodiacs. Whale-watching is conducted within the estuary, often in shallow waters, and belugas consistently approach all types of vessels. There is currently no set of voluntary guidelines. Information was collected in 2004 and 2005 to facilitate a multi-stakeholder approach to developing recommendations for whale-watching activities in Churchill. Our methods included: (1) community consultations, (2) discussions with local whale-watch operators, and (3) research on the behaviour of whales in the presence of all three

types of viewing platforms. Beluga behaviour in proximity to whale-watching vessels was recorded from the flying bridge of the largest whale-watching vessel, as it provided the highest vantage point, including shoreline, and provided safety from polar bears. We recorded group behaviour, dive times, and distance from the vessel in question, using a laser range finder. Our recommendations for whale-watching activities for the Churchill River estuary include decreasing vessel speed in shallower waters, traveling in straight lines with whales in close proximity, establishing travel routes, and separation of vessels.

Development of a Dolphin cDNA Microarray

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The Atlantic bottlenose dolphin (*Tursiops truncatus*) has been proposed as a sentinel species for the health of the marine environment. Dolphins, as top predators, are sensitive to the biointensification effects of marine toxins, pollutants and infectious disease agents. The aim of this project is to generate molecular tools to assess the health of wild dolphins, thereby indicating the status of the local marine environment and providing information for marine resources management. Random Expressed Sequence Tag (EST) clones have been isolated and sequenced from dolphin Peripheral Blood Leukocyte (PBL) cDNA libraries. Two cDNA libraries from known health status dolphin PBL have been generated including an IL-2 and an LPS-stimulated cDNA library, respectively biased towards T and B-cell gene expression. From the two cDNA-libraries 24,000 ESTs were collected and a total of 2200 unigenes have been sequenced and annotated (www.marinegenomics.org). Moreover, genes known to be important in the innate and adaptive immune responses of terrestrial mammals and in responses to stress and contaminant exposure have been targeted for cloning using PCR-based techniques. A total of 62 dolphin genes of known stress or immune function have been cloned by targeted PCR. The 2200 unigenes from the EST collection and the 62 immune-function targeted genes, together with other genes randomly selected without sequencing from the cDNA libraries, have been amplified and used to construct a cDNA microarray representing 3700 dolphin genes in duplicate for a total of 7400. The first set of microarray data were obtained using captive dolphin PBL RNA as probe. Results show the reproducibility of the hybridization. The slide/slide variability and the experimental variability have been validated as well. The cDNA dolphin array will be used to analyze PBL RNA from captive and wild dolphins of known health status with the aim to optimize the cDNA microarray as a sensitive and informative tool for dolphin health assessment. This work was supported by awards from the Office of Naval Research (#N00014-02-1-0386) and from NOAA (contract #WC133C04CN0012). Studies on wild dolphins were conducted under Scientific Research Permit # 998-1678-00 from the National Marine Fisheries Service.

A Comparison of the Predictive Abilities of Four Approaches for Modelling the Distribution of Cetaceans

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Accurate absence data for cetaceans are not always available, for logistical (high cost of dedicated surveys at sea) and ecological reasons (cetaceans spend most of their time underwater remaining undetectable to visual observers on the surface). This can limit the application of presence-absence modelling techniques, such as generalised linear modelling (GLM), to cetacean datasets. Recently developed techniques

for analysing presence-only data avoid these limitations and permit the analysis of data from a wider range of sources (e.g., non-effort corrected surveys, public sightings databases, etc.). This study compared the ability of GLM with three presence-only techniques (PCA, ENFA and GARP) to predict the occurrence of harbour porpoises on the west coast of Scotland in relation to ecogeographic variables. Data were collected during dedicated surveys using passenger ferries as research platforms. Two-thirds of the dataset was used to construct models of harbour porpoise occurrence and the remaining third was used to test and compare the model predictions using Receiver Operating Characteristic (ROC) plots, where the area-under-curve (AUC) indicated predictive ability. Results indicated that all four techniques produced models with significantly greater predictive abilities than a random model, and the presence-only models had similar predictive abilities to the GLM, suggesting that presence-only approaches may successfully be applied to predict the occurrence of cetaceans. Limitations between the different techniques were apparent when spatial predictions of distribution were compared visually; for example GLM predicted presence over a noticeably smaller area than the three presence-only models. Interestingly, combining the predictions of all four techniques provided the most representative picture of harbour porpoise occurrence within the study area. Such a combined modelling approach may provide the best understanding of actual species distribution since the limitations of any individual technique can be compensated for by the strengths of another.

The Usefulness of Remote-Operated Video Cameras for Long-term Tracking of Individual Steller Sea Lions

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Remote-operated video cameras were used to study Steller sea lions (*Eumetopias jubatus*) on a rookery in the northern Gulf of Alaska from 1999 – 2004. This technology allowed real-time observations on a year-round basis without disturbance to the animals or impairment by extreme weather conditions. Cameras, equipped with pan/tilt, zoom, windshield washer/wiper functions, were controlled from the convenience of the laboratory. During this study, we tracked 61 individual females and 18 breeding males using natural markings for a minimum of two years. The investigation monitored daily, seasonal, and annual population changes, maternal care, reproductive performance, breeding male behavior and intra- and inter-seasonal tenure, pup production and mortality. Average summer abundance of age 1+ sea lions ranged from 71 to 92; while pup production rose from 54 in 2001 to 80 in 2004. Measures of maternal care included long perinatal periods (average = 10.7 ± 0.2 [SE] days) and short summer foraging trips (average = 16.5 ± 0.6 hrs), suggesting that sea lions at this rookery had no difficulty finding sufficient food. Reproductive rates, estimated from identifiable females giving birth in successive years on the rookery, were higher (average = $82.5\% \pm 2.8\%$) than those reported in the 1970s and 1980s. Pup mortality during the first two months of life averaged $17.1\% (\pm 4.4\%)$ and its sources varied between years. Estimates of predation on sea lion pups by transient orcas ranged from 0 – 19% during 2001 – 2004. Remote-operated video cameras have proven to be a valuable tool in conducting observational wildlife studies by significantly reducing many external, uncontrollable effects on the researchers and impacts by the researchers on their subjects.

Gervais' Beaked Whale Auditory Evoked Potential Hearing Measurements

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Several mass strandings of cetaceans, particularly beaked whales, have been linked both spatially and temporally to military exercises involving mid-frequency sonar. Many hypotheses have been suggested to explain why these animals strand in response to military sonar, including acoustic or pressure trauma, relatively high hearing sensitivity resulting in permanent or temporary threshold shifts, and gas bubble formation (embolus) *in vivo*. Here we report the auditory temporal resolution and evoked potential hearing measurements of a live-stranded juvenile male beaked whale (*Mesoplodon europaeus*) as determined using auditory evoked potential techniques. Evoked potentials were measured with a jawphone on the left jaw while the whale was lightly restrained in a pool. The results show evoked potentials from 5 kHz to 80 kHz (over the entire range tested), with the best sensitivity at 80 kHz. Since these were the first evoked potential measurements made using a jawphone in a small pool, we also compared hearing of bottlenose dolphins measured behaviourally in a direct-field with hearing estimates made using the same jawphone in the same testing configuration that was used with the beaked whale (*i.e.*, at the surface with the jawphone attached). The hearing sensitivity of the beaked whale at 5 kHz appears to be similar to or less than that of bottlenose dolphins measured with evoked potentials. Thus, the beaked whale AEP measurements do not support the hypothesis that these species have a particularly high auditory sensitivity at the frequencies used in mid-range sonar. The data presented here, along with accurate sound propagation models, should be useful for estimating minimum distances at which beaked whales could acoustically detect mid-frequency sonar.

Are There Benefits to Tool-Use in Wild Dolphins?

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Tool use, often considered to be an indicator of intelligence, is rare in birds and mammals, especially cetaceans. The advantages of tool use prove difficult to measure because of low intrapopulation variation in the behavior. In Shark Bay, Australia, 34 bottlenose dolphins (*Tursiops* sp.), < 5% of identified individuals in the population, engage in a form of tool use called sponge-carrying, providing a rare opportunity to assess the costs and benefits of tool use. Vertical transmission of the behavior is evident in that virtually all are adult females and their offspring; no sponge-carriers have been born to non-sponge carrying females. Using focal follows of 14 sponge-carrying adult females and a comparison group of 12 deep water foragers who do not carry spongers (observed 727 h), we show that sponge-carrying is more specialized and exclusive to deep water. In fact, the proportion of time devoted to tool use exceeds that reported for any non-human mammal. Using the sighting records for 101 adult females (mean sighting # = 114.3±6.0) over a 20 year period, we calculated the reproductive rate (# of calves surviving to age 3 per year) and proportion of sightings in channel habitats (where sponge-carrying predominantly occurs) for females that had at least 4 years of known reproductive status. Sponge-carrying adult females have significantly higher calving success than sympatric non-tool-using adult females ($F_{1,98}=4.55$, $p<0.035$), but the contribution of channel habitats could not be determined because only 6.8% of non-sponge-carriers were sighted in channels as often as sponge-carriers (60-100% of sightings), although 74% were sighted in channels more than once. Other factors are likely correlated with sponge-carrying, making it difficult to attribute the calving difference to tool-use *per se*. We discuss whether sponge-carriers are at an advantage over non-tool-using females by effectively exploiting channel habitats with this innovative foraging technique.

Marine Mammal Sightings During Fishery Operations in Southeastern and Southern Brazil

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The distribution of marine mammals is poorly known along the coast of Brazil primarily due to the lack of systematic surveys. For this reason, platforms of opportunity represent an important source of data on the occurrence of these species. Since June 2004, data sheets and photographic cameras were systematically distributed to 12 fishing boats operating from the loading dock (TPS) in Santos (23°57'S, 46°20'W), São Paulo State, southeastern Brazil. Marine mammal sightings were recorded by fishermen and, occasionally, by on-board marine mammal observers. Fishing boats operated from Cabo Frio (22°52'S, 42°01'W), Rio de Janeiro State to Rio Grande (32°08'S, 52°05'W), Rio Grande do Sul State in depths ranging from 10 to 740m, but the bulk of the fishery takes place in shallower waters (depths 10-30m). A total of 21 sightings were recorded since systematic monitoring begun. An additional sighting, observed in 2001, was provided by one of the fishermen. *Stenella frontalis* was the species most commonly seen (n=12), followed by *Sotalia guianensis* (n=2), *Stenella longirostris* (n=2), *Steno bredanensis* (n=1), *Delphinus* sp. (n=1), a non identified delphinid (n=1), a balaenopterid whale (n=1) and a pinniped *Otaria flavescens* (n=1). A total of 43% of the records were observed in the spring and 33% in the winter months. This sighting frequency could represent seasonal variation in the occurrence of dolphins in the fishing grounds, but additional data is required for more unambiguous conclusions to be drawn. Support: Project AWARE Foundation

Shifts in the Timing of Weaning in an Increasing Population of Steller Sea Lions in Southeast Alaska

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During the 1990s, most Steller sea lion pups in the increasing population in Southeast Alaska were believed to wean at about one year of age. Information collected from 2000-2004 from sightings of branded sea lions suggests that age-at-weaning may now be closer to two years. To fully document the weaning process and determine whether age-at-weaning has increased as the population approaches carrying capacity, behavioural observations related to weaning were recorded for twelve consecutive months (2004-2005) at a Steller sea lion haulout site on Southwest Brothers Island in southeast Alaska. Recorded observations at the haulout included hourly counts of sea lions by age class, frequency of late-term abortions, proportions of known-aged animals suckling, and antagonistic behaviors between mothers and their young. Our observations revealed high numbers of one- and two-year olds continuing to suckle, and a high number of late-term abortions. Providing milk to offspring for an additional year may reduce the effects of nutritional stress on the juvenile and increase its chance of surviving to sexual maturity. This may in turn increase the overall reproductive fitness of female Steller sea lions. A high proportion of Steller sea lions in southeast Alaska may thus be giving birth biennially rather than annually as previously thought. Such a reduction in birth rates could significantly curtail population growth and have a profound effect on estimated population trajectories.

Sperm Whale Diet Variation: Evidence from Stable Isotopes

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We investigated diet of sperm whales by measuring natural stable isotope ratios of carbon and nitrogen in 115 sloughed skin samples. We examined how diet varies with region, year, sex, social group and cultural clan. We also measured stable isotope ratios of 10 squid beaks (*Histioteuthidae*) collected from sperm whale defecations. Samples

were collected during eight studies between 1989 and 2000 in the South Pacific. We compared isotopic signatures of groups and acoustic clans of sperm whales using a nested ANOVA and calculated absolute distances between each pair of samples. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values ranged from -17.769‰ to -14.548‰ and from 8.540‰ to 22.301‰, respectively. Mature males showed much less variation than the females and immatures in $\delta^{15}\text{N}$ values, but similar variation in $\delta^{13}\text{C}$ values. The $\delta^{15}\text{N}$ values of squids were about 3‰ lower than values of the sperm whale which correspond to a trophic difference of one level. There was a significant difference in both the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values between groups (nested within clans) and clans (nested within studies). The differences between samples from different studies (absolute distance of 0.632 for $\delta^{13}\text{C}$; 4.411 for $\delta^{15}\text{N}$) were much greater than those from the same study, regardless of clan membership (same clan: 0.383 for $\delta^{13}\text{C}$; 1.222 for $\delta^{15}\text{N}$, different: 0.471 for $\delta^{13}\text{C}$; 1.068 for $\delta^{15}\text{N}$). The latitude at which the samples were collected was negatively related to the $\delta^{15}\text{N}$ values. We suggest that the differences in diet between the groups from different clans are mainly caused by characteristic behaviour of the clans and differential use of micro-habitats (groups from a clan with a generally more inshore distribution had lower $\delta^{13}\text{C}$, a general characteristic of this isotope in marine habitats).

Imaging Marine Mammals

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In the past few years the emergence of new imaging technologies has provided marine mammal scientists with unprecedented access into the structural and functional anatomy of their subjects. In this talk I will elucidate the many new imaging methods that are currently being used to study marine mammals, including functional morphology and brain activity in live animals. The methods I will discuss include Computed Tomography, Magnetic Resonance Imaging, Positron Emission Tomography, ultrasound, and others. I will first describe the basis for these methods elucidating the kinds of data they provide that were unobtainable previously. I will then discuss current research giving examples of these methods. Third, I will describe my own ongoing research program and recent work that involves the use of various imaging techniques to explore the evolution of cetacean brains and modern cetacean neuroanatomy. Finally, I will preview new and exciting imaging methods on the research horizon and how they might be applied to the study of marine mammals in the near future.

Seasonal and Diurnal Use of Knik Arm Habitat by Beluga Whales in Cook Inlet, Alaska

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Detailed information on habitat use is important for conservation and management of Cook Inlet beluga whales. During year 1 (2004-2005) of an ongoing study, over 10,000 hours of observations with binoculars and spotting scopes were logged by trained field biologists working at nine shore stations on bluffs along Knik Arm, upper Cook Inlet, Alaska. Documented sighting information included group size, age class composition, location, heading, behavioral state, and environmental data. These data were complemented by information collected during 112 boat surveys of Knik Arm and adjacent areas during ice-free months. The spatial distribution of beluga whale sightings during boat surveys concurred with the distribution reported by shore-based observers. Sighting rates varied significantly by month, with beluga whales sighted most frequently and in greatest numbers in Knik Arm during August through October. Locations of sightings within Knik Arm also varied seasonally. Few whales were sighted in the mostly ice-covered waters of Knik Arm during the winter, while in spring whale sightings were confined mainly to the southwest portion of Knik Arm near the more open waters of upper Cook Inlet.

During the summer and autumn, beluga whale distribution varied significantly with tide height. Whales were sighted in the upper reaches of Knik Arm during high tides and transited to lower reaches of the arm during low tides. Beluga whales commonly used the deeper channels along the shoreline, particularly while traveling. Areas adjacent to the mouths of rivers and streams were also used by the whales, where apparent foraging activity was noted frequently. These results provide new spatial and temporal resolution for understanding Cook Inlet beluga whales' use of coastal habitat near Anchorage, increasing the scientific information available for resource management and conservation.

Behavioral Performance of Suction Feeding in Harbor Seals (*Phoca vitulina*)

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As part of a comparative study on the feeding performance of pinnipeds, suction generation capability was measured in harbor seals. Depending upon their geographic location suction is thought to be an important component of the feeding repertoire in harbor seals. However, behavioral performance studies that investigate suction generation have not been conducted. Harbor seals (N=2) were presented pieces of fish in a feeding apparatus in which they had a choice to ingest food projecting from a hole drilled through a sheet of plexiglass by biting, or from a recessed cylinder using suction. A Millar MPC 350 pressure transducer was inserted into one of the cylinders of the feeding apparatus and pressure data was collected with a portable electrophysiological recording system. Feeding behavior was videotaped and synchronized with physiological data using a pair of flashing LED lights whose optical pattern corresponded to a generated square wave pattern recorded as a separate channel. Harbor seals used suction, biting, and some hydraulic jetting when feeding from the apparatus. The mean suction force recorded was -10.0 kPa (SD± 6.54). The maximum suction pressure measured over 137 feeding events was 31.3 kPa. The mean duration of suction events were 0.5 s (SD± 0.36) and ranged from 0.13 s to 2.06 s. Suction events were occasionally preceded by a small increase in pressure (preparatory phase) followed by relatively large negative pressures (suction). In some cases a small increase in pressure was also noted after a suction event. These supplemental phases to the main suction event presumably served to remove excess water from the mouth either just before or after a suction event. Suction capability of harbor seal were considerably less compared to suction specialists such as bearded seals and walrus, but were strong enough to be an important part of the overall feeding repertoire.

Susceptibility of Fibroblast Cell Cultures of Striped Dolphin (*Stenella coeruleoalba*) to with Polybrominated Diphenyl Ethers (PBDEs): First Investigation on CYP 1A and CYP 2B Induction

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Polybrominated diphenyl ethers (PBDEs) are a major family of brominated flame retardants, being lipophilic, persistent, and toxic to fauna and humans. Today there is growing concern about accumulation of brominated organic compounds in the food chain. The highest levels of PBDEs have been found in top marine predators. In this study we use immunofluorescence techniques in fibroblast cell cultures to explore the susceptibility of cetaceans to PBDEs, with qualitative and quantitative evaluation of target proteins such as CYP 1A1-1A2 and CYP 2B4. Fibroblast cell cultures (third generation)

from two male and two female striped dolphins (*Stenella coeruleoalba*), sampled with biopsy darts in summer 2004 in the Mediterranean Whale Sanctuary, were treated experimentally with a commercial mixture (BDE-MXE, Wellington, Canada) containing 27 PBDEs, from mono- to deca-brominated. The cells were treated with the mixture solubilized in nonane (0.01 µg/ml) at three different doses: 0.1 µg/ml, 0.05 µg/ml and 0.01 µg/ml, for 48 h, and with nonane (0.01 µg/ml) as control. After a first reaction with the primary antibodies for CYP 1A1-1A2 and 2B4, the cells were treated with the respective secondary antibodies marked with a fluorochrome. The main results of this experiments were: 1) the detection of presence of the cytochromes 1A1-1A2 and 2B4 in striped dolphin fibroblast cells, revealed by the crossreaction of the antibody used and by the presence of fluorescence in the fibroblasts; 2) the increase of fluorescence in relation to the treatment doses of contaminants; 3) the preliminary detection of differences in the induction phenomena between specimens and gender.

Population Structure of Bottlenose Dolphins (*Tursiops* sp.) Around the Main Hawaiian Islands

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Fine-scale population structure has been noted in bottlenose dolphins (*Tursiops truncatus*) in coastal waters, but studies of oceanic or oceanic island populations are generally lacking. Bottlenose dolphins around the Hawaiian Archipelago are currently managed as a single stock under the U.S. Marine Mammal Protection Act. However, recent photo-identification studies around the main Hawaiian Islands have revealed a shallow depth distribution, high site fidelity, and no recorded movements of marked individuals among islands. These results suggest that the dolphins around each of the islands may represent small, demographically independent populations that warrant protection as separate stocks. Photo-identification has also revealed a bi-modal depth distribution of animals off the islands of Kaua'i and Ni'ihau, indicating that there may be two populations that are stratified by depth off this island group. We tested the hypothesis that island-specific populations around the main Hawaiian islands may have been isolated long enough for genetic differentiation to develop. We examined 400 basepairs of mitochondrial control region sequence from biopsies obtained from 121 animals. We found low levels of haplotypic diversity and statistically significant differences in haplotype frequencies among animals from different islands and depth strata, supporting the hypothesis that Hawaiian bottlenose dolphins represent multiple management units. Further, we identified one animal with a mitochondrial haplotype typical of *Tursiops aduncus*, raising the possibility that there may be two species of bottlenose dolphins in Hawaiian waters. Our results indicate that the management stocks of bottlenose dolphins within the Hawaiian Exclusive Economic Zone will likely need to be redefined.

The Pseudocervix and Vaginal Folds of Female Odontocetes: Form and Function?

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The lower reproductive tract of female odontocetes is unique among mammals. The internal structure of the vagina is described as having multiple folds, which are considered to be well-developed, funnel-like, muscular structures that are suggested as capable of movement. The pseudocervix, which lies a distally to the cervix, is also described as having as many as two transverse folds, resulting in two chambers within the vagina. An initial review of the literature found six species with these unique vaginal folds: *Tursiops truncatus*, *Lagenorhynchus obliquidens*, *Delphinus delphis*, *Phocoena phocoena*, *Stenella*

longirostris, and *Delphinapterus leucas*. The function of these vaginal structures is unclear. The folds appear anatomically capable of exerting a pumping action and it has been speculated that they may function to restrain seawater from entering after withdrawal of the penis, or may "milk" the end of the penis of seminal fluid, or may relate to the formation of vaginal plugs. We outline a protocol to describe and quantify the internal structure of female odontocetes and provide comparisons among species. Through dissemination of this protocol among the marine mammal community, we aspire to: (1) better understand the anatomy of the lower reproductive tract in female odontocetes, (2) collect data across a wide range of species with the help of colleagues and stranding networks, and (3) ultimately, to examine possible explanations for the evolution of these unusual structures.

Morphological and Genetic Differentiation of the Black Sea Harbor Porpoise (*Phocoena phocoena*)

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The harbor porpoise (*Phocoena phocoena*) is a coastal species, limited to the cold temperate and sub-arctic waters of the Northern Hemisphere. They are found throughout the Black Sea and except for rare sightings in the Aegean Sea they do not occur in the Mediterranean Sea. The current status of the geographically isolated Black Sea harbor porpoises is unknown due to limited information. Previous and ongoing studies have suggested that Black Sea harbor porpoises are morphologically and genetically unique, but more comprehensive sampling is necessary to design specific conservation plans. The goal of this study is to characterize Black Sea harbor porpoises using cranial morphology and mitochondrial DNA variation, make inferences about their evolutionary history, and make recommendations for conservation. One hundred eighty two adult skulls from the French Atlantic coast (14), inner Danish waters (55), North Sea (54), Greenland (11) and the Black Sea (48) were scored for 24 morphological variables. A stretch of 403 base pairs of the mitochondrial control region was sequenced for 141 individuals from the Eastern Atlantic (France 32, Gibraltar 4) and the Black Sea (Ukraine 30, Georgia 25, Bulgaria 30, Turkey 20). Genetic analyses show no differentiation and relatively low levels of genetic diversity within the Black Sea populations. Black Sea and Eastern Atlantic populations are maximally divergent with no shared haplotypes. Black Sea harbor porpoises were also found to be morphologically different from other regions (MANOVA, $p < 0.001$). Our results demonstrate that Black Sea harbor porpoises constitute a panmictic population with high gene flow within the Black Sea. They are genetically and ecologically isolated, and are likely on an independent evolutionary pathway.

Occurrence of *Pseudorca crassidens* in the Pacific Coastal Waters of Costa Rica

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The distribution of the False killer whale (*Pseudorca crassidens*) extends from tropical to temperate waters in the Indian, Pacific and Atlantic Oceans and the Mediterranean Sea. In Costa Rican waters False killer whales have been reported in the Pacific and the Caribbean

territorial waters. False killer whales reports are particularly concentrated in the South Pacific of Costa Rica, specifically along the coast of Drake-Bay, in Golfo Dulce, and Cocos Island. Despite of these observations, there has not been any systematic study to determine the status of these dolphins in Costa Rican waters. Therefore, the purpose of this study is to provide a first glimpse in the status of False killer whales in the protected waters of Caño Island, Costa Rica. Following monthly strip-transects the area was surveyed from December 2004 to date (June 2005). Survey effort was 168 hours (24 days). A total of four sightings were made in January and February (16% of the number of days). The average group size was 13.2 ± 4.7 individuals. Twenty-five animals were photo-identified. The predominant behavior was traveling (64%), followed by feeding-foraging (23%). January and February are dry months characterized by an increase in water productivity. The abundance and behavioral patterns of other two common delphinid species (*Stenella attenuata* and *Tursiops truncatus*) appear to vary seasonally in the Costa Rican Pacific waters, reaching a peak in abundance and bias towards foraging activities during these dry months. It is possible that False killer whales occurrence may be also associated with the seasonality of the area.

Cases of Prolonged Freshwater Exposure in Dolphins Along the Southeast United States

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Since 1992, there have been 13 reported cases of dolphins found swimming "out of habitat" in fresh water rivers and/or estuaries experiencing low salinity in the Southeast U.S. These cases involved *Tursiops truncatus* (*Tt*), $n=11$ *Stenella frontalis* ($n=1$) and *Stenella attenuata* (*Sa*), $n=1$. Coastal bottlenose dolphins have been observed to frequent fresh water systems associated with their home ranges. However, in the cases reported here, the animals were trapped in the freshwater system and were unable to leave due to various causes. Factors resulting in an "out of habitat" situation for these cases included climatic (e.g., hurricane), anthropogenic (e.g., construction) and other unknown host factors. Ten of the 13 cases resulted in the animals' death. In the three remaining instances, the animals were captured and released or rehabilitated. Here we report on the clinical signs of prolonged fresh water exposure in four separate instances which occurred in Louisiana (*Tt*, $n=1$), Florida Panhandle (*Sa*, $n=1$), Florida West Coast (*Tt*, $n=1$) and South Carolina (*Tt*, $n=2$). The salinity in all four sites ranged from 0 ppt to 5 ppt. Time of individual exposure was approximated to be from five days to three weeks. The clinical findings observed for freshwater exposure included corneal edema, generalized skin pallor, various skin lesions and electrolyte imbalance. The information presented here can be used to provide baseline information for prolonged exposure to freshwater and better determine a point to which intervention is warranted.

The Price of Puberty: Evaluation of Adrenal Function in Juvenile Steller Sea Lions (*Eumetopias jubatus*)

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The Alaska SeaLife Center has developed facilities and procedures to capture and temporarily hold free ranging juvenile Steller sea lions (up to 3 months) from the endangered western stock. Objectives of this study included evaluation of juvenile adrenal function and factors, such as gender or season that may contribute to differences. In this study 6 males and 2 females 14-20 months old were physiologically

challenged through administration of adrenocorticotrophic hormone (ACTH). ACTH challenges occurred in summer and winter, with four animals each season (3m, 1f). Serial blood and fecal samples were collected for 2.5 and 96 hours post-injection, respectively. Radioimmunoassay indicated 3-fold increases in serum cortisol 90 minutes post-injection in both seasons and 10- and 17-fold peak increases in fecal corticosterone at 28 hours, summer and winter, respectively. Fecal corticosterone returned to baseline 48 hours post-injection. Acute response in juvenile adrenal glands was detectable in feces after 24 hours, with peak duration of 16 hours, post-active phase. Mean serum cortisol concentrations were significantly above baseline both seasons (summer baseline 65 ± 4.2 ; peak 210 ± 18.0 ng/ml, $p = 0.004$; winter baseline 87 ± 15.7 , peak 238 ± 10.0 ng/ml, $p = 0.004$). Mean fecal corticosterone post-ACTH exceeded baseline significantly only in summer (baseline 117.8 ± 36.7 ; peak 1219.3 ± 298.4 ng/g, $p = 0.038$). Given that the mean magnitude of response in feces was greatest in winter (baseline 71.8 ± 13.7 ; peak 1198.57 ± 369.9 ng/g); the lack of significance was unexpected. We found a high degree of individual variability, independent of gender, in winter months. This suggested adrenal output of corticosterone, and therefore response to acute stress was strongly individual in juvenile Steller sea lions in winter months. Winter presents greater environmental challenges; therefore variability in adrenal response may indicate some juveniles may not respond appropriately to physiological distress during critical periods in winter.

The Spring Northward Migration and Summer Feeding of Mother Gray Whales in the Eastern North Pacific

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During March 2005, 16 female gray whales with calves in Laguna Ojo de Liebre, Baja, Mexico were tagged with implantable Argos radio tags. All tags reported data. Whales left the lagoon individually over 36 days. Re-sighting efforts occurred off California, Oregon and Alaska. At abstract submission, one whale had escaped from Mexican fishing gear and six whales had been tracked for more than three months during migration to the Bering ($N=2$) and Chukchi Seas ($N=4$), as far north as Barrow. Three whales visited the Russian coast, spending time in small areas, including a bay southwest of the Gulf of Anadyr, presumably feeding. Two whales have been closely associated with the offshore, receding, Chukchi sea ice. Considering sea ice, bottom feeding behavior, and how calves rub on mothers, tag retention has been excellent. These are the first tracks detailing the timing, water depths, distance from shore, and speed of northward migrant mother gray whales, as well as characterizing individual feeding habitats, site tenacity, feeding strategies, and home ranges. Despite limited sample size, our data suggest relatively higher use of the Chukchi Sea, Russian coast, and ice edges than previous ship- and aerial-based survey data. A recent Bering Sea regime shift has lowered amphipod biomass and contributed to speculation that Eastern North Pacific gray whales have reached or exceeded carrying-capacity. Tagged whale movements may reflect resultant changes in gray whales foraging over a wider geographic range than in the past, which emphasized the more traditional (and better known) feeding areas of the shallow Bering Sea shelf. Alternatively, tag data may not reflect the species-wide distribution. Nonetheless, tags have provided distribution in remote regions information very difficult to collect with other methodologies.

Specialists or Generalists? Population-Specific Variation in the Foraging Ecology of Transient Killer Whales in Alaska

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The Gulf of Alaska transients (GAT) are one of three genetically described Alaskan transient killer whale sub-populations. They range

from southeast Alaska to Kodiak Island. From 2000-2004 we made behavioral observations of eight GAT individuals in two groups in Kenai Fjords and Kodiak using vessel surveys, observers onshore, and video cameras on Chiswell Island. During seven periods from 2000-2004, up to three of these individuals made multiple-day visits to Chiswell rookery, mainly in August and September, when Steller sea lion pups began entering the water. From observations and pup counts, it was estimated that 13 Steller sea lion pups were taken by a solitary GAT in 2001 and at least five were taken in 2003 by three individuals. Spikes in pup disappearance from daily counts coincided with killer whale visits. Time spent foraging at the rookery was greatest for the lone female, declined when she joined another female with new calf, and increased again when the calf became a yearling and sea lion pups, sea birds, and sea otters were apparently used for training in prey handling. All eight GAT whales were observed preying only on Steller sea lions, while harbor seals, northern fur seals, grey whales, and Dall's porpoise, were more important in adjacent regions. Killer whales consumed an estimated average of 4.3% of the seasonal Steller sea lion population in Kenai Fjords which was unlikely to prohibit Steller sea lion recovery. The specialized feeding habits, low population density and low numbers of these GATs contrast with the more abundant and diversified transients in southeast Alaska and the eastern Aleutians. Killer whale prey choice is likely influenced by prey accessibility and abundance, handling cost, injury risk, and energetics. An understanding of killer whale behavioral ecology in Alaska requires a focused regional approach due to specialized behavioral adaptations to local environments.

Implications of Varying Food Distributions for Fitness in Steller Sea Lions (*Eumetopias jubatus*)

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Various hypotheses have been postulated to explain population declines in Steller sea lions (SSL). We attempted to synthesize much of the biological information (particularly foraging behaviour, energetics, reproductive/survival rates, growth and life-history variables) about SSLs within a modelling framework to assess the consequences of different management/policy scenarios. The model incorporated trophic interactions (Predator-prey model); Population structure (sex and size structure); Spatial structure (discrete haulouts and patches); Dynamics (discrete time-weekly intervals). A series of sub-models dealt with: mass-energy conversions; energetic value of prey field; metabolic rates; travelling time to patch; diving; maternal investment; growth; fecundity; background mortality; starvation mortality; mass at first breeding; lactation costs/efficiency; foraging ranges; time offshore; patch switching. Our modelling approach assumed that if declines were related to trophic interactions, there should be a set of parameters for the functional response that can emulate different population dynamics when the model is presented with different prey fields or predation pressures corresponding to declining and increasing populations. We fitted a four parameter functional response and a two parameter error model to two qualitatively different data sets representing populations in SE Alaska and Kodiak Island. We then used fitted parameters to perform a series of controlled experiments to investigate which of the trophic-related factors could have caused the observed time series and, given the current state of the subpopulations, which trophic-related factors seem most likely to reverse the decline? Results indicate that prey accessibility and quality are the most important trophic factors affecting SSL dynamics and apparently affect primarily the juvenile classes. We discuss the effectiveness of the modelling framework with emphasis on caveats concerning the prey-field (collapsed, multi-species prey-field & spatio-temporally coarse description of distribution), the fitting process (deterministic trajectory interpreted as expectation; arbitrary likelihood function; lack of demographic stochasticity; partially fitted model) and parameterisation (parsimonious but arbitrary foraging rules).

Diet Prediction and Individual Fatty Acid Metabolism in

Postabsorptive Plasma of Harbor Seals

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Fatty acid (FA) analysis is an important tool for estimating diet composition in free-ranging pinnipeds. However, the ability to address dietary questions of short duration surrounding life-history events or when serial sampling is necessary, can make blubber biopsies impractical. Furthermore, the specific metabolism of individual FA can impact diet interpretations. Our goal was to develop a rapid direct method for quantifying FA in seals for the prediction of diet that was suitable for high-frequency sampling. Our second aim was to determine how lipid intake and season affected individual FA metabolism. Utilizing a cross-over approach, we examined postabsorptive plasma FA profiles longitudinally over two years in captive harbor seals (n=8) fed alternating diets of either herring or pollock for four-month periods or a continuous mixed diet. FA profiles were correctly classified to diet group 96.6% of the time using discriminant function analysis. Patterns of individual FA over time showed that the level of 18:1n-7 was negatively correlated with daily fat intake (-0.8010). Three FA (18:0, 16:1n-7 and 20:5n-3) exhibited seasonal differences independent of diet. In light of these results, FA biosynthesis and modification will be discussed. These data suggest that despite lipid intake and seasonal influences on FA metabolism, qualitative diet prediction is robust.

Spatial and Non-Spatial Visual Multiple-Choice Matching in a Harbor Seal (*Phoca vitulina*): Evidence for Differential Encoding of Landmark Features and Local Stimuli

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A harbor seal was tested in a multiple-choice matching-to-sample task with delays of 0, 3, 6, 9 and 12 seconds under non-spatial and spatial experimental conditions. The non-spatial condition consisted of a DMTS task with four comparison stimuli (toy objects) presented on fixed positions in a classic matching apparatus. The spatial condition involved four places in the neighborhood of the apparatus equally distant from the seal's stationing device which were permanently marked by four other comparison stimuli serving as local landmarks. In a session, both experimental conditions and objects used as sample were balanced and their sequence followed pseudo-random schedules. After presenting a sample on the central position of the apparatus, the seal had to choose the comparison stimulus matching the sample either from the four apparatus stimuli or from the four landmark objects by touching it with its snout. During acquisition, the seal reached the learning criterion with the two conditions with comparable effort. The seal's performance for the two experimental conditions without delay surpassed 80% correct choices throughout the rest of the study and did not deviate significantly from each other. The seal's performance was impaired by delays only with comparison stimuli presented at the apparatus and significantly differed from performance with landmark stimuli already at 6 seconds delay. A delay of 12 seconds resulted in performance no longer significantly different from chance with apparatus stimuli. Replacing the comparison stimuli at the apparatus by identical spheres in a zero-delay matching task resulted in a performance still significantly different from chance, but clearly impaired. In contrast to that, performance with the landmark stimuli was neither impaired by delay nor by replacing individual stimuli by identical spheres. The ecological importance of spatial information in the marine environment and its role while testing cognitive skills of marine mammals is discussed.

A Comparison of Two Indirect Methods of Estimating Tidal Lung Volumes of Unrestrained Gray Whales in Winter Lagoons

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The protection of the gray whale, *Eschrichtius robustus*, has limited the collection of direct measurements and, therefore, understanding the physiology becomes dependent on observational data. Estimations of tidal lung volume (V_T) have been found to be a function of the duration of the exhalation (T_E) and are important for determining metabolic rates and energy usage in gray whales. Currently, one of the best methods to determine T_E on free-swimming gray whales is through analysis of the blow sound. Using audio recordings are sometimes problematic due to the inability to pick up sounds at a distance, background noise, or the direction of the wind. Video analysis of T_E would permit collection of more data with fewer complications. In this study, audio and video measurements were collected on unrestrained gray whales at San Ignacio lagoon in Baja California Sur in February, 2005. Data was collected on both adults and calves that could be heard exhaling from our shore observation site using a digital video camera with directional microphone attached on any whale that could be heard exhaling from shore. The duration of the visual and auditory components of the blow were determined separately and compared using regression analysis. When compared, audio versus video (in seconds) had an r^2 value of 0.9703 and a linear regression equation of (T_E , audio) = $0.983(T_E$, video) + 0.0436. No significant difference was found between the two methods of analysis for determining T_E . Therefore, video analysis of the duration of the blow is appropriate for estimating T_E in windy or distance conditions when the audio signal of the blow cannot be detected.

The Evolution of Cetacean Whistles: A Phylogenetic Comparative Approach

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In Cetaceans, communicative whistles are often associated with social interactions that involve group cohesion and individual recognition. Despite intense behavioral and bioacoustics work on whistles, their evolutionary history remains unclear. Five factors have been proposed to have influenced whistle evolution: phylogeny, sociality, morphological constraints, environment, and zoogeography. Using a recent phylogenetic hypothesis we first test for phylogenetic signal (similarity due to common ancestry) in standard whistle variables (minimum and maximum frequency variables and duration) using a test for sequential independence. Then we evaluate sociality, morphology, and environment using the independent contrast a phylogenetic comparative approach and reconstructions of ancestral characters of whistle acoustic variables. Our results suggest that whistles are a synapomorphy of toothed whales not just delphinids. Furthermore, whistles have been independently lost three to four times in toothed whales. What factors may have played a major role in the evolution of these signals? (1) Social complexity may influence whistle complexity: “complex” whistles are concentrated in highly social lineages (delphinoids) whereas “simple” whistles are unique to solitary river dolphins. (2) Both body size ($h=0.936$, $n=55$, $p<0.05$) and maximum mean frequency showed significant phylogenetic signal ($h=0.865$, $n=22$, $p<0.05$). (3) The often proposed negative relation of body size versus maximum frequency it is not as clear after correcting for the effect of phylogenetic relationships. (4) Correcting frequency variables by body size and phylogenetic correlation we tested the hypothesis that open-water dolphins produce high frequency whistles while riverine/coastal dolphins produced lower frequency whistles. In conclusion, testing for phylogenetic signals and the effect of phylogenetic relationships is fundamental in comparative studies seeking to cast light on the evolution of communicative signals.

Assessing Habitat Quality in Order to Manage the Causes of Right Whale Mortality

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The recovery of the North Atlantic right whale is compromised by mortality due to ship strike and gear entanglement and successful management of these impacts rests upon identification of locations where whales and industrial activities co-occur. Thus a method to better predict the location and timing of the aggregation, residency, and behavior of right whales is critical to conservation goals. Since 1999 we have assessed the quality and distribution of the zooplankton resource in Cape Cod Bay to predict the occurrence and behavior of whales in order to inform managers at the Division of Marine Fisheries, Commonwealth of Massachusetts of the potential risk of entanglement and ship strike. DMF has tuned their regulatory measures accordingly and has modified management plans and published seasonal ship strike alerts to reflect the resource-based assessments. Underpinning the assessment process is a sampling program that captures the salient aspects of the zooplankton quality and distribution by measuring bay-wide zooplankton information against a feeding threshold density of 3750 organisms/m³ and a caloric density threshold of 0.69 kcal/m³. By assessing samples relative to these standards and tracking conditions through the winter and spring residency period, predictions as to the aggregation and movement of the whales along with their tendency to feed near the surface have been made and published in weekly assessment reports to management agencies. A measure of the relationship between the assessed quality of the zooplankton resource and the occurrence of whales in the bay is demonstrated in the comparison between counts of whales from aerial surveys and mean zooplankton density. Because the right whale is intimately associated with rich patches of zooplankton, it is possible to both define and predict the aggregation of whales, thus providing a new tool that is useful in management of the principal causes of mortality of the species.

Bottlenose Dolphins (*Tursiops truncatus*) in San Luis Pass, Texas: A Small But Dynamic Community

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Bottlenose dolphins in the San Luis Pass (SLP) area, located in the SW portion of the Galveston Bay Estuary, Texas, were initially studied in 1990 with 247 subsequent photo-identification surveys during 1995-2003. Both resident and nonresident dolphins occurred, and resident dolphins displayed strong site fidelity with seasonal variation in habitat use. Using the 1995-2003 dataset, our objective was to examine association patterns and describe the social structure of this community. We used permutation tests to determine whether patterns of associations between individuals (defined as in-group-together) were significantly different from random, and to test associations between individual dyads against random. Lagged association rates were used to quantify temporal stability of associations, and models of temporal permanence of associations were fit to observed data. The residence rate of individuals was measured by calculating lagged identification rates, and models of residency were fit to observed data. Computer-generated models indicated that although groups differed greatly from day-to-day in their sizes and membership, in the long-term there were preferred associations. Standardized lagged association rates were significantly higher than by chance alone, although the overall pattern was fluid (‘rapid dissociations and casual acquaintances’). Lagged identification rates were stable over time and best described by the ‘closed population with emigration and reimmigration’ model. In general, bottlenose dolphins inhabiting SLP formed a small but dynamic community. Grouping pattern was fluid, life span of a group did not exceed a day (in most cases lasted only a few hours), and there were frequent interactions with animals from outside SLP. In the longer term, however, the community was

relatively closed and stable. These findings are an important step in our understanding and management of this species in the Gulf of Mexico, where, outside of Florida, there have been few long-term studies and little attention to social structure.

Spatial Characteristics of Bottlenose Dolphins in the Indian River Lagoon, Florida: Applications to Epidemiology

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The Indian River Lagoon (IRL) on Florida's central east coast is a shallow-water body with limited circulation and tidal exchange, and is particularly vulnerable to the influx of pollutants and other environmental impacts. Necropsy and photo-identification data on IRL bottlenose dolphins (*Tursiops truncatus*) have shown a high prevalence of infectious and inflammatory diseases of the skin and other organs, suggesting that the population may be in a state of altered immunologic homeostasis. Current analyses of spatial characteristics were based on 477 boat-based surveys conducted in the IRL from 1996 to 2004, and were undertaken to provide an empirical foundation for the sampling strategies and environmental exposure interpretations of a long-term health assessment of IRL dolphins. In this research we separately examined the occurrence and spatial characteristics of dolphins with two or more sightings within each of three geographic areas of interest: Mosquito Lagoon (ML), which has a high degree of geographical isolation within the IRL; South Merritt Island, which was the site of a recent unusual mortality event (UME); and St. Lucie River (SLR), which is subject to a high degree of agricultural runoff. ML dolphins (n = 101) had 97% of their sightings within the ML, suggesting these dolphins are geographically distinct. UME dolphins (n = 102) had 68% of their sightings within the UME area. Finally, STL dolphins (n = 43) had only 35% of their sightings within the STL area. While site fidelity for dolphins in these three areas varied from high (ML) to low (STL), there was little to no overlap in range of dolphins sighted in these three areas. It thus appears that these dolphins: a) may represent separate sub-population units within the IRL, b) that these regions should be sampled separately, and c) that dolphins in these areas may reflect exposure to different environmental profiles.

Expression of the Capsid Gene of New Genotypes of Marine Caliciviruses Isolated From Steller Sea Lions (*Eumetopias jubatus*) From Alaska

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Marine caliciviruses, exemplified by San Miguel sea lion viruses (SMSV), are a group of single-stranded, non-enveloped, icosahedral, positive-sense RNA viruses of ocean origin, belonging to the genus Vesivirus of the *Caliciviridae*. The first isolation of an SMSV (SMSV-1) was from a California sea lion in 1972. Since then, at least 17 serotypes of SMSV have been identified, most from pinnipeds, and one from a cetacean. Currently, identification of new caliciviruses is based primarily on serological methods, however, due to high mutation rates; emerging marine caliciviruses are frequently not typeable. Identification of new marine caliciviruses, therefore, requires molecular characterization of genotypes, and the production of new antigens for serology to represent the viruses currently circulating in the population. Two new isolates of marine calicivirus, from blister fluids and oral and rectal swabs from two populations of Steller sea lions (*Eumetopias jubatus*) in southeastern Alaska, have been identified by RT-PCR and sequencing of the complete capsid protein gene. Multiple sequence analyses and phylogeny of the amino acid sequences

deduced from both capsid proteins and their homologues from other marine caliciviruses available in the GenBank database, indicate that these viruses correspond to new marine calicivirus genotypes. To generate antigens representing these genotypes, the full capsid gene of both isolates was cloned into a baculovirus expression vector, pBlueBac4.5, and co-transfected into Sf-21 insect (*Spodoptera frugiperda*) cell cultures with wild type baculovirus to generate recombinant baculoviruses expressing the full capsid protein of each genotype. These antigens are being used in the development of ELISAs for sero-epidemiological surveys to detect calicivirus antibodies specific for these new genotypes.

Complexity of Southern Resident Killer Whale (*Orcinus orca*) Movement Patterns in Relation to Pacific Salmon (*Oncorhynchus* spp.) Distribution and Abundance

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The Southern Resident Community of killer whales (*Orcinus orca*) (SRs) is currently being considered for listing under the US Endangered Species Act. Limited data regarding the foraging activities of the SRs indicate that they selectively forage on salmonids (*Oncorhynchus* spp.). The spatial and temporal variability in the pattern of distribution of SRs and commercial catch of five species of salmon within the inland waters of Washington State and British Columbia between 1991 and 2001 were used to investigate the strength of the relationship between these top level predators and a declining prey resource. Daily whale sightings were aggregated by statistical week to match the temporal scale of the salmon data. All land areas were erased from the buffered travel models to create movement polygons which were intersected with salmon management areas and used to generate shape and pattern metrics. Four pattern metrics were used to analyze whale movement patterns in relation to salmon catch data. 1) Shape Indices of weekly patches of space used by pod, year, region, and season. 2) Number of patches per week used by pod, year, and month. 3) Percentage of individual catch areas occupied by weekly patches of whale movement. 4) A conditional use metric of the "re-use" of space from the previous weekly movement patch. Results indicate that more complex movement patterns are negatively correlated with higher relative salmon abundance at this time resolution. The autumn seasonal values correlate strongest over all years. There was high variability among the three pods regarding average number of movement patches per week, but significant pod differences in the re-use of space from the previous weekly time step. This study represents the first attempt to investigate SR and salmon distribution patterns in a spatially explicate model and has broadly applicable management implications for both predator and prey.

Characterising Fine Scale Foraging Movements in Grey Seals

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Argos satellite tracking has revealed that grey seals (*Halichoerus grypus*) undertake repeated foraging trips from haulout sites. However track location fixes are frequently too irregular in time and inaccurate in space to define satisfactorily trip duration and where and when they actually search for food. Here we examine grey seal movement at sea in unprecedented fine temporal and spatial scale to characterise foraging trip components and to interpret and smooth data from coarser tracking systems. An adult grey seal was fitted with a novel Fastloc (Wildtrack Telemetry Systems, England) - GSM mobile phone tag (SMRU, Scotland) that attempted to obtain GPS-quality locations every 15 mins. These were stored and relayed ashore whenever the

seals moved within GSM coverage. 51% of all attempts resulted on a GPS fix and a total of 1658 fixes were received covering six foraging trips. The seal used two haulout sites 110km apart and one foraging region 50-130 km offshore. The swimming speed distribution was multimodal and 95% of speeds were < 1.38 m/s. Their turning angle (TA) was strongly modal at zero degrees. TA variability was significantly greater at slow speeds, even after modelling and taking into account the effect of GPS error on this relationship. To objectively identify different movement modes we used a three-state hidden Markov model that clearly identified the following modes: nearshore (<0.9 km±0.03) associated with haulout sites, offshore (foraging) characterised by low-speed (mean: 0.24 m/s) and variable TA, and transit with high speed (mean: 1.12 m/s) and low TA. Offshore foraging modes, associated with sandeel habitats, displayed consistency of directional rather than random or levy flight movement. First passage-time analysis showed the spatial scale of foraging as a circle of radius 5 km.

Effect of Maternal Age on Reproductive Success in Antarctic Fur Seals

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Reproductive success may increase with age due to increases in size, body condition, and experience. This was investigated in Antarctic fur seals (*Arctocephalus gazella*) in the 2003/04 and 2004/05 breeding seasons at Cape Shirreff, Livingston Island (62° 28 S, 60° 46 W). Each year over 200 known aged tagged females were followed during the breeding season. During daily tag resights female presence and whether she was with a pup was recorded. A female was categorized as successful in the early season if the pup was seen after January 15th (at which point leopard seal predation started) and successful in the late season if the pup was seen after February 23rd. Median date of pupping was December 8th and 9th in 2003 and 2004, respectively. Reproductive success was similar in the two years. In 2003/04 early season success was 71.8% and late season success was 55.8%. In 2004/05 early and late season success was 85.4% and 55.1%, respectively. Using a logistic regression the impact of age on success was investigated. There was no relationship between age and reproductive success in early or late season in either year. Trip duration was below the 8 year average in both years indicating good foraging conditions. This suggests that in good years when food is plentiful that the benefits of size and experience that come with age may not affect reproductive success.

A Regional Assessment of Florida Manatees (*Trichechus manatus latirostris*) in Matlacha Pass, Pine Island Sound, and Estero Bay, Lee County, Florida

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We used a “weight-of-evidence” approach to provide environmental managers with a comprehensive analysis of Florida manatee use of Estero Bay, Matlacha Pass, and Pine Island Sound in Lee County, Florida. We examined human use of the areas, habitat features, large- and fine-scale manatee movements, manatee distribution and relative abundance, and manatee deaths. Manatees primarily use Estero Bay during late summer and early fall, prior to their migration to warm-water sites. In winter, manatees that use a nearby borrow pit may feed on those seagrass beds that lie in Estero Bay. Shallow water-depth precludes the use of larger vessels and may result in lighter overall boat traffic in Estero Bay. Data indicate, however, that the northwest portion of Estero Bay is an area of high spatial coincidence between manatees and boats. Matlacha Pass is important for large numbers of manatees. It contains a warm-water refuge, abundant and accessible forage, freshwater, and shelter. Due to water depth and

channel width, Matlacha Pass is not used by boats as intensively as other portions of Lee County. However, manatees and vessel traffic overlap greatly in San Carlos Bay. Manatees use Pine Island Sound during the warm season for forage and shelter. The lack of a warm-water source and shallow water depth prevent winter use, and cause manatees to concentrate to the south. The intracoastal waterway and inlets are places with high boat traffic and some overlap between manatees and watercraft. Manatees use southeastern Pine Island Sound as a stop-over feeding ground just prior to and immediately after the cold season. In the three study areas combined, manatee deaths caused by watercraft collisions are increasing at a rate faster than all other causes of death.

Use of GIS to Compare River Otter (*Lontra canadensis*) Habitat Preference in Inland and Coastal Populations

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Much is known about river otter (*Lontra canadensis*) habitat preferences on lakes and rivers, but less is known about coastal river otters. Between 1995-2000 the New York State Otter Project relocated 279 river otters, 31 of which were released in Monroe County to revive the population. Over the past year we have located toilet sites and collected feces on three major streams in Monroe County. During the summer months we collected samples from an indigenous population in British Columbia, which utilizes coastal areas of Queen Charlotte Sound. We took samples from each scat to perform dietary and genetic analysis. During the collection process we recorded GPS coordinates, determined the slope, amount of tree coverage, the speed of the current, any noticeable pollution, and if humans populated the area. We used ArcGIS 9 to map latrine sites and compare the observed surroundings and geographical information gathered from USGS to determine otter habitat preferences. We determined that otters in New York typically defecate in areas less than five meters from the rivers edge that have less than a 5% rise in slope (range 0-40%), which may be due to the amount of energy required to run on land. Also it was observed that most of the sites were near slow moving currents, where the concentrations of prey are likely higher. In British Columbia toilet sites were all located less than five meters from water and mostly on abandoned docks. Also the areas were protected inlets where the water was calmer, correlating with the results from the inland otters. By combining the results from the genetic analysis and mapping of sites, we will be able to determine movement patterns of individual otters as well as their territory ranges.

The Power of Whaling: Why Historical Data is Direct Evidence of Past Population Sizes

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Several recent papers using molecular data have assumed rather small pre-whaling populations of both right whales (*Eubalaena glacialis*) and bowhead whales (*Balaena mysticetus*) for the North Atlantic. Some have even suggested that the decline of those populations took place before the onset of commercial whaling. To ascertain whether these assumptions were consistent with the historical record, we analyzed documents related to the whaling by Basques (both Spanish and French), Dutch, English, Germans, Danes, Scots, and New Englanders for those species in the North Atlantic. The examination of these historical records indicate that: (a) many nations other than the Basques were involved in whaling in that part of the world to the point that their combined takes were higher than that of the Basques; (b) a conservative estimates is that European nations were responsible for the killing of about 200,000 right and bowhead whales; and, (c) the majority of the whales killed (even by the Basques) were not right but were bowhead whales. Although natural phenomena such as the “Little Ice Age” (ca. 1350-1800 CE) may have had some impact on these populations, they mostly likely affected the North Atlantic

population of the gray whale *Eschrichtius robustus* for which we found very few records despite the past widespread distribution of this species in that part of the world. We hypothesize that this may be the result of the close dependence of this species to coastal ecology that was probably greatly affected by the expansion of the ice sheets over the coastal areas of the upper North Atlantic. Also, the history of whaling in the North Atlantic is a well-researched topic but because most of the literature has been published in non-biology journals, most biologists working on past population estimates of whales for the North Atlantic are unfamiliar with such wealth of information.

The Massachusetts Right Whale Conservation Program: A Comprehensive and Collaborative Effort to Protect the Most Endangered Large Whale, the North Atlantic Right Whale, off the Coast of Massachusetts

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The Massachusetts Right Whale Conservation Program began in 1997 to reduce anthropogenic threats, especially entanglements and ship-strikes, to northern right whales off the coast of Massachusetts. Initiated by the Division of Marine Fisheries and working with many collaborators, it has become a comprehensive and successful conservation program and a model for other jurisdictions challenged to protect northern right whales. The program, in collaboration with the Provincetown Center for Coastal Studies, monitors right whale presence through aerial and vessel-based surveillance, and performs habitat analysis of whale forage providing near real-time forecasts on whale movements and residency. For the first time, right whale presence is being monitored through the use of real-time passive acoustic buoys operated by Cornell University. Sightings and acoustic detections contribute to the federal Sighting Advisory System, and when the threat of ship-strikes appears elevated, advisories are published to warn mariners. The Program conducts extensive gear research to better understand the entanglement threat posed by fishing gear by profiling fixed-fishing gear through the novel use of modeling and mini-loggers, small, archival pressure sensors attached to gear. Both have proved valuable in understanding the dynamic nature of fishing gear. The Commonwealth continues to aggressively, yet prudently, regulate fixed-gear fisheries in its waters. The use of floating groundline has been prohibited year-round in Cape Cod Bay, and other areas are likely to follow. The Program works with fishing and cordage industries to find and test “whale-safe” lines that have low profiles, but at the same time are practical, safe and economic for fishermen to use. Fishermen are now testing these lines in the field. All aspects of the program aid in the effective management of this highly endangered species and further the goals of the Atlantic Large Whale Take Reduction Plan, the Right Whale Recovery Plan, and the Endangered Species Act.

Genetic Assessment of 16th Century North Atlantic Right (*Eubalaena glacialis*) and Bowhead (*Balaena mysticetus*) Whale Bones: A Reinterpretation of Species History and Recovery Potential

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Sixteenth century Basque whaling represents the initiation of extensive commercial harvest of right (*Eubalaena glacialis*) and bowhead whales

(*Balaena mysticetus*) in the Western North Atlantic. It has been considered responsible for the greatest decline in population size of the North Atlantic right whale. However, genetic analyses of 21 16th century humeri suggested that right whales comprised a small proportion of the catch, contrasting previous evaluations of the catch data, which concluded that the historic population was reduced from 10,000 individuals. Genetic characteristics of these historic populations and the impact of whaling on genetic diversity have now been investigated using a larger sample size from a broader geographical region. Over 200 bone specimens from 13 16th century Basque sites in the Strait of Belle Isle, Canada, were analyzed. Mitochondrial species identification revealed no additional right whale bones. Microsatellite profiling suggests the sample set is composed of at least 100 bowheads that exhibit extensive diversity. Mitochondrial diversity is high, with shared haplotypes with Western Arctic bowheads, and evidence of a historically expanding population. The original right whale specimen was profiled at 27 of 35 microsatellite loci used to profile the extant population and no lost alleles were identified. Results indicate that the population from which the specimen originated was genetically similar to the population today. This is consistent with the hypothesis that right whales represented a very small proportion of the historic catch. Simulations were conducted to estimate what minimum effective population size would have been necessary to have maintained the alleles found over the last 440 years. They suggest that the population could not have dropped much below the current estimates for the extant population. A rare opportunity to compare early and post-exploitation genetic variability has provided a new view of the histories and recovery potential of both species.

Simulating North Atlantic Right Whale Entanglement: Design, Construction, and Testing of a 1/8th Scale Model

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Anthropogenic factors, mainly entanglement in fishing gear, continue to affect the North Atlantic Right whale population. To understand the process of entanglement we constructed the first known 1/8th scale model of a North Atlantic right whale based on Reynolds scaling and observed the interaction of the model with scaled fishing gear under simulated movement. The model design was derived from published morphological data, photographs, necropsy reports for whales #1004 and #2301, and personal communication. The 330 pound model was constructed using a foam core, fiberglass shell, and neoprene, which mimics integument properties. To simulate movement in the water, the model was pushed at various speeds through the water in an 8 ft deep, 12 ft wide, and 100 ft long tow tank. To simulate entanglement, a single floating mason line was used to mimic floating lines associated with pot and gillnet gear. Trials were visually recorded by an underwater video camera. At 2 m/s, the mason line ripped through the neoprene layer of the right flipper. However, with a single recorded test run into gear, a conclusion cannot be made as to the severity of the speed and line interaction. The application of this model is quintessential to the study of the North Atlantic right whale population and conservation. There are known scale models of right whales made for educational purposes, however, no model construction details have been published or shared with the public. The importance of designing such a model serves to better understand the relationship of the North Atlantic right whale and entanglement as well as to provide the first step in designing models for future research.

Requirements for Conservation Action? Small Population Size, High Site-Fidelity, Strong Associations, and Uncertainty: Pygmy Killer Whales off the Island of Hawai'i

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Despite their distribution throughout the tropics and sub-tropics worldwide, pygmy killer whales are one of the least known of the small cetaceans: most of what is known about this species comes from strandings or fishery catches. As part of a long-term research project on "blackfish" off the island of Hawai'i, we photo-identified pygmy killer whales in 34 different encounters in 13 separate years, over a 20-year span from 1986 through 2005. As this species is one of the less commonly encountered odontocetes in this area (the 11th most frequently encountered, representing less than 2% of the odontocete sightings), we hypothesized that pygmy killer whales seen off the island of Hawai'i were part of a larger population simply passing by the island. We photographically identified 92 individuals with distinctive markings, and had 92 re-sightings, 28 within-years, and 64 among-years. One individual was seen 15 times spanning a 19-year period. Given that there were likely a considerable number of births and deaths in the population over the 20-year period, the number of re-sightings relative to the number of individuals is extremely high, a rate greater than for the known small population of genetically isolated false killer whales from Hawai'i. This suggests that the pygmy killer whale population off the island of Hawai'i is very small, and shows tremendous fidelity to the island. An analysis of association patterns indicated strong and apparently long-term associations among individuals. A small number of individuals (24) were photographically identified off other islands (Lana'i and Ni'ihau), but no inter-island matches were found. The combination of small population size, high site-fidelity, strong associations, and uncertainty regarding threats put this population at risk, suggesting that efforts to determine population status are required.

Ontogenetic Development of the Skeleton in *Tursiops truncatus*

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Age estimates of individual specimens are critical in life history studies of cetaceans. Both relative and absolute aging techniques are necessary for understanding basic biology of cetacean species, including reproduction, physiology, behavior, and development. Previous studies on age have demonstrated that examination of the growth layer groups (GLGs) in the teeth of odontocetes, as well as growth layers or laminae in mysticetes, can be used to estimate absolute age of individuals. Fusion of cranial bones, vertebral epiphyses, and other skeletal elements are useful indices for estimating relative age. No comprehensive study has compared all the related age characters of a single species. We have examined all of the osteological characters that exhibit quantifiable ontogenetic development in 44 complete skeletons of bottlenose dolphins (*Tursiops truncatus*). We selected specimens for which we have complete skeletons and complementary absolute age data as determined by GLGs. We measured skull weight and morphometric parameters (condylobasal length, zygomatic width, rostral length, alveolar length), assessed cranial maturity, mandibular symphysis fusion and pulp cavity filling. In the postcranial skeleton, we examined epiphyseal fusion in the vertebrae (cervical, thoracic, lumbar, caudal) and propodial elements (humerus, radius, ulna), as well as hyoid and sternal fusion. Skeletal fusion (relative age) was then compared with GLG counts (absolute age). Several elements, such as fusion of the propodial epiphyses, correlated well with absolute age while elements, such as fusion of the mandibular symphysis and cranial maturity, are less useful in assessing the relative age of an animal. Such information is important when absolute age estimates cannot be obtained (bone fragments, lacking teeth, radiographic analyses).

Seasonal Patterns of Heat Loss in Wild Bottlenose Dolphins (*Tursiops truncatus*)

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Bottlenose dolphins use their appendages as thermal windows, allowing them to conserve or dissipate body heat. However, few direct measurements exist to clarify how wild dolphins utilize their appendages to control body temperature. Bottlenose dolphins resident to Sarasota Bay, FL experience water temperatures (T_w) that vary seasonally from 11°C to 33°C. Within seasons, we hypothesized that heat flux (W/m^2) would be higher across thermal windows than other body sites in summer and lower than or equal to other body sites in winter. Across seasons, we hypothesized that overall heat flux would decrease in winter, relative to summer, in response to decreased T_w . Simultaneous measurements of heat flux were collected at the lateral body wall (thorax and tailstock) and thermal windows (dorsal fin, pectoral flipper, flukes) of dolphins held stationary during health-monitoring events in June 2002 to 2004 ($n=38$, mean $T_w=30.2 \pm 1.1^\circ C$) and February 2003 to 2005 ($n=19$, mean $T_w=17.4 \pm 1.3^\circ C$). Within seasons, there was only one significant difference in heat flux between body sites (summer: flipper > flank, Repeated Measures ANOVA, Tukey Kramer, $p=0.0475$). Across seasons, mean heat flux values at lateral body wall sites were significantly higher in winter than in summer (Repeated Measures ANOVA, thorax: $p=0.0007$, tailstock: $p<0.0001$), despite significantly thicker winter blubber layers at these sites. There were no significant differences between summer and winter heat flux values at the thermal windows. These results suggest that bottlenose dolphins in Sarasota Bay do not necessarily respond to decreased T_w by decreasing heat loss. Higher winter heat loss rates may reflect higher metabolic rates or a thermoregulatory response to an overinsulated body wall. Alternatively, these dolphins may use mechanisms such as enhanced respiratory heat loss or shifts to cooler microclimates to dissipate body heat in summer. These mechanisms are currently under investigation. NOAA Scientific Permit #522-1569.

Heavy Metal Levels and the Basic Indicators of Oxidative Stress in Tissues of Bottlenose Dolphin (*Tursiops truncatus*) in Bahía de La Paz, B.C.S., Mexico

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In excess, heavy metals can be toxic, due to increased production of reactive oxygen species (ROS) and the potential for cellular damage. This study addresses the potential relationship between heavy metal content and the basic indicators of oxidative stress in tissues from bottlenose dolphins (*Tursiops truncatus*) in Bahía de La Paz, Baja California Sur, Mexico. Superoxide radical production ($O_2^{\cdot-}$), lipid peroxidation (measured as thiobarbituric acid reactive substances, TBARS) and enzymatic activity of superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) were measured by spectrophotometric analyses in heart, lung, liver and muscle extracts. Heavy metal concentrations (Cu, Fe, Zn, Ni, Cd) were determined by absorption spectrophotometry. Our results indicate that $O_2^{\cdot-}$ production was higher in lung than in heart, liver and muscle. Cu concentration was significantly higher in heart and liver than in lung and muscle ($p<0.05$), Fe levels were significantly higher in lung than heart ($p<0.05$) and Zn concentration was significantly higher in liver than heart, and lung. However, TBARS and SOD activity were not significantly different among tissues. A strong relationship between the content of Fe and the ROS production was found in tissues from bottlenose dolphin. These results suggest that bottlenose dolphin tissues have a highly developed antioxidant system.

Using Multibeam Sonar to Track the Underwater Behaviour of Grey Whales

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The study of marine mammal behaviour is made difficult by our inability to observe the animals underwater. This is particularly so of the large whales, which, it could be argued, are more surfacing mammals than diving mammals. Very generally, whales tend to spend 20-30% of their time near the surface, and 70-80% underwater – for example, feeding grey whales typically dive for 4 to 5 minutes, after which they surface for a minute before diving again. The time they spend at the surface is often simply to breathe and prepare for the next dive, so the interpretation of whale behaviour based on surface observations is unreliable at best. What is needed is a means of working with these animals underwater. Cameras are of limited use due to poor visibility, which even in clear tropical seas is limited to a few hundred feet (a few whale lengths). To get around this problem, we used a Reson SeaBat multibeam sonar to study the swimming biomechanics and underwater behaviour of grey whales in San Ignacio lagoon, Mexico, and Cape Caution, Canada. Biomechanical results include fluke motion and stroke frequency relative to acceleration and turning performance of the animals. Ethologically, we were able to describe three types of underwater behaviour from the lagoon: bottom-sleeping, mothers teaching calves to feed, and multiple whale behaviour which may be a reproductive display or dance. On northern feeding grounds, we used the sonar to describe the movement of whales relative to the bottom, each other and swarms of mysids, their primary prey in the area. We conclude that the multibeam sonar is a useful tool for the study of underwater whale behaviour. We note some issues with the current technology, particularly with regard to the precision of the instrument and its two-dimensional representation of the underwater environment.

Passive Moored Hydrophone Surveys for Right Whales

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Acoustic surveys for right whales were conducted using autonomous hydrophone recording instruments combined with automatic detection software. The aim of these surveys was to find right whales in locations where intense whaling once occurred but where they are now rarely found. Following the 1998 sighting of a single right whale near Kodiak Island, Alaska, in an area where only one had been seen since the 1950s, a hydrophone instrument was deployed at the sighting location (57°N 151° W) to record ambient sound for four months. Ten 'up' calls, occurring on 6 September 2000, thought to be from right whales, were found. Five additional hydrophone instruments were deployed in deep-water portions of the Gulf of Alaska in 2000-2001. After automatic scanning and manual checking of the data, 12 right whale 'up' calls were found among 88 total calls. These occurred at the westernmost site (53°N 157°W) on five different days between 7 August and 10 September 2000. Following these detections, two other projects were initiated: One on the Scotian Shelf, monitoring areas east of Brown's Bank where right whales were once hunted but where they have not been sighted recently; and one to start in 2006 in the northern Bering Sea, to survey for right whales and other endangered species. In parallel with these field efforts, lab efforts have focused on developing and optimizing algorithms for detection of right whale calls. These increase the chance of detecting faint right whale sounds in noise, and reduce the chance of false alarms; accurate detection of uncommon calls is essential for scanning these large data sets. These efforts are intended to improve our knowledge of right whale habitat needs. [Work supported by NOAA and ONR]

Fuel Selection in Fasting Juvenile Steller Sea Lions (*Eumetopias jubatus*): Are Leaner Animals the Losers?

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Juvenile Steller sea lions (*Eumetopias jubatus*) may be subject to periods of nutritional stress due to limited prey availability or poor foraging success. Four wild juveniles (17 ± 0.8 mo) were fasted and re-fed in temporary captivity in spring 2004 to examine their physiological response to an energetic challenge. Mass, morphometrics, body composition, hematology, blood chemistry and blubber thickness were monitored. Animals lost 0.5% body mass \times d⁻¹ while fasting (up to 13d). Although mean group body condition did not change, the two smaller, leaner animals (131 ± 8.0 kg and $11 \pm 0.9\%$ body fat) metabolized primarily protein whereas the two larger, fatter animals (172 ± 6.0 kg and $30 \pm 0.8\%$ body fat) utilized mostly fat. WBC, hematocrit and hemoglobin did not differ through the fasting period. Blood urea nitrogen, total protein, glucose, globulins and potassium decreased ($p < 0.01$). In contrast, albumin ($p = 0.03$) and creatinine ($p = 0.01$) increased. Ultrasound measurements indicated the site of greatest blubber mobilization to be immediately posterior to the foreflipper in all animals. Mass gain in the recovery period (up to 12d) was 0.7% body mass \times d⁻¹. Lean body mass was the primary source of mass gain, with the exception of the largest, fattest animal which gained primarily fat. The conflicting needs of maintenance energy requirements and thermoregulatory costs may lead smaller, leaner animals to sacrifice muscle mass in favor of insulatory needs. Repeated study in other seasons are required to assess the continuity of this response.

Lung Fat Embolism in Cetaceans Stranded in Canary Islands

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The objective of this study was to evaluate the presence of fat emboli in lung tissues obtained from cetaceans stranded in Canary Islands. Lung samples from 84 cetaceans of 15 different species were studied. The animals stranded in Canary Islands coast between 1995 to 2003. The tissues had been fixed in 10% neutral buffered formaline solution. Tissues samples were prefixed with osmium tetroxide. Lately routine laboratorial techniques for section and staining (hematoxylin-eosin) were made. 14 of 84 cetaceans of six different species, presented diverse lung fat embolism grades characterized by clear drops (H/E), black-stained with OsO₄ in the lumen of small and medium size of pulmonary vessels: *Kogia breviceps* (4), *Kogia sima* (1), *Mesoplodon densirostris* (1), *Physeter macrocephalus* (3), *Tursiops truncatus* (1) y *Ziphius cavirostris* (4). All these animals belong to deep and long time diving species (13/14) excepting the one *Tursiops truncatus*. The cause of stranding and/or death of the 14 positive animals were related to: Anthropogenic interactions (ship collision): 5/14; Massive strandings: 4/14; Unknown or natural causes: 5/14. According to these results, a clear association between lung fat emboli with violent trauma (ship collision) and with deep and long time diving species is observed.

Analyzing Demographic Impacts and Genetic Consequences of High Levels of By-Catch in the Franciscana Dolphin, *Pontoporia blainvillei*, in Argentina

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The Franciscana dolphin (*Pontoporia blainvillei*), endemic to the coastal waters of the western South Atlantic and the only representative of the Pontoporiidae family, is heavily impacted due to incidental captures in fishing gillnets. Between 2000 and 2005, over 170 animals have been by-caught in fisheries operations distributed across the Buenos Aires Province coastal area (management area IV, representing the southern range of the species' distribution). In order to investigate the genetic consequences of these high levels of by-catch, we evaluated differences in sex ratio and relatedness among by-caught animals. There was no significant departure from a balanced sex ratio in the group of animals considered in our study area, neither in a particular year nor across the entire temporal span of our analysis, suggesting that males and females are equally impacted from fisheries operations. However, out of twelve cases in which two individuals were found stranded in the same gillnet, eleven were pairs composed of an adult female with a juvenile. Estimates of relatedness tests using 13 microsatellite loci are being completed to determine whether by-catch is differentially impacting females with offspring or other related animals for this population. We also compared mtDNA lineage diversity and structure with the Brazil and Uruguay populations located to the north (management areas I-III). Eleven new haplotypes have been detected, compared to those previously reported for this species. Tests for population genetic structure showed significant differences between populations in the Buenos Aires area compared to those populations in Brazil and Uruguay. Our findings suggest that key aspects of the species' demography are being seriously impacted in the management area IV, which exhibits notable lineage diversity and haplotype richness. To help mitigate current threats to the species survival, the roles of integrated local and regional research and conservation are greater than ever.

Why Whales Imitate Sounds: Social Bonds or Distance Estimation?

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Cetaceans include more species that can imitate sounds than any other group of mammals. Bottlenose dolphins can imitate arbitrary sounds on command (Richards et al., 1984), and singing humpback whales copy sounds and sound patterns produced by other humpbacks (Payne et al., 1983). Most explanations of the evolution and function of vocal mimicry in cetaceans have focused on either sexual selection in the case of baleen whales, or on adaptations for individual and group recognition in toothed whales. There is an alternative possibility, however: the ability to imitate sounds may have evolved in cetaceans because this enabled them to determine the distance to sound sources more accurately. Whales may estimate the distance to a source by assessing signal degradation using acoustic cues like frequency-dependent attenuation and reverberation (i.e., environmental echoes) that are independent of both the received level and the source level. Distance estimation, or ranging, is most accurate when the listener has access to information about both environmental conditions and the sound source - familiarity with time-varying features of the undistorted source signal is critical. Ranging of sound sources based on signal degradation has yet to be demonstrated in any cetacean. However, simulations of sound propagation in shallow water environments where humpback whales sing suggest that range-dependent spectral degradation of humpback whale songs does occur (Mercado and Frazer, 1999). The ability to imitate sounds provides cetaceans with a way to rapidly represent complex acoustic features as they would appear near the source because the neural patterns necessary to produce a sound effectively smooth out environmental distortions. This means that whales can better judge the distance a sound has traveled if they can produce the sound they are hearing. The ranging hypothesis leads to the surprising prediction that cetaceans frequenting shallow waters will be better mimics than other cetaceans.

Development of Quantitative Listing Criteria for Marine

Species Under the U.S. Endangered Species Act

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The U.S. Endangered Species Act (ESA) provides little guidance to the NOAA and FWS for evaluating the magnitude of risk equating to an endangered or threatened listing. NOAA Fisheries Service (in consultation with FWS) is developing procedures to make listing decisions "more transparent, consistent, and scientifically and legally defensible." Lack of such a procedure slows listing and delisting actions with direct consequences on marine mammals, such as sea otters in Alaska, with rapidly deteriorating population health. Our process to develop quantitative listing criteria includes: (1) overarching listing definitions, (2) uniform values of policy parameters associated with the overarching definitions specified *a priori*, (3) decision metrics for proxies in data-poor cases, and (4) using simulations to evaluate the performance of alternate procedures. Three alternative overarching listing definitions are being evaluated. The *Probability of Extinction Threshold* states that a species is endangered (EN) if its probability of extinction within a specified time horizon exceeds some level. The *Depensatory Threshold* definition states that a species is EN if its abundance, area of distribution, or other relevant metric falls below some level. The *Comprehensive Threshold* definition is similar to the definition for the *Probability of Extinction Threshold*, except that the likelihood of extinction at each point in time is weighted to arrive at a comprehensive risk measure. Each overarching definition is associated with policy parameters, because their values establish the extinction risk at which society supports ESA protections. For example, the *Probability of Extinction Threshold* definition needs time (e.g., 100 years) and extinction probability (e.g., $p=0.05$) values to generate one possible listing criterion for EN. NOAA/FWS will test listing criteria performance and determine how decision metrics perform relative to management objectives over a three-year period beginning winter 2006.

Occurrence and Site Fidelity of Bottlenose Dolphins (*Tursiops truncatus*) in the Marlborough Sounds, New Zealand

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Research on New Zealand bottlenose dolphins (*Tursiops truncatus*) has been conducted primarily in two regions, the Bay of Islands, North Island and Doubtful Sound, South Island. Despite their presence in the Marlborough Sounds, northern part of the South Island, no study to date has investigated the occurrence of bottlenose dolphins in these waters. Data presented here form part of an ongoing study into the occurrence and behavioral ecology of bottlenose dolphins in this region. Photo-identification of marked individual dolphins was undertaken during 1992, 1995, and 1997-2004, using film and digital photography. Following photographic sorting for suitability based on angle, contrast, and focus, 4,500 photographs from 58 dolphin group encounters were used to develop a computerized catalogue of 279 marked individuals. Site fidelity was examined using resight rate, with sampling intervals defined by month and year. Estimated group sizes based on photo-identification and field counts ranged from 3 to

180 individuals (mean= 27m, SD=31.2), with most groups encountered containing only 8 to 12 dolphins. Most sightings occurred in water depths of 25-35m (mean=32m, SD=19.6), with sea surface temperatures ranging from 13 to 19° C. Sightings occurred throughout all austral seasons, suggesting that bottlenose dolphins utilize this region year-round. In total, 57% of catalogued individuals ($n=160$) were resighted during more than one year in the 8+ year study, with the total number of years that individuals were resighted varying from one to nine. Resights showed regular movements of bottlenose dolphins between Queen Charlotte Sound, Pelorus Sound, Admiralty Bay, and Current Basin in all seasons. Our data indicate that the Marlborough Sounds are an important part of the home range for at least a portion of this population.

Phylogenetic Analysis of Testes Size in Cetaceans: Using Primate Models to Test Predictions of Sperm Competition Theory

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We examine the size of the testes, relative to body size, in relation to mating behavior for toothed and baleen whales and interpret our findings based on predictions borne out from sperm competition theory. Data on testes sizes in 51 species of cetaceans in nine families were analyzed in the larger context of a study of sperm competition across 312 species of mammals from which robust inferences can be made about mating systems. We compared regression residuals of testes size for cetaceans with known mating systems and generated predictions for cetaceans with unknown mating systems while controlling for phylogenetic bias using CAIC (Purvis and Rambaut 1995). We found a significant and positive correlation between mean testes size and body weight. Using these data, we predicted that species with unknown mating systems and with positive residuals will exhibit mating strategies involving multiple partner matings with females and resultant sperm competition between males. In our data set, these species included Risso's dolphins, harbor porpoises and dusky dolphins, among others. In the extreme, dusky dolphins, at 8.5% maximum testes weight to body weight (Van Waerebeek and Read 1994) have the largest known relative testes among all mammals. Similarly, we predict that species with unknown mating systems and negative residuals will have mating strategies characterized by low sperm competition intensity. These species include sperm whales, Hubb's beaked whale, many balaenopterids, the baiji and the Franciscana, among others (mean testes to body weight ratios less than 0.05%). These predictions can be further tested by looking at additional correlates of mating systems, such as patterns of sexual dimorphism and morphological characteristics of sperm.

First Evidence of Nutritional Stress in the New Zealand Sea Lion (*Phocarctos hookeri*)

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Classified as a threatened species, New Zealand sea lions breed mainly on the Auckland Islands (50.5°S, 166°E) in the NZ subantarctic. Despite full protection, the estimated population of 15,000 has not increased since the mid-twentieth century. Low reproductive success through low pup production and a high neonatal mortality may be impeding species recovery. An additional hypothesis is that the species is under nutritional stress due to a diet of low energy density. The aim of this study is to quantify for the first time the diet of the NZ sea lion. Stomachs of sea lions ($n = 76$) bycaught between 1997 and 2004 by the squid fishery around the Auckland Islands were analysed. Arrow

squid (*Nototodarus sloanii*) formed the main prey by number (35%N) and by mass (37%M). Opalfish (*Hemerocoetes* spp.), a bottom living fish, was an important prey by number (31%N), while *Octopus* and hoki (*Macruronus novaezelandiae*) contributed to a major part of the diet by mass (27%M and 15%M respectively) due to their large individual mass (>1kg). Minor species were oblique-banded rattail (*Coelorinchus aspercephalus*), jack mackerel (*Trachurus* spp.) and red cod (*Pseudophycis bachus*). Even if the overestimation of the squid is obvious by the source of samples (bycatch), the arrow squid is the most abundant species in summer in the Auckland Islands shelf and it is likely to be a major prey as sea lions are opportunistic predators. The low energetic value of squid is possibly limiting growth of the sea lion population. A dietary comparison was also made with NZ fur seals from the east coast of the South Island where the population is growing: their diet consists primarily of fish not squid. Further dietary analyses using other methods like fatty acid analysis and year round scat samples are crucial to validate the nutritional stress hypothesis.

Vibration Characteristics of Vibrissae of the California See Lion: A Multifunction-Sensor

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The observation of blind but well nourished pinnipeds in the wild was one indication that besides vision other sensory information channels have to be considered for underwater orientation. Several investigations demonstrated the high sensitivity of seal vibrissae for minute water movements, enabling the animals to detect and track hydrodynamic trails. However, there is little information on the function of vibrissae as single sensory units. While there are studies on the structure and innervation of vibrissal follicles, the biomechanics of vibrissal hairs has not been studied yet. We determined the vibration characteristics of single vibrissae in a water-flow channel. Mechanical vibration induced by vortex abscission was detected with a piezo-electric force transducer and analyzed via FFT-algorithm. The correlation between flow velocity and signal frequency was analyzed under various attack angles. For vibrissae a piecewise linear correlation between these parameters was found, suggesting that these hairs are suitable for measuring velocities. In contrast, an elastic, one-sided fixed, cylindrical body passing through its eigenfrequencies shows a step function and thus would be inadequate for this purpose. Further measurements indicate that water flow disturbances can be measured using this kind of hair-sensor. This could enable a sea lion to detect the vorticity in the hydrodynamic trail of swimming prey. Thus, sea lion vibrissae represent multifunctional sensors not only for tactile stimulation, but also for the detection of flow velocity and hydrodynamic trails. These hair properties could be used in bionic applications for single component technical sensors.

Playbacks of Simulated Vessel Approaches Elicit Differential Responses from Manatees

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One of the most pressing concerns associated with the endangered Florida manatee is mortality due to collisions with watercraft. Watercraft collisions are the leading identified cause of manatee mortality, resulting in 25-30% of deaths each year. The primary management tools aimed at reducing mortality have been establishing zones where boat speed is regulated and limiting boat access in certain areas. The successful establishment and management of boat speed regulation zones and manatee sanctuaries depends upon the acquisition of data assessing behavior patterns, habitat-use patterns, and

identification of environmental characteristics influencing manatee behavior and habitat selection. Detailed information on manatee distribution, behavior patterns, and habitat-use during non-winter months is sparse compared to the amount of knowledge and number of studies at winter aggregation sites. Acoustic playback experiments were conducted to assess the behavioral responses of manatees to watercraft approaches in shallow-water environments during the non-winter season. Playback stimuli were constructed to simulate a vessel approach to approximately 10m in seagrass habitats. Stimulus categories were 1) silent control, 2) approach with outboard at idle speed, 3) planing outboard approach, and 4) fast personal watercraft approach. Analyses of swim speed, changes in behavioral state, and respiration rate indicate that the animals respond differentially to the playback categories. The most pronounced responses, relative to the controls, were elicited by the personal watercraft. All subjects showed a visible response to the personal watercraft stimuli, and the most common response (68%) was a fast swim directly away from the playback vessel towards deeper water. An increase in ventilation variability was also observed in response to both planing outboard and personal watercraft approaches. Quantitative documentation of response during playbacks provides data that may be used as the basis for future models to predict the impact of specific human activities on manatees and other marine mammal populations.

The Effects of a Shift in Herring Fishery Gear-Type on the Abundance of Two Species of Baleen Whales off Eastern Maine

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Atlantic herring (*Clupea harengus*) are an important commercial resource and key forage species for many upper-trophic-level predators in the northern Gulf of Maine. Over the past decade the herring fishery has undergone substantial transformation from a primarily purse-seine fishery to a predominance of mid-water and pair-trawl vessels. There has been little documentation reflecting changes in fishing gear type having a direct correlation to cetacean presence. With data collected from local whale watch vessels from 1995 to 2004 we have seen a notable decline in humpback (*Megaptera novaeangliae*) and fin (*Balaenoptera physalus*) whales off the Inner Schoodic Ridges. The mean number of humpback and fin whales reported per-trip from a commercial whale watch was 6.57 for the years 1995-1999 when trawl effort was minimal, declining significantly to 3.98 for 2000-2004 ($t = 13.69$; $p < 0.001$) coincident with the increase in trawl effort. An inverse relationship was identified between the number of large whales per-trip observed from 1995 to 2004 and regional trawl effort ($r^2 = 0.61$; $F = 12.43$; $p = 0.0078$). This relationship was more pronounced in the more piscivorous humpback whales ($r^2 = 0.54$; $F = 9.36$; $p = 0.016$) than in fin whales ($r^2 = 0.61$; $F = 3.49$; $p = 0.099$), which have been shown to feed on a lower trophic level. In contrast, landings of herring were not significantly related to whale sightings ($p > 0.05$). This suggests that the relationship between fishing effort and the presence of whales is a function of the gear type. While the mechanism for this is not clear, trawl fishing is believed to increase the efficiency of fishing vessels in locating and landing herring schools in concentrated areas, presumably removing a greater percentage of fish from a school than seine gear and leaving less for other predators.

A Hearing Test for Dead Odontocetes: What Cadaver Ears Can Tell Us About Dolphin Hearing

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In this study, material properties and tissue mechanics measured from

cadaver odontocete ears are used to predict general hearing capabilities for *Tursiops truncatus*. Stiffness measurements of the middle ear and cochlear partition of cadaver bottlenose dolphins were made using piezoelectric force probes in fresh, fixed and frozen/thawed specimens. The acoustic stiffness of the dolphin middle ear was measured to be 1.04×10^{17} Pa/m³. In terrestrial mammals, correlation between middle ear acoustic stiffness and low frequency cutoff of hearing threshold can be expressed according to the function $f_c = 1.02 \times 10^{-6} \cdot k^{0.58}$ where f_c is the 20 dB cutoff frequency and k is the acoustic stiffness of the middle ear. Using the middle ear stiffness value measured for bottlenose dolphin in the above equation yields f_c of approximately 7.56 kHz, which is close to value of 8 kHz obtained from inspection of the behavioral audiogram. Stiffness gradients along length of basilar membrane in bottlenose dolphin were measured for three ears from three different animals. Point stiffness was converted to volume compliance for comparison to terrestrial species. Estimates of bottlenose dolphin frequency-place map based on the behavioral audiogram and cochlear anatomy reveal that for a given characteristic frequency, the volume compliance of the bottlenose dolphin basilar membrane is similar to that of terrestrial species with good high frequency hearing. In short, there is a correlation between middle ear stiffness and low frequency hearing cutoff as well as a correlation between basilar membrane volume compliance and frequency-place map. Using these correlations it should be possible to predict the low frequency cutoff and frequency-place map of odontocete species for which no behavioral audiogram exists.

Hearing by a Harbor Porpoise During Echolocation: Auditory Brainstem Recordings (ABR)

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The biosonar signals of harbor porpoises are brief and narrow bandwidth pulses (about 100 μ s with a center frequency of about 130 kHz). One of our objectives was to study the hearing of a harbor porpoise during echolocation using the ABR technique. Experiments were conducted on a male porpoise in collaboration with Fjord & Bælt (FB), Kerteminde, Denmark. The animal had suction cups containing silver electrodes placed near the blowhole and near the dorsal fin. When fitted with the electrodes he moved to an underwater listening post where his outgoing sonar signal could be used to trigger a "phantom echo". Neural activity was amplified differentially and averaged over a variable number of presentations depending on trial duration and experiment. For studying the frequency/intensity response, "narrow band" pulsed stimuli were used in a "passive" hearing task, when a signal generator triggered the "echo", and in an "active" echolocation experiment, where the "echo" was time locked to the animal's emitted signal. Such stimuli were used to determine frequency/intensity responses and how noise influences these, stimulus delay, temporal resolution and auditory filter properties. Our results suggest greater neural activity or higher degree of synchronization at frequencies near the center frequency of the animal's own echolocation signals with a slight, but significantly higher response during "active" echolocation. The latter may have a methodological explanation. The responses shift linearly with applied noise. The amplitude of the ABR did not change as a function of echo delay. The temporal integration time is comparable to signal duration (about 100 μ s), and in the frequency range between 80 kHz and 160 kHz, the auditory filters are broadly tuned. We acknowledge the expert assistance from the FB trainers, and support from the Danish Research Council for Natural Sciences and the Office of Naval Research.

The Communication Capacity of Sperm Whale Echolocation Clicks

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Based on their apparent lack of directionality, Watkins (1980) proposed that regular clicks of sperm whales serve primarily as communication signals, but recent work now solidly supports an echolocation-based foraging function. Here we describe acoustic features of foraging clicks produced by one acoustic-tagged whale as recorded by a tag attached to another whale during simultaneous dives to 500 m after they "fluked-out" together in the Gulf of Mexico. 3-D tracks were estimated using dead-reckoning from orientation and depth sensors, and checked against the inter-whale distance calculated using the timing of click arrivals between the tags. Received foraging clicks contained a host of potential communication information. **Range:** in addition to the direct-path arrivals, surface and occasionally bottom bounces (in 800-1000 m water) were detected, which encode inter-animal range. **Movement:** the relative amplitude of the direct path and surface/bottom bounces were modulated by the clicking whale's pitch and orientation relative to the receiving whale, as was the click inter-pulse interval (IPI) structure. **Identity:** IPI's indicate body size and could aid individual identification. Source whale orientation altered IPI structure strongly, but an IPI corresponding to body length (measured by photogrammetry) was apparent when the source whale was oriented toward the receiving whale. The effect of pressure on the IPI of 406,500 clicks from 20 other tagged sperm whales was minor (2-4% depending on dive depth). **Behaviour:** 3 of 18 prey-capture "creak" buzzes were detected at the other whale at ranges of 105-410 m, suggesting a smaller active space than features of regular clicks. Sperm whale foraging echolocation clicks encode important information on the status of the clicking animal, though such information transfer may not necessarily be intended. The two whales in this study re-approached during ascent, suggesting they did use the communication capacity of echolocation clicks to aid their social synchrony.

Heart Rate is Not a Good Predictor of Metabolic Rate in Foraging Grey Seals

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Heart rate is often used as an indirect measure of metabolic rate in free-living marine mammals. Being able to use heart rate (f_H) to predict oxygen consumption (VO_2) relies on a close relationship between the two variables over a range of different activities and conditions, especially during those that are representative of those in the natural environment. We examined the relationship between f_H and VO_2 in 4 grey seals during voluntary diving in a quasi-natural setting. We looked at the effect of food intake, exercise, diving and varying temporal scale on the power of f_H to predict VO_2 . On a dive-by-dive and hour by hour basis, as average heart rate increased, there was also a significant increase in VO_2 . On a dive-by-dive basis, the nature of this relationship varied depending on whether the dives were classified as foraging dives or non-foraging dives. On both a dive-by-dive and hour-by-hour basis there was a large amount of both within and between individual variation. Behavioural variables such as dive duration and swim speed explained more of the variation in VO_2 than did heart rate. Given the extent of the variation in the f_H/VO_2 relationship we suggest that this technique may be of limited use in predicting the energy expenditure of wild grey seals and that models relating behaviour to energy expenditure may be of more use.

Marine Mammal *Salmonella*: A Comparison with Invertebrate, Domestic Animal, and Human Isolates

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Salmonella bacteria cause diarrheal disease in animals and humans under certain combinations of microbe, host, and environmental conditions. A number of fecal pathogens of public health importance have been documented in California marine mammals, but whether these pathogens are commonly spread from terrestrial to marine environments is unclear. We hypothesized that if fecal pollution is flowing from terrestrial to marine ecosystems, then the same *Salmonella* fingerprints may be detected in *Salmonella* from aquatic wildlife and invertebrates as is seen in terrestrial wildlife, domestic animals, and humans living in coastal California counties. To test this hypothesis, a variety of marine and terrestrial animal species were tested for *Salmonella* spp. by fecal culture, with isolates further characterized to detect patterns of antimicrobial resistance and unique pulsed-field gel electrophoresis (PFGE) chromosomal fingerprints. In 1999-2000, *Salmonella* prevalence averaged 4% (9/212) for the following species: California sea lions, harbor seals, northern elephant seals, and southern sea otters represented marine mammals; common murre, western grebes, common loons, western gulls, and surf scoters represented marine birds; and barn owls and northern harriers represented terrestrial birds. *Salmonella* isolates from 1999-2000 were compared with 2002-2004 isolates that included *Salmonella* from marine mammals, nearshore invertebrates, terrestrial animals, and humans. *Salmonella* serotypes included *Anatum*, *Enteritidis* Group D, *Heidelberg*, *Johannesburg*, *Montevideo*, *Newport*, *Ohio*, *Reading*, *Saint Paul*, *Typhimurium*, and 4,5,12:1 Monophase. Based on chromosomal fingerprints, there was not a predominant unique strain of *Salmonella* isolated from marine mammals that was also isolated from aquatic invertebrates, terrestrial animals, and humans. Extensive antimicrobial resistance was observed in some terrestrial *Salmonella* isolates but not in marine mammal isolates, suggesting that either the resistant strains are not spreading widely from terrestrial to marine populations, or that functional antimicrobial resistance genes may be lost once selection pressures such as exposure to antimicrobial drugs are removed.

Social Organisation of Short-Beaked Common Dolphins (*Delphinus delphis*) in the Northeast Atlantic Revealed by Microsatellite Loci and Mitochondrial DNA Sequences

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Short-beaked common dolphins in the northeast Atlantic form groups varying in size from few to hundreds of individuals. Social structure is unknown but is likely to be complex and may be characterised by age and sex segregation during the non-mating period, although results from a previous study in this area suggest promiscuous mating and sperm competition. In this study we describe the use of molecular markers to investigate the extent of genetic relationship between different age/sex classes of individuals that were accidentally caught in fishing nets in the Celtic Sea ($n=76$) and the English Channel ($n=20$) or live mass-stranded on the Irish coast ($n=9$) between 1996 and 2003. Nine newly isolated microsatellite loci and a 347bp fragment of the mitochondrial DNA control region were used for population structure analysis, parental assignment and genetic relatedness estimates. No deviations from Hardy-Weinberg expectations were observed at any locus and the lack of evidence for genetic differentiation between the Celtic sea and the English Channel indicate that animals from the two areas belong to the same population. High polymorphism of both nuclear and mitochondrial markers indicated dispersal of both sexes. Average relatedness estimates (R) within groups of animals caught together were not significantly higher than between groups. Same age class individuals caught in the same net appeared to be randomly related to each other and rarely shared the same mitochondrial haplotype. However comparisons between sex classes revealed that groups of males show significantly higher R values than groups of females. Our findings support the hypothesis of a fluid social

organisation. High dispersal rates and social affiliation between non-kin appear to be important factors in determining patterns of social structure in this population of common dolphins where promiscuous mating and sperm competition may occur.

Migrating Elephant Seals Minimize Both Time and Energy Costs During Foraging Dives

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Female northern elephant seals, *Mirounga angustirostris*, make two long-distance foraging migrations per year in the northeastern Pacific. For efficient travel and foraging, they must modulate swim speed, body angle and locomotory activity while traveling horizontally to prey patches and while diving vertically to capture prey. Recent studies showed that elephant seals and other marine mammals use prolonged gliding during descent to reduce energetic costs. Data, however, addressing cost-efficient diving during the course of long-term migration are lacking. We attempted to shed light on this issue by attaching acceleration data loggers (W-PD2GT; Little Leonardo, Co., Tokyo) to two female elephant seals, programming them to record fine-scale movements such as stroke cycle frequency and body angle for two weeks from their rookery in central California. Stroking during dive descent was significantly more frequent than expected, relative to gliding, despite its higher energetic cost. We show that higher stroke frequency was used to increase horizontal speed during U-shaped transit dives and was used to increase vertical speed during W-shaped feeding dives. These results lead us to conclude that a cost-efficient diving strategy during migration incorporates time as well energy savings.

Organochlorine Pesticides, Polychlorinated Biphenyls, Polybrominated Diphenyl Ethers, and Polycyclic Aromatic Hydrocarbon Levels in Dolphins from the Indian River Lagoon, FL and Charleston, SC

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The high toxicity and long environmental half-lives of persistent organic contaminants (POCs), including organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) in coastal environments pose significant concern. We measured 71 PCB congeners, 20 pesticides, and 6 PBDE contaminants in 72 blubber biopsy samples collected in 2003 during a capture-release health assessment study from dolphins in the Indian River Lagoon (IRL), FL and Charleston (CHS), SC. A subset of 6 samples from these sites was analyzed for polycyclic aromatic hydrocarbons (PAHs). Mean concentrations of PCBs were similar among the two sites and highest in male dolphins and lowest in females of reproductive age (≥ 7 yrs). Total DDT was greater for all CHS dolphins (22,570 ng/g) compared to IRL dolphins (19,755 ng/g) but age categories comparisons were similar to the PCB data. CHS animals had higher total PBDEs in their blubber tissue although the distribution pattern of blubber PBDEs congeners (28, 47, 99, 100, 153, and 154) were similar among dolphins at both sites with 4 congeners (PBDE100 > PBDE154 > PBDE99 > PBDE47) comprising 98% of all PBDEs. Male CHS dolphins had mean PBDE concentrations of 2,994 ng/g lipid ($\pm 1,193$ SD) compared to 1,275 ng/g lipid (± 855 SD) in IRL male dolphins. Adult females in both sites had the lowest PBDE concentrations. Juvenile CHS dolphins, both females and males, had 3-4X higher concentrations than IRL juveniles with the juvenile male dolphins near the same levels as in adult males, which are among

the highest levels found in marine mammals. PAH concentrations ranged from 2.4-5.6 ug/g lipid. The high body burden of complex mixtures of POCs including PCBs, DDT, DDE and PBDEs carried by these populations of dolphins and the known toxicities of many of these compounds may pose a significant health risk.

Why are Marine Mammals Considered to be Useful Bio-Indicator for Monitoring Marine Environment?

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Marine pollution caused by hazardous chemicals (e.g., organochlorine compounds, organotin compounds, heavy metals and radionuclides) is very severe global environmental issue in the world. Since the late 1960s mass die-off of marine mammals has been often occurred in the closed aquatic areas in the Northern Hemisphere. Pathological disorders were observed in Baltic grey and harbour seals, in striped dolphins from the Mediterranean Sea, and in beluga whales from the St. Lawrence Estuary. Impairment of immune system made by some hazardous chemicals is considered to be primary cause of death. Especially both Baikal and Caspian seals are exposed into the severe environmental condition. It was reported that in mass die-off of these seals, canine distemper virus infection was identified by serological and genetic examination. We examined an hemagglutination-inhibition (HI) test in sera samples of seals using H1-H15 reference influenza A viruses deposited in Department of Disease Control, Hokkaido University, Japan. We detected antibodies to the following influenza viruses: (1) A/Bangkok/1/79 (H3N2) in 28 of 77 Caspian seals (36%) collected from Caspian Sea in 1993 and 2000, (2) both A/Aichi/2/68 (H3N2) and A/Bangkok/1/79 (H3N2) in 1 of 7 Baikal seals (14%) collected from Lake Baikal in 1998, and (3) both A/Aichi/2/1/68 (H3N2) and A/seal/Massachusetts/1/80 (H7N7) in 1 of 6 ringed seals (17%) collected from Arctic Ocean in 1995. These viruses are known to cause widespread outbreak in the world and suddenly disappear from the human beings. We expect that epidemics often occur when viruses evolve into more virulent strains as they move from these marine mammals to the humans. We propose that systematic monitoring survey for pollution of hazardous chemicals in the marine environment using marine mammals and for their health should be established as the international research project.

Have North Pacific Killer Whales Switched Prey Species in Response to Depletion of the Great Whale Populations?

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Springer and colleagues hypothesized that the decrease in populations of pinnipeds and sea otters in the North Pacific Ocean was caused by increased predation by killer whales. This increase was supposedly due to the depletion of whale populations as a result of post-World War II whaling. We describe the rise, expansion, and decline of whaling during the latter half of the 20th century, and present data that refute the belief that large baleen whales have ever been a large part of the diet of killer whales. North of 50°N, whaling increased from 1946 to 1953, remained relatively stable from 1954 to 1962, and then increased sharply from 1963 to 1967 with a peak in 1964. After that there was near total drop-off as the whaling fleets moved south. The maps presented by Springer et al. masked the nature of the slow development and precipitous decline of whaling. The extraordinary biomass removals in the early 1960s would lead one to assume that any whaling related prey shifting should have started by 1968, not the mid-1970s as they suggested. The historical record indicates that killer whales rarely attacked healthy adults of the large rorquals, and that such attacks were usually unsuccessful. Between 1948 and 1967, remains of baleen whales were found in only 3 of 400 killer whale stomachs, even though at least 100 of those killer whales

had some mammal remains in their stomachs. The gray whale population was not depleted by post-war whaling, and was at a high level (10,000-12,000 adults) at the end of the whaling period. Therefore, gray whales have always been available as prey for killer whales. Studies by Black, Matkin, and Barrett-Lennard are showing that killer whales regularly attack gray whales during spring migrations, when calves are the primary victims.

Oceanographic Conditions Associated with the Distribution of Burmeister's Porpoise, *Phocoena spinipinnis* (Cetacea: Phocoenidae)

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Historical data (1965-2000) of temperature, salinity, and dissolved oxygen (0 and 50 m) were analyzed to understand the seasonal variability of the oceanographic conditions associated to the distribution of *P. spinipinnis* from Paita - Peru to Santa Catarina - Brazil. The analysis of historical data showed that the variability of historical average are associated to different process in function of the geographical position and the seasonality, with seasonal, inter-annual, and decadal fluctuations. These perturbations have different expressions in each coast in function of the system of circulation in each ocean. The characterization of the oceanographic conditions showed that the north boundary of the distribution of *P. spinipinnis* for Pacific coast in Paita (5°S) is coincident with the turn toward the west of the Humboldt Current, and it is incorporated to the Equatorial current. However, in the Atlantic coast the north boundary seems associated to Atlantic Subtropical Convergence (30° - 40°S). This would explain the occasional presence of *P. spinipinnis* in Brazil, two in 1986, and one in 2000, they were coincident with the intrusion of colder and less saline waters toward to the north. Based in the result we propose three oceanographic areas associated with the distribution of *P. spinipinnis*: (1) from Paita to south of Arauco Gulf (Chile), which has the influence of Humboldt Current, and oxygen minimum zone; (2) from south of Arauco Gulf to South of La Plata River, which present the influence of Cape Horn and Malvinas currents (downwelling process, and freshwaters contributions from fjords, glaciers and rivers); and (3) from La Plata River to Santa Catarina is characterized by the influence of Brazil Currents, and the freshwater contributions of the hydrographic basin of La Plata River and the estuarine system of Patos Lagoon. Probably, the presence of the OMZ is an important factor in the separation in two groups of the Chilean coast.

A Novel Approach to Assessing Oxidative Stress in Wild Bottlenose Dolphins, *Tursiops truncatus*

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Oxidative stress has been implicated in a number of human diseases, both acute and chronic, and is fundamental to pathogenesis. The products of nonenzymatic peroxidation of prostaglandins, e.g., F₂ isoprostane, serve as well established biomarkers of oxidative stress *in vivo*. Accordingly, urinary F₂ isoprostane concentrations were

determined as a measure of oxidative stress in two wild dolphin populations. Urine samples were collected from dolphins during capture-release health assessment studies conducted in Charleston (CHS), South Carolina and the Indian River Lagoon (IRL), FL. Urinary 8-isoprostaneF₂ (8-iso-PGF_{2α}) was measured by gas chromatography-negative ion chemical ionization mass spectrometry incorporating a deuterated internal standard in 32 dolphins from waters off CHS and 11 from the IRL. Urinary isoprostane concentrations in samples from CHS dolphins yielded a mean of 0.4271 (±0.2055 S.D.) ng/mg creatinine, and ranged from 0.1500 to 1.2567 ng/mg. The corresponding values for IRL dolphins were a mean and standard deviation of 0.4463 (± 0.1841 ng/mg) ranging from 0.2201 to 0.8591 ng/mg. These findings serve as the first report of urinary isoprostane levels in free-ranging bottlenose dolphins. Evidence implicating free radicals in the pathogenesis of a number of human diseases has led to quantification of isoprostanes as markers of risk. While normal isoprostane values have yet to be assessed in marine mammals, the results from this study will contribute to possible correlations with gender, age, site and other health parameters to determine its value in environment risk assessment. Measurements of isoprostanes may provide a valuable and non-invasive approach to defining oxidative stress in marine mammal and other wildlife populations.

The Behavior of Commercial Ships Relative to Right Whale Advisory Zones in the Great South Channel During May of 2005

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Ship collision is a major mortality threat to the endangered North Atlantic right whale. To mitigate this threat, NOAA Fisheries initiated the Right Whale Sighting Advisory System (RWSAS) that designates advisory zones (AZs) around right whale sightings. The program's goal is to have large ships route around or slow down when transiting AZs, thereby reducing collision risk. The efficacy of the program has not been evaluated because of difficulties documenting ship behavior. The United States Coast Guard's Automatic Identification System (AIS) is a newly created VHF tracking system that sends information about a ship's speed, heading and position to other vessels and shore-based stations. Combining AZs and AIS data provided a mechanism to quantify and assess ship behavior. AIS data for the Great South Channel region was analyzed for May, 2005, concurrent with NOAA's identification of a number of advisory zones. We used a GIS to map and analyze 40 AIS vessel tracks. Two analyses were conducted: a visual inspection for signs of rerouting, and a statistical summary of a vessel's speeds in and out of AZs. If vessels did not reroute (*i.e.*, steer around the AZs), we looked for indications that vessels reduced speed or slowed to the 12 knots recommended by the RWSAS. We found one instance where a vessel might have rerouted and slowed (18.8 to 13.9 kts), and one where a vessel slowed to below 12 kts (17.4 to 10.6 kts). 95% (38/40) of the ships showed no behavior change. Data suggests that RWSAS information was not adequately received, or responded to, by vessels. Data also suggests that conservation goals are not being met, emphasized by the loss of seven right whales since November, 2004; one in proximity to the study area. Improvements in information dissemination and/or incentives for compliance should be considered.

Are There Genetic Benefits from Mate Choice in Marine Mammals?

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Benefits from female multiple mating are easy to understand in species where males provide resources to females because material benefits are often conspicuous. However, in many species, including in marine mammals, females appear to gain nothing more from mating than the male's sperm. For these species it is assumed that females derive genetic benefits from multiple mating and mate choice. We are using large genetic and behavioural databases for Weddell seals (*Leptonychotes weddellii*) and Indian Ocean bottlenose dolphins (*Tursiops aduncus*) to investigate whether female marine mammals gain genetic benefits from multiple mating and mate choice. We are combining microsatellite DNA markers and major histocompatibility complex (MHC) genes with modern analytical approaches to test the heterozygosity and genetic diversity hypotheses. If females are found to exert choice, we will attempt to identify the strategies employed by females to maximize offspring heterozygosity and to assess the two proposed roles of the MHC in mate choice. Preliminary results based on microsatellite loci found no evidence that female seals and dolphins were selecting genetic dissimilar partners or more heterozygous males.

Potential Effects of Diminished Sea Ice on Open-Water Swimming, Mortality, and Distribution of Polar Bears during Fall in the Alaskan Beaufort Sea

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The Minerals Management Service Bowhead Whale Aerial Survey Project has recorded 329 sightings of 852 polar bears (*Ursus maritimus*) during flights over the Alaskan Beaufort Sea and associated coastlines since 1979. Since 1992, the average latitude of sightings is 62 km further south and the average longitude is 130 km further east than in previous years. Proportion of observations associated with ice has declined, whereas proportion of observations associated with land and open water has increased. From 1979-1991, polar bears tended to be dispersed across the region, and were frequently observed near the leading edge of annual pack ice or swimming among ice floes along the shelf break. Since 1992, observations have been dominated by bears swimming near shore, or resting on barrier islands or the mainland coast near Kaktovik. These observations may be at least partly explained by the tendency for bears to be associated with bowhead whale carcasses in the Kaktovik area and a lengthened open-water period, forcing the bears onshore to await fall ice formation. During aerial surveys in early-September, 2004, an unusually large number of polar bears were seen swimming > 2 km offshore near Kaktovik. Subsequently, polar bear carcasses were seen floating offshore. Extrapolation of survey transect data suggests that on the order of 40 bears may have been swimming and that many of those probably drowned as a result of rough seas caused by high winds. We speculate that mortalities due to offshore swimming during late-ice (or mild ice) years may be a relatively important and unaccounted source of natural mortality given energetic demands placed on individual bears engaged in long-distance swimming. We suggest that drowning-related deaths of polar bears may increase in the future if the observed trend of regression of pack ice and/or longer open water periods continues.

Modeling Haul-Out Site Selection in Harbor Seals

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Animals are expected to spatially distribute themselves non-randomly and select the most appropriate habitat to suit their immediate needs of reproduction, foraging and predator avoidance. Therefore, observing the ways that animals use heterogeneous space is central to

understanding their ecology. Pinnipeds haul-out on land or ice to rest, bear and rear their pups and molt. As these behaviors are fundamental to life history there are likely to be strong preferences for specific features of haul-out sites. Habitat selection studies of marine mammals commonly use satellite telemetry data to understand space use in the aquatic environment. However, for species of pinnipeds that are easily observed while on land, techniques aside from telemetry can be employed to research terrestrial habitat selection. In this analysis I used aerial survey data from April, June, August and October to count harbor seals at their haul-outs in central and lower Cook Inlet, Alaska. I then modeled haul-out site selection based on a series of environmental features. I converted the data into a raster based Geographic Information System (GIS) with values in each cell for seal abundance, bathymetry, sea-bed type, proximity to anthropogenic disturbance, substrate, wave exposure and prey availability. As seal abundance and several environmental features varied temporally, four separate models were developed to account for conditions specific to each survey month. I compared the observed haul-out sites with areas devoid of seals and found that the distribution of haul-out sites was most consistent with logical predictions that seals would avoid areas high in anthropogenic disturbance and aggregate near available prey. The seals also preferred offshore haul-outs, such as rocks and reefs, and avoided areas prone to high degrees of wave exposure. This study identifies likely harbor seal habitat and may have practical applications in assessing potential exposure to industrial accidents such as oil spills.

Neuroanatomy, Brain Volume Estimates, and Pathologies of Cetaceans and Pinnipeds from Magnetic Resonance Images

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Thyroid hormones (TH) play an integral role in neuro-development, particularly in the maturation of the corpus callosum, cerebellum, hippocampus, and inner ear. In rodents, it has been shown that persistent organic pollutants (POPs) interfere with TH signaling and cause hearing and cognitive deficits. These pollutants are widespread in the marine environment and bioaccumulate in marine mammals to very high levels. Hence, there is concern that some POPs may affect neuro-development in these animals. However, little is known about the variability of absolute and regional brain size within or among marine mammal species. We are using magnetic resonance (MR) imaging to better understand brain size variability in cetaceans and pinnipeds. The benefit of this technique is the non-destructive and non-invasive acquisition of external and internal brain structure data, which minimizes dissection artifacts and allows more accurate determination of regional brain shapes and sizes. Our research plan is to obtain total brain, hippocampus, cerebellum, and corpus callosum sizes (volume or area), as well as brain concentrations of PCBs, PBDEs, and their hydroxylated metabolites, in order to test the hypothesis that neuroanatomical alterations are seen in animals with high levels of thyroid hormone disrupting chemicals. We have devised a detailed procedure for MR imaging of the brain intact within the skull shortly after death. The data collected from these images have been extremely useful in identifying gross pathologies of the central nervous system in three common dolphins (*Delphinus delphis*) and one Atlantic white-sided dolphin (*Lagenorhynchus acutus*). The data have also given insight on the comparative neuroanatomy of brains in aquatic mammals, particularly larger hippocampal volumes in pinnipeds compared to odontocetes. In this presentation, we report regional brain volume estimates and various pathologies for one harbor seal (*Phoca vitulina*), one grey seal (*Halichoerus grypus*), eight common dolphins, and eight Atlantic white-sided dolphins.

Predicting Noise Induced Threshold Shifts in a

Bottlenose Dolphin: Effects of Noise Duration, Intensity, and Frequency

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Anthropogenic noise in the ocean is increasing from such influences as shipping, drilling, sonars and ocean exploration. Marine mammals, being adapted to utilizing sound in the ocean, are consequently of particular concern regarding the effects of this noise. Several recent marine mammal strandings have been definitively linked to anthropogenic noise induced events. One method to test the effects of loud sounds on marine mammals is to temporarily induce hearing threshold shifts (TTS) and thus predict permanent levels of threshold shift. This investigation explores the effects of octave-band noise, from 4-8 kHz, on the hearing of a bottlenose dolphin (*Tursiops truncatus*). Sound pressure levels (SPL) were increased from 160 to 172 dB re:1 μ Pa and time of sound exposure was decreased from 30 to 1.8 minutes to measure the effects of duration and intensity. To rapidly examine the effects of noise on frequency and map recovery, auditory evoked potentials were used to measure hearing thresholds at 5.6, 8, 11.2, 16, and 22.5 kHz at 5, 10, 20, 40, and 80 min post-noise exposure. Threshold shifts were dependent on frequency, with maximum shifts of 7-12 dB at 11.2 and 8 kHz. Five-point-six and 16 kHz had progressively less shift, and 22.5 kHz had minimal to no shift. Recovery time depended on shift and frequency, but full recovery was relatively rapid, usually within 20 and always within 40 minutes. As exposure time was halved, the same amount of TTS occurred with an increase in noise SPL of 3 dB. Thus, to induce TTS in a bottlenose dolphin with octave-band noise, there appears to be an inverse relationship of exposure time and SPL. This relationship may be used to predict the level of TTS that will occur if the intensity and duration of noise exposure are known.

Morbidity and Mortality of Chronically Entangled North Atlantic Right Whales: A Major Welfare Issue

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Since 1986, 6/64 right whales entangled in fishing gear have died. Thirty-five were disentangled or shed gear on their own. Death is presumed, if not sighted for 6 consecutive years, in at least 5 more cases. At least 12 cases are believed (as of 06/2005) to continue carrying potentially life-threatening entanglements. Of 17 entanglements not passively shed between 1999 and 2005, the average duration was at least 10 months. Chronically entangled whales lose weight, so when they die they sink: thus gear-induced mortality is underestimated more than ship kills. Often the animal is wrapped up in serial loops of rope (and sometimes net), with gear in the mouth, or around the flipper, body and tail stock. If the gear is anchored to the bottom, has a heavy weight hanging off the animal or is fixed in more than one place on the body, as the animal flexes to swim, the wraps of gear cinch increasingly tighter. This results in major progressive constriction and tissue damage. Histologically, constrictions are walled off with fibrosis and may include woven bone proliferating from the periosteum of underlying bones. Inflammation is absent to a remarkable degree. Computer tomographs of a chronically entangled flipper show a sequestered wedge of necrotic bone in the radius. In a growing whale the gear was tightly wrapped around both flippers and across the back so that part of the dorsal blubber coat was peeled back by the incising rope. In others, line with trailing gear, that has been wrapped around the tail for long periods of time, has cut in to the leading edge of the flukes and peduncle, eventually cutting in to major arteries. Thus gear entanglement is a major animal welfare issue as well as being an obvious conservation

concern for this critically endangered population.

Trends in Sea Ice Cover Within Habitats Used by Bowhead Whales in the Western Arctic

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Trends in sea ice cover over 24 years (1979-2002) was examined in four months (March, June, September and November) for 4 large (~100,000 km²) and 12 small (~10,000 km²) regions of the western Arctic, based on habitats used by bowhead whales (*Balaena mysticetus*). Significant reductions in ice cover were identified in eight regions of seasonal importance to this ice-adapted species. In large regions, increases in open water occurred during March in the East Siberian Sea (0.04% per year, $P = 0.003$) and during September in the East Siberian, Chukchi and Beaufort seas (0.71 to 1.29% per year, $P = 0.06$ in each test). In small regions, significant increases in open water occurred during: (1) June, along the northern Chukotka coast, near Wrangel Island and along the Beaufort slope; (2) September, near Wrangel Island, the Barrow Arc and the Chukchi Borderland; and (3) November, along the Barrow Arc. Bowhead whales have been observed feeding in, or oceanographic models predict prey entrainment to, each of these regions. Conversely, there was no change in sea ice cover in four small regions that represent wintertime refugia in the northern Bering Sea, nor in two regions that include the primary springtime migration corridor in the Chukchi Sea. The effects of sea ice loss on biophysical processes leading to bowhead prey has not been studied, so there are no empirical measures of impact. However, consistent shifts to longer (*i.e.*, June to November) ice-free or light-ice conditions in regions where bowhead whales feed likely extends foraging time and may alter prey composition and availability. This evaluation of sea ice cover at spatial and temporal scales linked to bowhead whale natural history provides a basis for research on specific regions critical to investigation of the effects of climate change on this pagophilic species.

Underwater Calling Depth of Harp and Weddell Seals

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Because the irregular undersurface of sea-ice interferes with the transmission of sound through water, by diving well below the ice polar seals should enhance the transmission range of their calls. Underwater calling depth of harp seals (*Pagophilus groenlandicus*) in pack-ice and Weddell seals (*Leptonychotes weddellii*) in land-fast ice was investigated during daylight in the breeding season for both species, and during daylight and darkness throughout the winter for Weddell seals. Calls were recorded on a DAT system connected to a two-element vertical hydrophone array with hydrophones placed at 10 and 60 m depth. Both rough calling depth estimates (< 35 m, ~ 35 m, > 35 m) and more accurate point depth estimates (≥ 5 m) were obtained. Significantly more calls were produced at depths of 35 m for both species. Point depth estimates indicated that approximately 60% of harp seal calls and 71% of Weddell seal calls occurred between 10 and 35 m depth. Harp and Weddell seals called predominately at depths where light could penetrate, but still avoided sea-ice interference by diving well below the ice to vocalize. For Weddell seals there were no significant differences in calling depths during darkness or light, or across seasons. Vocalization behaviors of the seals did not change over depth with respect to call type, the number of elements within a call or total call duration for either species. Frequency (kHz) of calls also did not change with depth suggesting that harp and Weddell seals control the pitch of their vocalizations with the vocal cords of the larynx. These findings suggest that most social behaviors of harp and Weddell seals occur near the surface. The acoustic communication behaviors of both species have, to some extent, been shaped by constraints associated with enhancing sound transmission when calling under sea-ice.

Distribution and Habitat Characteristics of Dolphins of the Genus *Stenella* (Cetacea: Delphinidae) in the Southwest Atlantic Ocean

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The distribution of dolphins of the genus *Stenella* is poorly known in the Southwest Atlantic Ocean. A complete review of records (n=295; 165 strandings, 113 sightings and 17 incidentally caught) of these dolphin species was performed in 23 museums and collections in Brazil, Uruguay and Argentina to describe distribution and habitat. Only records that could be unequivocally identified to species level were included in this study. Atlantic spotted dolphins (*S. frontalis*) occur in both southern (21-36°S) and northern Brazil (north of 06°S), with a hiatus in its distribution off eastern South America. This species presents the highest preference for nearshore habitats, restricted to waters within the 1000m isobath. Pantropical spotted dolphins (*S. attenuata*) are found in tropical waters as far south as 22°S and are mainly observed off northeastern South America. They occur beyond the continental shelf break in depths greater than 850m. There are no contemporary records of *S. attenuata* in Uruguay or Argentina. Clymene dolphins (*S. clymene*) are distributed in deep waters (1390-4500m) as far south as 30°S. Strandings are more common where the continental shelf is narrower. Spinner dolphins (*S. longirostris*) are found in oceanic waters as far south as 30°S. They inhabit tropical waters over the shelf and slope (depths ranging from 170 to 2700m). The striped dolphin (*S. coeruleoalba*) is the least known species of the genus in the western South Atlantic. Most of records are from temperate waters in southern Brazil and Argentina. The distributions of *S. attenuata*, *S. clymene* and *S. longirostris* overlap to a great extent and are predominantly oceanic and associated with warm ocean currents. *S. frontalis* seems to prefer a different, coastal habitat influenced both by warm currents and upwelling areas. The discontinuous distribution of this species suggests an isolated population inhabits the southern coast of Brazil. *Financial Support*: CAPES, CNPq, Society for Marine Mammalogy, Cetacean Society International, The Humane Society of The United States and Fundo Nacional do Meio Ambiente - FNMA.

Fine-Scale Environmental Predictors of Prime Bottlenose Dolphin Feeding Habitat

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Estuaries are productive inshore systems that serve as important nursery grounds, including for bottlenose dolphins. Several hydrographic features such as bathymetry and salinity influence prey distribution. Shrimp vessels also aggregate prey. Galveston Bay (GB) offers a useful model to evaluate factors determining bottlenose dolphin

feeding habitat: diverse physiographic conditions; occurrence of two feeding tactics (feeding in association with shrimp vessels vs. no association) and strong anthropogenic influence (commercial/recreational fishing and shipping). First, we aimed to identify prime feeding habitats and determine whether dolphins change feeding location depending on time of day and season (*i.e.* temperature and salinity seasons). Second, we identified natural and anthropogenic environmental indicators of core feeding densities (CFD). Finally, we evaluated the importance of the different feeding tactics. We conducted 367 boat surveys in five different habitats of GB totaling 3,814.77 km of search effort. Using a geo-referenced 500 m-grid, we associated dolphin counts and behavior with eleven environmental variables, collected at fixed stations and after group-follows. We detected 1,802 dolphins in 262 groups, 57% of which were feeding. Groups feeding in association with shrimp vessels comprised 34% of the feeding groups. Regardless of season and time of day, feeding consistently occurred in two locations, comprising only 1/5 of the total surveyed area. Areas of high core feeding density were less than 3 km². According to our Generalized Linear Model, the relevant predictors of CFD were, in decreasing order, distance to the Gulf of Mexico, water temperature, depth, number of boats, and temperature season. Interestingly, CFD was positively correlated with number of boats. This fine scale spatio-temporal study contributes to our understanding of bottlenose dolphin foraging ecology. It demonstrates that even in environmentally dynamic sites, bottlenose dolphins exhibit foraging preferences with predictive features. In addition, we present a useful analytical method for coastal habitat conservation and management.

Mixtures Of Organochlorines Modulate B And T Lymphocyte Proliferation In Marine Mammals and Mice And Leukocyte Subsets In Humans And Mice

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Marine mammals, as well as humans, bioaccumulate environmental contaminants such as organochlorines (OCs). The effects of individual OC compounds on the immune system have been studied, however, relatively little is known about the immunomodulatory effects of OCs in mixtures. This study focused on species differences in response to the immunomodulatory effects of OCs and determined interactions of OCs in mixtures. Five OCs including PCB IUPAC #138, 153, 169, and 180, as well as 2,3,7,8-TCDD and all possible combinations (26) were tested upon *in vitro* exposure. B6C3F1 mice were always tested along with marine mammals and humans for quality control, as well as for comparison amongst species. Con A-induced T cell proliferation was modulated mostly by non-coplanar PCBs in eight of nine species tested. LPS-induced B cell proliferation was modulated in four out of seven species tested. Similar exposures of OCs modified the proportions of leukocyte subsets in humans and mice. There were qualitative and quantitative differences in which OC mixtures modulated lymphocyte proliferation in different species, with evidence for additive, synergistic and antagonistic interactions. Additionally, toxic equivalent (TEQ) values did not predict the immunotoxic effects upon exposure to OCs in any of the species tested. Our results demonstrate that species differ in their response to OC exposures, and that the commonly used mouse model may not be appropriate to determine the risks associated with exposure to OC mixtures in other species. Furthermore, the effects of OC mixture cannot always be predicted from that of its components nor from the TEQ values, which will complicate assessing risks involved with exposure to OCs. Testing the immunomodulatory effects of OC mixtures in different species will better define risks associated with exposure to OCs in several species as well as contribute to future management and conservation efforts directed towards marine mammals.

Distribution and Residency of Indo-Pacific Bottlenose

Dolphins (*Tursiops aduncus*) in the Waters of the Ogasawara (Bonin) Islands, Japan

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Sighting cruises and photo-ID surveys were conducted to investigate the distribution and residency of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in the waters of the Ogasawara (Bonin) Islands, about 1,000km south of mainland of Japan. During 81 daytime sighting cruises were conducted between May 2003 and February 2005 within 40km from shore, at least 963 Indo-Pacific bottlenose dolphins in 120 schools were observed throughout the year and almost within 2 km from shore. School sizes ranged from 1 to 28 individuals (mean = 8.03, SD = 6.25). These included all stages of age and sex. In total, 91 individuals were photo-identified from the scars on the body and the shape of the dorsal fin and fluke edges by under waters shot. Number of resighted individuals were 62 (68% of total identified dolphins). 16 (17%) individuals were resighted throughout at four seasons (spring: March – May, summer: June – August, autumn: September – November, winter: December – February) and 25 (27%) were observed at three seasons. Our data suggest that Indo-Pacific bottlenose dolphins distribute in the coastal waters of these islands throughout the year, and at least some dolphins are living throughout the four seasons.

Genetic Analysis of Killer Whale (*Orcinus orca*) Historical Bone and Tooth Samples to Identify Western U.S. Ecotypes

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Little is known about the historical range of killer whale ecotypes (Residents, Transients and Offshores) in the eastern North Pacific (ENP). Because these types cannot be easily identified visually, historical accounts cannot be used to determine range. It is also possible that ranges have changed in the last few decades because of changes in prey availability. In particular, Southern Residents, currently the southernmost resident ecotype now found primarily in Washington state and British Columbian waters, are known to prey on Chinook salmon, which have declined in biomass in recent decades along the outer coasts of Washington, Oregon, and California. To investigate historical distributions of this and the other ENP ecotypes, we obtained samples of teeth and bones of 30 individuals primarily from the waters off California, Oregon, and Washington from NMFS and museum collections. We amplified a short section of the mitochondrial DNA control region which contains four diagnostic sites that differentiate between ecotypes of ENP killer whales. We identified haplotypes from 25 of the samples, indicating that eight were of the Offshore haplotype, eleven were Transients, four were Southern Residents, and one was a Northern Resident. In every case except one (Northern Resident), diagnostic haplotypes were from animals sampled in the region of their current known distributions. One whale genetically identified as a northern resident extends the known southernmost distribution of the ecotype from Oregon to California. Items of diet identified from stomach contents of six of the whales genetically identified to ecotype conformed with what is known of the feeding habits of the various ecotypes. Currently, small sample size and limited distribution of samples limit conclusions concerning the historical range of Southern Residents.

A Review of Evolution of Tonal Sounds Produced by Odontocetes: The Origin and the Anti-Predator Strategy

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Odontocetes communicate with each other via various sounds that are classed as pulsed sounds or tonal sounds (whistles). The development of echolocation in odontocetes is hypothesized as one precursor for divergence into the aquatic environment. There are few studies that have examined the evolution of whistles from odontocetes. Many odontocetes produce whistles, some species do not. In this study, literature on odontocete sounds was reviewed by the phylogenetic relationship between whistling and non-whistling species. Results suggest two points. The first is that whistles were acquired after Platanistidae diverged. Herman and Tavorla (1980) suggested that whistles have evolved for some special benefit in the large groups. The review conducted here did not support this hypothesis for two primary reasons: 1) whistle emerged prior to species found in large groups and 2) solitary species such as Lipotidae produce whistles. Thus, whistles primarily might have evolved for a benefit for relatively small groups. The second point is that whistles were lost independently and secondarily at least three times in the phylogeny. It was hypothesized that species that secondarily lost whistles (whistle-secondary-loss species; Pontoporiidae, Phocoenidae, and genus *Cephalorhynchus*) may have adopted a cryptic strategy against the hearing of their predators, especially killer whales. Frequencies below 100 kHz in their echolocation signals are cut off and whistles are not produced to avoid eavesdropping by predatory killer whales. Mammal-eating killer whales produce little echolocation and may adopt a passive listening strategy for prey detection and orientation (Barrett-Lennard *et al.* 1996). These killer whales demonstrated good high-frequency hearing for their size (Szymanski *et al.*, 1999), which implies there was an evolutionary 'arms race' between killer whales and their prey, or whistle-secondary-loss species.

A Killer Whale Group Resighted: A Look at Movement and Associations of *Orcinus orca* in Antarctic Waters

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Research on killer whales (*Orcinus orca*) in Antarctic waters has focused primarily on physiology, morphology, and defining ecotypes. Individual and group behavior of killer whales in this region remains largely unknown. Inference's can be drawn from well-studied populations elsewhere and stable associations are to be expected, with group size and range of movement determined possibly by diet. Presented here is a direct observation of the range of movement and stable associations of individually identified killer whales within a season in Antarctic waters. The International Whaling Commission conducts annual surveys to estimate cetacean abundance in the Southern Ocean during the austral summer (IDCR/SOWER). This survey provides a platform of opportunity for ancillary projects, including the photo-identification of killer whales. The research area from January thru March of 2005, was longitude 000°E to 070°E and from latitude 64°30'S to the ice edge. Sightings of killer whales in the research area included 16 groups totaling 173 individuals. 8 of the 16 groups were photographed including 2 groups sighted on 9 February and 16 February. Group composition was similar in the two sightings, which contained an estimated 12 and 14 individuals respectively. In both groups a distinct animal with a severed dorsal fin was observed prompting a thorough examination of the images. Photographs of 4 individual whales were matched between the two sightings. Lesser quality photographs suggest at least 3 additional matches. The photographs and group composition indicate a stability of association between observations. The animals traveled at minimum 261 nm during 165.7 hours, and on both occasions were within 20 nm of the pack-ice edge.

Adaptive Management of Harbor Seals (*Phoca vitulina richardii*) in a Disturbed Colony

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Adaptive management is an approach to manipulating conditions in complex and often unpredictable natural environments. This poster reports on an adaptive management strategy adopted to minimize disturbances to a harbor seal rookery through an on-site docent program. How effective can on-site docents be in reducing disturbances to breeding pinnipeds? This study analyzes two long-term series of observations in which harbor seal disturbance data were systematically collected before and after the establishment of a docent program. Monitoring from March through June from 1991 through 1996 showed that recreational clam harvesters disturbed a harbor seal rookery at Clam and Seal Islands in Tomales Bay, California at a rate of 0.39 flushes an hour. Beginning in 1997 docents were stationed on the islands, demarcated the seal haul-out, and offered harbor seal natural history and on-site interpretation to clam harvesters. Following the inception of this docent program, the number of seal flushes, into the water associated with clam harvesters fell to a mean of 0.11 flushes an hour, averaging 5.5 flushes a season of observation, validating the use of this conservation technique. Yet overall disturbances of the seal rookery later grew in the docent program, largely because of increasing numbers of motorboats on the bay. A ferry operation, transporting clam harvesters to Clam and Seal Islands was abandoned after the 1998 pupping season. Clam harvesters then used small 4-6 person motorboats to access the mudflats. The level of motorboat activities subsequently doubled in the study area. The number of seal flushes into the water also rose more than threefold. Because of the increased flushes associated with motorboats, an additional on-the-water interpretive enforcement program is recommended for the management of further disturbances to the harbor seal rookery and other wildlife.

Altered Immune Status in Free-Ranging Harbour Seals of the Northeast Pacific is Associated with Exposure to Environmental Contaminants

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Polychlorinated biphenyls (PCBs) are environmental contaminants with immunotoxic properties that have become widespread due to their persistence and bioaccumulative nature, and have affected the health of humans and wildlife. Marine mammals, in particular, remain exposed to, and affected by, elevated levels of these compounds through the consumption of contaminated prey over a long life span. Contaminant-related immunotoxicity in marine mammals is thought to have played a role in the occurrence and severity of a number of mass mortalities during recent decades. On the Pacific coast of North America, certain populations of harbour seals (*Phoca vitulina*) are characterized by elevated levels of contamination, highlighting their potential vulnerability for immunotoxic effects. Using blood samples from free-ranging harbour seal pups (n=44) from British Columbia, Canada and Washington State, USA, we measured a variety of immunological endpoints, encompassing haematology, as well as innate - and cell-mediated immunity. Total blubber PCB concentrations, ranging from 0.40 to 6.59 mg kg⁻¹ lipid weight, correlated with changes in the proliferative responses of T lymphocytes (R²=0.16), lymphocyte counts (R²=0.17), phagocytosis (R²=0.30), and respiratory burst (R²=0.45) (in all cases p<0.05). Increased eosinophil counts (R²=0.52, p=0.000) suggested that more contaminated animals may be more vulnerable to parasitic infection. We also measured the expression of the primary mediator of immunotoxicity, the aryl hydrocarbon receptor (AhR), in white blood cells and blubber. AhR

expression was positively correlated with PCB levels, suggesting a contaminant-related upregulation (R²=0.21, p<0.01). Our results indicate that harbour seals in certain Pacific coastal regions are exposed to toxicologically relevant concentrations of environmental contaminants. These immunologically compromised seals could therefore be more vulnerable to disease. This, together with emerging infectious diseases, could have population level consequences and must be considered in the conservation of marine mammals.

The Effects of Water Temperature on Energetic Costs of Juvenile and Adult California Sea Lions (*Zalophus californianus*)

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Pinnipeds often encounter marked changes in water temperature associated with diving as well as with seasonal, geographic, and climatic phenomena. To determine how such changes impact energetic costs in California sea lions, we measured resting metabolic rate by open-flow respirometry in four adult female and four juvenile sea lions over a range of experimental water temperatures (T_{water} = 0 - 20°C for adults, 5 - 20°C for juveniles). We found that the resting metabolic rate of adult sea lions averaged 6.36 ± 0.72 mlO₂×kg⁻¹×min⁻¹ and did not change with T_{water} = 6 - 20°C. The lower critical temperature of these animals, as identified by an increase in resting metabolism, was 5.9 ± 0.8°C. This temperature limit is approximately 6°C lower than sea surface temperatures routinely encountered by this species off coastal California. In comparison, juvenile sea lions showed a narrower range of water temperatures in which they could remain physiologically neutral. Resting metabolic rate of the younger animals was 6.33 ± 0.53 mlO₂×kg⁻¹×min⁻¹ and increased as water temperatures dropped to 12°C. Because water temperatures in their natural range are often this low, juvenile sea lions may be thermally challenged when resting at sea. To determine whether muscle thermogenesis associated with activity could mitigate this thermal limit, we also measured the metabolic rates of the same juvenile sea lions swimming against a current in a water flume at T_{water} = 5, 12, and 20°C. Swimming metabolism for juveniles (11.17 ± 0.36 mlO₂×kg⁻¹×min⁻¹ at 1 m×s⁻¹) was 1.8 times resting and was not statistically different among the three water temperatures. These results suggest that activity can compensate for the reduced thermal capabilities of juvenile California sea lions. However, this mechanism represents an added energetic cost for younger sea lions compared to adults. (Supported by the Alaska SeaLife Center)

Patterns of Associations Among Bottlenose Dolphins, *Tursiops truncatus*, in the Bay of Islands, New Zealand

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A high degree of plasticity in social organization and habitat use is observed within the genus *Tursiops*. Here we describe patterns of associations among *T. truncatus* in the Bay of Islands, NZ, a shallow, highly reticulated embayment opening to the South Pacific Ocean. Dolphins in this population range widely along the coast but most of the 415 identified individuals are observed frequently, but not continuously, in the Bay. Groups range in size from 2-50 individuals (median = 15) and generally remain in the Bay for a few days before moving out and being replaced by other groups. We examined patterns of associations between individuals (n=147) sighted at least four times in 64 independent encounters between 1996 and 1999. Association analyses were restricted to data from encounters where all identifiable individuals were photo-identified. Tests for departures from randomness and presence of preferred and non-preferred companions were carried out using SOCPROG 2.2 modules. The null hypothesis of random association was rejected and there was significant evidence for both short and long-term association patterns (p<0.001). The persistence of preferred associations was confirmed by the lagged association rate, which remained higher than the null association rate

across the entire four-year study. Some dyads and trios, including males and females, showed association indices as high as 0.8 during this time. Although dolphins in the Bay of Islands are part of a larger and more widely ranging population, their patterns of associations resemble those reported for resident communities found in enclosed bays, providing insight into the various selective pressures acting on sociality in this genus.

Location and Timing of Haul-Outs of Individual Harbour Seals (*Phoca vitulina*) from the German and Danish Wadden Sea

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All pinnipeds are dependent on land or ice for activities such as breeding, molting and resting. The duration of haul-out periods is dependent on both the species as well as the putative purpose of the haul-out. Of the many species that make more or less regular haul-outs outside the breeding and molting season, the harbour seal (*Phoca vitulina*) from the German and Danish Wadden Sea may spend up to two weeks at sea before returning to land. Data from Harbour seals equipped with satellite telemetry and dead reckoning technology were used to determine the location of haul-out sites as well as the movement between haul-out sites undertaken by individuals. Haul-out data were also used to investigate the duration and timing of haul-out periods with respect to environmental factors such as tide. Most animals used more than one haul-out site although haul-out location was not changed on a trip-by-trip basis. Instead, seals returned repeatedly, sequentially to the same location before changing it. The timing and duration of haul-outs was highly dependent on the accessibility of sites during high tide. Animals from sandbanks that get flooded during high tide often made shallow dives with a low degree of activity during the high tide before hauling-out again as soon as substrate became available. On beaches seals may be hauled-out for more than two days, however, these periods are always interspersed with occasional short excursions into the water which may be caused by disturbance.

Discrimination of Stainless-Steel Spherical Out-Of-Phase Targets by an Echolocating *Tursiops truncatus*

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In this experiment the dolphin was asked to perform a discrimination task between two simulated targets. The echoes from these targets were created using a phantom echo generator which replicated the actual echo characteristics of a solid spherical stainless-steel target and a solid spherical stainless-steel target 180 degrees out of phase. The phantom echo system provided full knowledge of each click produced by the dolphin and the corresponding echo received by the dolphin. During the discrimination task the dolphin used a range of clicks that differed widely in peak frequency and bandwidth. However, the echoes that were returned to the dolphin showed significantly less variability in peak frequency and bandwidth and were similar with the exception of being 180 degrees out of phase. The goal of this study was to determine if the dolphin can detect phase shifts within the echoes. In other words, the goal was to decipher if the dolphin can discriminate between the two similar targets by solely using the phase difference information, or if the two echoes appear to be indistinguishable to the dolphin. Based on the results of this experiment, the dolphin did not appear to accurately discriminate between the two echoes. These results support the implication from previous experiments that because its discrimination performance fits the energy detection model, phase information is not required for the dolphin to make its discrimination.

Measurement of Auditory Temporal Resolution in the California Sea Lion (*Zalophus californianus*) Using Auditory Evoked Potentials

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In contrast to studies of temporal auditory processing in odontocete cetaceans, the ability of non-echolocating marine mammals to resolve acoustic stimuli in time has received little attention. However, temporal resolution likely plays an important role in the ability of sea lions and other animals to distinguish relevant features of acoustic signals. We measured the temporal resolution abilities of the California sea lion (*Zalophus californianus*) using auditory evoked potentials. The auditory brainstem responses (ABRs) and rate following responses of two anesthetized California sea lions were recorded at the Marine Mammal Center in Sausalito, California. Stimuli were 20 ms click trains consisting of 70 is bipolar clicks presented at repetition rates between 125-1500 Hz. ABRs were measured from three subcutaneous electrodes and a customized amplification and averaging system connected to a PC laptop. At click presentation rates below 500 Hz, distinct individual brainstem responses were clearly visible following each click in a train. As presentation rates increased, responses to the initial click in a train remained relatively large with a typical ABR form while responses to subsequent clicks decreased in amplitude and became more sinusoidal. Rate following responses remained evident for click rates up to 1000 Hz. The results suggest that the temporal resolution capabilities of sea lions are better than previously suspected. These findings improve our understanding of auditory processing in sea lions, motivate additional comparative research with other pinnipeds, and provide guidance in the application of electrophysiological methods to the study of sea lion hearing.

Passive Acoustic Research on North Pacific Right Whales (*Eubalaena japonica*) in Alaskan Waters

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We used two types of passive, underwater acoustic instrumentation to provide information on critically endangered North Pacific right whales (*Eubalaena japonica*) in the Bering Sea and western Gulf of Alaska. We deployed DIRECTIONAL Frequency Analysis and Ranging (DIFAR) sonobuoys during vessel-based cetacean surveys in Alaska in summers of 2002 and 2004 to detect and localize calling right whales and provide data on right whale acoustic repertoire and behavior. The most common call type (75%) among analyzed calls (n=385) was an upswept tonal call, on average from 88 Hz to 159 Hz and 0.82 s in duration. Real-time acoustic detection and localization of right whale calls preceded right whale sightings on most occasions, guiding the vessel to whales at unprecedented ranges (up to 100 km) and enabling researchers to conduct more detailed studies. We also deployed autonomous, seafloor-mounted hydrophones in three study areas: the southeast Bering Sea middle-shelf domain (in years 2000-2002 and 2004-2005), the Bering Sea shelf break (2004-2005), and the western Gulf of Alaska (2003). The seafloor packages recorded continuously at an effective bandwidth encompassing the most common North Pacific right whale calls. Automated detection software was configured to detect upswept calls, and detections were reviewed by an analyst, who also browsed data surrounding positive detections to find additional calls. In the southeast Bering Sea 2000-2002 seafloor hydrophone data, over 1000 right whale calls were detected, occurring seasonally as early as May and as late as November. Peaks in calling were observed during dark early-morning hours and at dusk. Right

whale calls in the southeast Bering Sea were clustered into 'bouts', lasting usually less than 10 minutes and separated by tens of minutes to days.

Collection of Systematic North Atlantic Right Whale (*Eubalaena glacialis*) Data by Whale Watchers in the Lower Bay of Fundy, Canada

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Dedicated research surveys for North Atlantic right whales (*Eubalaena glacialis*) have been occurring in the Bay of Fundy, Canada, since the 1980s. However, this species exhibits extreme heterogeneity in the use of habitats at a range of scales. Equipping whale watch vessels with portable hand-held computers suited for simplified data collection offers an additional inexpensive way to gather annual observations of whales throughout this habitat. This will provide researchers with an increased data set to determine how these animals are using their habitat on an annual basis. These systems will increase both the area surveyed for whales (whale watch vessels often visit areas not covered by dedicated surveys) and the time data are collected (whale watching begins prior to dedicated research and continues after the primary research vessels have departed), thereby providing better spatial and temporal data on the distribution of right whales in this critical habitat area. During the summer of 2005, six whale watch companies in Nova Scotia and New Brunswick, Canada will be collecting species information through the duration of their cruises. Opportunistic data such as this is often lacking in its ability to be analyzed using statistical procedures. Standardizing the data collection for each vessel through the use of portable hand-held computers, including automatic collection of location, time and tracklines will address this issue by allowing calculation of sighting effort for each vessel. The information that is collected will be evaluated for the usefulness of using these vessels as a research platform. Results will be measured by the amount and quality of data collected by volunteers and by evaluations of the usefulness and practicality of data collection by whale watch vessels. Assessments of whether this system can be used in other habitat areas with other types of vessels will also be made after this practical trial.

Contaminants in Steller Sea Lions (*Eumetopias jubatus*) and Other Marine Mammals from the North Pacific

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Many marine mammal species have declined in the North Pacific and the causes remain unclear. The objective here was to test the hypothesis that accumulation of organochlorine contaminants in Steller sea lions could have contributed to the decline or has hindered recovery. PCB concentrations in Steller sea lion (*Eumetopias jubatus*) blood from southwest Alaska pups (n=76) ranged from 0.21 to 13.00 ng/g wet weight (ww) with a mean of 2.12 ± 0.27 ng/g. In Russian pups (n=138), PCBs ranged from 0.33 to 13.00 ng/g ww with a mean of 4.24 ± 0.43 ng/g. Mean contaminant concentrations were significantly higher in Russian sea lions (p = 0.001). Blood and blubber samples (n=22) were collected from juvenile Steller sea lions from the central Gulf of Alaska. PCB levels in blood ranged from 0.30 to 6.70 ng/g ww with a mean of 2.10 ± 0.39 ng/g. PCB levels in blubber ranged from 230 to 3000 ng/g ww with a mean of 1229 ± 188 ng/g. For comparison, blubber samples from two cetacean and two pinniped species from the North Pacific were analyzed. Sum PCBs in blubber from Eastern Kamchatka killer whales (*Orcinus orca*) (n=13) ranged from 12 to 3400 ng/g wet weight with an average of 664 ± 237 ng/g. In Cook Inlet Beluga whales (*Delphinapterus leucas*) (n=8) sum PCBs in blubber ranged from 0.84 to 8.5 ng/g ww and averaged 2.58 ± 0.91 ng/g. In

Bering Sea Steller sea lions (n= 9), PCBs in blubber ranged from 990 to 5700 ng/g ww, averaging 2410 ± 546 ng/g. For Gulf of Alaska harbor seals (*Phoca vitulina*) (n=46) PCBs in blubber ranged from 150 to 3400 ng/g ww, averaging 663.26 ± 84.39 ng/g. PCB levels in Steller sea lions and other marine mammals are high enough to be of concern and warrant further investigation.

Measuring Hearing During Echolocation: How Well Does *Pseudorca crassidens* Hear its Outgoing Click and Returning Echo?

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Recent work has demonstrated the value of measuring audiograms of animals by measuring brain wave patterns in response to particular acoustic stimuli. Within limits, sound levels are reflected in the amplitude of the brain wave response. A variant of this technique has been developed to measure the hearing of a false killer whale *Pseudorca crassidens* while it echolocates. Keyed on the time of the emitted click, the whale's auditory evoked potential has been measured for both the outgoing click as well as the echoes that return to the animal based on received returns based on the two way travel time of sound between the animal and the target. AEPs were recorded during an active echolocation task in which the whale accurately reported the presence or absence of a -22 dB aluminum cylinder presented 1 to 8 m away while she was stationed within a hoop. The results indicated that the evoked responses to outgoing clicks and the echoes were of equal amplitude even though the measured difference of the outgoing clicks and the echoes exceeded 40 dB. She apparently heard the quieter echoes as well as she heard the louder outgoing clicks. Evoked responses to the targets at 6 distances ranging from 1 to 8 m also did not differ even though the echo intensity changed as much as 36 dB. These data indicated that perhaps the whale perceived the target echo as a constant independent of echo strength. Target strength was then further varied by varying target size with 4 targets varying from -22 to -40 dB and distance varying from 1 to 6 m. Echo intensity remained constant, but AEP to outgoing clicks varied and increased as target strength decreased. These results indicate that *Pseudorca* may possess a very fine automatic gain control regulating its hearing during echolocation.

Resolution of a Potentially Conflict Situation Through Cooperation Among Bottlenose Dolphins (*Tursiops truncatus*) in Experimental Setting

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The issue of cooperation between individuals is critical for understanding complex social structures found among whales and dolphins. The purpose of the described series of experiments was to determine the possibility of cooperation among dolphins in an intrinsically conflict setting. This research was conducted using an innovative method that involves introducing a potentially conflict element into the problem-solving task while operating in accordance with an abstract rule. Under the new approach, animals were given a total freedom in selecting a particular type of social interaction model. Earlier, two dolphins independently solved the task of choosing two identical stimuli out of three presented. In a critical experiment, these dolphins were solving this task together. This research demonstrated that dolphins chose cooperation as the model of social behavior when facing an intrinsically conflict task. This allowed the animals to develop in a short period of time (7 trials) a successful method for solving the problem. Not only were they successfully solving the task using an abstract rule, but also they were doing it

while coordinating their actions to achieve optimal efficiency: each animal was selecting one stimuli out of two needed to solve the problem. The overall success rate was 82%. This experiment offers important new data regarding cooperative behavior among dolphins. It appears, that cooperation may develop as an individual adaptation to changes in the environment, even in a situation where resources are limited and a possibility exists for competition. In our opinion, this is a result of dolphin's highly developed reasoning, which allows these animals to rapidly analyze new situations and develop optimal models of behavior. The findings of this experiment indicate that cooperation is significantly more important in the social structure of the bottlenose dolphin than antagonistic models of behavior.

Technological Role and Expectation of "Bio-Logging" in Marine Mammal Science

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Although animal borne "bio-logging" actually started in 1964 with Weddell Seals in Antarctica, the term "bio-logging" is a recent term added to the lexicon among field biologists studying marine animals. The emerging term of "bio-logging" may suggest strong expectation for new technologies, which serve as useful tools for science on the frontier of marine biology and oceanography. For example, one of our most difficult objectives of discovery is the mystery of marine mammal biology at sea. For us to know more about these animals, we inevitably have to use appropriate tools for remote observations. In this respect marine mammal science is fully dependent on the modern technology. It is up to us as marine mammal scientists to create the ideas and suggest the directions of the technological developments essential for new discoveries and concepts. For a deeper understanding of marine mammal biology, bio-logging technology will have to continue to mature. Here we present possible next steps that the next generation of marine mammal scientists may pursue.

Vocal Tremor and Stress in Captive Bottlenose Dolphins

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Studies on bottlenose dolphins (*Tursiops truncatus*) have shown that each individual produces an individually distinctive signature whistle. Signature whistles consist of both stereotyped and variable features. Variations in the signature whistles are thought to communicate the factors such as the individual's emotional state. But only few studies describe the whistle features characterizing such correlates. In this study, we assessed whether the modification of social environment influences the structure of signature whistles of the bottlenose dolphins. We recorded the whistles of four captive bottlenose dolphins under several stressful situations and compared their whistle production and structure with usual (baseline) phase. When a dolphin was under high-stress situation (isolated in unfamiliar surroundings), the signature whistle production was increased and the vocal tremor was observed in signature whistles. Vocal tremor is a low-frequency fluctuation in amplitude or frequency (or both). After habituation to the surroundings, the signature whistle production was decreased and the vocal tremor was no longer observed. On the other hand, when a dolphin was under low-stress situation (isolated in familiar surroundings), the signature whistle production was increased but the vocal tremor was not observed. In human and non-human primates, the vocal tremor is positively linked to the psychological stress. The results indicate that the vocal tremor in the signature whistle correlates with the high-stress and is useful as an indicator of stress in bottlenose dolphins.

Use of Microsatellite DNA Markers for Studying Genetic Relatedness and Spatial Position on Land in the New

Zealand Fur Seal, *Arctocephalus forsteri*

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Pinnipeds are a valuable model for studying many aspects of mammalian reproductive ecology. Like nearly all the pinnipeds, New Zealand fur seals mainly reproduce terrestrially (births and most copulations) and have an apparently polygynous mating system. The stability and increasing abundance of New Zealand fur seal populations provides the opportunity to use this species as a model for investigating population dynamics, social organisation and polygynous mating systems. New Zealand fur seal females are philopatric, returning to their birth site for breeding. Dominant New Zealand fur seal males hold territories and defend harems of females. The literature shows that observed mating success correlates with male reproductive success in some species (for example, elephant seals). Under such a scenario, genetic variability between pups born in one territory might be low in a mating system dominated by polygyny. However, studies in other pinnipeds species have demonstrated discrepancies between behavioural data and measurements of reproductive success in polygynous species. Thus, genetic variability between pups born in one territory might be high. In either case, relatedness between philopatric females mating at one spatial position should be high. We evaluated the distribution of genetic variation among individuals according their spatial position landing in a breeding colony of NZ fur seals. We used 14 DNA microsatellite markers to collect genetic data on individuals from a portion of a breeding colony in Kaikoura, New Zealand, that was subjected to intensive behavioural analyses. We have used these genetic data to estimate relatedness between New Zealand fur seal individuals in relation to their spatial position on land during the breeding season and then to relate male reproductive success to spatial position and level of relatedness.

Humpback Whale Entanglement Rates in Southeast Alaska

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Entanglement in fishing gear is recognized as a potentially significant source of serious injury and mortality for humpback whales (*Megaptera novaeangliae*) in some parts of their range. In recent years an increasing number of humpback whales have been reported entangled in Alaska. In 2003 and 2004 we conducted the first systematic study of entanglement in southeastern Alaska, using a scar-based technique developed and ground-truthed in the Gulf of Maine. We photographed the caudal peduncle of unique individuals as they dove, assessed them for evidence of wrapping, binding and linear notch scars indicative of a previous entanglement and then assigned a code representing the likelihood (low, ambiguous, high) that the whale had been entangled at least once. Analysis of photographic data from 179 unique individuals revealed that a minimum of 53% (95% CI 45-60%) of the whales had a high likelihood of having been entangled. The frequency of entanglement scarring in males (82%) was significantly higher than in females (54%), χ^2 (2, N = 94) = 7.64, p = 0.0219. Twenty-eight whales were assessed in both years and a minimum of 7% had acquired new entanglement scars when they were re-sampled in 2004. A scar-based approach is expected to underestimate the true frequency of entanglement because it can not account for: a) whales that died before they could be detected, b) entanglements that did not involve the caudal peduncle and c) injuries that were so old or faint that they had healed beyond recognition. Nevertheless, the proportion of whales in our study area with entanglement scarring is comparable to that reported for one western North Atlantic population (the Gulf of Maine) where entanglement has been identified as a substantial

management concern. Consequently, humpback whale-fisheries interactions in southeastern Alaska may warrant a similar level of scrutiny.

Evidence for a Change in Northern Fur Seal (*Callorhinus ursinus*) Maternal Strategies Since the Late Holocene

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Archaeological sites along the northeast Pacific margin, including sites at mid latitudes (35-50°N), contain a high abundance of northern fur seal (NFS) remains relative to other pinnipeds. The modern pattern of offshore foraging and largely high-latitude breeding, coupled with the relatively short time period NFS congregate onshore, would have made NFS less available to prehistoric humans in comparison to other pinnipeds. Furthermore, harvest (mortality) profiles from archaeological assemblages provide two conclusions about prehistoric NFS ecology; (1) all sites contain young pups 0-4 months of age, confirming that NFS had rookeries along the entire northeast Pacific margin; (2) strong representation of 5-12 month old individuals is odd in light of modern nursing behavior. NFS young-of-the-year were available to humans year-round, not just during the ~4 month breeding season. To explore whether the modern maternal strategy is a result of their high-latitude breeding distribution, we measured $\delta^{15}\text{N}$ values of fossil NFS between 2 and 20 months of age. Isotopic results suggest that late Holocene NFS breeding south of the Bering Sea used a maternal strategy more similar to other sympatric otariids, who typically wean their pups and ~10-14 months. In the absence of strong selective pressure for early weaning (*i.e.*, severe winter conditions in the Bering Sea), weaning at an older age may have been adaptively advantageous for NFS, especially for populations breeding at mid-latitudes. Our study confirms there were more mid-latitude NFS rookeries in the Holocene at that these rookeries were large enough for NFS to be a dominant species in areas where, today, it represents a small fraction of the marine mammal community. Our results have implications for the conservation of NFS, confirming that a wider range of sites are viable rookery locations, and that certain aspects of their reproductive behavior may change as they adapt to life at mid-latitudes.

A Simple Two-Dimensional Model of Ship/Right Whale Encounters in Cape Cod Bay and Implications for Proposed Management Strategies

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To provide a baseline estimate of risk to right whales from collisions with shipping traffic in Cape Cod Bay, a simple two-dimensional model was constructed to estimate the expected number of ship/whale encounters based on right whale densities and ship traffic data. Effort and sighting data from systematic aerial surveys of the bay from 1998 to 2002 were used to estimate right whale density (whales/km²) within 1.5-minute quadrats and over 2-week periods from December to mid-May. Traffic data for the same 2-week periods were provided by the US Army Corps of Engineers for vessels transiting the Cape Cod Canal and aggregated into routes within the bay based on origin/destination. For each route and each 2-week period, the expected number of ship/whale encounters was calculated based on the passage of a known number of vessels through quadrats of estimated right whale density. This calculation assumes that the whales are always at the surface and that neither whales nor vessels attempt to avoid collision. An average of seven vessel transits/day occurred in the bay, the highest volume of which were bound to or from Boston (four) and ports in the northern Gulf of Maine (two); 75% of the traffic was composed of tug-barge combinations. The results suggest

~1.5 expected ship/whale encounters in Cape Cod Bay each year, of which Boston traffic contributes 46%, and Gulf of Maine traffic contributes 35%. Gulf of Maine traffic leads to a high proportion of expected encounters despite relatively lower volume because it transects areas of higher whale density than other routes. Proposed routing measures that involve shifting vessel traffic to the western portion of the bay would result in reductions of 37%-45% in the number of expected encounters (from ~1.5 encounters/year to 0.83-0.95).

Recent Trends in Live-Strandings of the Southern Sea Otter and Relevance to Mortality

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During the last few years annual salvage records from beach-cast carcasses of southern sea otters represent roughly 10% of the estimated size of the wild population (Hatfield, USGS), and approximately 50% of estimated mortalities. These salvage records have provided substantial evidence that increased mortality is the primary reason for the population's slow growth (Estes *et al.* 2003). Since 1984 the Monterey Bay Aquarium's Sea Otter Research and Conservation (SORAC) program has recovered more than 300 live-stranded sea otters but has experienced a significant recent increase in (1) live-strandings, (2) proportion of stranded prime-age adults, and (2) incidence of infectious disease as primary stranding cause. We hypothesized that demographics and stranding causes of live-stranded sea otters would be similar to salvage records, indicating that live-stranded animals are another important resource to better understand factors related to increased mortality. We compared 117 live-stranding cases (2001-2004) with 105 salvaged carcasses (1998-2001, Kreuder *et al.* 2003). Prime-age adults stranded most frequently in both groups (57% live-strandings vs. 58% salvaged carcasses), followed by juveniles (34% vs. 29%) and aged otters (9% vs. 12%). In addition, infectious disease was the primary cause of stranding for live animals and salvaged carcasses (35% vs. 60%), followed by trauma (30% vs. 29%). Protozoal encephalitis (17% vs. 21%) and acanthocephalan peritonitis (13% vs. 15%) were primary infectious diseases, and shark attack was a common source of trauma (9% vs. 10%). These results indicated that causes of live sea otter strandings were similar to causes of mortality. Furthermore, live-stranded otters may provide information regarding clinical signs of disease and responses to novel treatments that is unobtainable from dead otters, and may enhance understanding of factors related to slow recovery of the southern sea otter population.

Post-Release Monitoring of Three Stranded Guadalupe Fur Seals: Movements, Dive Behavior, and Habitat Use

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Little is known about the Guadalupe fur seal (*Arctocephalus townsendi*) outside of its rookery on Isla de Guadalupe, Mexico. They have been known to strand ashore as far north as Washington state, but their at-sea behavior has rarely been documented. In 2003, three juvenile Guadalupe fur seals stranded along the central California coast. After rehabilitation, they were released with satellite dive recorders (SDR T-16, Wildlife Computers) to monitor their behavior post-release. Unlike an adult female released with an SDR in 1999 that returned directly to Isla de Guadalupe, all three fur seals remained off the coast of California. Tags were duty cycled to transmit every other day and lasted 26, 54, and 76 days. The minimum cumulative distance seals traveled from time of release was more than 1000 km with overall minimum travel rates from 19 - 40 km/d. The maximum dispersal observed was by a male yearling that moved directly north to Mendocino County, California (approximately 550 km) before transmissions ceased. Within the central California region, locations of all seals were distributed over distinct bathymetric/hydrographic

domains (e.g. onshore-offshore ecotones associated with shelf-slope regions, deep oceanic waters, SST fronts), although the influence of these features differed among individuals. Dive data was binned into 4 time periods (9:00-15:00, 15:00-21:00, 21:00-3:00, and 3:00-9:00) and all three fur seals were inactive during the 9:00-15:00 time period. The greatest proportion of dives was 4-10m deep and lasted less than one minute. The maximum depth recorded was 64m. Diving tended to reflect patterns associated with different bathymetric domains; shallow nighttime diving was common in the oceanic or off-shelf domain, whereas in the shelf-slope region dives were generally deeper and distributed more uniformly across the three active time periods. These dive patterns are similar to those reported for other species.

Impacts of Seals on Fish Populations in Narragansett Bay, Rhode Island, USA

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Seals have been protected in the U.S. since the MMPA took effect in 1972. Since that time, seal populations in New England waters have increased 5-fold. At the same time that seal populations have been expanding, the commercial landings for several fish species in Narragansett Bay, RI, have declined significantly. Winter flounder landings in particular, have declined from over 8 million lbs/year in the early 1980's, to about 1.3 million lbs/year during the late 1990's, and suggested among the possible reasons for this decline is an increase in predation by an expanding seal population. We used bioenergetic models to estimate the potential impact on this fishery by seals. With a maximum population of approximately 1000 seals, each consuming 6% of its body mass per day, we calculated that seals would take 88,155-244,875 kg of prey per season (193,941-538,725 lbs/season). This take represents 0.15-0.4% of the total commercial annual landings for all fish species, suggesting minimal impacts on overall fish stocks. If seals were eating winter flounder exclusively, seal predation would be equivalent to 14-41% of the commercial and recreational take, however an exclusively flounder diet is highly unlikely, as in other nearby areas flounder makes up only 7-15% of a seal's diet. We conclude that seals would play only a minor role in the observed decline in fish stocks.

The United States Coast Guard (USCG) as a Valuable Resource for Marine Mammal Management

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The United States Coast Guard (USCG) plays a valuable role in several management programs that the National Marine Fisheries Service (NMFS) has in place to protect north Atlantic right whales and other whale species. Two programs that the USCG participates in are the Critical Sightings Program (CRISP) and the Right Whale Sighting Advisory System (RWSAS). CRISP is an outreach program that was designed to provide information to the USCG for reporting sightings of live right whales as well as dead, injured or entangled whales of any species observed by USCG personnel or reported by the public. Included within CRISP is the RWSAS, which was developed in 1996 to provide mariners with current positions of right whales to prevent collisions between vessels and right whales. In 2004, the USCG contributed 15% of right whale sightings to the RWSAS. While USCG participation is beneficial, there are difficulties when working with agencies with short personnel tenure and multiple responsibilities. NMFS is working with Northeast USCG (District 1) stations providing educational and reference materials to improve the efficiency of the CRISP and RWSAS. Future plans include continuing outreach to USCG stations in the mid-Atlantic and southeast regions. Collaboration with other marine mammal organizations is sought.

Downward Shift in the Frequency of Blue Whale Vocalizations

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Blue whales in the northeast Pacific produce long, tonal vocalizations known as A-B calls. While constructing an automatic detector for recordings of these sounds spanning several years, one of us (MAM) noticed that a detector designed using calls of one year did not work well in other years; it appeared that the call had changed in frequency. To test this hypothesis, the frequency of blue whale B calls was systematically measured between 1993 and 2004. To prevent any bias produced by geographic or seasonal variation, measurements were made in the same geographic region, offshore of the U.S. Pacific Northwest, and at the same time of year, between September and November. Consistency of measurement was essential, and the following method was used to measure frequency: B calls have an initial downward frequency sweep, followed by a nearly-constant tone, followed sometimes by a brief period of silence, followed by another downward frequency sweep. The frequency at the beginning and end of the nearly-constant tone was measured, and these two frequencies were averaged to arrive at a "call frequency." Preliminary measurements for the 1993-2004 period show that the call frequency changed downward by 2.1 Hz over this period, or ~0.2 Hz/year.

Major Histocompatibility Complex *DQB-1* Polymorphism in the Gulf of California Fin Whale Population

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The fin whale *Balaenoptera physalus* shows a worldwide distribution. Photoidentification and distribution studies, point the existence of a small population in the Gulf of California (~400-800 individuals). According to polymorphism shown by neutral molecular markers, this fin whale population has low genetic diversity and is isolated from the North Pacific fin whales. This study analyzed the genetic variation of the *DQB-1* locus belonging to the Major Histocompatibility Complex (*Mhc*) genes, that elicit immune responses, to obtain knowledge that will help to identify risk factors threatening this population's adaptive potential, and elucidate the demographic processes of this population along its evolutionary history. For this analysis 36 skin biopsies were collected at five different localities along the Gulf of California. Total DNA was extracted from such biopsies, and used to amplify exon 2 *DQB-1* sequences, encoding the peptide binding region (PBR), using the Polymerase Chain Reaction (PCR). exon 2 *DQB-1* polymorphism was assessed in this sample of fin whales using Single Stranded Conformational Polymorphism protocols (SSCP), and every unique SSCP electrophoretic band was automatically sequenced. Only three *DQB-1* alleles were found in this fin whale population. Pairwise comparisons among sequences showed a higher ratio of nonsynonymous than synonymous substitutions per site, most of which resulted in non conservative substitutions at important positions for pathogenic peptide recognition, and all 3 alleles showed to be divergent, according to the operation of diversifying selection. Both *Mhc* and microsatellite polymorphism in this population showed Hardy-Weinberg equilibrium and reduced genetic variation, suggesting the absence of balancing selection in recent generations and a evolutionary scenario of a reduced founding population after a demographic bottleneck. It appears that the Gulf of California fin whale population has remained reduced along its history and shows low but divergent *Mhc* polymorphism, that maintain the capacity of eliciting immune responses against diverse pathogens.

Inter-Singer Spacing and Movements Do Not Support a

Spacing Function for Song in Humpback Whales

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Male humpback whales produce long, complex songs. While their function remains speculative, one long-standing hypothesis is that songs influence the spacing between singers. We tested this hypothesis by tracking singing whales, visually using a theodolite and acoustically using a static array of three to five hydrophones, during migration off the east coast of Australia. Distances between 118 pairs of singers in the study area were measured, pooled into 1-km, 2-km, 3-km and 6-km wide bins, and compared against the distribution of separation distances between pairs of random points in the survey area (a random model). Contrary to the predictions of the spacing hypothesis, inter-singer spacing did not differ significantly from the random model for any bin width ($P > 0.05$). Furthermore, there was no significant correlation between the separation distances between singers and their speed of movement towards or away from each other. Net movements of individual singers were then classified as 'towards', 'neutral' or 'away' from the other singer in the pair. Singers separated by less than 2 km were significantly less likely ($P < 0.01$) to show neutral movement and more likely to retreat from each other than expected by chance. While this is consistent with the spacing hypothesis, singers 6-7 km from each other were significantly more likely to move neutrally and less likely to approach each other ($P < 0.01$), which is not consistent with the spacing hypothesis. Overall there was no evidence supporting a gross spacing function for song, although the movements of singers relative to each other suggests that song may influence the behavior of other singers in more subtle ways. Listening whales can probably discriminate between singers that are close to other singers, with important implications for our understanding of how these whales interact with their acoustic environment.

Visual Acuity in Two Species of Delphinid (*Tursiops truncatus* and *Orcinus orca*): Above- Compared with Below-Water Comparisons

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It is clear that much cetacean behavior is visually guided. Yet, little is known about visual processes in these animals. In a series of experiments that utilized a two choice discrimination paradigm, the ability of individuals of two delphinid species to respond to visual stimuli that varied in location, size and distance was assessed. The subjects were bottlenose dolphins (*Tursiops truncatus*, N=3) and killer whales (*Orcinus orca*, N=2) held at Marineland of Canada. Their task in each study was to detect and target single small stimuli, presented on two dimensional panels. With white targets presented underwater on black backgrounds, the animals were able to reliably respond to stimuli that subtended a visual angle of approximately 0.3 degrees (or greater). This corresponds to the detection of a 1 cm² stimulus at a distance of 2 m. Above the water, reliable discrimination of the same targets occurred only when the stimuli subtended an angle of at least 1.1 degrees (equivalent to about 3.5 cm² at 2 m distance). When similarly tested with black targets presented on white backgrounds, the corresponding angles were 0.6 deg underwater and 2.0 deg above. Thus, and not surprisingly, the vision of these animals was far better underwater (than above), and far better when detecting white stimuli on black backgrounds (than black stimuli on white backgrounds). Interestingly, performance on these visual discriminations tests did NOT vary when ambient light level was varied between 0.05 and 8.0 mW/cm², suggesting a rather constant visual experience for the subjects throughout a wide range of illumination. We offer these results as providing the lower limits of what these animals are able to see with respect to stationary stimuli, and as a contribution to a better understanding of their perceptual world.

Monitoring Prey Ingestion in Pinnipeds

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Accurate methods for quantification of prey intake in pinnipeds are needed in order to assess the role these top predators play in their ecosystem. We have utilized captive Steller sea lions feeding on live fish to examine different methods of remotely determining prey ingestion including stomach temperature measurement, jaw opening (inter-mandibular angle), head striking and associated neck extension, and animal-borne video camera recording. Estimation of the quantity of ingested prey from stomach temperature changes is complicated by body temperature and stomach heat flux changes, movement of the transmitter within the stomach, diverse prey size and shape, potentially concomitant water ingestion, and insulation of the stomach temperature transmitter by previously swallowed prey, and therefore suffers a large margin of error. The measurement of inter-mandibular angle is advantageous in that all ingestion events will be recorded, but it is difficult to separate prey ingestion from underwater vocalization and aggression towards conspecifics (biting), and quantification is complicated when prey handling involves multiple openings of the jaw before successful swallowing occurs. Data from accelerometers attached to the head and torso of sea lions were compared with kinematic video analysis, but the acceleration of the head independently of the body during the action of striking at prey did not provide an unambiguous signal of prey ingestion. Video recording with animal-borne cameras holds great promise, but for predators such as Steller sea lions that often feed on loosely schooled or solitary prey in water with limited visibility, images should be taken at rates greater than 1 Hz, which requires a larger capacity to store images than is currently feasible with commercially available systems. We will describe suggestions for improvements to these methods and novel methods under development.

Evaluating Quantitative Fatty Acid Signature Analysis (QFASA) Using a Captive Harbour Seal (*Phoca vitulina*) Feeding Study

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Quantitative fatty acid signature analysis (QFASA) has been developed to estimate the species composition of marine mammal diets by comparing fatty acid (FA) signatures of their blubber with that of their potential prey. The technique was tested using 21 harbour seal pups that were either fed smelt (n=7 seals), herring (n=7), or smelt followed by herring (n=7) over 6 weeks. Full depth blubber biopsies were taken dorsally at day 0, 21, and 42. Species-specific calibration co-efficients required by QFASA were developed from 4 other animals fed exclusive herring diets (>1 year). The ability of the QFASA model to predict known dietary histories was evaluated using 15 subsets (2 of which were published) of individual fatty acids and up to 11 prey species. QFASA predictions reflected major dietary trends when modelling biopsies from day 21 and 42, however some misclassifications were apparent. Using the strongest newly developed FA subset, QFASA predicted (at day 42), a diet of 74% smelt, 13% herring, and 13% other species for the smelt fed group, and a diet of 0% smelt, 96% herring, and 4% other species for the herring fed group. In some cases, prey misclassification appeared consistent (e.g. herring was misclassified as capelin and smelt was reported as Coho salmon). Excluding prey not fed from the model generally produced diet proportions similar to estimated intake. Turnover of fatty acids in the blubber appears to be in the order of 1.5 – 2 months, as determined by temporal changes in the proportion of smelt detected in the diet. QFASA demonstrated the ability to detect modifications of FA blubber signatures after a long term and consistent switch in diet but clearly care is required when selecting FA subsets for predicting diet contributions of prey species with similar FA signatures or with signatures that become similar during synthesis.

Behavior of Southern Resident Killer Whales in the Presence of Vessels in San Juan Islands, Washington, USA

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The Southern Resident killer whales that frequent the San Juan Islands suffered a 20% population decline from 1996 to 2001. One of the potential risk factors to these whales is vessel disturbance. To address whether vessel presence affects the behavior and energetics of Southern Resident killer whales, focal follows of adult killer whales were conducted over two years. Swim speeds, respiration rates, dive durations, surface durations, and the occurrence of percussive behaviors were recorded. Scan samples were also conducted to record the number and types of vessel present and distances between the focal whale and nearest vessels (including the research vessel). Continuous focal follows ≥ 15 minutes were used in the analyses (2003: n=11 male follows; 2004: n=32 male follows and n=10 female follows). Results demonstrate no relationship between dive duration and the number of vessels present. However, for males (but not females) there is a weak but significant inverse relationship between the number of vessels present and both surface duration and the ratio between surface duration and the preceding dive duration. These small changes likely have minimal energetic effects. Although there is no relationship between number of vessels or vessel distance (>100 m) to the focal whale and the rate of percussive behaviors, on two occasions females repeatedly performed percussive behaviors when approached within 100 m by a small motorized boat. Although these preliminary results suggest that vessels following protective operating guidelines may have minimal effects on the behavior and energetics of killer whales, further research, particularly in the field of acoustics, is needed to fully understand potential vessel impacts on killer whales.

The Swimming Kinematics of Mother-Calf Dolphin Pairs: Echelon Position Reduces the Locomotor Efforts of Calves

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Dolphin calves must swim immediately after birth with a small proportion of locomotor muscle and low aerobic capacity compared to adults. Calves may compensate for limited stamina by swimming in "echelon position" (calf close to mother's dorsal fin), which theoretically reduces the locomotor costs of calves as they are carried in their mothers' pressure wave. This study is among the first to examine the swimming kinematics of dolphin calves. We compared calves and adults swimming alone and in echelon position to ascertain the extent to which echelon position reduces the locomotor efforts of calves. Three bottlenose dolphin (*Tursiops truncatus*) mother-calf pairs housed at Dolphin Quest, Hawaii were studied during the first month postpartum. Data were collected from videotapes of mother-calf pairs swimming in a straight line, either alone or together in echelon. The rostrum, dorsal fin, and fluke tip were digitized using a motion-analysis system (Peak Performance), and swim speeds, stroke amplitudes (SA), and stroke frequencies (SF) were calculated. Effects of swim speed and behavior (alone versus echelon) on swimming kinematics were examined. Results demonstrated that SA of both calves and adults were unrelated to speed. Although SA of calves were half those of adults, SA were similar on a length-specific basis. In contrast, SF increased with speed in both calves and adults and were approximately two times greater for calves than adults at any given speed. Closer examination indicated that SF were highest in calves swimming alone since intermittent periods of stroke and glide reduced SF of calves in echelon. These results provide empirical evidence that calves in echelon maintain proximity with their mothers at reduced locomotor efforts. These findings may help to resolve whether calves can become permanently separated from the pod during tuna purse-seine fishery chases, which may preclude the recovery of Eastern Tropical Pacific dolphin populations.

Multidisciplinary Investigation of Stranded Harbor

Porpoises (*Phocoena phocoena*) in Washington State with an Assessment of Acoustic Trauma as a Contributory Factor

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Observations of altered behavior of marine mammals in the area of mid-range sonar use by the naval vessel USS Shoup in the eastern Strait of Juan de Fuca and Haro Strait on 5 May 2003 prompted the National Marine Fisheries Service (NMFS) to conduct an extensive investigation into the causes of coincidental harbor porpoise strandings. Fifteen harbor porpoises were reported stranded from 2 May – 2 June 2003, which represented an abnormally high number when compared to the average stranding rate of 6 per year recorded over the past decade. Eleven of the stranded harbor porpoises were collected for this investigation. NMFS assembled a multidisciplinary team to conduct extensive necropsy examinations on the specimens, complemented by high-resolution computerized tomography (CT) scans, followed by laboratory diagnostic and histological analyses. Samples were collected for a variety of analyses including disease screening, parasitology, chemical contaminant and lipid analyses, aging studies, prey identification and domoic acid analysis. Over 70 percent of the specimens were in moderate to advanced states of decomposition, which made interpretation of the cause of death difficult. The cause of death was determined for five of the 11 porpoises examined. Of these five animals, two were found to have blunt force trauma, while illness (peritonitis, salmonellosis, pneumonia) was implicated in the remaining three cases. A cause of death could not be determined for the remaining 6 animals. The examinations did not reveal definitive signs of acoustic trauma in any of the porpoises. The investigative team noted that lesions consistent with acoustic trauma can be difficult to interpret or obscured, especially in animals in advanced postmortem decomposition. Since many of the carcasses investigated were in moderate to poor condition, the possibility of acoustic trauma from exposure to mid-range sonar as a contributory factor in the mortality of any of the porpoises could not be excluded.

Hear Me, See Me: An Acoustic and Visual Survey of Deep-water Cetaceans in Hawaiian Waters

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We surveyed deep waters (>100 fathoms) near the Hawaiian Islands of Ni'ihau, Kaua'i, and O'ahu for cetaceans from a large research sailing vessel (*R/V Dariabar*) during an eight-day pilot study in February 2005. Deep-water species were visually and acoustically surveyed using a passive acoustic system that incorporated dual, towed

hydrophone arrays. Acoustic localization was accomplished from signals of one of these arrays via triangulation using ISHMAEL/Whaltrak software. Species encountered included beaked whales, pilot whales, sperm whales, humpback whales, minke whales, spinner dolphins, and bottlenose dolphins. Of particular interest was a sighting of a minke whale that occurred 12 nm off the island of Kaua'i. To the best of our knowledge, this is the first documented sighting near (< 50 nm) of the main Hawaiian Islands. In addition, over 200 acoustic detections were made of "boing" signals (believed to be produced by minke whales in the North Pacific). From these detections we were able to localize at least 6 different animals. The combined visual and acoustic results from our study provide evidence that minke whales are relatively common, at least seasonally, during winter/spring near the Hawaiian Islands. Our results confirm that acoustic-visual methods are effective for detecting and locating deep-water cetaceans, especially in poor sighting conditions (e.g. rough seas and large swells) that occur in offshore Hawaiian waters. More importantly, we have provided additional information about the occurrence of deep-water species around the Hawaiian Islands. We plan to further develop the passive acoustic system so that it will be capable of instantaneous 2-D localization and eventually 3-D tracking of deep-diving species. A more extensive, acoustic-visual study is planned for Hawaiian waters in 2006 and will focus on the occurrence, behavior, and sensory ecology of deep-diving odontocetes (e.g. sperm whales, pilot whales, and beaked whales). Work was sponsored by Cetos and Pelagikos.

Marine Mammal Hot Spots Along the Mid-Atlantic Ridge from Iceland to the Azores Investigated by Integrated Acoustics, Biological Sampling and Visual Observations

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Aggregations or hot spots of marine mammals were observed along the Mid-Atlantic Ridge (MAR) between Iceland and the Azores during the MAR-ECO expedition (www.mar-eco.no) onboard R/V "G.O.Sars" in June 2004. The highest aggregations of baleen whales and especially sei whales (*Balaenoptera borealis*) were observed north of and in relation to the Charlie Gibbs Fracture Zone (CGFC), dividing MAR with an up to 4500 m deep canyon. The highest aggregations of toothed whales and especially sperm whales (*Physeter macrocephalus*) were observed north of the CGFC. Sperm whales, hunting for cephalopods such as *Gonatus fabricii*, were common along the MAR in waters shallower than 2000 m and often observed at the surface above underwater seamount peaks. Number and concentrations of all cephalopod species caught during deep-water trawling were used and correlated with our hot-spot areas. It is impossible to detect cephalopods acoustically in deep water. Highest concentrations of *Gonatus fabricii* and related cephalopod species were collected close to or within our sperm whale hot-spot areas. Consequently, sperm whales probably aggregated in these areas due to increased prey concentrations compared to areas outside the hot-spot areas with lower catches of cephalopods. Sei whales were most common over the slopes of seamounts and rises in waters with depths between 1500 and 3000 m. Sei whales, mainly feeding on zooplankton, aggregated in areas with the highest concentration of planktonic prey in the upper 200 m of the water column as quantified by acoustic recordings. Furthermore, highest relative concentrations of zooplankton from net-samples were found closest to the sei whale aggregations. Favourable topographic features combined with biologically productive water masses along the MAR probably explain the observed distribution of baleen and toothed whales in certain hot spot areas.

Development of Microsatellite DNA Markers for Genetic

Studies on the Florida Manatee (*Trichechus manatus latirostris*)

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The Florida manatee is an endangered species which inhabits the southeastern United States. The management of this species could be improved by incorporating genetic data into the current recovery plan. Due to the lack of genetic diversity seen with allozymes and mitochondrial DNA, previous studies have failed to resolve questions regarding the Florida manatee population structure. Microsatellites are known to show high levels of polymorphism, even in small populations with low diversity, as is often the case with an endangered species. Microsatellites vary among different species, and therefore must be designed and optimized for each new species being examined. Ten microsatellite primers were used with over 200 Florida animals. However, the corresponding loci have shown low allelic diversity. More primers have been developed by screening a second set of microsatellite libraries. To date, five of these new primers appear to be polymorphic when tested on 35 manatees from the Ten Thousand Islands population in southwestern Florida. Additional microsatellite libraries are being constructed in an effort to identify still more polymorphic loci. The collection of microsatellites will be useful not only for individual identification, but also for pedigree studies and for assessment of general population structure and status.

Whose Line Is It Anyway? The Influence of Social Structure on Vocal Signatures in Group-Living Resident Killer Whales (*Orcinus orca*)

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Constant association with a specific set of individuals appears to be advantageous for some species and may modify the behavior of individuals within the group. Northern resident killer whales (*Orcinus orca*) live in matrilineal groups of consistent membership, and this high level of social stability has been correlated with distinct group-specific vocal signatures. This study explored the potential for individual vocal signatures within these groups. A towed beamforming array of hydrophones allowed calls to be ascribed to specific individuals, and call similarity was measured using a pattern recognition neural network to discriminate between frequency contours of individuals. A total of 127 pairwise comparisons were performed using each of the two frequency components, termed the low frequency component (LFC) and high frequency component (HFC) of 626 stereotyped calls recorded from 12 different individuals representing six matrilineal groups, three pods and two clans. Similarity of both the high and low frequency contours was strongly affected by the social relationship of pairs of whales, with the network having the highest error rate for same whale comparisons, a lower error rate for comparisons within a matrilineal group, and the lowest error rate for comparisons between individuals in different matrilineal groups (ANOVA: LFC: $F_{2,52}=37.70$, $p<0.006$; HFC: $F_{2,49}=7.03$, $p<0.05$). Group identity appears to have a stronger influence on the time-frequency structure of stereotyped killer whale calls than individual identity, mostly likely a behavior advantageous in maintaining group cohesion. Therefore, the social bonds between groups of individuals appear to take precedence over individual relationships within this population.

Transmission of Vessel Noise Through Right Whale Environments

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North Atlantic right whales may continue to be hit by ships because they have habituated to ship noise. Alternatively, the whales, while resting at the surface, are unable to hear or localize oncoming ships accurately enough to avoid being hit. Sound traveling in surface waters can be subjected to several physical phenomena, which depend on local conditions and location. Changes in perceived ship noise can include amplification, attenuation, and/or the formation of interference patterns in which sound energy at the surface varies in amplitude with range. Using standard Navy procedures, *i.e.*, source characterization and propagation models, we modeled transmission loss (TL) through representative right whale environments for a typical merchant-ship propeller-cavitation source. The analysis focused on narrow as well as 1/3-octave frequency bands, centered at 20, 80, 320, and 1250 Hz. We developed scenarios with different water depths, bottom types, and sound-velocity profiles. Additionally, to simulate the effects of shadowing by the hull, we 'baffled' the source to varying degrees. Finally, given the amount of time whales spend in near shore waters, we modeled transmission over a sloping bottom. Our results indicate that the "surface-image interference effect" does result in increased attenuation near the surface, but even with this loss the signal should still be audible to a whale at the surface based on current knowledge of right whale hearing and background noise levels. The addition of surface roughness to simulate the effects of wind reduced the image interference effect, especially at the higher frequencies. No 'shadow zones' were found at depths away from the surface, due at least in part to the existence of good bottom-reflected paths in these shallow environments. We did find considerable variability in the sound field as would be experienced by a whale at different ranges/depths, even for 1/3-octave bands.

Hydrodynamic Sensor Capabilities and Structural Resilience of the Male Narwhal Tusk

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The unique configuration of dentinal tubules and hard tissue architecture within the narwhal tusk supports a new hypothesis for function. Two freshly harvested male tusks, examined under scanning electron microscopy, reveal dentinal tubules that are open and extend continuously from the pulp to the external environment. Approximately 1 tubule opening every 200 μm^2 , ranging from 0.1-4 μm are visible on the pulpal wall. Analogous surface lumina are visible within a 10-20 μm layer of diatoms and algae that cover the cementum surface. Brannstrom's hydrodynamic theory identifies pain sensitivity in mammals that have tubule communication of pathologic origin from the tooth or root surface to the pulp. With over 10^6 tubules in an eight-foot tusk, potential exists for the tusk to be used as a hydrodynamic sensor to detect fluid flow responsive to gradients of salinity, temperature and pressure. Chemical and mechanical properties of the tusk also indicate unusual functional adaptation. Cross-sections of one tusk near the tip (#1), $\frac{1}{4}$ length from the tip (#2), and near the base (#3), were dry polished and mapped by Fourier-transform infrared reflectance microspectroscopy (FTIR-RM) at 100x100 μm to 200x200 μm spatial resolution and by nanoindentation at 200x100 μm spatial resolution. FTIR-RM analysis showed higher mineral to collagen ratios (MCR) near the dentin-pulp interface and decreasing toward the cementum interface in #1 and #2, with non significant difference in #3. Mechanical indices of hardness

and Young's Modulus were highest at the dentin-pulp interface and decreasing outward toward the cementum in all sections. All three properties declined from tip to base, with modulus demonstrating dramatic decline moving from pulp to the outer surface. The outer layers being less mineralized and more flexible than the inner layers in sections closer to the tip indicate unusual resilience and flexibility of the tusk and suggest important evolutionary functional adaptation.

Crossing Significant Boundaries: Evidence of Mixed-Stock Origins of New Steller Sea Lion, *Eumetopias jubatus*, Rookeries in Southeast Alaska

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Steller sea lions are currently listed as endangered to the west of 144 or threatened otherwise. This distinction resulted from a phylogeographic analysis of mtDNA variation (238bp) in 224 pups sampled between Oregon and Kamchatka in 1991-3 that revealed a deep evolutionary division at that location. We examined genetic variation in a large number of pups including two new rookeries located within the threatened Eastern stock: Graves Rock, founded in 1998 just inside the boundary, and White Sisters, founded in 1990 between Graves and Hazy Island (founded in 1979). We use mtDNA sequences (531bp) in Bayesian and maximum likelihood assignment tests. Phylogeographic level differences were observed among rookeries in the Western Stock ($n = 1,115$) and the older rookeries in the Eastern Stock ($n = 497$) ($F_{st} = 0.18$, $\Phi_{st} = 0.27$, $P < 0.001$), indicating an ancient divergence between respective populations. In contrast, the newer boundary rookeries in the Eastern stock, White Sisters ($n = 180$) and Graves Rock ($n = 48$) exhibited limited differentiation from several Western Stock rookeries ($F_{st} = 0.002$, $\Phi_{st} = 0.099$, $P = 0.101-0.357$). Graves Rock was estimated to comprise 26.4% Eastern stock and 73.6% Western stock breeding females. White Sisters was estimated to comprise 64% Eastern stock and 36% Western stock breeding females. No mtDNA haplotypes characteristic of the Western Stock were found in Hazy Island ($n=129$), suggesting it was likely founded solely by females from the Eastern Stock. These findings provide new insight into the mechanism of Steller sea lion rookery colonization and re-colonization and indicate that the genetic structure of what we currently call the Eastern stock has changed since the original designation.

Nutrient Composition of the Diet Consumed by Threatened Southern Sea Otters

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The slow growth of the threatened sea otter population in California is accompanied by other phenomena, such as declining mass to length ratios, high and increasing time spent foraging, high dietary diversity, and high rates of infectious disease, that are consistent with nutritional inadequacies in sea otter diets. We are investigating nutritional constraints on this population by combining an examination of the nutrient composition of sea otter prey with information on the diet consumed by wild sea otters. We have collected samples of more than 80 species of intertidal and subtidal invertebrates from the Monterey Bay National Marine Sanctuary and adjacent areas, including seasonal samples (spring, summer, fall, winter) of the major prey types ingested by sea otters, such as crustaceans (*Cancer* crabs, kelp crabs), echinoderms (sea urchins, sea stars), bivalves (mussels, clams),

gastropods (*Tegula* snails, abalone) and sipunculans (fat innkeepers). Our analyses on major prey species include caloric and water content, fat, protein, major and minor minerals, and selected vitamins. Large variation in the edible dry fraction of otter prey (ranging from about 13 to 29% of whole prey) suggests that there may be diverse returns from foraging effort, depending on prey type. Otter prey tend to be low in fat (<10%, dry matter basis) but variable in protein content. We will examine the extent to which variation in nutrient composition among the prey types is phylogenetic and the extent of seasonal variation in nutrient composition within each prey type. In addition, we will estimate the nutrient composition of the average diet consumed by sea otters along the mainland coast of California by combining results from our nutritional analyses of prey species with data on the type, number and size of prey consumed by over 30 radio-tagged otters.

Changes in Strandings and Entanglements of Cetaceans in Japanese Waters from 1961 to 2005

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There have been recent changes in the numbers of cetacean strandings and entanglements reported in Japanese waters. We examine the incidence of cetacean strandings in Japan in recent years in comparison to records going back to 1961. Strandings were compiled from reports from fishermen, news accounts, and as reported to ICR, MMCJ and IKRP. A total of 2,368 strandings of cetaceans were compiled for 1961 to 2004. These included the following endangered species (# in parenthesis): Humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), minke whale (*Balaenoptera acutorostrata*). These included 23 stranding of killer whales (*Orcinus orca*). The most recent was of 12 killer whales mass stranding in Hokkaido in February 2005. Tissues from these animals were tested for contaminants and revealed mean levels of PCBs in blubber of 51.7 ppm and 57.7 ppm mercury in liver (need to specify whether these are by wet, dry, lipid weight and if this is total mercury or methyl mercury). Reports of entanglements of both humpback and minke whales have increased dramatically in recent years. For humpback whales, reports of entanglements went from a total maximum average 10 per year for 1961 to 2001 to more 112 and 130 in 2002 and 2003, respectively. Similarly, minke whale entanglements increased from 2001 but have exceeded 100 each year for 2002 to 2005. This is likely the result of both 1) more complete reporting due to a change in the law in the end of 2001 allowing fishermen to sell entangled whales for human consumption, 2) a real increase in entanglements due to changes in whale distribution or abundance or changes in strategy by fishermen.

General and Fine-Scale Movement Patterns of Pacific Coast Bottlenose Dolphins (*Tursiops truncatus*)

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A two-part study was carried out to analyze the daily movement patterns of Pacific coast bottlenose dolphins in north San Diego County. In the first study, 697 hours of land-based behavioral data collected on coastal bottlenose dolphins identified two distinct movement patterns: "localized" and "directional." During "localized" (42%) movement dolphins remained within a restricted area of coastline and engaged in more feeding, socializing, and resting vis-à-vis "directional" (29%) movement in which more travel occurred. In the second study, 128 hours of boat based GPS tracking data were collected to carry out a fine-scale analysis of "localized" and "directional" movement patterns. Reversal rate, calculated as number of times dolphins changed, or reversed, directions per minute, was greater during "localized" compared to "directional" movement; however, during "directional" movement, speed, as well as distance

from shore, were greater than during "localized" movement. Considered together these results indicate that "localized" movement is an adaptation which optimizes the search and capture phases of foraging while in productive coastal areas. In contrast, "directional" movement appears to be a strategy optimized to move through less productive coastal areas while permitting a low level of concurrent foraging.

Stomach Contents of Short-Finned Pilot Whale (*Globicephala macrorhynchus*) and False Killer Whale (*Pseudorca crassidens*) in Okinawa, Southern Japan

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We analyzed forestomach contents of 19 short-finned pilot whales and 8 false killer whales that were caught by local harpoon dolphin fishery in Okinawa Island. Forestomach contents of 5 stranded false killer whales in Okinawa were also analyzed. Prey items in the contents were identified by outer morphology if possible, but almost squids were heavily digested, therefore, lower beaks were used for identification. In the stomach contents of short-finned pilot whales, smaller squids comprised 99% number of prey. *Enoploteuthis chuni* (firefly squid) was found from all pilot whales, and it was the most numerous squid. More than half number of pilot whales fed on *Histioteuthis* spp., *Ommastrephidae* spp., and *Ancistrocheirus lesueurii*. Fish was very few, but several species of mesopelagic fishes were found. For false killer whales, about 84% of prey items were squids. More than 90% number of squid was *Thysanoteuthis rhombus* (diamondback squid), which is a large squid. Fish was not numerous, but relatively large species were found such as *Acanthocybium solandri* (wahoo), *Coryphaena hippurus* (dolphin fish). Stranded false killer whales fed on *E. chuni*, *Sepioteuthis lessoniana* (oval squid), *T. rhombus*, and *Ommastrephidae* sp. The difference of feeding habits between two whale species can be summarized that the pilot whales feed on mesopelagic smaller squids, and false killer whales feed on larger prey including epipelagic species. However, short-finned pilot whale in central Pacific coast of Japan is known to feed on large mesopelagic fish. This implies that the pilot whale potentially can feed on large fish. The difference of prey between two species in Okinawa should not be simply attributed to the food preference for each species, but food segregation as a result of competition among whale species should be considered.

Distribution Patterns of Humpback Whales (*Megaptera novaeangliae*) in the Barents and Norwegian Seas

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About 1,400 incidental sightings of humpback whales (*Megaptera novaeangliae*) made through the past 30 years give a comprehensive picture of the occurrence of this species in the Barents and Norwegian Seas. The general distribution pattern shows concentrations around Bear and Hopen Islands in the Barents Sea and along the Finnmark coastline off northern Norway. The incidental sightings indicate a northern boundary around the Svalbard archipelago of 80°N, and in the Norwegian Sea a northern boundary of around 72°N approximately following the ridge between Jan Mayen Island and Bear Island. Eastwards in the Barents Sea humpbacks are found to about 45°E. Distributional patterns vary throughout the year and between years. Sighting surveys conducted over the past 15 years have mapped the summer distributions of whale species in the Norwegian and Barents Seas. In the late 1980ies humpbacks seemed to be distributed thinly over a larger area than compared to 1995 when humpbacks seemed to be very concentrated around Bear Island. This has later changed to a distribution over a larger area in the late 1990ies. These patterns may be related to the collapse of the capelin stock in the Barents Sea

in the mid 1980ies followed by a recovery around 1992. Photo identification work has focused on the Bear Island – Hoppen Island area and has been conducted at a relatively small scale since 1992. Over this period 474 photo ID encounters have been made, and about half of them in the years 2002 and 2003. There have been few recaptures between years, nevertheless indicating some kind of site fidelity. In one case a period of eight years elapsed between first identification and recovery within the same area. Short-term recoveries, from one day to a few months after the first encounter, also indicate fidelity within an area when first arrived there.

Life History and Population Dynamics of Northern Resident Killer Whales (*Orcinus orca*) in British Columbia

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Long-term photo-identification studies of killer whales have been underway in coastal waters of British Columbia for over 3 decades. During the 1970's, 80's and early 90's, the northern resident population grew steadily at a rate of 2.6% per annum, showing no signs of density dependence. The population peaked abruptly in mid-1990s and then fluctuated, showing no consistent trend over the last decade. A sex- and age-structured model was developed to compare population dynamics during the periods of unrestrained growth and no net change. During the period of growth, mean life expectancy of females was 46 years and maximum longevity on the order of 80 years. Females typically gave birth to their first viable calf at 14 years of age, and those that survived produced a total of 4.7 calves at average intervals of 4.9 years over a reproductive lifespan that typically lasted 24 years. Older females exhibited reproductive senescence, with 50% being post-reproductive by 38 years of age, and none reproducing beyond 46 years of age. Males typically matured at 13 years of age, mean life expectancy was 31 years, and maximum longevity on the order of 60-70 years. Surprisingly, reproductive parameters changed little as the population growth subsided, with the reproductive potential of females declining only slightly from 4.7 to 4.5 calves. The drop in population productivity was due almost entirely to an increase in natural mortality, which was evident across all sex- and age-categories, particularly the youngest and oldest age-classes. Mean life expectancy declined from 46 to 30 years for females, and from 31 to 19 years for males. Due to their lower survival, the expected reproductive output of females dropped from 3.6 to 2.2 calves. This assessment suggests that population productivity of these long-lived, slow-reproducing animals may be regulated more by changes in survival than reproductive rates.

Geographic and Seasonal Variability in Blue Whale Visual and Acoustic Encounter Rates from Shipboard Surveys in the Southern California Bight

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The addition of passive acoustics to cetacean surveys has increased the precision of abundance estimates for some species. Concurrent visual and acoustic monitoring for baleen whales has generally been opportunistic, preventing quantitative comparison of visual and acoustic encounter rates, required for calibrating call rates to estimate relative or absolute abundance, or to evaluate habitat use or anthropogenic impact. We investigated the relationship between visual and acoustic encounter rates for blue whales using dual-mode surveys in nine subregions of the Southern California Bight (SCB) from April to November, 2000-2003. Hourly counts of visual and acoustic (AB and D caller) encounters were evaluated using generalized additive models (GAMs) to determine the temporal and spatial variability in and the relationships among encounter types. Visual and D caller encounters were positively related, showing similar seasonality and geographic distribution. In contrast, visual and AB

caller encounters were not related, with the peak of AB calling two months later than the mid-summer seasonal peak in visual encounters, and significantly higher visual encounter rates in some northern regions of the study areas. The positive relationship and shared seasonality between visual and D caller encounters indicate D calls may be a robust proxy for blue whale distribution and abundance. Calibration of AB calling rates for estimating blue whale abundance and distribution will be complicated by the seasonal offset between visual and AB caller encounters, as the proportion of whales producing this call type increases into the fall. Further, the incongruence between visual and AB caller encounters suggests that this commonly reported and widely studied call type may not be a good indicator of whale density, but can provide a measure of the proportion of animals missed through visual surveys alone.

Current Threats to Antillean Manatee Conservation in the Wetland Systems of the Southern Gulf of Mexico

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Within the extensive wetland systems of the Mexican states of Tabasco and northern Chiapas, in the southern Gulf of Mexico, it is distributed a large population of manatees, which is perhaps the largest in Mexico; this supposition is based on frequent opportunistic data of sightings and stranding reports. Since 1984, there are at least 81 confirmed beached individuals and 10 of these cases have been registered in the last two years. The number of registered localities is also increasing. In spite of this, the research in the region is limited to a few past studies. Among the threats to the conservation of manatees, we can highlight the lack of knowledge on their abundance and distribution; stranding and mortality directly related to human activities and natural diseases; habitat perturbation; modification of the hydrological regimens; small populations isolated in lakes, even in urban areas, or maintained in captivity without formal management. The conservation efforts have focused to the attention of some stranding cases and mortality reports and urgent actions in captive animals. There is limited capacity to assist and rehabilitate the alive beached manatees, especially for orphan calves, which resulted in two calves and four adults transferred to private aquariums outside of the region. In this work, we analyzed the different threats to the conservation of the manatee in the region to have a general idea of the situation of this species in the region and we present alternatives for short, medium and large trend strategies for research and management lines.

Intelligent Migration of a Sei Whale from the Azores to the Labrador Sea in April – June 2005

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Current knowledge suggests that most species of Atlantic baleen whales conduct annual large-scale migrations from breeding areas in subtropical waters to feeding areas in boreal and arctic waters. Annually, in April, large baleen whales appear in Azorean waters during their northbound migration. It is hypothesized that the whales use the mid-Atlantic Ridge (MAR) as a migration corridor to the northern feeding areas. Between April 12 and April 14, three sei whales, and one blue whale were tagged with positional satellite transmitters (WC-SPOT4 tags) as part of the MAR-ECO project. Only one transmitter, on one of the sei whales functioned, and was followed from April 13 to June 7. From April 13 to May 8 the whale first conducted a straight northward migration and apparently commenced feeding in the vicinity of the

Charlie Gibbs Fracture Zone along the MAR. Surveys conducted in 1989 and 2004 have shown that this area is a high density area for sei whales in the summer months. From May 8 to June 7 the whale made an almost straight westward movement, interrupted by a few apparent feeding bouts before arriving in the Labrador Sea in the beginning of June. In the Labrador sea the whale moved closer to the Labrador shelf break where contact was lost on June 7, probably due to the tag falling off. The tracking data is compared with satellite data of chlorophyll A and SST. The whales movement in relation to current patterns were studied based on the Regional Ocean Model System (ROMS) current. Lastly the migration was studied in relation to abundance indices for zooplankton based on survey (2004) and Continuous Plankton Recorder (CPR) data. These analyses showed that apparent feeding behaviour took place in areas of known high plankton abundance.

Fine Scale Population Genetics of the Harbour Seal (*Phoca vitulina vitulina*)

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The harbour seal (*Phoca vitulina vitulina*) has a wide distribution across the northern hemisphere. A large scale genetic differentiation across this range is widely supported but the extent of genetic differentiation at a finer scale is yet to be investigated. Using 16 polymorphic microsatellites in a sample of 259 individuals from 12 geographically separated haul out areas we analyzed the population structure of this species within Danish and neighboring Swedish waters. An analysis of the genetic substructure using a Markov Chain Monte Carlo approach revealed the existence of at least three subpopulations inhabiting the Wadden Sea (WS), inner eastern part of the Limfjorden (LF) and the inner Danish waters (Skagerrak/Kattegat/Baltic Sea, SKB), respectively, with a marked genetic differentiation especially between subpopulations west (WS and LF) and east of Jutland (SKB). Applying the more traditional G statistic supports these findings and further indicates some differentiation within the inner Danish waters not detectable by the Markov Chain Monte Carlo approach. The overall differentiation between haul out sites was moderate ($F_{st} = 0.05$). A significant correlation between geographic distance and genetic isolation was found and our study indicates that previous suggestions of philopatry operating over 300-500 km might be a bit overestimated; especially over distances with discontinuous distribution where the philopatric range is more likely to be 200 km or less. Overall these findings suggest a pattern of some genetic differentiation at a finer scale than previously recognized. The implications for management of harbour seals are discussed.

Patch Foraging Dynamics and Prey Response in a Gray Whale Summer Foraging Area on the West Coast of Vancouver Island, Canada

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Gray whales (*Eschrichtius robustus*) forage on dense patches of hyperbenthic mysids (Family Mysidae) in our study area throughout the summer, depleting patches, and moving to new patches or to more distant sites as the season progresses. The research objective of this paper is to quantify the number of patches in a discrete foraging area and monitor the response of the prey patches to foraging pressure from gray whales. Within-season fluxes in predators and prey are almost solely the result of the top down effects of predation as a highly mobile predator interacts with a spatially discrete prey base in a short, simple food chain. We measure prey patches with a dual frequency sonar that enables us to accurately identify and map hyperbenthic mysid swarms along a transect on 14 occasions through

a 4 month season. The dual frequency technique solves the significant issues of sorting the swarms from the bottom material and giving us improved capacity to delineate this prey type by remote methods. Whales were located and counted on a census transect through the study area, on 29 occasions throughout that same period. We discovered a very sharply defined pattern of concomitant prey patch depression and reduced predator numbers as the season progressed. In fact, as prey patches reached a low ebb, the whales deserted the study area completely. Consequently, the mysid swarms reformed, showing us a behavioural response to release from whale foraging at a much finer scale. The simultaneous analysis of predators and prey in this manner gives us a systematic method to unravel the spatial behaviour of gray whales.

Body Measurements of Tropical Killer Whales

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Killer whales (*Orcinus orca*) are the most cosmopolitan of cetaceans, however most of our knowledge of this species comes from research on coastal populations in mid to high latitudes. Little is known about killer whales in the pelagic, tropical environment. During the years 1993, 1998-2000, and 2003 we obtained external measurements on free-ranging killer whales in the eastern tropical Pacific Ocean, from 7 to 620 miles offshore, using aerial photogrammetry. Photographs were taken from a helicopter with a vertically mounted 12.7cm format camera at altitudes between 97-246 meters. Selected photographs were digitized and measured using ImagePro Plus (Version 5.0) software. Photo scale was based on calibrated radar altimeter readings. 38 whales from 9 groups were measured for total body length, and 23 of these whales were additionally measured for fluke span and/or pectoral flipper lengths. Adult males were identified by proportionally larger dorsal fins and pectoral flippers; adult females were identified by the presence of a calf and/or proportionally smaller dorsal fins and pectoral flippers. Six of these identifications were confirmed from genetic samples. The mean length of adult males was 6.3m, ranging from 5.1-8.0 m (n=8); mean length of adult females was 5.7 m, ranging from 5.0-6.1 m (n=16). Two of the whales categorized as subadults were recognized as male based on their relative flipper sizes. The smallest whale measured was 2.9 m long. Fluke spans ranged from 32-36% and 26-33% of total length for males and females respectively. These measurements fall in the ranges generally given for killer whales. Adult females in this sample exhibited flipper lengths of 13-17% of body length, longer than the reported standard of 11-13%. Flipper lengths of the adult males ranged from 18-22% of the body length, in line with the 20% standard.

Comparison of Two Metabolic Stress Hormones and Two Leukocyte Subsets in Rehabilitated and Free-Ranging Harbor Seal Pups

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Health of harbor seal pups in rehabilitation and in the wild were compared using two metabolic hormones (cortisol and total thyroxine, or TT4), two cellular immunity components (lymphocytes and eosinophils), and morphometric measurements. Neonatal harbor seals in two rehabilitation facilities, the Alaska SeaLife Center and The Marine Mammal Center in California, were compared to wild harbor seal pups from Tugidak Island, Alaska. Total thyroxine (TT4) concentrations in the rehabilitation pups (n=32) ranged from 0.7 to 11.4 ng/ml in animals age 2 days to 14 weeks. Cortisol concentrations ranged from 2.3 to 76.4 ng/ml. The wild pups' (n=59) TT4 ranged from 1.61 to 7.62 ng/ml and cortisol ranged from 7.07 to 20.57 ng/ml. In the pups undergoing rehabilitation, there were indications of hormonal changes due to how the animals were housed, introduction of other animals into housing areas, and alternating feeding regimes (live fish, different prey). High levels of cortisol at weaning suggest

changes in stress response may be due to diet adjustments in pups during rehabilitation. The lower cortisol concentrations post-weaning suggest that pups in rehabilitation had overcome the challenge of pre-weaning diet, handling or environment and avoided chronic stress. TT4 concentrations were significantly higher in wild pups, likely attributed to a more energetically demanding life in a dynamic environment. The rehabilitated pups showed lower lymphocyte counts, but not eosinophils, compared to wild pups. Wild harbor seal pups were heavier and longer than post-weaned pups in rehabilitation. It is probable that the animals in rehabilitation were nutritionally compromised at stranding, maternally abandoned, or diseased; but it is also possible that current rehabilitation practices do not mimic what a healthy pup would receive from its mother in the wild, thus pups undergoing rehabilitation likely remain smaller and possibly immunologically compromised despite repeated and constant care in rehabilitation.

Diving Parameters of Harbor Seal Pups (*Phoca vitulina concolor*) During Post-Weaning Dispersal

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In Northern New England, harbor seal pups disperse from their natal sites after weaning. Although several studies have examined pup diving behavior during the lactation period, little is known about behavior during the post-weaning dispersal. The haulout and diving behavior of pups during dispersal is the focus of this analysis. Satellite-linked tags (SDR-T16, Wildlife Computers) were placed on five weaned pups born in Blue Hill Bay, ME, in June 2004, and were monitored for up to four months. Data were divided into 10 day blocks for this analysis. The majority of dives performed by the pups were 10-20m maximum depth. Only 13% of the dives were deeper than 40m, despite the fact that pups traveled over much deeper water. Contrary to expectations, there was no increase in average dive depth over time. Dive durations rarely exceeded 3 minutes, and were more commonly 1-2 minutes in length. The longest dives were between 5 and 10 minutes. Overall, there was no increase in dive duration over the study period. During the first four months post-weaning, pups spent on average 53% of their time hauled out. Of additional interest is the diving behavior that occurred at locations where pups remained for protracted periods of time, presumably feeding. This research will continue for the 2005 pupping season in order to increase the sample size and look for annual differences.

Oh Mother Where Art Thou? Genetic Investigation into Mass Strandings of Long-finned Pilot Whales

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The long-finned pilot whale (*Globicephala melas*) is the most common cetacean species involved in mass strandings, often including more than an hundred individuals in a single event. Here, we present the first genetic study on this species from the Southern Hemisphere based on 280 samples collected from five mass strandings distributed around New Zealand. As expected from previous studies in the North Atlantic, sequencing of the mitochondrial DNA control region and protein coding genes ($n = 180$, >1000 bp) revealed extremely low diversity ($h = 0.198 \pm 0.038$, $p = 0.079 \pm 0.089 \%$), with the majority of all pods dominated by a single shared haplotype. However, contrary to expectations of a strictly matrilineal social structure, we found that three of the five stranded pods included more than one haplotype, demonstrating that at least some pods are composed of unrelated matrilineal. Genetic relatedness within and between stranded pods was also investigated by genotyping with 15 microsatellite loci. Particular effort was concentrated on one mass stranding at Stewart Island in 2003 ($n = 122$), where the position and age/sex class of each stranded whale was mapped along the beach. Contrary to the

expectation that close kin would be closely associated during these traumatic events, various analyses failed to detect a correlation of kinship with the spatial distribution of stranded individuals. Even inferred cow-calf pairs were often found widely separated along the beach. Although the observed separation of close kin could be either a cause or a consequence of the stranding event, this disruption of kinship bonds could help explain the behavioral distress of stranded individuals and the tendency of many whales to restrand even after being refloated.

Ontogeny of Diving Behaviors of Immature California Sea Lions (*Zalophus californianus*)

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Otariid pinnipeds are marine mammals that lead an amphibious existence. During their ontogeny they undergo a prolonged, purely terrestrial phase after birth relying on their mother's milk and with age they gradually forage independently in the aquatic environment. During this transition, an individual otariid is able to store more oxygen in its lungs, blood, and muscles as it grows, which allows it to dive to greater depths, travel longer distances, and forage on a greater variety of prey. As part of a multidisciplinary study to examine the development of diving and foraging behaviors, we summarized dive and movement data of 11 young-of-the-year California sea lions (*Zalophus californianus*) at San Miguel Island, California (34.03°N, 120.44°W). Satellite transmitters (SirTrack KiwiSat Platform Transmitter Terminal, Havelock North, New Zealand) and time-depth recorders (Mk9, Wildlife Computers, Redmond, WA, USA) were deployed on animals aged 8 ($n=2$), 9 ($n=6$), and 10 ($n=3$) months old during February through May 2005. Data from recovered instruments indicated that of 19,843 dives mean depth = 20.5 m (SD = 8.1), mean maximum depth = 103 m (SD = 41.4; maximum = 167 m), mean duration = 1.21 min (SD = 0.4), mean maximum duration = 3.97 min (SD = 0.98, maximum = 4.77 min), and mean distance from haulout = 20.2 km (SD = 13.7, maximum = 49.6 km). These results were similar to those reported in the literature of immature Steller sea lions (*Eumetopias jubatus*), a similar species. Additionally, these dive characteristics and movement patterns indicated that immature California sea lions have developed to an extent that they are capable of performing dives and movements similar to adults.

Are Blue Whales from Baja California Pygmy? Clarification Base on Aerial Photogrammetry

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Of the three known subspecies of blue whale, *Balaenoptera musculus musculus* has long been considered the only blue whale in the northern hemisphere. Since 1999, however, it has been suggested that a normally Antarctic subspecies, *B. m. breviceauda*, occurs in waters off California-Mexico-Central America. To verify which subspecies occupies the waters of Baja California, Mexico, we performed allometric and morphometric analysis on 94 blue whales, whose body proportions were clearly measurable on aerial images taken from a Cessna 182 between 1994 and 2004. These were compared with whaling era data of *B. m. intermedia* and *B. m. breviceauda*. Of the 10 body proportions measured on aerial images, we observed that the forepart of the blue whale grows faster than the peduncle. This disproportionate growth is most marked in *B. m. breviceauda* ($b = -3.38$, $F = 203.87$, $p < 0.05$). Likewise, the peduncle proportion was the only measurement that discriminated to *B. m. breviceauda*. In this study the peduncle of the Baja California blue whales (22.3-28.4%, $n = 59$) did not show significant difference from that of *B. m. intermedia*, the south hemisphere blue whale (23-28%, $n = 555$) in agreement with

Mackintosh and Wheeler (1929), but differed significantly from those of *B. m. brevicauda* (19.1-28%, $n = 57$, $p < 0.05$). This confirms that the blue whales observed in Baja California waters are not *B. m. brevicauda* and there is no reason to believe that they are not *B. m. musculus*.

Habitat Characterization of Satellite-Tracked Sperm Whales in the Gulf of Mexico

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The physical habitat of sperm whales in the northern Gulf of Mexico was studied by analyzing environmental variables for locations of 39 individuals tracked with satellite transmitters. Tags provided 3-183 locations during 17-607 days of operation. Movement paths of the whales were characterized with each location categorized as a meandering or transit movement type. The bottom depth, bottom slope and sea surface height (SSH) at each location were compared between sex class and movement type. Significant differences were observed in median bottom depth and slope at locations for both sexes, as well as median depth between meandering and transit categories. Median bottom slope was not different for movement type. No significant difference was found in SSH between females and males, although it was different between meandering and transit locations. The mean SSH for all locations (-4.64 dynamic cm) agreed with previous studies that found higher numbers of sperm whales in areas of cyclonic circulation and cyclone-anticyclone confluence. Tracked females were located most frequently on the upper continental slope in the northern Gulf. Males were also located there but moved more often into the central Gulf or over deeper waters with less steep bottom slope (*i.e.* lower continental slope and abyssal plain) than females. Although most whales were tagged near and frequented the Mississippi Canyon (MC) and the Mississippi River Delta (MRD), home range analysis showed differences between males and females, as well as among individuals, in the specific areas frequented during the year. The observed trend was for the tagged whales to aggregate near the MC and MRD in the summer. While some individuals may spend several months in those areas, other dispersed to different regions the rest of the year.

A New Tool for Real-Time Acoustic Species Identification of Dolphin Whistles Utilizing Two Different Statistical Methods

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Many cetacean species produce characteristic calls that propagate well under water and acoustic techniques can therefore be used to detect and identify them. The ability to identify cetaceans to species using acoustic methods varies and is affected by the statistical techniques employed. Two multivariate statistical methods commonly used in classification studies are discriminant function analysis (DFA) and classification tree analysis (CART). These methods were compared using the whistles of 9 delphinid species recorded in the eastern tropical Pacific Ocean ($n = 1516$). While the two statistical methods resulted in similar overall correct classification scores (DFA: 37%, CART: 33%), their performance varied by species. For 7 of the 9 species, correct classification scores produced by DFA were higher than those produced by CART. For the remaining two species, correct classification scores from CART were greater than correct classification scores from DFA. A whistle-by-whistle comparison showed that DFA and CART agreed on predicted species identification for 52% of whistles. Of these, 44% were classified correctly. Of the whistles for which predicted species did not match between the two methods, DFA was correct 29% of the time and CART was correct 20% of the time. An understanding of the differences in the

performance of these two methods makes it possible to use them in tandem and improve classification success. As such, they have both been incorporated into a new automated system for real-time acoustic species identification during cetacean abundance surveys. This new matlab-based tool allows species distribution data to be collected even when visual efforts are compromised. It may also prove valuable for studies utilizing bottom-mounted recorders, where visual species identification is not possible.

Artificial Tail Flukes 3 - Swimming Behavior

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“Fuji”, a female bottlenose dolphin, *Tursiops truncatus*, from the Okinawa Churaumi Aquarium, lost most of her tail flukes following a serious disease contracted in 2002. After this excision, she did not swim anymore and only floated at the water surface, staying close to the verges of the tank. Artificial tail flukes were developed in order to help her swim normally (technical details of the flukes design are described in the poster by Seki *et al.*). Since the artificial flukes were attached, “Fuji” started swimming and leaping again. From that moment on, she swam even without the flukes. In this paper, we evaluate the effect and practicality of the flukes. The swimming behavior of “Fuji” was recorded using an acceleration data logger attached to the dolphin’s back with a suction cup. The data logger recorded depth, swimming speed and tail-beating activity and was deployed for a total of 4 hours during which “Fuji” swam about 70 % of the time and leaped 57 times. In order to compare Fuji’s swimming aptitudes to that of other dolphins, we calculated a dimensionless swimming number (Sw), which is defined as the swimming speed divided by body length and beat frequency. Sw of bottlenose dolphin are generally around 0.8-0.9, while those of Fuji were 0.6-0.7 with flukes and 0.4-0.5 without flukes. Although the Sw of Fuji with flukes did not reach the values of non-impaired dolphins, her swimming ability improved and progressed regularly from the beginning of this experiment. Our experiment suggests that artificial tail flukes enabled Fuji to swim more efficiently. Furthermore, her activity level was as high as before she lost her tail and her health condition improved from the moment the flukes were attached.

Population Genetic Structure of Southern Right Whales (*Eubalaena australis*) in the Western South Atlantic Ocean

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The southern right whale (*Eubalaena australis*) migrates during the austral winter to different breeding/calving grounds in the South Atlantic Ocean. Although the movements of right whales between calving grounds or between calving and feeding grounds are known from some photographically identified individuals, the geographic differentiation and main migratory routes of the species remains unknown. In this study, we examined the genetic diversity and population structure of the southern right whale in the western South Atlantic Ocean using sequences of the mitochondrial DNA (mtDNA) control region and 10 nuclear microsatellite loci. A total of 77 southern right whale samples

from two breeding grounds (southern Brazil, n=48 and Argentina, n=21) and one feeding area (South Georgia Island, n=8) was analyzed. The overall estimated genetic diversity was relatively high at both mitochondrial ($h=0.956$; $p=2.23\%$) and nuclear levels ($H_o=0.695$; $A=7.8$). The sequences of the mtDNA control region (495bp) revealed a total of 43 polymorphic sites, defining 30 haplotypes: 14 unique to Brazil, two exclusive to Argentina, and one found only in South Georgia. Nine haplotypes were shared between Brazil and Argentina, three between Argentina and South Georgia and one between Brazil and South Georgia. In addition, three haplotypes were common to all regions. Phylogenetic analysis identified three principal clades without a clear geographic partition, since haplotypes from all regions were distributed between them. The analysis of molecular variance (AMOVA) based on mtDNA sequences and microsatellite data showed a high degree of genetic homogeneity, with less than 1.62% of the genetic variation distributed among populations. This high level of gene flow, in conjunction with data from previous photoidentification studies, indicates that the southern right whales that migrate to southern Brazil and Argentina comprise a single population that also use the South Georgia as one of their feeding ground. *Financial support: The National Council for Scientific and Technological Development (CNPq, Brazil) and World Wide Fund For Nature (WWF-Brazil)*

Cetaceans as Seascape Species the Northeast Coast of Venezuela: A Preliminary Assessment Based in the Seascape Species Approach

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The *Seascape Species Approach* developed by Wildlife Conservation Society is a frame work for site based conservation through a dual role: a conservation umbrella, and foci for strategic planning. The northeast coast of Venezuela is a renowned sardine fishery area given its notable productivity, as well as the most complex marine topography within Venezuelan waters. To date, except for Mochima National Park no MPA or marine sanctuary has been designated for most of the basin. The aim of this contribution is to apply in a preliminary way the *Seascape Species Approach* taking advantage of the flagship role of cetaceans in Northeast Venezuelan waters. The study site is centered in Margarita Island and adjacent waters, diversification was based in four marine sub-areas: A) the shelf edge on the north coast of Margarita Island and La Blanquilla Island; B) Margarita Island's east coast and Margarita-Los Testigos submarine platform; C) The north coast of Araya Peninsula, including Coche and Cubagua Island; and D) The Cariaco trench southwest of Margarita and Cumaná. The corresponding Threat Assessment was resolved among experts, but instead of a workshop, consulting was done through questionnaires and voting sent by e-mail. Three majors threat were identified: *non planned coastal development, fishery over-exploitation, and species extraction* through non selective fishing methods that causes incidental catches. Giving the relevance to cetacean conservation *oil pollution and increase of maritime traffic* were also considered. *Balaenoptera edeni* and *Delphinus* sp. were selected as potential seascape species based on a scoring process. However, following the complementary principle of the approach *Tursiops truncatus* and *Megaptera novaeangliae* were also included. Extension of the suite of species is being considered including other key elements of the marine fauna of the northeast coast of Venezuela as the sardine *Sardinella aurita*.

Ontogeny of Temperature Regulation of the Testes of Male Bottlenose Dolphins (*Tursiops truncatus*): Insights from Long-Term Field Studies

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Male bottlenose dolphins possess a countercurrent heat exchanger (CCHE) that functions to regulate the temperature of their intra-abdominal testes. We investigated the development of CCHE function, by measuring deep body temperatures of wild dolphins from a well-studied community in Sarasota Bay, Florida, USA. During periodic health-monitoring events, individuals were temporarily encircled, restrained, and given a veterinary examination. During 14 field sessions (June 1993-February 2005), we collected deep body temperatures of 49 known-age males. Nineteen dolphins were sampled multiple times, over a span of 2-10 years. The CCHE flanks a region of the colon and in captive dolphins colonic temperatures measured within this region are cooler than those measured either cranially or caudally. Thus, we used a specially-constructed probe, housing a linear array of thermocouples, to measure colonic temperature simultaneously at multiple positions. For most individuals, testis size (measured *via* ultrasound) and serum testosterone levels were also measured. Young males (2-9 years) displayed uniformly high (37.1-37.3°C) temperatures along the length of their colons - there was no measurable influence of the reproductive CCHE on colonic temperatures. In older males (10-43 years) colonic temperatures were dependent upon position; temperatures measured at the CCHE (36.5±0.4°C) were on average 0.5°C, and maximally 1.7°C, cooler than those measured outside this region. Temperatures measured at the CCHE were lowest (36.1±0.7°C) in males between 20-36 years old, with testis length greater than 20 cm, and serum testosterone levels greater than 25 ng/mL. Longitudinal records from individuals that became sexually mature during the course of the study also showed that temperatures at the CCHE decreased as testis size and testosterone levels increased. These results, the first to demonstrate that CCHE function changes with age and reproductive maturity, also illustrate the importance of long-term field studies to enhancing our understanding of marine mammal biology. *NOAA Scientific Permits 655, 945, 522-1569.*

Simple Analyses of Ship and Large Whale Collisions: Does Speed Kill?

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Large whale deaths and serious injuries that result from ship strikes are of increasing concern among those engaged in whale conservation worldwide, and ship strikes pose a considerable threat to recovery of the North Atlantic right whale. Proposed ship strike reduction strategies have included reducing ship speeds as an approach to reducing ship strikes. We analyzed recent records of ship and whale collisions in cases that vessel speed was reported (n=64). We tested speed as a predictor of the probability of whale death or serious injury in a logistic regression model. We also compared the distribution of vessel speeds from ship and whale collisions with the distribution of speeds from large vessels that transit two important North Atlantic right whale habitat areas where ships are required to report upon entry. One area was near Cape Cod, Massachusetts, USA, and the other encompassed part of the right whale calving area along Southeastern USA. We found strong evidence that the probability of death or serious injury increases rapidly with increasing ship speed. A predicted 50% [0.27-0.62 for 95% C.L.] chance of death or serious injury occurred at 10.5 knots, but increased to 90% at 17 knots. There was little coincidence between the distribution of speeds of ships striking

whales and speeds reported by ships entering the Mandatory Ship Reporting (MSR) areas near Cape Cod and the southeastern US calving area. The distribution of speed for ships striking whales was relatively linear and was influenced by both relatively slow and very fast vessels that struck whales. Speeds of vessels entering the MSR areas were heavily concentrated (90% of reported speeds) between 10 and 20 knots with a median of 14.5 knots. We conclude that managing vessel speed could be an important consideration in reducing large whale deaths from ship strikes.

Humpback Whale (*Megaptera novaeangliae*) Photo-Identification in Brazil: Aspects of Habitat Use in Two Different Breeding Areas

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The Brazilian coast is visited by humpback whales (*Megaptera novaeangliae*) during the austral winter. The Abrolhos Bank (16°40'–19°30'S and 38°00'–39°30'W) is considered their most important breeding ground in the Southwestern Atlantic Ocean. Nevertheless, during the last years the sightings of humpbacks are increasing in the northern coast of Bahia state in the waters surrounding Salvador city (13°01'S – 38°32'W), about 240 nautical miles north of Abrolhos Bank. In this study, we compared the occupation and occurrence of humpbacks between these two sites. We also compared 2,800 whales photo-identified between 1992 and 2003 in Abrolhos bank with 400 individuals identified in North Coast between 2001 and 2003. Only one match was found between these areas during this study. Some differences in the duration of the breeding season were noted during these first years of monitoring. At Abrolhos Bank the humpback whales remain from July to November (5 months) while in the North Coast the sightings begin around two weeks later and last only until October (3 months). The proportion of calves was also different. In Abrolhos Bank, 350 (15%) out of 2,331 individuals composing 994 different groups were newborn calves. On the other hand, in the North Coast this proportion is considerably smaller, with 42 (6.5%) out of 642 whales sighted in 284 groups being newborn calves. The results found here may reflect differences in the use of these two adjacent breeding areas by the humpback whales off Brazil. Continuing monitoring of the humpbacks from the North Coast is recommended in order to clarify the reasons of these differences. The proximity of this area to an urban center makes it a potential whale watching site and reinforces the need of a long term monitoring program.

First Report of Sounds Recorded from Individual Humpback Whale Calves on the Hawaiian Wintering Grounds

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Humpback whales are born into a rich acoustic environment filled with conspecific song and “social sounds.” Here we provide the first report of sounds recorded from individual calves and the relation of these sounds to those produced by non-calves. Using hydrophone-equipped underwater video cameras, we recorded calf sounds and behaviors as well as song and social sounds from non-calves over eight field seasons (1996–2003) in Hawaiian waters. We assigned sounds to individual calves when a calf was alone, when it was temporarily separated from other whales and proximal to the video recorder, and/or when vocalizations were coincident with bubble expulsion from the blowhole. Forty-nine sounds were recorded from

eight different calves. Vocalizations were located on WAV-format sound files that were recorded from videotapes at a sample rate of 22,050 Hz with 16-bit resolution. Analyses were performed with SpectraPRO signal analysis software. We found that (1) calf sounds could be categorized into four broad groups: constant rate pulses (mean sound bandwidth (MSB = 794Hz), pulses of increasing or decreasing rates (MSB = 775 Hz), upswep frequency tones (MSB = 1297 Hz), and combinations of sounds (MSB = 1021 Hz); (2) fundamental frequencies of several sounds were at or near 30 Hz (median = 90 Hz), (3) calf sounds were brief (mean = 0.38 sec, range 0.11 – 0.71 sec); (4) four calves produced sequences of sounds (mean time between onset of sounds = 4.4 sec); (5) both male and female calves produced sounds; and (6) spectral content, duration, and frequency modulation of calf sounds were more restricted than non-calf social sounds or song units. We conclude that humpback whale calves of both sexes produce a limited repertoire of relatively low frequency short sounds within the first months of life that overlap in character with some non-calf sounds, and whose development is likely influenced by their acoustic environment.

Temporal Variations in Blue Whale Acoustic Detections in Relation to Environmental Conditions in the Northeastern Tropical Pacific, 1996–2002

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We present a 6.6-yr (1996–2002) time series of blue whale (*Balaenoptera musculus*) calls recorded by a moored hydrophone at 8°N, 95°W, near the Costa Rica Dome, a persistent, highly productive oceanic eddy in the northeastern tropical Pacific. An annual cycle in detections peaking in winter and spring months is the most evident signal in the series, with considerable interannual variability in the timing and number of maximum calls. Contemporaneous *in-situ* and remotely sensed oceanographic series at the site of the mooring are used to examine possible correspondence with environmental variations, including thermocline depth (Z20) from the TAO array; sea surface height (SSH) from TOPEX/Poseidon; sea surface temperature (SST) from AVHRR; and ocean color (CHL) from OCTS/SeaWiFS. A principal component analysis (PCA) is applied to the deseasonalized whale and oceanographic series to extract the main patterns of covariability. The dominant component (PC1; 61% of the variance) represents the ENSO signal (deep Z20, high SSH, high SST, and low CHL during El Niño and opposite during La Niña), but the whale signal is largely independent of it. Whale calling is captured by the second and third components, covarying inversely with SST (PC2, 16%) and CHL (PC3, 11%), respectively. Underlying time trends are also evident in PC2 and PC3. Linear regression of the leading series in these PCs (whale calling and CHL) on time shows that over the period of observation, the annual maximum number of calls decreased by an order of magnitude, at a rate of 0.54 calls/mo (p -value = 0.0033), while CHL increased at a rate of 0.1 mg m⁻³/mo (p -value < 0.0001). We interpret the declining trend in whale calling as a redistribution of the wintering population in response to an expansion of the productive habitat. These observations illustrate the response of baleen whales to low-frequency climate variability.

Statistical Models to Predict Bycatch Rates Under Potential Mitigation Measures, Using Coastal Bottlenose Dolphins as an Example

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To investigate the efficacy of potential mitigation measures to reduce bycatch of coastal bottlenose dolphins (*Tursiops truncatus*) in the US mid-Atlantic gillnet fishery complex, a two-step analysis was conducted. First, observer data from a sample of the US mid-Atlantic gillnet fishery complex were analyzed with a log-linear regression model to quantify which fishing practices and gear characteristic variables were most commonly associated with the bycatch. Second,

predicted bycatch rates due to potential mitigation measures were estimated from the observer data set that was re-sampled to create a data set that could have been collected if the mitigation measure had been implemented. An effective mitigation measure was defined as a measure that resulted in a predicted bycatch that was below the Potential Biological Removal (PBR) level. The most highly associated variables were water body (state [0 to 5.6 km (3 nmi) offshore] and federal waters [> 5.6 km offshore]), and mesh size (small: ≤ 12.7 cm (5.0 in), medium: > 12.7 cm to < 17.7 cm (7.0 in) and large: ≥ 17.7 cm). Bycatch rates in state waters were 4 - 11 times higher than rates in federal waters, rates in large mesh fisheries were 10 - 30 times higher than small mesh fisheries and 4 - 9 times higher than medium mesh fisheries, depending on the coastal bottlenose dolphin seasonal management unit. Three alternative mitigation measures were investigated. Predicted bycatch was lowest with Alternative 1 (no fishing in state waters). Alternative 3 (fishing in state waters allowed 12 out of the 24 hours) resulted in lower predicted bycatch than Alternative 2 (no fishing within 3 km from shore) for all dolphin seasonal management units.

Whales Before Whaling in the North Atlantic: Take II

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The recent emergence of analytical approaches permitting simultaneous estimations of population genetic diversity and directional migration rates in a population matrix have spurred several studies employing such estimates of local genetic diversity to make inferences about pre-exploitation levels of abundance in endangered species. There are several principal as well as practical issues with this approach. Estimates of genetic diversity from coalescent based methods integrate over the entire genealogy and hence the resulting estimate is an harmonic mean over evolutionary time scales — often in the order of million of years. Other more practical issues include how to account for the contribution to diversity from “unsampled” (ghost) populations into the target population as well as deviations from population genetic equilibrium. We revisited the estimations undertaken by Roman and Palumbi (2003) with respect to the above issues. Employing identical procedures with greatly expanded data sets in the same three species we show that estimates of abundance vary by one order of magnitude depending on the model employed and that the “best” estimate is four to 10 times lower than those reported by Roman and Palumbi (2003). More importantly, however, is that the statistical uncertainty of these estimates ranges from ~10,000 to 3-400,000, therefore lacking any useful information for management. Our study (along with other recent theoretical assessments) reveals that the application of [evolutionary-based] population genetic methods to infer absolute abundance is too sensitive to the choice of samples and the underlying models to act as a guide to conservation.

The Importance of Enumerating the Whales Before Whaling

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Estimates of the number of whales before whaling have long been a key part of harvesting strategies, but severe uncertainty about the value of whaling log records have eroded their impact on future conservation plans. Whereas the US National Marine Fisheries Service listed pre-exploitation values for 22 species or populations in 1984, by 1999 none were considered reliable. Population genetic variation provides a different source of information about past whale populations. First estimates of historic population size using within-species variability in mitochondrial dloop sequences showed a much higher mean population size than expected, and a range of possible population sizes that exceeded conventional log book summaries. Dloop estimates require careful control of the data set and mutational models because a mutational hotspot in the ‘Palsbøll’ region causes it to differ uncontrollably from the mutational model of the ‘Baker’ piece. We sought an independent test of molecular population estimates using Baker dloop data and cytochrome b data from

Antarctic minke whales sampled from Japanese retail sources. Results suggest Antarctic minke whales have long had a high population size; both data sets converge on a population estimate of 400-800,000 animals. These values refute claims by scientific whaling advocates that minke whale populations in the Antarctic were traditionally small, and only grew in numbers after the removal of large baleen whales from this ecosystem. Concordance of cytochrome b and Baker-dloop data helps generate reliable population estimates from molecular data, and more data from other independent loci are needed for further confirmation of this approach. Another future need is for use of coalescence models to estimate recent population size changes, not just long-term averages. Overall, molecular data suggest that previous estimates of pre-whaling abundances of many species were in general too low.

Are Mediterranean Fin Whales Threatened by Ship Strikes?

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Evidence of ship collisions has been reported for 11 species of large whales over all the world's oceans, with the fin whale the species most frequently hit. This presentation details an extensive collation and analysis of ship collision records for the Mediterranean population of fin whales. The data come from stranding networks and historical and anecdotal records. 281 records of dead individuals from 1971 to 2001 were examined, indicating that 42 specimens (14.9%) were killed by a vessel collision. The vessels most commonly involved were traditional ferries prior to 1996, and fast ferries after this year. 85.7% of the reported ship strikes occurred in or adjacent to the Pelagos Sanctuary for Marine Mammals, a MPA characterized by very high levels of naval traffic and whale aggregation. Considering an estimated Mediterranean fin whale population of 3,500 individuals, and a mean annual ship strike mortality of 1.35 individuals, we face a mortality rate of 0.0004 due to collisions only. This value, clearly underestimated due to unreported collision events, has to be added to other human induced mortality and to the natural mortality rate for fin whales (0.04-0.06), unavailable for the Mediterranean and estimated in the Southern Hemisphere. It is noteworthy that the annual number of whales struck by vessels has increased over the last three decades from 1 to 1.7. This increasing number suggests that appropriate management and mitigation schemes, together with ship traffic control measures are required to reduce accidents and to keep mortality rates at sustainable levels. Possible mitigation measures include: yearly monitoring of whale presence and distribution to move ferries routes to areas of cetaceans' low density, and reducing ships' velocity in high density areas. Future research to describe the whales' behavior in relation to approaching vessels includes controlled exposure experiments combined with passive tracking and multi-sensors recording devices.

New Records of Cetacean Species in the Coast Region of Santa Marta and Tayrona National Natural Park TNNP (Colombian Caribbean Sea) Related with Some Particular Environmental Features of the Area

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Research on cetaceans is poor in the Colombian Caribbean Sea (CCS) and this is the first one in the region of Santa Marta and TNNP. Some environmental features of the coast were characterized and then related with attributes of the species sighted (local distribution, group size, behaviour, general remarks, etc.). The area was explored along

nine months on rainy and dry seasons with systematic and opportunistic shipboard surveys, land based surveys and additional information supplied by previously trained volunteers. Unpublished sightings and stranding evidences (photographic material) that occurred before and during the research were compiled. In this way it was established the stranding of one individual of *Stenella coeruleoalba* near the airport who died later in Mundo Marino aquarium. This is the first record of the species for the CCS since 1986. The first records of *Globicephala macrorhynchus* for Santa Marta were made with two sightings of the species in the TNNP and in Gaira bay. A total of seven species were recorded: *Balaenoptera edeni*, *Sotalia guianensis*, *G. macrorhynchus*, *Tursiops truncatus*, *Stenella attenuata*, *Stenella frontalis* and *S. coeruleoalba*. Group sizes were small (1–30 ind.), except for *G. macrorhynchus*. The sightings were mostly concentrated at Gaira bay, Santa Marta bay and Granate, but animals were recorded in almost all sectors. There were three species on rainy season and four on dry one. The most frequent behaviours were foraging and travelling, and it seems that the most important environmental features which influence incursion of the animals are the high depths near the coast caused by the foothills of the Sierra Nevada de Santa Marta, the regular presence of clupeid and carangid species and the local upwelling event on dry season which brings nutrients and cold waters. More systematic shipboard and land based surveys are needed on future studies.

Pupping Site Fidelity Among Individual Steller Sea Lions (*Eumetopias jubatus*) in the Northern Gulf of Alaska

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Pupping site fidelity in Steller sea lions was investigated at a small rookery in the northern Gulf of Alaska during the breeding seasons of 2001 to 2004. Photo-identification and GPS locations including elevation of the rookery were used to determine site fidelity for individual females. Fifteen females that gave birth every year of the study period exhibited 73% site fidelity, giving birth in the same location or within 5.4 meters of a previous location. Females that were observed giving birth in one year and returned to give birth the next year moved significantly greater distances from their previous pupping location if another female had given birth in that location within 24 h, ultimately affecting individual site fidelity. However, competition or aggression among females was not observed in preferred locations; indicating the rookery is not overcrowded and many pupping locations exist. Storms during the pupping season also affected individual site fidelity. Locations of births were not randomly distributed. Approximately 45% of all births occurred in 20% of the locations used for pupping, implying multiple births occurred in the same location throughout the breeding season. Pups were born most frequently in proximity to vertical rock walls, with easy access to water for thermoregulation and greater than 5 m from the high water level. Multiparous females exhibited pupping site fidelity and generally gave birth in the most common (or preferred) pupping locations with similar physical attributes. Primiparous females frequently gave birth in pupping locations with fewer advantageous physical attributes, such as steep slopes or less than 1 m from the surf zone. Long-term monitoring of pupping site fidelity in combination with other measures of maternal care will ultimately determine which factors have the greatest effect on pup survival.

North Atlantic Right Whales Shift Their Frequency of Calling in Response to Vessel Noise

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The North Atlantic right whale (*Eubalaena glacialis*) lives in a highly urbanized environment, with its known habitat extending along the

east coast of the U.S. and Canada. These whales are regularly exposed to noise from vessels, both chronic levels of noise from distant shipping and shorter-term higher intensity transient exposures when vessels pass close to the whales. Right whales produce a variety of sounds for social communication, and it is likely that the increased level of noise in the same frequency range of their vocalizations impacts their ability to communicate by limiting the range over which they can communicate. This study looks at both short- and long-term changes in right whale sound production that are associated with increased noise levels. Over the short-term (minutes), both the fundamental frequency and peak frequency of tonal calls were found to increase. Over the longer term (decades), the minimum and maximum frequency of the most stereotyped right whale call type, the upcall, were found to significantly increase from the late 1950's through 2004, with a gradual increase in frequency documented through the decades. A comparison of the upcalls recorded from the North Atlantic right whale and the Southern right whale (*Eubalaena australis*) indicate a significant difference in start and end frequency, which, given the previous findings, may be a result of differing ambient noise conditions in their habitats. These results are significant, as they present evidence for a long-term, chronic behavioral change in the North Atlantic right whale calling behavior. Both the shift to a higher frequency and the increase in ambient noise combine to limit the range of communication in right whales.

Two Societies, One Habitat: Phylogenetic Influences on Dolphin's Social Structure

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Comparative studies of the social structure across different genera of cetaceans are rare. Delphinids are the most widespread and diverse family of marine mammals. Intra- and intergeneric differences in their social structure have been mainly attributed to ecological and social pressures, regardless of their phylogenetic history. We compared the school sizes and association patterns of sympatric snubfin, *Orcaella heinsohni*, and Indo-Pacific humpback dolphins, *Sousa chinensis*, in Cleveland Bay, northeast Queensland, Australia. Despite both genera living in almost identical ecological conditions, we could distinguish two very different social structures. Schools of snubfin dolphins were larger in size than those of humpback dolphins. While the size of snubfin dolphin schools was relatively constant across different behavioural activities, schools of humpback dolphins showed significant variation with behaviour. Association patterns indicated that individual snubfin and humpback dolphins were more frequently seen with particular companions. The model that best described the temporal association patterns suggested that an individual snubfin dolphin had two types of associates at any time: "constant companions", which an individual associates for long-term periods of time, and "casual acquaintances", which an individual only associates temporarily. Associations between individual humpback dolphins appear to be more dynamic involving different types of associates with variable temporal patterns: a fission-fusion society. Differences in the social structure of both species correspond with their phylogenetic lineage: humpback dolphins' society appears like that of other Delphininae, snubfin dolphins' society resembles that of killer whales. This result has important implications for the understanding of the evolution of sociality in delphinids, and emphasizes the need to consider phylogeny as well as ecology when studying social structure in marine mammals.

From Whaling to Whale-Watching: The History of Marine Mammal Exploitation in Scotland

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Scotland has over a thousand year history of marine mammal exploitation. They've been culturally significant in Scotland since at least the Iron Age, evidenced by carvings on standing stones resembling cetaceans, and wide-spread legends of selkies (or seal-people). Exploitation also dates back to at least this period, for example early monastic settlements considered seals as "fish" and, therefore, eatable on fast days. Nordic occupation of the northern and western islands of Scotland was particularly accompanied by marine mammal consumption and utilisation of bones for carved goods and building materials. Local cetacean consumption continued in this region until at least 18th Century. Commercial whaling started in Scotland in Aberdeen in 1753, expanding to Peterhead, Fraserburgh and Banff, on the east coast. By 1820 there were 15 whaling vessels, but the whaling fleet then declined with only two vessels in 1838, and the last whaling ship ceased operating in 1865. In 1903 a coastal whaling stations opened on the Isle of Harris and the Shetland Isles – these stations operated until 1923, with the Harris station briefly reopening between 1950 and 1951. Over 8,000 animals, from 7 species, were harvested from Scottish waters during this period. Commercial harvests of seals have a history to match that of commercial whaling, but data on harvesting effort is not available. In 1900, grey seal harvesting was banned due to fears of extirpation. Harbour seal pups were commercially harvested in Scotland until early 1970s, with 90% of pups taken in some areas. However, a seal fur trade ban in 1973 stopped this practice. Today, marine mammals are still an economic resource in Scotland, via tourism. In 2000, 47% and 75% of surveyed tour operators consider whale-watching and seal-watching to be important to local economies, respectively, with whale-watching alone estimated to be worth \$18 million Scotland-wide.

Long-Term Social Dynamics of Fish-Eating Killer Whales

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Among marine mammals, odontocete cetaceans provide some extreme examples of highly stable matrilineal social structuring. The natal philopatry of both males and females exhibited by fish-eating killer whales in the eastern North Pacific is often cited as a unique example of such sociality in mammals. These whales have been characterized as comprising closed maternal lineages from which effective dispersal has never been documented. However, even such apparently stable social systems may experience changes over time in response to critical changes their ecosystem. The so-called southern resident killer whale (SRKW) population, consisting of less than 100 whales, has become the focus of much conservation and management concern in recent years. This population, typically described as consisting of three matrilineally-based social units ('pods'), has been photographically censused on an annual basis for nearly three decades, providing a unique opportunity to examine temporal changes in the social dynamics of this long-lived highly social cetacean. Here we use this longitudinal dataset to assess changes in the social structure of the SRKW population at the level of both the individual and the matriline. Using both coefficients of association and novel Bayesian clustering methods, we quantify the stability of social affiliations within this killer whale population based on data from more than 1,360 encounters, and 118,000 high quality individual killer whale identifications. Inter-annual comparisons of social patterns from these photographic data demonstrate dramatic changes in the social affiliations of these killer whales within the last decade, coinciding with the most recent period of population decline. Moreover, pod-specific changes suggest differences in the social stability within pods.

Understanding these social dynamics may provide insight into the influence of social structure on population demographics, and help identify critical changes in key ecological forces driving such social changes.

Characterizing Human Interactions with Marine Mammals on Cape Cod and Southeast Massachusetts, USA: 1999-2004

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Between 1999 and 2004, 1,228 marine mammals stranded on Cape Cod and southeastern Massachusetts. All stranded animals are examined for evidence of human interaction (HI) following a standardized protocol and datasheet. Of the 1,228 cases, 88 animals were documented with evidence of HI. No evidence of interaction was found in 711 cases. In 429 cases, proper evaluation could not be conducted due to decomposition or inexperienced examiners; thus the animals were designated as CBD (Could not Be Determined). There are distinct patterns in the seasonality, sex ratio, condition code, and geographic distribution of affected animals. A seasonal peak in HI cases occurs from May through July and a smaller peak occurs October. This pattern is consistent when examined in correlation with the type of interaction. Entanglement in fishing gear and marine debris makes up 51% of interactions and drives the seasonal pattern. Vessel strikes peak in July and August, the most popular months for recreational boating. Harassments generally occur from April through July, the months in which harbor seals are born and weaned. Due in part to their size and haul out locations, young harbor seals are particularly susceptible to harassment. Live stranded animals comprise 47% of HI cases. The geographic distribution is generally correlated with the type of interaction observed and the species involved. One cluster of interaction involves entangled gray seals found within a one month period in a small area bordering Nantucket Sound. A summary of HI results is presented with a discussion of the spatio-temporal distribution of findings. Fortunately, human interactions appear to affect a relatively small proportion (7.1%) of the marine mammals that strand in this region. Regardless of the number of cases, all stranded animals should be examined for evidence of human interaction so that the data may be used to guide conservation measures.

The Demographic and Genetic Impact of Whaling on New Zealand Southern Right Whales: How Few Whales Were There After Whaling?

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We describe a simple approach for examining the consistency between estimates of mtDNA haplotype diversity and a demographic population model of exploited whales to answer the question: How few whales were there after whaling? Using the estimated current abundance and the historical catch record of southern right whales around New Zealand we applied a generalized logistic population model commonly used by the International Whaling Commission to extrapolate the past decline and recent recovery of this population. Predicted loss of mtDNA haplotype diversity was calculated from this trajectory, assuming a pre-exploitation diversity based on contemporary diversity of populations wintering in Argentina and South Africa and compared to the current haplotype diversity in the New Zealand population. The historical reconstruction confirmed the precipitous decline of right whales around New Zealand due to 19th century whaling, from more than 17,000 prior to exploitation to less than 100 by 1860, and a further decline due to low levels of hunting in the early 20th century. Following international protection in 1935, the model shows a slow recovery until the onset of illegal whaling by the Soviet Union. The predicted bottleneck of less than 17 mature females was concordant with the current low haplotype diversity and

the minimum number of maternal lineages observed in the extant New Zealand population. The evidence that so few whales survived even the crude methods of 19th century whaling provides a clue to the variable rates of recovery of some local populations. Two New Zealand southern right whale stocks (mainland and sub-Antarctic) have been proposed based on the overlap in the timing of the arrival of whales on the different grounds. The remnant population recovering in the sub-Antarctic Islands numbers less than 1000 while recent assessment of the mainland population based on sighting data and photo-identification suggests that it remains severely depleted and likely numbers less than 20 reproductive females.

Analysis of Data Collected During Humpback Whale Sighting Surveys at Cape Byron, Eastern Australia, 1998 to 2005

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Humpback whales (*Megaptera novaeangliae*) that migrate past the east coast of Australia comprise part of the Group V stock. From 1995 to 2004 an annual 16 day survey was conducted from Cape Byron (28° 37' S, 153° 38' E) the most easterly point on the Australian mainland, monitoring the peak of the humpback whale northern migration. This population of humpback whales is one of the few to show signs of recovery following commercial exploitation. The annual rate of increase between 1998 and 2004 for humpbacks whales observed off Cape Byron is 11.0% with a 95% confidence interval of $\pm 9\%$. This rate of increase is consistent with that recorded by other observers on the east coast of Australia. In 2005 the annual survey was expanded to include a number of land based survey locations (at a range of altitudes) to investigate the influence of survey height in accurately determining pod composition. This expanded program also allowed the tracking of pods over an extended range to investigate pod size stability, course linearity, speed and behaviour.

An Investigation of the Factors Underlying the Abandonment of the Roseway Basin Feeding Ground by the North Atlantic Right Whale (*Eubalaena glacialis*): 1993-1999

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Western North Atlantic right whales (*Eubalaena glacialis*) largely abandoned their summer/fall Roseway Basin feeding ground on the Nova Scotian Shelf for a seven-year period (1993-1999). The objective of this study was to determine the reason(s) that this shift in habitat use occurred. The study's underlying hypothesis was that the right whales abandoned Roseway Basin because there was inadequate prey species composition or densities. Their main prey species, *Calanus finmarchicus*, is entering or in diapause and found at depth throughout the months when right whales forage on the Scotian Shelf. Since there are no available historical data on zooplankton abundances at depth on the Scotian Shelf, near-surface zooplankton abundance data from the Continuous Plankton Recorder were used to infer abundances at depth. In addition, oceanographic and atmospheric conditions that are often correlated with high prey densities were examined. The hypotheses tested were that changes in these oceanographic and atmospheric parameters would be detectable between the three time periods of the study: pre-1993, 1993-1999, and post-1999. *Calanus finmarchicus* abundance was found to be lowest throughout the 1993-99 period, inferring that right whales were not foraging in Roseway Basin because of the near-absence of their main prey species. Upon exploring oceanographic and atmospheric conditions that may have caused this low prey abundance, higher *in situ* temperature and lower salinity in the lower water column appeared to have the most effect on the abundance and/or aggregation of these copepods onto the Scotian Shelf. These oceanographic conditions most likely affected the over-winter survival of *C. finmarchicus* as well as the timing of the spring bloom. Also, the

change in circulation that occurred throughout the late 1990s, evident here from the low salinity anomaly, may have had an effect on the advection of *C. finmarchicus* onto the Scotian Shelf.

Gray Whale Foraging and Benthic Ecology in Clayoquot Sound, British Columbia

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Gray whales, *Eschrichtius robustus*, have high energy requirements and an efficient foraging strategy. As a result, they can significantly impact the prey populations that they target. During the summer, gray whales feed on benthic and hyper-benthic prey in Clayoquot Sound, British Columbia. There has been a decline in gray whales foraging on benthic amphipods here over the last twelve years. We propose that there has been a collapse in amphipod populations, which may have been caused by the exploitation of this resource by gray whales. Benthic samples were collected from two bays in Clayoquot Sound through the summer and fall of 2004 and 2005. Amphipods were counted, measured and weighed. Findings were compared to the results of sampling conducted in the mid-1990's. Initial results from 2004 indicated that the density, biomass, and average length of amphipods have declined. At current levels the amphipod populations in these bays may not be large enough to meet the energy requirements of gray whales. Depletion of this resource may have caused reduced use of these bays by gray whales.

Foraging Preferences of Gray Whales (*Eschrichtius robustus*) and Top – Down Pressure Exerted Upon Mysid Communities: Potential Roles in Shifts of Habitat and Prey Utilization

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Ongoing research on the distribution and relative abundance of gray whales (*Eschrichtius robustus*) and their prey in Clayoquot Sound, BC, Canada has shown interannual differences in whale abundance and a shift in predation focus from benthic amphipods (Ampeliscaidae) to hyperbenthic mysids (Mysidacea). After several years of intensive foraging pressure on mysids, gray whale presence in Clayoquot Sound was very low during the 1999 and 2000 seasons. Through the use of a plankton net and an underwater video camera, mysid populations were sampled to assess spatiotemporal, reproductive, and foraging dynamics. Mysid presence and community structure were found to differ significantly between years, as was whale predation effort. Predated mysid aggregations had higher mean body length and a higher percentage of gravid females; as gravid females are the longest animals these results represent both an indirect and direct foraging preference for gravid females. This preference may hamper or halt recovery of mysid populations when bottom-up limitations in primary productivity exist simultaneously. In that scenario there is a greater potential for mysid abundance to reach a low stable state, thus rendering previously valuable foraging habitat empty. Understanding of these processes is necessary in order to accurately assess the habitat requirements of whales and to contextualize changes in whale distribution within areas where human activities, such as fishing, aquaculture, whale watching, and coastal development, are taking place at increasing rates.

G-Banded Karyotype and Ideogram for the Critically Endangered North Atlantic Right Whale (*Eubalaena glacialis*)

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Although cytogenetic studies have been completed for some cetacean species, data remain incomplete for the group as a whole. A review of the literature located karyotypic data for seven of the thirteen species of the suborder Mysticeti (baleen whales). The North Atlantic right whale (*Eubalaena glacialis*) is one species that had yet to be described. We propose a first generation G-banded karyotype and ideogram for the species (2N=42). The karyotype produced is compared with the general mysticete karyotype, and the karyotype of another balaenid species. Peripheral blood chromosome preparations from a live, stranded male calf were used for the studies. Information of this nature has great potential in resolving many different issues. Karyotypic data will be useful in genetic mapping projects and for interspecific and intraspecific genomic comparisons by techniques such as zoo-FISH. These data may also prove useful for determining relationships among the extant right whale species.

Noise Spectra and Biological Sounds from the NEMO-Test Site

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Within the large NEMO Project that addresses the underwater detection of high energy neutrino, an experimental deep station, named ONDE, has been developed for measurement of underwater acoustic noise. It has been placed on the sea bottom 21 km offshore Catania (Sicily, Italy) at 2000 m depth. It is connected to the shore labs through electro-optical cables to provide real-time monitoring and it is operating since the end of January 2005. The main experiment hosted by the station concerns the study of the underwater acoustic environment to develop the strategies required for the acoustic detection of acoustic pulses generated by high energy neutrino interacting in water. The experiment is highly interdisciplinary and other than providing long term data on the underwater noise, it also provides an unique opportunity to study the acoustic emissions of marine mammals living in the area or passing through it during their seasonal movements within the Mediterranean basin. Four calibrated broad-band hydrophones, sampled at 96 kHz, send digital data to the shore lab 24/24h; as the continuous recording was not possible due to storage space constraints (uncompressed recording would require 124 GB/day), recordings were made at intervals. Nonetheless the amount of data acquired is huge and provides important new information. Dolphins living in the area have been recorded almost every day, while sperm whales and fin whales have been recorded with less regularity. Tracking algorithms developed to track the movements of impulsive acoustic sources have revealed the movement of sperm whales whilst in the detection range.

Behavior of Territorial Male Sea Otters in Prince William Sound, Alaska

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Photo-identification and focal animal sampling were used to examine the daytime behavior of territorial male sea otters (*Enhydra lutris*) in Simpson Bay, Prince William Sound, Alaska during the summer (June to August) of 2003. The average number of otters (all age classes of males and females) in the study area was 121 ± 12.1 SD ($n = 5$ surveys). The bout duration of six behaviors (resting, grooming, foraging, interacting with other otters, swimming at the surface, patrolling), time budgets, and interactions with females were determined for territorial males. Ten males were observed during 183 focal follows (i.e., observation periods) representing 92 h of observation. More time was spent foraging (30%) than any other activity, and foraging bouts were longer than all other activities. A similar amount of time was allocated to resting, grooming and

patrolling, which together represented 50% of the daytime activity budget.

Structure of the Cetacean Community of an Oceanic Island: La Gomera, Islas Canarias

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The oceanic islands are important habitats for cetacean species, mainly those with deep-diving habits. The present study assess the distribution and relative frequency of cetacean species in the south-west of La Gomera, an area of 131,39 km², designated especial area for conservation (SAC ES-7020123) for the presence of bottlenose dolphins (*Tursiops truncatus*). A total of 1205. 57 nautical miles and 210.25 hours of boat based survey (45 days) were conducted from August 2004 to June 2005. A part of this study was carried out outside the designated protected area. Out of a total of 110 sightings of 9 species, of the 27 recorded in the Canary Island, short-finned pilot whale, *Globicephala macrorhynchus* (28 sightings, 25.45%) and bottlenose dolphins (22 sightings, 20%) had the highest sighting abundance with peaks in the months of February, March and June. These peaks coincide with the highest probabilities of sighting recorded from the months of February to June, predominantly in March (0.61/nm; 2.62/ hour) and June (0.23/nm; 1.48/hour). *Stenella frontalis*, a seasonally distributed species had the third highest score in abundance with 21 sightings (19.09%) and a acute peak in the month of May (9 sightings). Up to 18 sightings in one day were recorded in the area. We can conclude that the water off the south west coast of La Gomera are of high frequency and unexpected diversity of cetacean species, mainly of the family delphinidae, with the highest abundance present in the months around the spring season probably due to the increase in food availability in the area. Most of the sightings of the target species of this SAC (bottlenose dolphin) were recorded outside the area. It is important to highlight the presence throughout the year of the rough tooth dolphin, *Steno bredanensis* or the Blainville's beaked whale.

Establishing a Relationship Between North Atlantic Right Whale Presence and Abundance of Copepods in the Gulf of Maine

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Each Spring North Atlantic right whales (*Eubalaena glacialis*) enter the Cape Cod Bay critical habitat area to feed and nurse their young. Later in the spring, aggregations of feeding right whales become more common in the Great South Channel critical habitat, a region that is bisected by the Boston harbor shipping lanes where there is significant risk of whale-vessel collision. Movements within and between these habitats are thought to be driven by the need to find ultra-dense patches of copepods. Unfortunately, it is difficult to sample with the frequency and resolution needed to identify these patches. Using aerial sighting data of right whales and ship-based measurements of copepod abundance, we test the hypothesis that right whale movement between two critical habitat areas (CCB & GSC) is motivated by large-scale average concentrations of the copepod *Calanus finmarchicus*. Understanding the relationship between region-wide average concentrations of copepods and presence of right whales would provide managers with a tool to more effectively balance the management of the species with the fishing and shipping demands of the Boston harbor region.

A Preliminary Evaluation of Incidental Sightings of Polar Bears During Aerial Surveys for Seals in the Central

Alaskan Beaufort Sea, 1997-2002

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We analyzed springtime polar bear (*Ursus maritimus*) sightings recorded as part of a systematic aerial survey using strip transects to document the effects of a nearshore oil production facility (Northstar) on ringed seals (*Phoca hispida*) in the central Alaskan Beaufort Sea between 1997 and 2002. These data allow a preliminary analysis of habitat factors that may be important to nearshore polar bear distribution in the Beaufort Sea in spring. This is important in evaluating possible risks to polar bears from oil development and changing ice conditions as a result of climate change. Habitat factors analyzed included water depth, distance from ice edge, ice deformation, distance from Northstar and Cross Island (site of harvested bowhead whales [*Balaena mysticetus*]). A χ^2 goodness-of-fit test assessed the significance of observed differences in polar bear densities with respect to habitat variables. The Generalized Linear Model assessed the relationship between polar bear sighting density and the variables. A total of 81 polar bear sightings comprising 107 individuals were recorded. The overall observed density of polar bears was 0.2 sightings/100 km² across all years. Annual observed (minimum) densities ranged from 0.1 to 0.6 sightings/100 km². The average group size for the study period was 1.3 bears per sighting, which resulted in a minimum average density of 1 bear/385 km². Analysis indicated that water depth (bear density increased with increasing depth), distance from Cross Island (bears were present near the island), and distance from ice edge (density was highest nearer to the ice edge) significantly affected polar bear distribution, allowing for effects from other variables. The degree of ice deformation had no effect. Preliminary investigation suggested an inconclusive interaction between the distance from Northstar and bear density, possibly due to small sample size. This interaction was complicated by the analytical approach of this investigation and warrants further examination.

Variability in Calf Production in the Eastern Pacific Population of Gray Whales is Linked to Arctic Climate

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Over the 12 consecutive years of monitoring eastern Pacific gray whale calf production from shore-based counts of calves passing Piedras Blancas, California, we have observed almost six fold differences between our high (1527 in 2004) and low (256 in 2000) estimates of the number of northbound calves. We suspect that some of the observed variability in calf production in this population is related to inter-annual variability in Arctic climate. Our climate focus has been on the relationship between fluctuations in the spatial and temporal distribution of seasonal ice relative to known feeding grounds for gray whales. Using bi-weekly ice charts and plots of known feeding grounds for gray whales, we developed indices of prey availability based on the proportion of known feeding grounds that are free of seasonal ice. We have taken a Bayesian approach to investigate the relationship between our climate indices and gray whale reproduction. Posterior distributions support a high correlation between ice distribution early in the feeding season and calf estimates the following spring. Results do not support correlations between calf estimates and ice distribution during the later half of the feeding season or during the feeding season two years prior to calf estimates. We hypothesize that prey availability is influenced by the distribution of ice, and, as pregnant females return to the feeding grounds in the spring, prey availability impacts the probability that existing pregnancies are carried to term. Ice distribution, however, only explains inter-annual variations in calf production. Observed longer-term variations in calf production are likely the result of climate variables or other factors related to system-wide, bottom-up

productivity affecting gray whale condition and reproduction.

Sonar Click Repetition Rate of Wild Harbour Porpoises, *Phocoena phocoena*

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The exact usage and extend of sonar use in wild harbour porpoises (*Phocoena phocoena*) is not known. Some knowledge of the sonar behaviour exists for harbour porpoises in captivity, but there is reason to believe that porpoises, like the thoroughly investigated bottlenose dolphin, will adapt the use of their sonar to their captive surroundings. A better knowledge of the sonar use in wild porpoises is, however, essential for understanding why these animals get entangled in fishing gear, thus making it possible to develop more effective ways of reducing this bycatch. The present study is based on day-time recordings made with a single hydrophone deployed below a small boat, anchored in the waters just West of Fyns Hoved, DK. The click trains generated by passing porpoises were recorded on an MD recorder, using a click detector to convert the ultrasonic clicks to the audible frequency range. In an attempt to make the porpoises direct their sonar towards the hydrophone, "enticing" sounds (simulated porpoise click trains) were played from a transducer next to the hydrophone in some of the encounters. The surfacings of the porpoises were monitored by a team of observers operating a digital theodolite from a 20m high cliff next to the experimental area. Based on 37 click trains recorded without enticing sound emissions, a median inter-click interval (ICI) of 75ms was obtained, ICI varying from 23 to 397ms. In the presence of enticing sounds, the median ICI was 74ms, based on 74 click trains, here with ICI varying from 26 to 456ms. These data allowed for an evaluation of the probability of the sonar beam "hitting" a single transducer in the test area, an important factor in the development of a new, biosonar-activated, "interactive" pinger concept.

Biological and Functional Validation of Stress Hormone**Assays for an Array of Pinnipeds**

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Sample collection for stress monitoring assays that require animal handling (e.g., blood, urine, and saliva), may in fact, be stressful themselves. In order to non-invasively monitor stress in a variety of pinnipeds, we validated a commercially available fecal corticosterone radioimmunoassay in adult Pacific harbor seals (*Phoca vitulina richardii*), adult Atlantic harbor seals (*Phoca vitulina vitulina*), Pacific harbor seal pups, ringed seal (*Phoca hispida hispida*) pups, a walrus (*Odobenus rosmarus divergens*) pup, and recently weaned northern elephant seals (*Mirounga angustirostris*). Fecal corticosterone has previously been shown to act as an indicator of adrenal activity in Steller sea lions, California sea lions and sea otters. Our corticosterone radioimmunoassay was successfully validated with standard methods including HPLC in order to quantify stress in these additional pinniped species. We also analyzed opportunistic fecal samples during rehabilitation (n=147) for the Pacific harbor seal (n=5m; 6f), ringed seal (n=3m), and walrus (n=1m) pups. Fecal corticosterone values indicated responses to acute stressors, including, but not limited to, initial adjustment to a novel environment, disease, change in management (i.e., diet changes), and normal maturation from nursing pups to independent individuals. Female and male harbor seal fecal

corticosterone concentrations did not differ (196.8 ± 224.0 ng/g). Ringed seal and walrus pup corticosterone concentrations were 658.8 ± 832.4 ng/g and 400.9 ± 162.3 ng/g, respectively. Individual levels varied as high as 57.3 – 2878.3 and 91.0 – 2771.0 ng/g for two of the male harbor seal pups. Our results indicate that fecal corticosterone levels can effectively be used as a non-invasive tool for stress assessment for pinniped pups undergoing rehabilitation.

A Flat Sub-Dermal Radio Frequency Identification Tag

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Significant declines have occurred among many populations of Steller sea lions (*Eumetopias jubatus*), northern fur seals (*Callorhinus ursinus*) and harbour seals (*Phoca vitulina*) in Alaska since the late 1970s. Radio frequency (RF) tags could help to determine why their numbers have changed by monitoring the movements of young animals – the age classes thought to be at greatest risk. Lengths of time that pinnipeds spend on shore and at sea can be determined using local base stations to monitor the presence or absence of known individuals. Presence and absence data can also be used to estimate survival rates. Unfortunately, tags glued to the fur of pinnipeds fall off when the animals molt or the hairs break and existing implantable RF tags are of limited life span, too large, or surgically too invasive for use in a young animal. We have developed a means of electronically monitoring immature individual pinnipeds by placing small RF tags under their skin. Considerations we have addressed include critical issues related to longevity (3-yr targets), suitable range, positive identification, overall tag size, changing skin conditions, proximity of other tagged animals, mortality detection, biocompatibility and life-time protection. The tag packaged in alumina operates at 915 MHz band, contains battery and all the required circuitry including a small loop antenna and special self-tuning circuitry, and uses a power aware communication protocol. Performance data obtained from live-rabbit and pig trials, and other experiments will be used to suggest new ways to monitor the survivorship and attendance patterns of individually identifiable pinnipeds.

The Buzz of Bats and Dolphins: Temporal Patterning of Click Trains During Natural Behaviors in Indian Ocean Bottlenose Dolphins (*Tursiops* sp.)

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Click trains emitted by dolphins are generally associated with echolocation and have been well studied in captivity under controlled conditions. Wild studies are critical because under natural conditions click train characteristics and associated behaviors may differ from captivity. Natural conditions provide a broader range of acoustic targets under widely varying socio-ecological conditions. We investigated interclick interval (ICI) patterns of click trains in wild Indian Ocean bottlenose dolphins under natural contexts at a provisioning beach in Shark Bay, Australia. One omni-directional hydrophone was suspended at 1-2 m depth during 77 h of acoustic recordings. Simultaneous behavioral data were collected *ad libitum*

on a focal group of dolphins by video taping with spoken commentary. Click trains (N=120) were categorized by temporal patterning and related to behavior categories. Four categorization methods were used: 1) least squares high order polynomial regression, 2) k-means cluster analysis, 3) the frequency distribution of the data, and 4) observer analysis. Click trains were best categorized by a k-means cluster analysis and using a peak in the frequency distribution of ICIs. Click trains could be classified into at least two categories (low ICI, high ICI). Click trains with high ICIs occurred during all behaviors whereas click trains with low ICIs were tightly associated with foraging behaviors ($X^2=13.82$, N=107, DF=1 $p=0.0002$). These data suggest that temporal patterning of echolocation during foraging behaviors in dolphins parallels that recorded in bats. Click trains with low ICIs recorded during dolphin foraging may be equivalent to the 'terminal buzz' recorded in bats just prior to prey capture.

Ultrastructural Features of the Integument of the Pacific Walrus (*Odobenus rosmarus divergens*)

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Walruses are often associated with pack ice, on which they haul out to rest. Despite the lack of a thick protective pelage, the walrus integument does not appear to suffer from temperature-induced injuries such as frostbite. Few studies have examined the cellular adaptations of the walrus integument that permit these animals to inhabit their cold environment. This report presents the initial description of the ultrastructural features of the walrus integument. Tissue samples were obtained from four female animals taken during the spring subsistence hunt around Savoonga, AK. Skin samples from the back, chest, and flipper were processed for transmission electron microscopy. From superficial to deep, the epidermis was arranged into four distinct strata (corneum, granulosum, spinosum, and basale) on the back and chest. An additional stratum, the stratum lucidum, was present on flippers. The stratum corneum was unusually thick, with approximately 40 cells present in all regions examined. Keratinocytes of this layer were largely devoid of organelles but contained nuclear remnants. Keratinocytes of other strata resembled those of terrestrial mammals. Prominent intracellular lipid droplets, a common feature of cetacean keratinocytes, were notably absent. Intermediate filaments were numerous and occasionally formed large aggregates. Bundles of intermediate filaments inserted into desmosomal plaques at cell surfaces. Spider-shaped melanocytes, filled with electron dense pigment granules, were common in the stratum basale and stratum spinosum. Occasional pigment granules were observed within keratinocytes of these two strata. The dermis was unusually thick and highly vascularized. Active sebaceous and apocrine sweat glands were common and were related to hair follicles. Arrector pili muscles were absent. These results indicate the walrus integument is very similar to the integument of terrestrial mammals, with its major difference being its unusual thickness. Temperature regulation is likely to do to the well-developed blood vessels of the dermis.

Vocal Individuality in Territorial Male South American Fur Seals

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Territorial male fur seals in breeding colonies need to conserve energy to maximize the duration of their tenure and consequent opportunities for mating. Their ability to recognize neighbouring males by vocal cues should be adaptive because, once territorial boundaries have been established, it minimizes time and energy spent on unnecessary physical interactions. Although time budgets have been described for territorial males in a number of fur seal species, few studies have quantified individuality in male agonistic calls. To test the hypothesis that Full Threat Calls (a.k.a. roars) of South American fur seals (*Arctocephalus australis*) exhibit individually distinctive characteristics, we selected 84 high quality calls recorded from 7 territorial males at Punta San

Juan, Peru. We measured 14 acoustical variables from each call and used ANOVA and DFA to explore variation among individuals. Full Threat Calls showed low variation within (CVs, 9-30%) and high variability among (added variance components, 40-92%) males. All variables differed significantly among males, and DFA correctly assigned 79-100% of calls to the correct male. Individuality was attributable primarily to the fundamental frequency measured at the end of the call, to formant frequencies and to the number of call parts. We conclude that Full Threat Calls of South American fur seals are highly individualistic and likely enable or augment individual recognition among territorial males. Further experiments are needed to clearly quantify recognition abilities of males and the effect of selective responsiveness on males' energy expenditure during tenure. We also suggest that since formant frequencies are an important component of individuality and should be related to the size of the vocal tract, Full Threat Calls likely convey information about the sender's body size that may facilitate both male competition and female selection of prime males for reproduction.

Captive Feeding Study of Pacific Harbor Seal (*Phoca vitulina richardii*) Improves Species-Specific Consumption Estimates

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To properly evaluate potential impacts of increasing pinniped populations on commercially valuable and threatened fish stocks, accurate diet estimates are necessary. Scat analysis is a tool to determine diet using undigested hard parts to calculate frequency of occurrence or biomass of prey consumed. However, discrepancies between methods can result in inaccurate consumption estimates. We conducted captive feeding experiments ($n=177$) with Pacific harbor seals to quantify scat analysis biases. Seals were fed Pacific sanddab, Pacific sardine, market squid, shortbelly rockfish, pink salmon, steelhead smolt, and Pacific hake ($n_{\text{total}} > 2,700$). We found hard parts 4.0 to 161.0 hours after ingestion, and 73.2% of hard parts passed within 48 hours of ingestion. Further, hard parts from a single meal were recovered in 1 to 10 scats (mean=3.8), confirming that a single scat does not represent a single meal, but rather a series of foraging events throughout the previous 24-48 hours. A mean of 58% of otoliths and 89% of cephalopod beaks were recovered. Recovery of all prey except pink salmon was improved by 31.7% when all diagnostic skeletal structures were used, indicating that the all-structure technique will improve recovery biases due to complete otolith erosion. However, recovery of pink salmon was 9.5 times that fed to seals when the all-structure technique was used, highlighting the issue of fragmentation of a single meal across a series of scats. Species-specific length correction factors improved estimates of all ingested prey length except sardines ($P < 0.05$) and furthermore, prey with highly eroded otoliths (shortbelly rockfish, hake) benefited from grade-specific correction factors that account for varying erosion levels. We found that, when compared to known consumption rates of seals in this study, diet estimates based solely on frequency of occurrence (e.g. split sample frequency of occurrence) are flawed, whereas estimates based on biomass calculations (e.g., reconstructed biomass) are likely accurate.

Occurrence and Movement Patterns of Indian Ocean Bottlenose Dolphins, *Tursiops aduncus* Along the North Coast of KwaZulu/Natal, South Africa

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Indian Ocean bottlenose dolphins (*Tursiops aduncus*) occur in coastal

waters of KwaZulu/Natal on the East Coast of South Africa. Knowledge of their distribution and abundance in South African waters is limited, particularly towards the northern extreme of their range. Previous distribution studies on the lower part of the KwaZulu/Natal coast, indicate that resident bottlenose dolphins occupy distinct, consecutive but non-overlapping segments of coast in this area, suggesting that the population is composed of a number of distinct stocks. There have been no studies focusing on the ecological parameters underpinning this fragmentation, or comparative analyses of habitat use within each coastal segment. The aim of this study was to investigate the occurrence and movement patterns of bottlenose dolphins on the north coast of KwaZulu/Natal, where no directed studies had previously been carried out. Data on occurrence and movement patterns were collected during a shore-based survey from Cape Vidal, KwaZulu/Natal, South Africa, during the austral winter months of 1988-1991, which focused on humpback whale migration. Bottlenose dolphins were the most frequently sighted delphinids. On a diurnal scale, sighting rate (0.28 sightings/hr search effort) remained stable from the early morning until 14h00 and decreased thereafter, and was highest in August and September. Average group size was 22.6 (S.E. 0.81). Ninety percent of sightings were made within 1km from shore, equivalent to the 30m isobath. The dominant movement trend was northward travel, representing 89% of observations. Dolphins moved in a consistent northerly/north-easterly direction throughout the day until 14h00 when direction appeared to shift toward the east. Direction of travel was also related to distance from shore; dolphins traveled southwest and south significantly further offshore than in any other direction. We propose that this is part of a medium scale spatiotemporal movement cycle, with a potential link to foraging.

Phylogeography of Harbour Seal (*Phoca vitulina concolor*) in the Northwest Atlantic, Using Microsatellite Markers and Mitochondrial DNA

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Harbour seals are generally considered as sedentary animals, limited by access to coastal haul-out sites. Although harbour seals are distributed throughout eastern Canada, little is known about the genetic relationships between colonies separated by large bodies of water. Here, the population genetic structure of northwest Atlantic harbour seals, *Phoca vitulina concolor*, is described using ten microsatellite markers and nucleotide sequences of the mitochondrial DNA d-loop. A total of 294 individuals were sampled from 12 sites: seven in Canadian Atlantic, four in the Gulf of St. Lawrence and one in Hudson Bay. Statistical analyses of microsatellite data indicate moderate levels of population differentiation over the study area (global $F_{st} = 0.137$). However, pairwise comparisons of F_{st} values provides evidence for three groups of harbour seals in the Northwest Atlantic. The first two are represented by the samples from the Hudson Bay and Sable Island respectively. The third group comprises samples collected from the Labrador coast, in the Bay of Fundy, Cape Breton, Nova Scotia coast, south and east of Newfoundland and those from the Gulf of St. Lawrence (Bic-Métis, Anticosti Island, Prince Edward Island and West of Newfoundland). F_{st} values between the three groups vary between 0.105 and 0.323 and are significantly different ($P = 0.017$), while F_{st} values between the samples of the third group vary between 0.00 and 0.10 and are generally not significant. The higher level of gene flow observed among the samples of the third group may be related by the capacity of the individuals to migrate along the coasts as observed in other studies. This observation also agrees with the higher degree of genetic differentiation observed when the colonies are separated by large bodies of water. Mitochondrial DNA, which is currently being analyzed, will be used to confirm the population structure observed with microsatellites.

Distribution, Abundance and Trends in Abundance of Fin and Humpback Whales in the North Atlantic

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The North Atlantic Sightings Surveys (NASS) are a series of international cetacean line transect surveys, including participation from the Faroe Islands, Iceland, Norway and Spain, that have been conducted in 1987, 1989, 1995 and 2001. The NASS have covered a very large area of the central and eastern North Atlantic, from East Greenland east to coastal Norway, and from Svalbard south to the Iberian peninsula. Target species were minke, fin and pilot whales, but all species encountered were registered. Here we present estimates of abundance for fin and humpback whales from the Northeast and Central portions of the survey area. Fin whales occurred in highest densities in Denmark Strait west of Iceland, while humpback whales were most abundant in shelf waters east and west of Iceland. The abundance of fin whales increased in the survey area over the period, with the greatest increase observed in the waters west of Iceland. There were 29,000 (cv 0.11) fin whales in the area in 2001. There has been a great increase in the abundance of humpback whales around Iceland, but not in other areas. Aerial surveys conducted in Icelandic coastal waters indicate an annual rate of increase of 11% (cv 0.24) in this area. There were 12,600 (cv 0.26) humpback whales in the entire survey area in 2001. The observed trends are consistent with increases in abundance following the cessation of whaling in this area, but the magnitudes of the observed increases, taken at face value, are greater than expected. For humpback whales in particular, our recent estimates are substantially higher than most estimates of pre-whaling abundance. Other factors, including differential harvesting of sub-stocks, changes in carrying capacity, immigration from other areas, the near extirpation of some other cetacean species, and operational factors in the surveys themselves, may be involved.

Patterns of Haul-Out Distribution of Weddell Seals *Leptonychotes weddellii* Along the Mawson Coast, East Antarctica

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The aim of this study was to survey Weddell seals on the fast ice to examine the relationship between the seals and their ice habitat. We sought to determine if haul-out sites are random, or if they are associated with distance to coast, distance to ice edge, or with islands and/or icebergs. We also quantified spatial and temporal variation in abundance, size, sex ratio and age structure of seal groups. Three study areas were established in 2000 at different locations along the Mawson coast. Within each study area, there were two transects (1500 m wide, 1500 m apart) extending 20 km north over the sea ice from the coast. Each study area was surveyed three times - in winter (late July), late winter (mid September) and spring (mid-October). One study area (Area 2) had a high concentration of icebergs and islands, another area (Area 1) had islands near the coast and fewer icebergs, and the third area (Area 3) had very few icebergs. Area 2 consistently had more seals than the other two areas. The abundance of seals increased in each area from winter into spring. Distance to ice edge was not correlated with seal haul-out along the Mawson coast, possibly due to the width of the fast ice sheet at Mawson (50+ km). We propose that Weddell seals prefer to haul-out on ice > 5km from the coast, and that mostly adult females and their pups utilise the inshore fast-ice area during the spring

breeding season, though it is possible that breeding males were not observed due to being underwater guarding the haul-out holes. The findings of this study support Lake *et al.*'s (2005) hypothesis that Weddell seal distribution is determined by environmental factors causing the fast-ice to crack, independent of the proximity to open water.

Get Shorty: A Dwarf Form of Killer Whale Confirmed in Antarctica

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During the early 1980s, two groups of Soviet scientists independently described new species of killer whale (*Orcinus orca*) based on Antarctic whaling catch data, and named them *O. nanus* (Mikhalev *et al.* 1981) and *O. glacialis* (Berzin and Vladimirov 1983). Although it is not clear if the authors were describing the same or different species, both descriptions emphasized that the new form(s) was on the order of 1.5-2 m smaller than "regular" killer whales. Due to a lack of holotype specimens and generally poor descriptions, the possibility of new species of Antarctic killer whales has been discounted. Recently, however, it was shown that there are at least three distinct, field-identifiable ecotypes of killer whales in Antarctica (Pitman and Ensor 2003) which include a purported fish-eater (Type "C") that lives in the ice and seems referable to *O. glacialis*. We photographed over 100 Type C killer whales from a helicopter in the southern Ross Sea and used photogrammetric methods to measure total body length and fluke width from the digital images. The mean length of adult females (*i.e.*, those with calves) was 5.2 m (4.8-5.4 m, n = 13); mean length of adult males (identified by tall dorsal fin and convex trailing edge of flukes) was 5.5 m (4.9-6.1 m, n = 11). The smallest calf was 2.1 m, and a 6.1 m male was the only animal that measured over 6 m. "Regular" killer whales from the Soviet catch data averaged 6.4 m for females (n = 118) and 7.3 m for males (n = 205), with maxima of 7.7 and 9.0 m, respectively. Our results confirm that there is at least one diminutive form of killer whale in Antarctica that measures at least 2 m shorter than regular killer whales. This provides further support for the separate species hypothesis.

Skunks of the Sea? The Composition and Function of Pygmy Sperm Whale "Ink"

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Pygmy sperm whales (*Kogia breviceps*) have a characteristic behaviour of squirting "ink" and circumstantial evidence suggests that this occurs when the animals are distressed. It has been speculated that this behaviour serves either as a predator defence mechanism or aids in hunting. The objectives of the present study are to a) describe the anatomy of the rectal sac in which the "ink" is stored, b) to examine the chemical composition of the "ink", and c) to examine behavioural responses of potential elasmobranch predators to the "ink". Results indicate that the "ink", which consists of liquid faeces, is stored in a rectal sac, which is found in the lower part of the colon. The largest amount recorded from a single animal was nine litres of the fluid. The rectal sac is a dilation of the last part of the colon just prior to the rectum. This structure is present in both male and female adult and sub-adult animals, as well as foetuses. Close examination did not reveal any presence of an ink gland. The histological examination showed the presence of a normal glandular epithelium. The ink-like substance has a characteristic odour and a dark reddish-brown colour unlike the faeces of other odontocetes. Examination of foetal animals indicated that these already had a substance similar to the "ink" present in the rectal sac and chemical analysis showed that this substance is similar in biochemical composition to that of born specimens. Trace levels of protein were detected in born animals (as opposed to foetuses), which may be diet related. Further results from mass-spectrometric analyses will be discussed in comparison to the ink found in squid, the main diet of

pygmy sperm whales. The results of the behavioural experiment will be discussed in light of a possible anti-predator role for pygmy sperm whale "ink".

Health and Condition of Captive Harbor Seal Pups on High and Low Fat Diets

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A change in prey abundance or availability has been one of the leading hypotheses proposed to explain diminished numbers of marine mammals in the Gulf of Alaska. To investigate long-term health consequences associated with prey availability and diet of harbor seal, we captured 4 healthy, recently weaned female pups in Prince William Sound in 2004 and 2005. Genetically these seals are from stocks that have been strongly affected by the Gulf of Alaska decline and thus represent seals adapted to conditions in the Gulf but susceptible to decline-related perturbations. Seals were assigned to two groups A and B. Both groups received an identical base diet including species with < 4% fat (pollock, squid, capelin) for dietary balance. Group A received the remainder of their diet from high fat herring; Group B received the remainder of their diet as low fat herring. Group A were fed to trainable satiation. Group B seals received the same diet (as a proportion of their weight) except low fat herring were substituted for high fat herring. This design allows the seals to adjust their intake naturally by season as determined by the appetite of Group A seals. A successful preliminary test of the tracking diet was run on resident adult seals at the Alaska Sealife Center (ASLC). The preliminary data provided baseline data for monitoring the condition of the seals on a tracking diet. The tracking diet was implemented on the pups 3 months after their arrival to ASLC. Health and condition parameters were collected from the seals every 6 weeks. Parameters include percent body fat determined by deuterium oxide, blubber thickness via ultrasound, mass and morphometrics. The seals that entered the study under 26 kg, although on different diets, have shown similar fluctuations in body mass and percent body fat. Seals that entered over 26 kg have shown little fluctuation in mass or percent fat. The smallest seal in group A and B have shown little progress in weight gain and are losing blubber depth. Analysis of metabolic rate may prove to enhance the tracking model to individual energetic demands.

Genetic Structure of Bottlenose Dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida

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This study aims to characterize the genetic structure of bottlenose dolphins in the Indian River Lagoon (IRL), Florida and test the hypothesis that they comprise a discrete population. DNA extracted from skin samples obtained during capture-release health assessment studies (n=64), as well as from strandings, both within the lagoon and surrounding areas (n=64), was used to examine the genetic composition of the IRL dolphins. Samples from dolphins in the coastal waters surrounding Charleston, South Carolina (n=56) were used to serve as a population outgroup. Eight established nuclear microsatellite markers were analyzed for all samples. Comparisons made to the Charleston animals used the same markers. Polymorphism was estimated for each marker as the number of alleles per locus, expected heterozygosity (H_e), and observed heterozygosity (H_o). Results from IRL dolphins were compared with Charleston dolphins, as well as a previous study by Natoli *et al.* (2004), which used the same microsatellite markers. The dolphins in the IRL showed lower H_o for 5 of the 8 markers, and 2 of the 3 remaining showed only slightly higher H_o . In addition, comparisons of total number of alleles at each marker indicated that the IRL had 3 loci with significantly fewer alleles than Charleston or the previous study. The 5 remaining loci had a higher number of alleles, but many were sparsely distributed (private), and for each locus, one allele was nearly fixed for all animals surveyed. Animals in the IRL and Charleston waters share 48.5% of alleles. The IRL has 26 unique alleles, which are sparsely distributed,

and 8 alleles were unique to Charleston.

Associations of Breeding Grey Seals Persist at Sea

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Concurrence of at-sea movements may result from seals responding similarly to oceanographic conditions, copying "public information" from conspecifics or coherence within social units. Here we examine post-breeding movements of five groups of four grey seal mothers which pupped at North Rona (Scotland) in 2003 and were classified as "associated" (birth dates within 9d and pupping within 20m) during lactation. We test whether these individuals maintain greater cohesion at sea than individuals from the same breeding locations amongst whom there is no evidence of a social relationship. Post breeding movements were monitored with SPOT-3 satellite tags (Wildlife Computers), providing locations until tag failure around moult (4-76 days after application, median = 51). Post-breeding associations were defined initially as locations falling within 10 km in a 12 hr window. Spatial overlap of tracks within groups occurred at sea and at haul-outs in Groups 2,3,4 and 5. Pairwise associations occurred in 22/25, 44/59, 13/49 and 14/70 possible days and 3-way associations occurred in 1/8, 10/51, 0/43 and 0/66 possible days in groups 2,3,4, and 5 respectively. No 4-way associations were observed beyond the breeding site. Within-group associations continued up to 64 days after tag application but some were much more likely than others. We conclude that concurrence of movements occurred in 2/5 test groups ($p < 0.05$). Existing models of foraging, habitat use and population change explicitly ignore social effects and may be inadequate or even erroneous for real populations, making assessment of the nature and extent of such phenomena essential.

Population Structure of Southern Hemisphere Humpback Whales from Wintering Regions A, B, C, and X Based on Nuclear Microsatellite Variation

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Proposed divisions for management of large whales have significant implications for designing and implementing the appropriate conservation plans. Humpback whales (*Megaptera novaeangliae*) of the Southern Hemisphere are separated by the International Whaling Commission (IWC) into seven wintering Regions (A-G) based on tropical distribution. To evaluate the biological significance of these stock subdivisions, an analysis of nuclear genetic markers was conducted for the eastern and western South Atlantic (Regions A and B), and the southwestern and northern Indian (Region C and X) Oceans. A total of 1,531 individual whales representing ten sampling sites within the four wintering Regions were genotyped at eleven microsatellite loci.

A hierarchical analysis of molecular variance using F_{ST} or R_{ST} estimators supported differentiation among the Regions, although the degree of substructure was low. When contiguous wintering Regions were tested the most differentiated were Regions X and C, followed by Regions A and B, and finally the least differentiated Regions B and C. A Bayesian clustering procedure was however unable to partition the individuals into different groups, with the exception of Region X which formed a separate cluster. Overall the level of structure observed was considerably lower of the one previously detected with mtDNA. Although some support was encountered for further sub-divisions within Regions B and C, the divisions supported do not correspond to the ones currently in use. Estimates of dispersal rates, based on a maximum likelihood approach and coalescent theory, revealed high numbers of effective migrants per generation exchanged between contiguous wintering Regions, as well as within Regions. The direct detection of movements by genetically identified individuals, confirm that gene flow is ongoing across present boundaries.

Geographic Variation in Skull Morphology of *Delphinus delphis* and *D. capensis* in the Eastern Tropical Pacific

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The skull is a well conserved structure and provides information on the history of individuals which may lead to insights in the evolution and ecology of species. Common dolphins (*Delphinus* spp.) have a complicated systematics which is necessary to clear as they are affected by several fishing activities in the eastern tropical Pacific. Intense research has been conducted on this issue based on morphology and genetics but many questions are still open. In this work, we examined variation in 25 skulls of *D. delphis* and 33 skulls of *D. capensis* from the eastern Pacific between Costa Rica and the Sea of Cortez. Age of the specimens was determined by dentine layer counting and 101 measurements were taken twice for each skull. For *D. delphis* there are two sexually dimorphic characters being these, the right and left widths of premaxillae at half length of the rostrum. In the case of *D. capensis*, sexual dimorphism is much more evident in almost all measures, especially in the masticatory apparatus. The growth rate of condylobasal length at Von Bertalanffy's equation is 0.61 for males and females of *D. delphis*, 0.64 for males of *D. capensis* and 0.52 for females of *D. capensis*. This may result from a different mating system of *D. capensis* and/or from a differential feeding ecology between sexes in this species which has been also suggested by studies on stable isotopes contents. Cluster analysis shows that individual variation overlaps between the two species but principal component analysis shows for *D. delphis* well defined clusters for Costa Rica, the mouth of the Sea of Cortez, and the Sea of Cortez, the last region being more distinctive. The masticatory apparatus makes the greatest contribution to this separation showing again that feeding ecology plays an important role on population differentiation/adaptation processes in dolphins.

Dolphins Prefer Attractive Human Faces

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We investigated whether dolphins (*Tursiops truncatus*), like human infants, children, and adults, prefer attractive human faces. We found that dolphins looked significantly longer at attractive compared to unattractive human faces and thus showed preferences similar to those of human adults and infants. This study is the first in the area of attractiveness to investigate the preferences of a species other than humans. These findings are inconsistent with social learning and mate selection theories of attractiveness preferences but consistent with a general-purpose information processing mechanism: cognitive averaging.

Muscle Biochemistry of Nursing Harbor Seal (*Phoca vitulina*) Pups

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Harbor seal (*Phoca vitulina*) pups begin swimming almost immediately after birth, although dive performance lags that of adults for several months due, in part, to the pups' lower body oxygen stores. Blood and muscle are the main tissue oxygen stores, and recent studies in pinnipeds have suggested that muscle development begins during the lactation period, perhaps in response to developmental cues and muscle activity. As muscles develop to support breath hold diving activity, we predict that there would be a shift in their biochemical profile to reflect an increase in ability to support sustained aerobic metabolism. Changes expected are an increase in myoglobin concentration [Mb], higher densities of slow-oxidative muscle fibers, as indicated by increased levels of aerobic enzymes such as citrate synthase (CS) and β -hydroxyacyl CoA dehydrogenase (HOAD), and decreased levels of anaerobic enzymes such as lactate dehydrogenase (LDH). To examine muscle development in harbor seals, muscle biopsies were collected from the longissimus dorsi of known-age pups (n=65) and adult females (n=16) from the St. Lawrence River estuary in Quebec, Canada throughout the four-week nursing period during May-July of 2000-2002. Myoglobin concentration and enzyme levels were determined for the pups, and compared to those determined for adult females. Pup [Mb] were found to increase linearly from early to late lactation, but remained 59% lower than adult [Mb] at weaning (2.4 ± 0.2 vs. 5.9 ± 0.7 g/100g wet tissue). The levels of CS, HOAD, and LDH were determined in pup muscle tissue and compared to the enzymatic profiles of the adult tissue. The results of this study suggest that while the pup's muscles are becoming more aerobically poised during the nursing period, they are not fully developed at weaning. Future research will include determining muscle fiber types, mitochondrial densities, and capillary densities using transmission electron and light microscopy.

Rest Behavior in Bottlenose Dolphin Calves and Their Mothers

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The aim of this study was to examine the rest behavior in bottlenose dolphin calves and their mothers, and to compare the parameters of rest with that of females, which did not have calves. We video recorded the behavior of four captive bottlenose dolphin mother-calf pairs for two continuous nights from birth until the calves were 2-13 months old. We also monitored the behavior of 2 non-pregnant and one pregnant female. Females without calves rested at the surface 48-65% of the nighttime. Similar to previously studied killer whales, dolphin mothers exhibited complete disappearance of rest behavior at the surface for a period of about one month postpartum, swimming up to 97% of the time. Calves engaged in continuous swimming for a minimum of 8 weeks. Rest at the surface progressively increased in mothers and calves with age. During the first three months postpartum, the total duration of rest at the surface, and the length and number of rest episodes was greater in the mothers than in calves. During this time mothers continuously monitored their calves surfacing with both eyes open 95-98% of time. In calves two eyes were seen open 67-92% of the time. The eye directed to the mother was always open, while the other eye was open (81-92%), closed (2-12%) or in an intermediate state (10-17%). Dolphin mothers increased the frequency of breathing during the first 1-2 weeks postpartum to accommodate newborns. Afterward they resumed their typical breathing pattern, alternating long breathing pauses (1-3 min) with a series of 2-4 frequent respirations with intervals of 5-10 sec. Calves surfaced for breathing more often than their mothers and those surfacing likely disrupted their sleep. Little rest behavior in dolphin neonates and their mothers contrasts to the pattern seen to date in all other animals, from insects to mammals.

Changes in Winter Abundance and Distribution of Steller Sea Lion (*Eumetopias jubatus*) in Commander Islands, Russia

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A naturalist George Steller described species *Eumetopias jubatus* in the Commander Islands during Vitus Bering's expedition over 250 years ago. At Steller's time the species inhabited the area year around but was noticeable higher in abundance in summer and breed at least on Bering Island. By mid of 19th century the species stopped breed in Commander Islands and by 20 century almost extinct in the area. The governor of the Commander Islands Nikolay Grebnitsky wrote in 1902 that the species showed up in small groups in winter and was absent in summer. Later in 1920s winter abundance of Steller sea lion increased and the species became common in summer time especially soon after WWII. Survey in March-April 1965 counted ten thousand Steller sea lion in Commander Islands hauled out in seven sites while in summer time only about 2.3 thousand mostly males inhabited the islands. Noticeable changes in seasonal abundance occurred by end of 1970s. The census taken at the same March-April dates as in 1965 demonstrated a sharp decline of the abundance of Steller sea lions wintering on the Islands. The counts in 1978 were only 2,646 individuals, which is about one-third of the respective estimates in 1965. Survey in spring (March-April) 2005 showed total 500 Steller sea lion hauled out at four sites only in Commander Islands while in summer 2004 over 800 individuals were seen. By contrast, their numbers during the breeding season proved somewhat higher there than in winter. Some Steller sea lions breeding on the Islands migrated to other regions in winter. That is exactly opposite seasonal pattern to compare back in 1910-1930s.

Assessment of Trophic Relationships Between Fisheries and Small Delphinids in the Highly Exploited Bay of Biscay

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In the context of incorporating ecosystem objectives within fisheries management, attention was drawn on the small delphinids populations of the highly exploited Bay of Biscay. Trophic relationships between fishery and delphinids were here assessed to determine areas of strong potential interactions. The diet of by-caught oceanic common (N=61) and striped dolphins (N=60) and stranded neritic common (N=76), striped (N=23), bottlenose dolphins (N=25) and harbour porpoises (N=29) were determined through stomach content analysis. Morisita overlap indexes (Mo) between delphinids' diet and fishery landings and between delphinids and the main commercial species diets were computed for both oceanic and neritic areas. Dolphin yearly biomass consumptions were estimated using a standard mammalian metabolic model and compared to fisheries landings obtained from ICES fisheries database. In the neritic area, common and bottlenose dolphins overlapped significantly with fisheries and showed consumptions of similar order of magnitude in total (e.g.: bottlenose 40,038T/year, fishery 129,118T/year) and for some of the main commercial species (e.g. for sardine: common dolphin 10,010T/year, fishery 10,273T/year). Harbour porpoise diet overlapped significantly with fisheries but its consumption was negligible (278T/year). Striped dolphin did not overlap significantly with fisheries (Mo<0.1) but its consumption was important (20,494T/year). The dietary overlap was significant between at least one delphinid species and the following main commercial species: the cuckoo ray, the hake and the albacore tuna. In the oceanic area, the overlap was neither significant between the dolphins and the fisheries, nor between the dolphins and the main commercial species (swordfish, albacore tuna

and blue shark). Hence, no sign of evident strong potential direct or indirect interaction were found in the oceanic Bay of Biscay between delphinids and fishery, while we highlighted such interactions in the neritic area where dynamic modelling is now needed to address with more certainty this challenging question.

How Did Fossil Odontocetes Echolocate? An Investigation of Morphological Evidence Using Phylogenetic and Soft Tissue Inference

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Odontocetes echolocate using sound pulses generated in a complex arrangement of soft and bony craniofacial tissues. Although echolocation has only been documented in several species, shared anatomy indicates that echolocation occurs in all living odontocetes. Echolocation has not been convincingly demonstrated in living mysticetes nor is it thought to have occurred in any archaeocetes. Specific osteological correlates (e.g., premaxillary sac fossae) have been interpreted to signify echolocation ability in fossil odontocetes because they reflect the skull's accommodation of soft tissue sound-generating apparatus (i.e., the melon, air sacs and associated musculature). Based on broad comparisons, previous researchers hypothesized that extinct Miocene odontocetes echolocated as well as extant taxa, though it remains unclear how stem odontocetes could have echolocated using even more plesiomorphic facial morphologies. Because the odontocete echolocation apparatus is an integrated system with different configurations of bony tissue and soft tissue complexes, we propose that this system evolved via sequentially interacting adaptive and/or exaptive components. Although soft tissue evolution can only be inferred using extant taxa, fossil odontocetes document important transitions in the sound generating facial tissues using osteological correlates. The phylogenetic pattern of these morphological transformations can test different hypotheses about the sequence of soft and bony tissue changes, and infer echolocation capabilities in fossil odontocetes. We investigated the qualitative and quantitative parameters of bony and soft tissue characters associated with sound production (e.g., external bony nasal passages) by examining X-ray CT scans and skull measurements of well-preserved species from different stages of odontocete evolution (e.g., *Simocetus rayi*, *Kentriodon pernix*). Preliminary results indicate that, relative to basilosaurid archaeocetes and "archaic" toothed mysticetes outgroups, features like the external bony nares provide critical landmarks for understanding the evolution of the odontocete face independent of other odontocete cranial modifications, such as cranial telescoping and directed facial asymmetry.

A Bayesian Approach for Analyzing Line Transect Survey Data for Estimating Marine Mammal Density

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Accurate estimation of expected animal densities from line-transect data is fundamental to many scientific and management analyses. We present a novel Bayesian approach for analyzing line-transect survey data that specifically accounts for the disproportionate number of non-occurrence values commonly encountered on marine mammal surveys. Because marine mammal survey data often contain a disproportionate number of non-occurrences (0 values), traditional distance sampling methods are not optimal for representing this type of distribution. We propose to use a Bayesian analysis approach and incorporate statistical methods for analyzing zero-inflated data. These approaches include: Zero-Inflated Poisson (ZIP) for use with density and habitat models; Zero-Inflated Binomial (ZIB) for habitat models; and Zero-Inflated Negative Binomial (ZINB) for habitat models with over-dispersion. In addition, we treat $f(0)$ as a random variable and estimate it simultaneously with other model parameters.

This treatment is a sensible alternative to the traditional approach of separating the density estimation and the estimation of the detectability function. Our results indicate that using zero-inflated improves a model's fit to the data. The zero-inflated approach also introduces a way of combining marine mammal habitat modeling and density modeling under one single model framework.

Polybrominated Diphenyl Ether (PBDE) Compounds in Blubber from the Bering Sea Subsistence Harvest of Ice Seals in Alaska

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Polybrominated diphenyl ether compounds (PBDEs) are used as flame retardant additives in carpet, upholstery, and electronics (e.g., televisions and computers). Due to increased use, PBDEs are a relatively recent suite of chemicals of concern. Little is known about their toxicology. Their chemical structure, however, is similar to that of polychlorinated biphenyls (PCBs) and they are thought to be capable of disrupting thyroid function. Concentrations of PBDEs have not previously been reported in seals in Alaska. Blubber tissue from six ringed seals (*Phoca hispida*), five bearded seals (*Erignathus barbatus*), three spotted seals (*Phoca largha*), and six ribbon seals (*Phoca fasciata*) harvested near Little Diomed and Hooper Bay was analyzed for 38 congeners of PBDEs. Eleven of the 38 congeners were detected and the highest concentration (28.6 ng/g wet wt) was of BDE 30 (2,4,6 TriBDE) measured in a 9-year-old male ribbon seal. BDE 47 (2,2',4,4' TetraBDE) was the highest brominated compound detected. No penta-, hexa-, or heptabrominated compounds were detected. Results indicate that lower brominated congeners of PBDEs are present in the Bering Sea environment.

Bottlenose Dolphin (*Tursiops truncatus*) Whistles from Laguna de Términos, Campeche, México Are Not as Frequency Modulated as Previously Reported

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Tursiops truncatus has the characteristic to establish complex social relationships and to develop an acoustic repertoire formed by whistles and clicks. The organization of the whistle repertoire is still not entirely defined because there are variations according to dolphin behavior, among populations, and with the classification method used. We know that whistles have a communicative function and are important in determining dolphin social structure. To establish the whistle repertoire, acoustic recordings were made during 36 days between January 29th and November 6th, 2004 in Laguna de Términos in the southern Gulf of Mexico using a 24 kHz frequency band Digital Audio Tape recorder (DAT) and an omnidirectional hydrophone (-194±2dB re 1V/μPa), obtaining 1,468 minutes of acoustic recordings from 1,824 bottlenose dolphins found in 110 herds. DAT recordings were redigitized at a sampling rate of 48 kHz to obtain their time-frequency information and select whistles for analysis, and to define their repertoire by classifying contours into one of six categories: constant, ascending, descending, concave, convex, and multiple. Whistles were selected for analysis when their fundamental frequency was within the recording system frequency band (100% of all whistles) and their signal-to-noise ratio (SNR) was greater than 3dB re 1μPa (79% of all whistles); although no differences were found in whistle characteristics (t , $p>0.72$) and repertoire ($c2$, $p=0.99$) if considering whistles with SNR<3 dB re 1 μPa. Preliminary results (N=239) show that bottlenose dolphins from Laguna de Términos produce mainly ascending (61%) and multiple (25%) whistles of short duration (521±510 ms) with a mean frequency of 9.77±4.38 kHz and a frequency span of 7.08±3.43 kHz. While whistle characteristics do not differ from those previously reported for bottlenose dolphins from the same area, the whistle repertoire does. These differences may be attributed to the classification

method and sample size used. Work supported by CONACyT-Gobierno Edo. de Campeche, PAPIIT, UNAM, and ICMYL, UNAM.

Vocal Exchanges in Wild Bottlenose Dolphins

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Whistle exchanges have been described for a variety of marine mammal species. However, we know little about the specific function of exchanges in the wild. In this study we investigated the behavioural context of stereotypic and non-stereotypic whistle exchanges in wild bottlenose dolphins to infer function from whistle usage. We studied dolphin whistle exchanges off the north-east coast of Scotland during 2003 and 2004. Concurrent acoustic and non-acoustic data sampling was conducted from a 6 m research vessel during focal follows. Acoustic recordings were made on a four-element distributed array. 540 minutes of recordings from 12 separate days were analysed. From these 537 individual whistles were extracted and the calling animal's position determined through cross correlation of acoustic arrivals between the six hydrophone pairs for 58% of the total whistles. Instances of vocal exchanges (i.e. whistles from different individuals within 3 seconds of each other) of either stereotypic (2 whistle types produced repeatedly by at least 2 animals) or non-stereotypic (different whistle types produced by different animals with no repetition of whistle types in the sequence) nature occurred during 10 focal follows from 9 separate days. Stereotypic interactions occurred prior to dolphin subgroups joining in 66% of observed joins and in 50% of cases where animals then engaged in visible aerial behaviour. Non stereotypic types primarily occurred when animals were in large groups (>15 animals), 80% of cases, and secondly when small subgroups passed, 20% of cases. Vocal exchanges of stereotyped whistles between individuals appear to be an important tool in maintaining contact in wild dolphin groups. Stereotypic interactions occurred prior to the context of groups joining and aerial behaviours suggesting that individuals emit distinctive stereotyped calls as contact calls, to advertise individual identity and maintain contact in situations of increased activity.

Communication Range of Social Sounds Used by Wild Bottlenose Dolphins During Fission-Fusion Events (*Tursiops truncatus*)

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Bottlenose dolphins exhibit flexible associations in which the compositions of temporary groups change frequently. We explored the relationship between dolphin separation distance and potential communication range, based on their use of whistles for maintaining contact. We quantified the propagation range of sounds in the frequency range of whistles in different habitats in Sarasota Bay, Florida, relative to the distances of natural separations of mothers and their dependent calves. We conducted sound transmission experiments; five in shallows (<2.5 m) and four in channels (>2.5 m). Sound propagation varied with habitat type, bottom type, depth, and sound source level. Sounds were most attenuated in areas with seagrass. Based on propagation and background noise measurements, we estimated the hypothetical detection distance for a dolphin whistle. In a seagrass shallow water area (mean depth = 1.57 m, SD = 0.15), a loud whistle (source level = 165 dB) ranging in frequency from 5-19 kHz could travel and still be heard by a dolphin at 150 m. In a shallow area with mud bottom (mean depth = 1.4 m, SD = 0.3), all whistle frequency components of the same whistle can travel up to 2 km and still be heard by a dolphin. In channels, whistles could be detectable over a much larger range (>14 km) depending on mean water depth. Our findings indicate that in Sarasota Bay, FL, the communication range of social sounds greatly exceeds the mean separation distances of mothers and calves (n = 85 m). Ecological pressures might play an important role in determining the distance of separation between mothers and calves.

Comparative Morphology of the Pterygoid Sinus among Porpoises (Cetacea: Phocoenidae) Using CT Data

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The pterygoid sinus is a unique air-filled sinus extending from the middle ear into the pterygoid bones in cetaceans. It is one component of a complex sinus system associated with sound reception and production. Mysticetes and more basal odontocetes (e.g., ziphiids, monodontids, and physterids) have a relatively simple sinus system, having fewer diverticula than seen in later-diverging odontocetes. The greatest elaboration of the system is in phocoenids; unlike other odontocetes, they have both a dorsal extension of the sinus into the frontals and a sphenoidal portion of the sinus. Although the presence of the sinus has been previously documented, the three-dimensional relationship of the sinus within the skull and its morphology independent of the skull were unattainable by traditional methods of dissection and osteological examination. For this study the pterygoid sinus in the skulls of one fossil and four extant porpoise species have been visualized and measured using high-resolution X-ray computed tomography (HRXCT). Endocasts of the sinuses were extracted from these skulls by digitally segmenting the sinus cavities. These endocasts provide morphological information that augments previous descriptions. Volumetric and linear measurements based on the CT data quantify the variation of the sinuses among porpoise species. Morphological differences in the sinuses among porpoises reflect phylogenetic change. The preorbital lobe of the sinus of the earlier diverging *Neophocoena phocoenoides* has much less extension into the frontals than *Phocoena sinus*, one of the later diverging species. The fossil phocoenid displays the derived condition of having a longer dorsal extension of the sinus into the frontals. These results offer insight into the evolution of the pterygoid sinus among phocoenids, illustrating the effectiveness of HRXCT for interpreting the internal cranial anatomy of both extant and fossil cetaceans.

Finback Whale (*Balaenoptera physalus*) Behavior on Jeffreys Ledge in the Gulf of Maine

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Jeffreys Ledge is a 54-km long rocky ridge in the Gulf of Maine located approximately 32-km off the northeast coast of the United States. Several commercial whale watch vessels visit this area on a daily basis during the whale watch season (May through October) each year. During the 2004 season, the dive time and behaviors of finback whales (*Balaenoptera physalus*) opportunistically sighted from commercial whale watch vessels were recorded. The dive times of finbacks times ranged from zero to 20 minutes. Differences in average length of submergence were found between morning and afternoon sightings (5.89 minutes in the morning and 5.83 minutes in the afternoon). Additionally, finback whales increased their dive times during the latter part of the season. Overall, the most common behaviors recorded were feeding and traveling, providing evidence that Jeffreys Ledge is an important feeding area for finbacks during the summer. Behaviors also varied slightly based on time of day. This study suggests that finback whales adjust their behaviors and submergence times based on time of day and season possibly in response to prey abundance. Continued studies are essential for the better understanding of finback whale behavior in the Jeffreys Ledge area.

Basic Aspects on the Biology of the Bottlenose Dolphin, *Tursiops truncatus*, in the Coast of Nautla, Veracruz, Mexico

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Bottlenose dolphin populations in the Mexican coasts of the Gulf of Mexico have not been as extensively studied as those from the Pacific. The few available studies comprise mostly the Caribbean, thus the western Gulf of Mexico has only one research conducted more than 10 years ago. Between July 2002–2003, 26 boat-based surveys were conducted within a 12x4 km coastal area in front of Nautla, Veracruz (20°12'N, 96°45'W). This is the first attempt to formally study bottlenose dolphins in the area. The goals were to obtain a photo-ID catalogue and to assess the spatial and temporal distribution, relative abundance, as well as group size and composition. Total survey effort was 103 hr (search time was 79 hr), resulting in 23 encounters with 263 dolphins, where 4.8% were calves. Average group size was 11 (s.d.=14.1), but most (63%) had less than 10 dolphins; no significant seasonal differences were found, but nursing groups were significantly larger ($p<0.05$). Photographic efficiency was low (23.3%), and individualization success on adult animals was 62.4%. Some 148 individuals have been photographed within the area, where 79.7% were captured just once and the rest in no more than four occasions. Median relative abundance was 2.47 dolphins hr⁻¹, with no significant seasonal differences. Geographic distribution of dolphin sightings showed no evident pattern, and the depth range reached no more than 28m, where 57% of the encounters occurred in shallow waters (<20m depth). Seasonal differences in population parameters have been reported in other populations of this species within the Gulf of Mexico; thus, the fact that no significant differences were obtained, may be due to the high variability of the analyzed data. This study suggests there is an open population; however, more data over larger periods are needed to raise conclusive evidences on temporal and spatial trends in this population.

Photo Identification and Classification of Bottlenose Dolphins (*Tursiops truncatus*) in Central Coast of Peru

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Photo identification of dolphins for catalogues and behavioral research has been undertaken worldwide. However, little is known about pods moving along the coast of Peru. Looking for photo identification of resident and transient pods along the Peruvian coast, ORCCAMM's Inshore Cetacean Population Research Program has focused on the photo identification and classification for long term lineage follow up of bottle nose dolphin pods (*Tursiops truncatus*) distributed in the inshore waters of Lima State in the central coast of Peru. Identification was made using 35 mm cameras with 28-600 mm lenses taking photographs of dorsal fins of females and calves, juveniles, and males within pods. Classification provides an identification code that allows researchers to get the most information possible from each identified individual. The code uses a two-parted accession name and last name with emphasis in relative alphabetical sequence in the first letter. Name indicates gender, age class and generation. Last name indicates species and maternal lineage. Each pod is classified with an alphabetical letter. In the first stage, each mother within the pod is classified with a last name, using the same alphabetical letter for the pod. This is the initial lineage for calves. In the second stage, calves and subsequent juveniles and males out of the classified pod carry the maternal lineage in its identification code. Juveniles and males of independent pods in the first stage are registered with a two-parted identification code separately. Up to 40 identified dolphins were classified using this method. This classification is an operational tool for a long term population analysis and support further genetic studies in resident and transient pods of this and other dolphin species in the area.

Population Structure and Dynamic of Humpback Whales (*Megaptera novaeangliae*) in the Gulf of St Lawrence, Canada

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Two humpback whale aggregations can be found in the Gulf of St. Lawrence in Eastern Canada. The first is located in the Mingan/Anticosti area and forms the St Lawrence stock while the second one is situated in the Northeast Gulf and is part of the Newfoundland/Labrador stock. In 25 years of research 207 animals were photo-identified in the Mingan area and 464 in the Northeast Gulf. Fifty animals were observed in both areas. The sex ratio was 1.4 females for 1 male. Altogether 52 females were seen with 86 calves. Mean calving interval was 3.3 years. Very few males observed as calves were seen a second time, while half of the females returned, suggesting a higher site fidelity for females. Only two females seen as calf returned with their own offspring, after 9 and 11 years respectively. The high number of individuals seen only once (both calves and adults) created an age structure in the mark recapture analysis. Different models (CJS, Barker's, Pradel's and Multi State) yielded estimates of adult survival rate ranging from 0.973 to 0.986. No significant difference in survival was observed between the two stocks or between sexes. The dataset was analyzed in several time spans, backwards and forwards. Results show that longer data sets provide more precise survival estimates at first, but eventually very long datasets can potentially hide short-term trends or between-years differences.

Impact of Vessels on Bottlenose Dolphin Behavior in Kvarneric (Croatia)

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Responses of the resident population of bottlenose dolphins (*Tursiops truncatus*) in Kvarneric to encounters with vessels were studied during the summer of 2004. The study was restricted to vessels within 500m of the animals. The behavioral state of the focal group was recorded before, during, and after a vessel encounter and classified as feeding-related, traveling, socializing or resting. For each encounter, the occurrence and (if present) the nature of the dolphins' immediate avoidance behavior was recorded. Responses of groups with and without calves were compared using a two-sample homoscedastic t-test. Relevant vessel characteristics including type, size, power, speed, heading, distance from the dolphins and actions, were correlated with avoidance behaviors and behavioral state changes. Twenty-one encounters between dolphins and vessels were observed, 12 involving groups with calves. There was no difference in frequency of avoidance responses between groups with calves and those without them ($t_{\text{calc}}=0.213$, $p=0.05$, $df=19$), but a significant difference between the two subsets was observed in the frequency of behavioral state changes ($t_{\text{calc}}=2.488$, $p=0.05$, $df=19$). Groups with calves changed their behavioral state more frequently as a consequence of a vessel encounter; the most common change being from feeding-related or social behavior to travel, presumably in order to leave the area. The most important factors in determining the presence and type of immediate avoidance response were engine type of the vessel ($R^2=0.51$) and whether it intentionally approached the animals ($R^2=0.62$). Changes in vessel course ($R^2=0.56$) and distance of the vessel to the dolphins ($R^2=0.46$) were the most influential factors initiating a change in behavioral state. In conclusion, this preliminary study reveals that the presence and behavior of vessels disturbs bottlenose dolphins (especially groups with calves) in this area. Engine type and propeller noise may play a primary role in this disruption.

Long Beaked Common Dolphin (*Delphinus* spp): The Dominant Cetacean Species Associated with the Complex Topography in the Cariaco Trench

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Common dolphin exclusive occurrence in the northeast coast of Venezuela has been widely documented. The increased of the research efforts toward cetacean fauna inhabiting the territorial waters of the country, have allowed the proper determination of the distribution range of this dolphin species.

This contribution identifies the association of a potential morphotype of long beaked common dolphin (Esteves 2005) with the complex topography and bathymetry of the Cariaco Trench Basin. A subsample of *Delphinus* spp. sightings ($N=17$) and environmental variables gathered through a documentary search were filed and incorporated to a Geographic Information System (MapInfo 6.5). Common dolphin accounts for more than 80% of the sighting records taken opportunistically in the study area during 11 Cariaco Project research cruises including additional observations made by the authors. The spatial distribution of the sightings includes long beaked common dolphins observed in the eastern core area ($N=12$) with a bathymetry record of 1300 m, as well as in the outer rim. The temporal distribution of the sightings comprised the months of Sep, Oct, Nov, Mar and May. Feeding activity was documented in 12% of the observations with interspecific association events ($N=2$), one with *Balaenoptera edeni* and the other with an unidentified blackfish species. The affiliation of common dolphin with uneven underwater topography has been described in other latitudes (Hui 1979). Acevedo *et al.* (2004) zonified and termed this unusual deepwater feature within the continental shelf as a key area for the conservation of odontocetes cetaceans. The oceanic-like characteristic of the habitat with the enhanced productivity due to upwelling processes promote the occurrence of common dolphin populations. An increase in survey efforts in the west side of the basin is recommended. *This investigation could not have been possible without the valuable support of the Cariaco Project of Fundación la Salle de Ciencias Naturales (FLASA).*

Entanglement of Steller Sea Lions in Marine Debris: Identifying Causes and Finding Solutions

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Marine debris is a global concern impacting a variety of species in the world's oceans including marine mammals. Because many species are either rarely observed or die at sea, entanglement in marine debris is extremely difficult to quantify. Moreover, entanglement can be a "silent" killer (e.g., swallowed hooks) with no apparent external signs of entanglement. The vulnerability of a particular species to entanglements depends on individual behavior as well as proximity to fishing grounds and the ability to survive an encounter. The incidental take of Steller sea lions (*Eumetopias jubatus*; SSL) through entanglement in fishing gear is one hypothesis being addressed in the continuing decline of the western population of SSLs. Our objectives were to estimate the percentage of entangled SSLs by sex and age class on haulouts in Alaska and British Columbia, identify materials causing entanglements, and identify fishing practices and fishing zones most associated with entangled SSLs. We recorded total number of SSLs per haulout, number entangled, sex, age class, entanglement type, and when possible photographed entangled individuals encountered on haulouts during surveys from 2000-2005. Observed entanglement frequency was 0.22%, representing a minimum estimate (visible signs of entanglement are often lost). Entanglements affected both sexes and all age classes (adult females, 39.0%; adult males, 23.8%; subadults, 4.8%; juveniles, 21%; and unknown, 11.4%). Observed entanglements were primarily fishing line, packing bands, or net around the neck (58.4%), line and flashers (34.9%), and longline gangions (6.7%) protruding from the mouth, indicating a swallowed hook. Entanglement of SSLs in marine debris may be a greater problem than previously addressed and additional effort to document entanglements should be included during future field research. By identifying types of gear causing the majority of entanglements, we can work with fishing industries to reduce entanglements of SSLs.

An Overview of Small Cetacean Strandings in the Pacific Northwest, 1999-2004

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Within the Pacific Northwest, stranding networks coordinate recovery and post mortem examination of dead, beach-cast marine mammals. In Washington, primary responders include the NMML, Washington Department of Fish and Wildlife, Cascadia Research, The Whale Museum, San Juan County Marine Mammal Stranding Network, SeaDoc Society, and in British Columbia, the Marine Mammal Research Group, DFO and Vancouver Aquarium. Between 1 January, 1999 and 31 December 2004, 104 small cetaceans have been recovered, including 72 harbor porpoises, 17 Dall's porpoises, 9 Pacific white-sided dolphins, 2 common dolphins, 1 northern right whale dolphin, 1 bottlenose dolphin, and 2 unspciated individuals. There have been 72 adults, 25 juveniles and 7 neonates with 50 males, 47 females and 7 cases of unknown gender. Although solitary animals have been recovered within each month of the year, there is an apparent bimodal seasonal stranding distribution for harbor and Dall's porpoises, with increased number of recovered animals from late May to early June and a smaller clustering in September and October. A proximate cause of death could be confirmed in 40-60% of all examined animals and included infectious disease, trauma, emaciation, and possible metabolic derangements. Prime bacterial pathogens included *Edwardsiella tarda*, *Clostridium difficile* and *Pseudomonas* spp with sporadic cases of *Salmonella* spp, *Vibrio vulnificus*, *Brucella* spp, and *Enterococcus* spp. The first multispecies outbreak of *Cryptococcus neoformans gatti* has been reported on Vancouver Island and in adjoining coastal waters with 14 cases documented in stranded Dall's and harbor porpoises. Harbor porpoises neonatal mortalities have been attributed to individual cases of intestinal volvulus, mesenchyma hamartoma, salmonellosis, and presumptive hypothermia or hypoglycemia. Due to the relative abundance of beach-cast animals, these marine mammals provide an excellent opportunity to define baseline information on established and potentially emerging disease concerns.

Got Milk? – Assembling Physiological Indices of Weaning for Steller Sea Lions

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It is difficult to define weaning in sea lions, and even more difficult to determine when and how it occurs, particularly in species where behavioral observations are limited. Our approach with Steller sea lions (SSL) has been to assemble a number of physiological indices that each contribute to our understanding of how a young animal makes its living; whether individuals are ingesting milk, ingesting prey, or both at a given age and how abruptly this nutritional transition occurs. During research on young SSL (2.5-44 months old, n=506), a 14F stomach tube was used to sub-sample stomach contents during anesthesia with the presence of milk providing positive identification of nursing animals (n=75). Presence of particular parasite infections requiring fish intermediary hosts, imply at least minimal prey ingestion. High blubber or serum levels of specific fatty acids, typically underrepresented in milk, identify young sea lions that are ingesting prey high in these fatty acids. Changes in the levels of stable isotopes of carbon and nitrogen deposited in the vibrissae also indicate that a diet lower in trophic signature than milk has been ingested, in addition to, or replacing milk (n=52). In juvenile SSL (14 to 27 months old), peak nursing $\delta^{15}\text{N}$ values ($20.0 \pm 0.1\%$) were followed by decreases of 2.3 to 5.0‰ towards the root, suggesting a dietary switch. Each of these indices by itself cannot discretely identify the source of nutrition (milk, prey or both), but in combination can be used with behavioral observations to build a case identifying where each individual is along the continuum to nutritional independence. In combination these indices currently suggest that a higher proportion of young SSL are nursed into

their second year in the eastern population (southeast Alaska) than in the western population.

Experimental Tests of Gill Net Detection by Wild Bottlenose Dolphins

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Many attempts to mitigate fisheries by-catch of small cetaceans assume that animals use echolocation to detect nets, but dolphins and porpoises may use a variety of senses to detect and discriminate objects. We examined how bottlenose dolphins detect commercial and simulated gillnets along the coast of North Carolina by conducting boat-based focal animal follows. Commercial nets were 300m long and 6m deep, extending from the surface to the sea floor and were set perpendicular to shore for Spanish mackerel *Scomberomorus maculatus*. We also deployed a simulated net that consisted of an anchored float line, with no actual net. We recorded dolphin vocalizations with an HTI-96 hydrophone and Sony DAT recorder with a sampling rate of 44 kHz. In 14 of 18 encounters with commercial nets focal dolphins swam around the inshore or offshore end of the net. Dolphins seldom used echolocation during these follows, even while close to nets. Echolocation occurred only for 2.68 ± 0.52 (SE) seconds each minute; this rate did not vary as a function of distance from the net ($p = 0.82$). We observed seven encounters with the simulated net. On four occasions dolphins diverted around the offshore end of the simulated net, but one focal animal swam directly under the float line. Echolocation occurred frequently when dolphins were within 100m of the simulated net (30.1 ± 4.1 seconds per minute); this rate was significantly lower when dolphins were 500m or more away the simulated net ($p = 0.008$). We conclude that dolphins use vision or passive listening to detect nets in shallow water, but use echolocation to investigate novel objects, such as the simulated net. Any conservation measure that leads to increased detection of nets will likely decrease the probability of entanglement; such modifications should not be limited to those which rely on echolocation.

Seeing the Whole Picture: Interpreting Variation in Fatty Acid Composition of Both Inner and Outer Blubber Layers of Bottlenose Dolphins (*Tursiops truncatus*) from Charleston, South Carolina

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The blubber of many odontocetes exhibits vertical stratification, with the innermost layer likely being the most metabolically active. Thus, the importance of analyzing the inner blubber has been emphasized when examining fatty acid (FA) composition. However, this should not lead researchers to underestimate the importance of the outer blubber layer. Nor, in the case of small cetaceans, should it limit research to stranded or by-caught animals. We conducted the first known analyses of bottlenose dolphin blubber FA composition sampled from free-ranging animals over four consecutive seasons (n = 70). Full-depth samples were collected by remote biopsy from several estuarine and nearshore regions around Charleston, SC. Corresponding specimens of nine prey species (n = 330) were also analyzed. Cluster analysis and principal components analysis (PCA) demonstrated seasonal variation in the inner blubber (Welch ANOVAs; PC1 & PC3, $p < 0.0001$). Discriminant function analysis based on the prey FAs suggested striped mullet (*Mugil cephalus*) and red drum (*Sciaenops ocellatus*) were of greater dietary importance during fall and winter, while suggesting important spring and summer prey species may not have been included in analyses. Cluster analysis and PCA confirmed both blubber layers varied among geographic regions, but the variation was more significant in the outer blubber (PC2, $p < 0.0001$). Photo-ID data confirmed animals which clustered together in outer blubber analyses shared similar geographic sighting histories. Variation in the dietary impacts of striped mullet, striped anchovy (*Anchoa hepsetus*) and star drum (*Stellifer lanceolatus*) were likely responsible for a portion of the variation among regions. While inner blubber better reflected seasonal variation, FA composition among individuals was highly variable. Outer blubber variation among geographic regions suggested the outer layer may sources. Because western Hudson Bay is near the southern limit of the

polar bear's range, our findings may foreshadow how more northerly populations will respond to projected warming in the Arctic ecosystem.

The Effect of Spatial Scale on Cetacean-Habitat Models

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The relationship between species distributions and environmental variables typically varies with the spatial scale of the unit of observation. Prior cetacean-habitat models have been developed at scales ranging from 2 km to approximately 200 km using line-transect data, but the effect of these differences in the scale of the unit of observation has rarely been investigated. We explore these effects using eight years of cetacean and environmental data collected aboard research vessels in the eastern tropical Pacific Ocean. Specifically, we develop generalized additive models (GAMs) of cetacean-habitat relationships at five spatial scales by varying the unit of observation from 10 km trackline segments to 160 km segments. Four species or species groups were selected to represent a broad range of habitat preferences: eastern spinner dolphins (*Stenella longirostris orientalis*), striped dolphins (*Stenella coeruleoalba*), blue whales (*Balaenoptera musculus*), and sei/Bryde's whales (*B. borealis/edeni*). The GAMs were built at each scale to relate species encounter rates and school sizes to both fixed and dynamic environmental variables including bottom depth, bottom slope, distance to shore, sea surface temperature, sea surface salinity, thermocline depth and strength, euphotic zone depth, and surface chlorophyll concentration. For all four species, the ability of the best-fit GAMs to predict the observed species distributions varied more among years than among the spatial scales. For the spatial scales analyzed in our study, these results suggest that unexplained environmental variability has a greater impact on our ability to predict cetacean distributions than the scale of the unit observation. Although the effect of spatial scale appeared to be small, differences in the number of variables selected in the best-fit GAMs at smaller versus larger scales suggest hypotheses about the habitat selection strategies of species found in high and low productivity waters.

Fusariosis and Its Implications in the Mortality of a Neonatal Southern Right Whale, *Eubalaena australis*

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On 16th September 1999 a necropsy was performed on a neonatal southern right whale (*Eubalaena australis*), 4.84 m in length, at Hermanus, South Africa. Its umbilicus was partly healed, there was no meconium and the lungs contained air, indicating the calf had been alive for some time before stranding. On gross inspection, the skin appeared unusually formed in places, seemingly lacking in epidermal covering and carpeted with cyamids, especially *Cyamus erraticus*. The presence of this cyamid species, in high densities, generally infers that its host's health is compromised. Additionally, the pericardium contained several litres of straw-coloured fluid and the bladder was grossly distended, indicating a breakdown in the metabolic pathway, such as kidney failure. Scanning electron microscopic analysis showed the skin to be broken up and covered with mats of fungal and yeast-like mycelia, as well as bacterial colonies. Genomic DNA was extracted from skin samples taken from different positions along the neonate's body. The internal transcribed spacer region of the ribosomal DNA was amplified with PCR using fungal specific primers. Sequence analyses subsequently revealed that the sequences belonged to the fungal genus *Fusarium*, known to include species that may act as opportunistic mammalian pathogens. Skin infections (fusariosis) in immunocompromised humans, caused by this fungus have proven to be fatal. In addition, consumption of fumonisins (*F. moniliforme* mycotoxins) has been reported to be hepatotoxic, nephrotoxic, atherogenic, immunosuppressive and embryotoxic in experimental animal systems. This represents the first description of a *Fusarium* infestation in southern right whales. Whether it played a primary or secondary role in the demise

of the calf is uncertain, and the frequency of occurrence of the fungus on healthy right whales is currently unknown. However, it could possibly help to explain some of the currently inexplicable skin anomalies seen on North Atlantic right whales (*Eubalaena glacialis*).

Humpback Whale (*Megaptera novaeangliae*) Winter Range Off Hilo, Hawai'i: Comparison of Data from 2001, 2003 and 2005

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One of the main northern Pacific humpback whale winter birthing areas is the Hawaiian Islands. This is the first population survey for the east coast of Hawai'i Island, eastern edge of the whales' winter range in the archipelago. Research was carried out in alternate years (2001, 2003, 2005) from 1 December to 30 April. To collect count and behavior data, daily shore-based observations were conducted, weather permitting, for thirty minutes starting at 9 am, using 7–10 power binoculars. The vantage point was two miles north of Hilo (19° 44' N, 155° 05.6' W), approximately 25m above sea level. Data were analyzed only from dates when observations took place in all three years; Kruskal-Wallis was used because the data failed normality. Results showed no significant change in total number of individuals from 2001 to 2003 ($P > 0.05$), but significant decreases between 2001 and 2005 ($P < 0.05$) and from 2003 to 2005 ($P < 0.001$). Total number of groups in 2003 was significantly more than in either 2001 or 2005 ($P < 0.0001$), including a very significant drop from 2003 to 2005 ($P < 0.001$). Peak trends were comparable in all three years: upsurges in late January and early March, followed by dips in sightings. Observations of cow and calf pairs peaked earlier in 2005 (late January) compared with early April in 2001 and mid-March, 2003. There were significantly more total cow and calf pairs for 2003 over 2001 ($P < 0.05$), and for 2005 over 2001 ($P < 0.01$), but no change for 2003 versus 2005 ($P > 0.05$). Fewer individuals and groups in 2005 may be due to a shift of the population to other islands in Hawai'i or to a decrease in the actual number of animals wintering there. Cow and calf pairs did not decrease despite the drop in the general population, suggesting east Hawai'i continues to be an acceptable nursery.

Population Decline of Polar Bears in Western Hudson Bay in Relation to Climatic Warming

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Polar bears (*Ursus maritimus*) in western Hudson Bay, Canada, rely upon annual sea ice for access to their primary prey, ringed seals (*Phoca hispida*). During the summer months when Hudson Bay is ice-free, bears remain on land where they make little use of terrestrial food sources. In the past 30 years rising temperatures have increased the duration of this ice-free period – and the bears' seasonal fast – by 3 weeks. Although the resulting nutritional stress has been correlated with downward trends in body condition and recruitment, this study is the first to identify a population-level effect. We estimated population size and demographic parameters from capture-recapture data collected 1984–2004, and from handling records for bears that entered the town of Churchill, Manitoba, located adjacent to the study area. We conclude that the size of the western Hudson Bay polar bear population declined from approximately 1200 bears in 1987 to less than 950 bears in 2004. Estimates of apparent natural survival (*i.e.* excluding anthropogenic mortality) for prime age (5–19 yr) bears of both sexes remained stable over the course of the study at approximately 0.940. For all other age classes, a statistical relationship was established between earlier summer ice break-up and decreased survival. This relationship provides quantitative evidence for the effects of climate-related stressors on polar bear population dynamics. It also may explain why Churchill, like many communities in the Canadian Arctic, has experienced an increase in the number of bear occurrences in and around town.

Apparently, a larger number of nutritionally-stressed bears are visiting the Churchill area each year in search of alternative food sources. Because western Hudson Bay is near the southern limit of the polar bear's range, our findings may foreshadow how more northerly populations will respond to projected warming in the Arctic ecosystem.

Organization of Diving Behavior Discriminates Among Generalist Predators: An Example in Steller Sea Lions (*Eumetopias jubatus*)

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Diving behavior is often used to indicate potential foraging by air-breathing marine predators. Common behavioral measures include dive depth, duration, recovery time and the diurnal distribution of diving. These traditional measurements alone, however, are not sufficient proxies for prey pursuit and capture by generalist predators, because they result from complex interaction among diving ability, dissimilar prey behaviors, habitat and non-foraging activities. Steller sea lions (SSL) are one such generalist predator. Because diet analysis indicates SSL select densely aggregated prey resources, we used optimal foraging theory to predict strong temporal organization within SSL diving behavior when animals were foraging. As older sea lions (>12 mo) are more likely to be foraging than pups (<12 mo), we expected to see greater temporal organization in the behaviors of older animals. Using data from 40,300 dives recovered from satellite-relayed data loggers deployed on 32 SSLs ranging in age from 9-46 mo, we tested for organization at three temporal scales. We objectively determined individual dive shape, reflecting vertical prey patch structure, dive bout organization, reflecting horizontal patch structure, and the organization of trips to sea, reflecting the distribution of patches across the seascape. Analysis of temporal organization showed that 52% of dives were square in shape, 60% of dives fell within bouts and 63% of trips were organized non-randomly over time. Because this organization was variable by individual, we integrated all dive measures into linear discriminant models to determine the features necessary to properly assign individual SSL to their age categories. Only models that incorporated both temporal organization and traditional metrics were able to properly classify all SSL by age, while those using traditional metrics alone could not. This suggests that for generalist predators, it is insufficient to consider traditional dive metrics alone and ignore temporal structure when assigning function to behavior.

New Viral Findings and the Development of Seroepidemiological Screening Tests and the Corresponding Vaccines

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Lesion-derived specimens coming from health assessment studies of free-ranging *Tursiops truncatus* in the Indian River Lagoon (IRL), FL, and the coastal waters of Charleston, SC, conducted by HBOI and NOAA were used to investigate the presence of viruses. The complete nucleotide sequence of a novel Papillomavirus (a known cancer-associated agent in humans), TtPV-2, *Tursiops truncatus* Papillomavirus type 2, isolated from a genital lesion of a bottlenose dolphin from the coastal waters of Charleston, SC, was cloned and determined. This virus represents the first identified North American cetacean PV. A phylogenetic analysis revealed that TtPV-2 belongs to the close-to-root sea mammal "Omikron"-genus together with TmPV-1 (*Trichechus manatus latirostris* PV-1), PsPV-1 (*Phocoena spinipinnis* PV-1) and TtPV-1 with the highest L1 nucleotide sequence similarity to TtPV-1 (70%), a PV found in a genital lesion of a captive European *Tursiops truncatus*. The L1 nucleotide sequences of TtPV-1 and -2 encoding the major component of the viral capsid were identified and cloned. To create virus-like-particles (VLPs) as a vaccine, which can be applied to captive animals,

insect cells were transfected with a baculoviral vector containing TtPV-1 L1 and TtPV-2 L1. A high titer VLP production was performed after which the VLPs were purified and analyzed. Antibodies against dolphin Ig were generated in mice, isolated and purified to serve as a control in future seroepidemiological studies to screen captive and free-ranging dolphins for active infections with TtPV-2 and -1. Antibodies against the VLPs are being induced in mice and will complete the development of the screening analysis method. **ACKNOWLEDGEMENTS:** We thank Dr. M. van Ranst and A. Rector from the Laboratory of Clinical and Epidemiological Virology in the Rega Institute for Medical Research, University of Leuven, Belgium for sharing the TtPV-1 DNA with us.

Florida Manatee Over-Wintering Strategies in the Northwestern Everglades

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Florida manatees (*Trichechus manatus latirostris*) have adapted behavioral strategies to over-winter in the subtropical environments of Florida, including migrations south along the coast and movements to natural and artificial thermal refuges. A large proportion of the southwest Florida manatee population occurs throughout Everglades National Park and north into the Ten Thousand Islands (TTI). Cold-related mortality is high for manatees in this region due to the absence of industrial warm-water effluent, major springs, or influence of the Gulf Stream. We radio tracked manatees in the TTI for a study on manatee use patterns and hydrologic restoration, which focused primarily on movements outside the winter season. We also conducted a two-year study on manatee over-wintering strategies in the greater Everglades. Tracking data during winter documented strong responses to cold fronts by tagged manatees. We characterized water temperature and manatee use patterns through a network of data-logging temperature probes and aerial surveys. During cold fronts, tagged manatees moved inshore to a few key aggregation sites that serve as passive thermal refuges, all of which were within inland canals. Observations and temperature data show that manatees using these sites bottom-rest within thermally-inverted, higher salinity bottom layers that are 1 to 3 degrees (C) warmer than surface waters. With the return of warm weather following extended cold fronts, significant numbers of manatees shift to shallow in-shore bays, where water temperatures increase rapidly due to solar heating. Cooler Gulf water temperatures during much of winter limit the frequency and duration of feeding bouts on offshore seagrass beds. Because this undeveloped area is occupied by significant numbers of manatees, we suggest understanding their winter behavior will be of importance to the long-term management of manatees in this natural region, and in regions where power plants will be shut down or where spring outflow is greatly reduced.

Don't Go Out Without Protection: Patterns in the Evolution of the Aerodigestive Tract in Aquatic Mammals

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The larynx evolved initially to protect the lungs from incursions of liquids and solids. This protection is critical in aquatic mammals, as they must additionally coordinate aerodigestive activities while exposing this region to water. This study explores whether similar mechanisms of aerodigestive protection exist in unrelated aquatic taxa and, if so, are they derived through convergent evolution. Dissections were performed post mortem in specimens representing 6 genera of aquatic amphibians and reptiles, 28 of aquatic mammals, and 43 of terrestrial mammals. Results show variation in degree of aerodigestive tract protection. In amphibians and reptiles, a simple valve (larynx) regulates the tracheal opening. Aquatic and terrestrial mammals have both rostral and lateral laryngeal barriers (epiglottis, aryepiglottic folds) and expansion of the palatal arch (soft palate-epiglottic overlap). Mysticetes enlarge the larynx rostrally and caudally (epiglottis, corniculates), and extend a shelf-like prominence of the dorsal pharyngeal wall. Odontocetes elongate rostral, lateral, and caudal laryngeal barriers,

and expand palatal and pharyngeal elements (palatopharyngeal sphincter). Our findings indicate that secondary mechanisms of aerodigestive tract protection are not unique among aquatic animals. Laryngeal barriers and palatopharyngeal expansion arose in terrestrial mammals to protect airflow for olfaction while feeding. Caudal laryngeal protection and dorsal pharyngeal modification are not aquatic adaptations, but rather protective features that probably arose initially in long necked ungulates in response to head-down feeding, and were further exaggerated in artiodactyls to facilitate rumination. Maintenance or elaboration of these aerodigestive tract protections in cetaceans, however, allows airway protection during underwater open-mouthed behaviors. The degree of protection in aquatic animals does not correspond with dietary variations or amphibious vs. fully aquatic lifestyle. Rather, differing degrees of aerodigestive tract protection observed appear dependent upon evolutionary relationships, rather than similar constraints of an aquatic habitat. *Support: ONR N00014-96-1-0764 & N00014-99-1-0815, AMNH Speech Origins Fund, NA03NMF4390402, DOD (SAIC) A100389.*

Lobomycosis in Atlantic Bottlenose Dolphins (*Tursiops truncatus*) from the Indian River Lagoon, Florida

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The purpose of this paper is to describe the prevalence of lobomycosis, a mycotic infection caused by a yeast-like organism (*Lacazia loboi*) among Atlantic bottlenose dolphins. A comprehensive health assessment was conducted in populations in the Indian River Lagoon, FL (IRL) and the estuarine waters near Charleston, SC (CHS) during 2003 and 2004. Bottlenose dolphins were captured, examined, and released after conducting a comprehensive physical examination. Skin lesions were photographed and biopsied after disinfection and local anesthesia. Tissues were fixed, processed and stained with hematoxylin and eosin and Gomori methenamine silver for identification of *Lacazia loboi*. All cases were confirmed by histologic examination. The prevalence of lobomycosis among dolphins captured in the southern section of the IRL was 30 percent (9/30). Lobomycosis was not detected among 45 dolphins captured in the northern section of the 260 km waterway, nor among 71 dolphins sampled in CHS. Photo-identification data suggest the presence of lobomycosis in 38 IRL dolphins sighted between 1996 and 2004; preliminary analysis of their sighting histories supports the spatial gradient reported here. We report the emergence of a rare fungal disease in Florida bottlenose dolphins in epidemic proportions. Dolphins and humans are the only species known to be naturally susceptible to infection with *Lacazia loboi*. Localization of the disease to the southern section of the IRL, characterized by freshwater intrusion and lower salinity, suggests that exposure to environmental stressors may contribute to the unusually high prevalence of the disease but the specific factor(s) is unknown. Dolphins may represent a sentinel species for an emerging infectious disease.

Analysis of Vocalizations in the Dolphin Drives in Japan: Further Evidence for Distress Whistles in Dolphins

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It has been hypothesized that dolphins produce distinctive whistle types described as either a falling or rise-fall whistle contour in the context physiological pain or distress. In the Fisheries Drives in Japan, fisherman herd dolphins and other small cetaceans into bays where they are inhumanly slaughtered. Although it has been prohibitive to videotape this process, a few recordings have been made. Two recordings were obtained and analyzed to determine the types of vocalizations produced in this context. Spectrograms were produced using Raven software and whistles were categorized into different whistle types by visual inspection. One videotape was recorded during the slaughter of bottlenose dolphins in

Futo, Japan. Analysis of this tape (35 s) yielded 35 whistles that were categorized into 7 different whistle types. There were two predominant call types: falling whistle contours (n=16, 46%) and rise-fall whistle contours (n=5, 14%). A second sequence that was analyzed was an audio tape recorded at Iki Island during the process of herding cetacean species (species were not identifiable) by using the Oikomi method of banging pipes to create an acoustic 'net' to drive cetaceans in a specific direction. Analysis of this 1 min : 40 sec sequence yielded 246 whistles that were categorized into 7 whistle types. As in the first recording, the predominant whistle type used was a falling whistle contour (n= 121, 49%). Falling and rise-fall calls were the predominant whistles types produced in these two recordings are consistent with past descriptions of distress whistles in dolphins. These findings provide further evidence for the existence and use of distress whistles in dolphins and possibly other cetacean species that could serve as an important indicator of welfare and the health. Hopefully these findings will contribute to increased scientific and public awareness of the plight of dolphins in the Drive Fisheries in Japan.

Testing the Icy Waters: Micro-Evolutionary Correlates of Sea Ice Dynamics in the Pagophilic Ringed Seal (*Phoca hispida*)

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The pagophilic ringed seal (*Phoca hispida*) is centrally placed in the Arctic marine food web. Ringed seals rely on specific sea ice conditions for critical aspects of their life history, yet the micro-evolutionary effects of annual sea ice dynamics are unexplored. We assessed the effects of annual sea ice dynamics on the effective population size and connectivity among ringed seal populations around Greenland and Svalbard. We estimated the degree of diversity and gene flow at the mitochondrial control region among 157 ringed seal samples from six geographic regions from sequences of the first 400 nucleotides. We identified 153 unique haplotypes, which included a large 64 base pair deletion. The haplotype diversity was estimated at 0.99, which is unusually high among marine mammals. The nucleotide diversity for all samples was also high ($\delta = 0.036$). An analysis of molecular variance indicated high gene flow overall ($F_{ST} = .025$, $p < 0.005$) with ~97% of molecular diversity found within geographic regions, consistent with estimates of census population size in ringed seals of around 2 million. Homogeneity tests among sample regions revealed no apparent correlation between geographic distance and genetic divergence. The southward flowing East Greenland Current carries old sea ice from the Polar Basin to South Greenland. In contrast Northwest and Southwest Greenland are separated by long stretches of open water. Accordingly the degree of genetic divergence was twice as high along the West Greenland coast ($K_{ST} = 0.029$) compared to equidistant populations along the East Greenland coast ($K_{ST} = 0.012$). All regions but one exhibited the uni-modal, Poisson-like mismatch distributions characteristic of recent expansion in effective population size. In contrast, northwestern Greenland did not exhibit such a signature suggesting that a more stable, ideal ringed seal habitat is subject to fewer fluctuations in effective population size.

Fatty Acid Signature Analysis as a Potential Forensic Tool for Florida Manatees (*Trichechus manatus latirostris*) and Other Marine Mammals

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Fatty acid signature analysis (FASA) has become an important tool by which marine mammal scientists gain insight into foraging ecology. FASA is also a promising biomarker by which marine mammalogists may be able to assess exposure to certain natural and anthropogenic stressors. Florida manatees are well studied, and an excellent necropsy program provides a basis against which to "ground truth" this promising tool. Preliminary results on manatees assigned to four cause-of-death categories indicate that those animals exposed to or dying due to brevetoxin exposure demonstrate a statistically distinctive hepatic fatty acid profile. Further,

animals suffering long-term health stress have certain fatty acids not found in animals that die quickly. Some manatees that die due to watercraft collisions demonstrate the fatty acid profile associated with brevetoxin exposure even though other findings at necropsy did not suggest the latter; this observation potentially links exposure of manatees to brevetoxin with vulnerability to boat collisions. If further study demonstrates that exposure to harmful algal blooms, contaminants, or other factors provides a clear and diagnostic fatty acid profile in manatee livers, this approach could: a) provide an additional forensic tool to assist scientists and managers to understand cause of death or debilitation in manatees; and b) serve as a model that could be subsequently applied to studies designed to better assess cause of death in other marine mammals.

Monitoring the Movements of Beach-Released Mass Stranded Dolphins with Satellite Telemetry

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Mass strandings are extraordinary, catastrophic events. In Cape Cod Bay, they often involve large numbers of pelagic delphinids coming ashore within a short period of time, sometimes over a large geographic area. The process of stranding triggers, in an otherwise healthy cetacean, a cascade of physiological changes, which become progressively more debilitating over time, causing damage to muscle and vital organs, and eventually resulting in death. Deciding the fate of live animals involved in a mass stranding is a particularly pressing issue that must be handled quickly and efficiently, if humanely. With a shortage of available rehabilitation space in the vicinity of Cape Cod, responders generally have two basic options for live stranded cetaceans: 1) immediate beach release or 2) euthanasia. Until recently, determining the survivability of refloated cetaceans has been limited to opportunistic re-sightings (or re-strandings) of fin-tagged animals. Satellite telemetry now provides us the means to determine conclusively how well stranded dolphins can respond after beach release. Here we describe deployment of satellite tags on two relocated and beach-released Atlantic white-sided dolphins (*Lagenorhynchus acutus*), from two separate mass strandings, in February and April 2005. The first of these animals was tracked for 33 days; the second, to date, for over 70 days. Both tracks indicate survivorship and vigorous swim and dive behavior following return to offshore habitats. Although the post-release outcomes of rehabilitated and released stranded cetaceans are well documented, this project marks the first time satellite telemetry has been used to monitor the activities of refloated mass-stranded cetaceans, offering us the means to definitively measure our success in returning these animals directly to sea, and enabling responders to better evaluate the effectiveness of triage procedures.

Using Resource Selection Function Analysis to Determine Ice and Shelf Habitat Use in Beaufort Beluga Whales

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Beaufort beluga whales summer in the eastern Beaufort Sea, a region undergoing hydrocarbon exploration and climate warming. To understand beluga habitat use, migration patterns, foraging behaviour, and diet, we deployed satellite telemetry tags on whales while in the Mackenzie Delta region that provided locations from late summer to early fall in 1993, 1995 and 1997. We tested for differences in habitat use from resource selection models according to ice concentration and shelf habitats. Beluga whales differed in habitat selection depending on age, sex, and reproductive condition (females with or without a calf). Three groups were defined by their habitat use; the first group selected open water habitats and were largely comprised of females and a few smaller males; the second group selected habitat along the ice edge and were comprised of both males and females; the third group selected regions of heavy ice concentration and were comprised of males, of which three were the largest. Intra-population segregation of habitat use during summer may relate to different feeding and foraging ecology among the three groups requiring future research to

test for differences. From a conservation perspective protecting their habitat would require meeting the specific needs of the different reproductive and gender groups.

Reproductive and Survival Senescence in Polar Bears: The Effects of Sex, Age and Body Condition

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We investigated age- and sex-specific reproductive and survival rates in polar bears (*Ursus maritimus*) from western Hudson Bay, Canada. Female reproductive rates were estimated using longitudinal capture and radio telemetry data. Cormack-Jolly-Seber models were used to estimate age- and sex-specific apparent survival rates from capture-recapture data collected 1984-2004. Survival and reproductive senescence were apparent for both sexes. The observed maximum life span for male and female bears was 29 and 31 years, respectively. Survival senescence was evident after 20 years of age for both sexes. Reproductive senescence in females appeared to begin with the onset of survival senescence at about 20 years of age and resulted in decreases in litter size, cub mass and the proportion of females with young. Female body condition and associated reproductive rates reach a peak at around 18-19 years of age and declined thereafter. Reproductive senescence in males was determined from paternity assignments assessed using 20 microsatellite loci and the likelihood-based assignment calculator CERVUS, was associated with declining body condition, and began earlier than females at around 17 years of age. Examination of the physical condition of captured bears indicated that canine breakage and facial scarring were more prevalent in males than in females. These differences suggest that mating systems and male-male aggression, may be important in explaining the evolution of marked sexual dimorphism in polar bears. To our knowledge this is the first study to quantify reproductive and survival senescence in both sexes of a long-lived carnivore. These results underscore the importance of long term monitoring of marked individuals for studying the evolution of life history strategies.

Responses of Marine Mammals to Seismic Surveys by Lamont-Doherty Earth Observatory

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L-DEO implements a marine mammal monitoring and mitigation program during its marine seismic surveys in various oceans, most often from the NSF vessel R/V *Maurice Ewing*. The program consists of visual observations, passive acoustic monitoring (PAM) where warranted, and mitigation. Mitigation includes shut downs of the seismic source if marine mammals are detected in or about to enter designated safety radii. Systematic visual observations for marine mammals have taken place during all 10 L-DEO seismic surveys since 2003, and PAM was done during five of those cruises. Six cruises involved relatively large seismic sources (10–20 airguns; 3,050–8,760 in³), and PAM occurred during four of those. For two surveys with large seismic sources and >23 sightings, sighting rates and densities of marine mammals were lower during seismic than non-seismic periods. In those two surveys, apparent cetacean densities during seismic periods were 13–55% of those without seismic, and the closest observed point of approach to the airguns was (on average) closer during non-seismic periods. Acoustic detection rates during periods with and without seismic were variable for three large-source surveys with PAM, with rates during seismic ranging from 1/3 to 6 times those without seismic ($n = 0$ for fourth survey). The large-source results suggest that, with operating airguns, some cetaceans tended to avoid the immediate area but often continued calling. Some level of displacement was also apparent during three interpretable surveys with small sound sources (up to 6 airguns or 3 GI guns; 75–1,350 in³), although the evidence was not as clear as for large-source surveys. For the one small-source survey with PAM, the

acoustic detection rate during seismic was 1/3 of that without seismic. With both large and small sources, although some cetaceans avoided the airguns and vessel, others came to bowride during seismic operations.

Acoustic Behavior of Antarctic Killer Whales (*Orcinus orca*) Recorded Near the Ice Edge of McMurdo Sound, Antarctica

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Underwater recordings of killer whales (*Orcinus orca*) were made opportunistically along a lead penetrating the fast ice in McMurdo Sound, Ross Sea, Antarctica in December 1979 by J. A. Thomas. A group of seven to nine killer whales appeared to be actively foraging on Adélie penguins (*Pygoscelis adeliae*) at the time of the recordings. A total of 87 min and 39 sec were examined and 506 sounds analyzed. Echolocation clicks, buzz sequences, and whistles were produced by the animals; however, analysis was limited to the buzzes, whistles, and pulsed signals (echolocation clicks were not analyzed due to the limited frequency response of the equipment). Acoustic measurements of frequency, duration, frequency-modulation, and harmonic structure were conducted using spectrographic, power spectrum, and waveform analyses. Based on consistent aural and spectrographic observations of signals with similar features and repetition of combinations of component, seven call types were described. This study is the first, but a preliminary investigation on the acoustic signals and acoustic behavior of one group of killer whales in Antarctic waters. The signal characteristics produced are consistent with the sounds described from other killer whale populations throughout the world and consistent repetition of discrete call types suggests the existence of a pod-specific repertoire. Although killer whales appear to be specialists for hunting one particular prey type (either exclusively marine mammals or fish) the observations of these animals chasing penguins suggests these killer whales are more catholic in their diet and are perhaps generalists or opportunistic feeders on multiple prey types.

Evaluation of the Somatotrophic Axis in Harbor Seals (*Phoca vitulina*) and Steller Sea Lions (*Eumetopias jubatus*): Hormones Associated with Nutrient Utilization and Growth in Two Pinniped Species with Distinct Rates of Development

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The post-weaning period is a crucial time characterized in many mammalian species by reduced growth and high mortality. The somatotrophic axis, including growth hormone (GH), insulin-like growth factor (IGF)-I and IGF binding proteins (BP), is associated with growth rate and is responsive to nutrient intake. By investigating factors that link nutrition and growth, we can assess the impact of nutrient intake on growth, which may influence survival. To quantify components of the somatotrophic axis, blood samples were collected from adult (>5yr) Steller sea lions (n=6) and harbor seals (n=6), and stranded harbor seal pups (<1yr, n=6) housed at Mystic Aquarium. Samples were also collected from free-ranging Steller sea lion pups (<1yr, n=27) captured by Alaska Department of Fish and Game. Serum concentrations of GH and IGF-I were determined by radioimmunoassay, and IGFBP-2 and -3 were quantified by ligand blot. Relative to adults, harbor seal pups had greater concentrations of GH (3.2 vs. 23 ng/ml), and greater and more variable IGF-I concentrations (47.5 to 72.5 vs. 51.7 to 245.8 ng/ml). Serum IGFBP-3 was greater in adults than pups [600 vs. 120 AU (arbitrary units)], and IGFBP-2 was greatest in male pups (70 AU). Concentrations of GH in Steller sea lion pups ranged from 4 to 60 ng/ml, and IGF-I concentrations were similar in pups and adults (49.4 vs. 50.7 ng/ml) however, pup concentrations were more variable. Serum IGFBP-2 and -3 were greater in adults compared with pups (34 vs. 16 AU and 607 vs. 217 AU, respectively), and adult males had the greatest IGFBP-3 concentration (790 AU). Similar to terrestrial species, gender and age influence

components of the somatotrophic axis. With this preliminary assessment, we begin to investigate the role of the somatotrophic axis in nutrient allocation and growth potential, which may have implications for survival.

Studying the Dolphin Brain with PET

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Brain physiology of bottlenose dolphins, *Tursiops truncatus* has been studied with positron emission tomography (PET). Often used in studies of human physiology and medicine, PET is a noninvasive technology that permits direct assessment of regional physiological processes in the brain. In human subjects PET has been used in diagnosis of disease, in studies of complex cognitive tasks, and in localizing areas of sensory activation, motor movement, and visual attention. The dolphin brain is in the human size range but is more highly convoluted. Dolphins have a multi-tiered cortex with an extensive extra lobe, the paralimbic lobe, which does not occur in mammals or other animals outside the Order Cetacea. Because of its inaccessible location, there are no functional studies of the paralimbic cortex. PET offers an opportunity to study activity in this unique part of the dolphin brain during various stimulus conditions that may help to reveal functional aspects of the paralimbic cortex. A special table was constructed to hold the dolphin during scans since dolphin subjects were too heavy for human tables. Dolphins were trained to slide out of their bay enclosure on to a padded mat and remain still during the scan period. A ligand, Fluro-deoxy-d-glucose (18-F- FDG) was injected into the common brachiocephalic vein. After the injection, there was a 15 minute uptake period while the molecules of 18-F- FDG were taken into brain structures. For a control scan, the animal was kept in a quiet darkened room during the uptake period. For experimental scans, the dolphin was exposed to light or other stimuli to reveal areas of relative brain metabolism during 18-F-FDG administration. These scans have revealed interesting features of the living dolphin brain including the cetacean specific paralimbic lobe.

Using Digital Photography to Aid in the Identification of Marine Mammal Food Habits

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The Oregon Department of Fish and Wildlife has researched the diet of Steller sea lions, California sea lions and harbor seals by analyzing scat (fecal) samples since 1981. Over 9,000 scat samples were collected from 12 locations along the Oregon coast. Identifying these samples has proven to be a difficult and lengthy process. In 1990, we began using the "all structures" method of identification, which includes the identification of otoliths as well as other diagnostic structures. Applying this technique has required the preparation of an extensive comparative collection and the development of methodology to streamline this tedious process. We have designed a digital photographic catalog to incorporate hundreds of images of bones and otoliths to aid in these identifications. A digital camera and dissecting microscope are used for photographing structures. Photographs are taken of common diagnostic structures used in the identification and quantification of pinniped prey. Because of changes that occur in fish osteology during growth, multiple photographs of different aged (size) fish are taken to incorporate these changes. Differences in diagnostic structures between species have been highlighted to aid in identification of large families. Eroded structures recovered from scat have also been included for reference. The catalog can be searched by family, species or type of structure. Here we illustrate the use of the catalog with a recent project to age otoliths recovered from scat samples. Digital photography has also been used to document structures destroyed for DNA analysis. Although researchers continue to refine identification techniques, reference documents and available comparative

collections remain limited. We feel that using a digital photographic catalog in combination with these other tools can standardize and simplify the process of identifying and quantifying marine mammal prey.

Is Low Reproductive Success in New Zealand Sea Lions a Reflection of Inadequate Diet and Milk Quality?

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The endemic New Zealand sea lion (NZSL), *Phocartos hookeri*, is a threatened species. The population is small and static, and has not grown in the last decades. Detrimental effects on the population included bycatch by the squid fishery, disease, and low reproductive success. Reproductive success is impacted by low and variable pup production, low pup weight gain, and high neonatal mortality. It is hypothesized that diet, due to changes in the quality and diversity of prey items or competition for resources, may also be contributing to low reproductive success. To test this hypothesis, reproductive success was analysed over seven years in relation to variation in the energy content of milk. Milk samples were collected from NZSL females (n=357) of known age during seven summer seasons (1999 to 2005) at early lactation in the Auckland Islands. To further test the relationship between diet and milk quality a "feeding experiment" was conducted with lactating NZSL (n=24) to determine how diet influences milk fat composition using a "Cocktail of Natural Vegetable Oils" (CoNVO) with distinct fatty acid profiles. Fatty acid signature analysis was carried out on milk collected before and after the CoNVO was administered. There was a significant variation between years in the milk fat concentration (%) ($P < 0.05$). Significant changes occurred in fatty acid composition of milk lipids after the CoNVO was administered. These included an increase in the weight % of 12:0 and 18:2 (n=6). We concluded that changes in seasonal conditions and prey availability could be responsible for the variation in the milk fat concentration (%) between years. We have demonstrated that milk fatty acids reflects diet, therefore, milk fatty acid analysis from NZSL will be used to determine whether variations in diet between years may reflect reproductive success in those years.

Epidemiology of the 2002 Phocine Distemper Outbreak in the Netherlands

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Phocine distemper virus (PDV) infection was held responsible for the deaths of around 22,000 seals in Europe in 2002. In this PDV epidemic, 2,284 seals stranded along the Dutch coast, of which 1,315 were necropsied. Using these data, we determined how characteristics of individual seals (species, age and sex) and environmental factors (location, wind, spring tide and state of decomposition) affected the dynamics of the epidemic in the Netherlands. We also compared epidemiological characteristics of the 2002 PDV epidemic with the first recorded epidemic in 1988. The epidemic had a rapid course (June to November 2002) and the epidemic curve a bimodal peak. By gross necropsy, serology and RT-

PCR, PDV infection was confirmed as the primary cause of stranding. Most (2,279/2,284) seals were harbor seals (*Phoca vitulina*), only 5 were gray seals (*Halichoerus grypus*), consistent with experimental findings that PDV infection is less pathogenic for the latter. Subadults stranded significantly earlier than juveniles and adults, and in each of these age categories, males earlier than females. Possible explanations are differences in social behavior and levels of contaminants. Seals stranded significantly later in Zealand than in the Dutch Wadden Sea, probably linked to the small size and wide dispersion of the Zealand seal population. Wind appeared to have a confounding effect on stranding rate. Overall stranding rates decreased with southerly winds and increased with northerly winds. The proportion of seals recovered in a decomposed state increased significantly with time, showing that stranding rate became a less accurate estimate of mortality rate over time. Cumulative mortality in 1988 (53%) and 2002 (54%) were similar, suggesting that the pathogenicity of PDV for harbor seals had not changed.

Bottlenose Dolphin Strandings at the Terminos Lagoon Area, Campeche, Mexico

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The first record of a bottlenose dolphin stranded in the Terminos Lagoon area was a single animal during 1989 while 5 stranded dolphins were recorded during 1995-1997 and there were no available data until 2002-2003 when 12 more dolphins stranded. From April to December 2004, 18 stranded dolphins were recorded. Unfortunately, no environmental federal agency had the capacity to attend these events neither did they allow to take any biological samples so that valuable biological information about these cetaceans was lost. Until March 2005, 5 stranded bottlenose dolphins have been registered, the perspective seems to be encouraging because of a permit was given for the biological material collection and a group of stranding response was formed within the University of Carmen having the advise of a *Tursiops* stranding expertise group. All the available information have been collected so now we have a data base, a GIS and a scientific collection of stranded dolphins. Despite the fact that there was no systematic registration of the strandings in 2004, some information came out from the analysis of available photographic material and visual examination of the dead animals: 4 dolphins had total or partial fluke mutilation indicating human-related death; 2 dolphins had cookie-cutter shark bites that would confirm the presence of offshore forms in the Gulf of Mexico. The number of strandings proves the necessity of carrying out the systematic record of these events, having a protocol for responding to stranded cetaceans and the minimum infrastructure to perform the internal evaluation in order to collect samples to determine the causes of death, and establish measures of protection and conservation since the regional economy is based mainly on the oil extraction, fishery and agriculture.

Nutritional Indices of Young Steller Sea Lions in Alaska

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The decline of western Steller sea lion stocks (*Eumetopias jubatus*) from 1970 to the early 90's has lead to ongoing monitoring of health indices using blood metabolites as indicators of nutritional stress. Samples were collected from July 1998 to April 2005 (n=307, pups <11 mo, juveniles >12mo) in the Aleutian Islands (AL), Gulf of Alaska (GOA) and Prince William Sound (PWS) the western stock regions, and Southeast Alaska (SEA). Plasma concentrations of ketone bodies (β -HBA), blood urea nitrogen (BUN) and non-esterified fatty acids (NEFA) were measured spectrophotometrically. Statistical analysis was performed using ANOVA ($\alpha=0.05$) and Tukey-Kramer post-hoc test. Juvenile AL and GOA sample sizes were too small to include in the analyses. Plasma β -HBA concentrations were higher in AL pups ($0.261 \pm 0.182 \mu\text{M}$; n=33) than SEA pups ($0.167 \pm 0.175 \mu\text{M}$; n=52). The mean β -HBA in GOA pups ($0.277 \pm 0.127 \mu\text{M}$; n=13) could not be distinguished from AL or SEA,

likely due to smaller sample size. In GOA 54% of pups had β -HBA levels above the threshold value of 0.3mM, indicative of fasting in pups, while AL and SEA had 19% and 26% of pups above threshold. There were no differences in plasma BUN concentrations among regions, although juveniles showed significantly higher values than pups, presumably related to the higher protein content of fish compared with milk. Although β -HBA results suggest a higher proportion of western stock pups were fasting, elevated BUN levels indicate short-term fasting rather than Phase III or "starvation". Plasma NEFA concentrations were higher in PWS and GOA compared with SEA pups ($p=0.027$) which corresponds to metabolism of lipid reserves during short-term fasting in these western populations. These indicators of increased fasting do not appear to result in poor body condition and are consistent with previous findings that pups from western stocks were larger and maintained greater fat reserves.

Extraction of DNA from Formalin-Fixed Cetacean Tissues

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Procedures to obtain DNA from formalin preserved samples exist; however, most have been based on paraffin embedded tissues prepared for histological examination. Few studies have demonstrated the ability to obtain DNA directly from formalin preserved tissues located in museums and historical collections. The SWFSC Marine Mammal Life History Collection is comprised mostly of small cetacean tissues collected from animals incidentally taken in the Eastern Tropical Pacific (ETP) tuna fishery and California gillnet fishery. The formalin-fixed samples collected from the ETP date back over 30 years and, represent a valuable resource for genetic stock structure analyses. We tested several extraction protocols on formalin preserved skin (removed from jaw sections) and teeth. We were able to obtain small amounts of fragmented DNA using two protocols. For skin, a modified protocol based on the antigen retrieval principle was found to be successful. Of 18 skin samples (13 spotted dolphin, *Stenella attenuata*, 5 short-beaked common dolphin, *Delphinus delphis*), ten partial sequences (80-200 bp) of the mitochondrial (mt) control region were generated. For the teeth (7 common dolphin), a silica based ancient DNA extraction protocol was used in the SWFSC Ancient/Bone DNA Laboratory that is maintained separately from the rest of the genetics laboratory. All seven tooth samples yielded sufficient DNA to amplify 200-400 bp of the mt control region, however, useable sequence was only obtained from six of the samples. All sequences were checked for species identifications using either Genbank or the SWFSC's sequence library. The protocols above have demonstrated that mtDNA can be obtained from museum archived formalin preserved cetacean tissue samples. Additional techniques will be explored in order to increase yield of DNA so other genes may be examined and used for stock structure analyses.

First Passage Time: The Spatial Scales of Search Behavior in Northern Elephant Seals (*Mirounga angustirostris*)

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Pelagic predators face distinct challenges with respect to the search for prey. Because stationary cues, such as bottom topography, are not available, many species rely on dynamic oceanographic cues. However, relying on oceanographic cues alone is problematic due to the spatio-temporal lag between primary production and the associated increased abundance of intermediate predators. Previous investigations have revealed strong associations between track features, diving behavior, foraging success, and ocean thermal structure. These investigations have also suggested marked variability in both the oceanographic feature selected and the behavioral response of individual seals. Given the large spatial scale of foraging habitats and oceanographic features, the use of a specific search regime may be employed to increase patch encounter rates. It has been hypothesized that highly mobile pelagic predators utilize a nested search pattern that encompasses several spatial scales. Here, we

provide the first quantitative estimates of the location and extent of these area-restricted searches in female northern elephant seals. To investigate spatial scale utilization, satellite tags and time-depth recorders were deployed simultaneously at Año Nuevo State Reserve, California, USA and San Benitos Islands, Mexico. We utilized a technique novel to the field of marine mammal tracking: First Passage Time (FPT) analysis. This technique uses track data to identify unique search strategies that can be compared at several levels: individual and seasonal variation within a population, and variation between populations foraging in the same habitat. A dive-type analysis was then applied to investigate the primary behavior within the important spatial scales. FPT analysis successfully identified a spatially nested search pattern in the northern elephant seal using ARGOS-quality data. Understanding use of spatial scales in the northern elephant seal may provide insight into how marine vertebrates search for and locate prey in a dynamic ocean environment.

Identification of Odontocete Clicks and Whistles in the Southern California Bight and the Gulf of California

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A method for the automatic classification of odontocete species from groups of clicks, burst pulses, and whistles is presented. We consider the vocalizations of four dolphin species which were recorded in pelagic environments of the Southern California Bight and the Gulf of Mexico over a period of approximately four years. 57B naval sonobuoys sampling at 48 kHz were used to record the calls of common (*Delphinus delphis*), Risso's (*Grampus griseus*), Pacific white-sided (*Lagenorhynchus obliquidens*), and bottlenose (*Tursiops truncatus*) dolphins. Linearly filtered cepstral feature vectors are automatically extracted from vocalizations whose start and end times have either automatically or manually been identified. Groups of feature vectors are then identified as one of the target species using Gaussian mixture model classifiers. Training and test data are from disjoint recording sessions, illustrating the system's ability to perform classification in different acoustic environments with a high likelihood of the vocalizations originating from different individuals. Over two hours of calls from the represented species are identified with an error rate that compares favorably with the performance of trained human listeners.

Cultural Use and Management of the West Indian Manatee (*Trichechus manatus*), in the Alvarado Lagoon System, Veracruz, Mexico

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The West Indian manatee (*Trichechus manatus*) has been classified by the IUCN as in danger of extinction. In Mexico, some of its populations are insignificant and a few isolated survive throughout the Gulf of Mexico. Little is known about the status of this species in Alvarado, Veracruz. This study presents the existing local information on this species and its relation to human use and habitat management within the Lagoon System of Alvarado. From July 2002 to May 2004, I conducted interviews with local coastal fishermen from Alvarado, Arbolillo, Punta Tia Pancha, Costa de San Juan, Costa de la Palma, and Paso Platanar, all where manatees are known to inhabit coastal and estuarine areas. Most of the questionnaire was aimed to understand the current use of manatees, as well as what and how much knowledge they had about the species. From these interviews, information regarding the habits and biology were assessed, including reproduction, habitat requirements, and homerange seasonality, feeding, and hunting. Analysis of the questionnaire showed that manatees have been heavily utilized in the past (since 1940's), mostly as a food resource, which contributed to the reduction of the population and its home range. During the summer of 2002, two females were rescued near Costa de San

Juan and Punta Tia Pancha. The rescue of these animals changed the point of view within the fishing community; they first saw the manatee as a food source, and now many of them conceive the manatee as a species that needs protection from human predation and habitat change. Throughout the investigation, the need to educate and inform the public about the presence and state of conservation of the manatee became evident. It is important to consider the role of these communities in the wellbeing and survival of this species in Mexico's Alvarado region.

Long-Term Interspecies Association Patterns Between Atlantic Spotted Dolphins and Bottlenose Dolphins in the Bahamas, 1993-2004

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There have been many descriptions of interspecies interactions, however none have quantified these in association values. This study reports on associations between Atlantic spotted dolphins (*Stenella frontalis*) and bottlenose dolphins (*Tursiops truncatus*), in the Bahamas, from 1993-2004. The half-weight index was used to determine coefficients of association (COA) during mixed species encounters (MSE, n=184) for individuals with 7 or more MSE sightings. There were 109 individuals: 94 spotted (49 male, 45 female), and 15 bottlenose (7 male, 8 female). Total group size ranged from 3 to 78, with spotted dolphins having significantly higher groups sizes (average=12.97) than bottlenose (average=4.79). Spotted dolphin individuals had a significantly higher number of MSE sightings than bottlenose. Spotted dolphin males had significantly higher number of MSE sightings than females. Of the total possible associations, 77% were observed (COA > 0). Of these associations 72.7% were low (≤ 0.39), 4.25% were moderate (0.4 - 0.79) and 0.05% were high (≥ 0.80). Within species COA were significantly higher than between species COA for both males and females. For both bottlenose and spotted dolphins, same-sex pair COA were significantly higher than mixed-sex pair COA. Male-male pairs for both species had higher COA means than female-female pairs. Sixty-five percent of all moderate COA were between spotted dolphin male-male pairs. Two of three high COA were also spotted male-male pairs. The majority of the males with moderate-high COA are members of known alliances. Only two known male bottlenose alliances were present in MSE sightings, with COA of 0.32 and 0.37. There appear to be no long-term associations between species during MSE. However, male spotted dolphins retain long-term associations within species during MSE, and bottlenose do not. This suggests that the function of within species male alliances is more important for spotted in MSE than for bottlenose.

Acoustic Surveys Offer Promise for Surveying Some Antarctic Pack Ice Seals

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Pack-ice seals (crabeater, Weddell, leopard, and Ross) are large-bodied, top order predators, their population levels are thought to react to large-scale climate changes. Traditionally, many seal populations have been estimated by visual surveys which count the animals that are 'available' (hauled-out on the ice). Corrections are then made to include those seals that weren't seen (underwater). However, when the majority of the animals in a population are not available to a visual survey this approach may be less effective. Here we investigated whether acoustic surveys offered promise for estimating the distribution and abundance of Antarctic pack-ice seals. Four acoustic surveys were conducted (October 1996, 1997; December 1997, 1999) between longitudes 60°E and 150°E. Surveys were bounded to the south by fast-ice, shelf-ice or the Antarctic continent and to the north by the edge of the pack-ice. Thirty minute underwater acoustic point-transect surveys were made using sonobuoys (Sparton Electronics AN/SSQ-57A) and a receiving system of two 9-element Yaggi antennas (YH09, R F Industries Pty Ltd), a custom multi-channel receiver and Sony Digital Audio Tape recorder (TCD-D8), frequency bandwidth 10 - 22,000 Hz + 3dB. Visual surveys were conducted at the same time as part of a second program (Southwell, APIS program). Although crabeater seals were

seen in great numbers they were not heard either in the October or December surveys. Whereas the leopard and Ross seals were seen rarely in visual surveys but were vociferous in December coinciding with their breeding season. In December leopard seals were detected acoustically at most (92%) locations. To estimate the number of leopard seals calling we modelled calling behaviour and predicted the survey area by modelling transient loss and measurements of received background levels. Preliminary estimates calculated 0.13 male leopard seals/km² for the December surveys which is in the high-density range described for the species.

Trace Metal Burdens in Liver Samples from Seals Stranded on Long Island, New York between 1988 and 2004

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Toxic (Ag, As, Cd, Hg, Pb) and essential (Cu, Fe, Se) trace element levels were determined in liver samples from 4 seal species stranded in Long Island waters between 1988 and 2004, to examine temporal and species-specific patterns in these top marine carnivores. The majority of samples were obtained from harp seals (*Phoca groenlandica*; n = 35) and harbor seals (*Phoca vitulina*; n = 34); few were obtained from gray seals (*Halichoerus grypus*; n = 10) and hooded seals (*Cystophora cristata*; n = 7). Liver samples were acid-digested and analyzed by Inductively Coupled Plasma Mass Spectrometry. Mercury levels were highly variable, but showed no obvious temporal trend in the 4 species over this 16 year time period. As in other marine mammal studies, high Hg values (>1000 mg/kg dry weight) were buffered by high Se values, in a 1:1 molar ratio. The highest Hg levels were found in all adult-sized harbor seals (n = 8) and a single sample from an adult gray seal, but not in 5 adult-sized harp seals. Silver concentrations were also elevated in some of the adult *P. vitulina*, while As, Fe and Pb were undetectable in our samples. Arctic harp and hooded seals have only appeared in Long Island waters in recent years, and their diets (particularly as juveniles) are believed to include more invertebrate prey than the mostly piscivorous harbor and gray seals. This was reflected in significantly higher Cd burdens in the two arctic species (Single factor ANOVA, p = 0.007). The fact that coastal residents (*P. vitulina*) had higher Hg loads, and migratory seals (*P. groenlandica*) showed higher Cd levels suggests that these two species do not utilize local resources in the same way. This is supported by the different behavior of these 2 species following successful rehabilitation and release.

Male Gene Flow and its Effect on the Incipient Genetic Differentiation Between Coastal and Offshore Bottlenose Dolphins *Tursiops truncatus* in the Gulf of California

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The interaction between habitat characteristics and behavioral, and ecological specializations (e.g., phylopatry to foraging grounds), are the main factors influencing the structure of cetacean populations. After the description of coastal and offshore bottlenose dolphin morphotypes and of their population genetic divergence in the Northeastern Pacific and the North Atlantic, research efforts started in the Gulf of California to prove the existence of both morphotypes. To test two hypotheses, one that states that bottlenose dolphins are segregated in coastal and offshore forms, and an alternative one that groups of bottlenose dolphins show latitudinal segregation in this study area, we obtained skin biopsies from fifty five individuals identified *in situ* as belonging to either the coastal or offshore form, by experienced field observers. Two genetic markers (mtDNA control region and a hypervariable intron of the proteolipid protein) were amplified

and automatically sequenced using PCR technology. Amplified mtDNA (480bp), showed nucleotide substitutions at 34 sites, defining 27 haplotypes. Analyses of such mtDNA sequences pointed to moderate but significant levels of genetic differentiation between coastal and offshore bottlenose dolphin morphotypes ($F_{ST}=0.10128$, $p<0.002$; $\Phi_{ST}=0.07616$, $p<0.054$), the coastal form showing less genetic variability suggesting the existence of a population bottleneck. Also, a database of 155 bottlenose dolphin mtDNA sequences was compiled and analyzed, and showed limited genetic differentiation among geographically distant groups, as pointed by F_{ST} and Φ_{ST} values around 0.15. In addition, intronic DNA data pointed that no genetic differentiation exist between groups of male bottlenose dolphins sampled in the Gulf, suggesting that male dependent gene flow among dolphin groups tend to homogenize the structure of this population of dolphins.

Determining Reproductive Status of Right Whales (*Eubalaena glacialis*) Using Fecal Hormone Metabolites

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Knowledge about the reproductive physiology and endocrinology of baleen whales is very limited. Research has been conducted primarily on stranded or hunted whales, while techniques for studying living baleen whales have been lacking. We present a new approach to investigate reproduction in western North Atlantic right whales (*Eubalaena glacialis*) by measuring metabolites of the major reproductive hormones in fecal samples. The objectives of this study were to: (1) determine the feasibility of collecting fecal samples from right whales; (2) validate radioimmunoassays for fecal estrogens, progestins and androgens, and; (3) evaluate the relationship between hormone metabolite levels and the gender, age and reproductive status of individual right whales with known life histories. Floating fecal samples (n=84) were collected from right whales in the Bay of Fundy from 1999-2002 in tandem with photo-identification surveys. Validation studies showed that immunoreactive reproductive hormone metabolites can be accurately measured in right whale fecal samples across a range of concentrations. Hormone results were analyzed with ANOVA in relationship to sex, age, and reproductive status for samples from photo-identified right whales (n=45) using data from the Right Whale Catalog and database. Our results show that gender can be unambiguously determined using a ratio of fecal androgens to estrogens ($p < 0.001$); pregnant females can be easily identified by their exceedingly high concentrations of fecal progestins ($p < 0.001$); lactating females are characterized by fecal estrogen concentrations intermediate between pregnant and non-pregnant females ($p < 0.001$); and mature males are characterized by markedly elevated fecal androgens compared to juvenile males ($p=0.002$). Ongoing studies are using this method to investigate the erratic reproductive success in the North Atlantic right whale, and may ultimately provide better information on reproductive parameters (e.g., age of sexual maturity and pregnancy rates) for management and conservation of this endangered species.

A Possible Reoccupation Flux of Estuarine Dolphins *Sotalia guianensis* in the Santos Estuarine System, Southeastern Brazil

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Estuarine dolphins *Sotalia guianensis* have been historically known from the region of the Santos Estuarine System (SES), São Paulo state coast, Brazil, but since the seventies very few, if any, confirmed observations have been done in the area. This lack of occurrences may be possibly due to the expansion of the port of Santos, which has generated increasingly high anthropogenic impacts over the SES along the last few decades. However, since the mid of the nineties, some sporadic sightings have been reported by local fishermen and residents. In the end of 2004, we began to conduct systematic boat surveys in order to evaluate possible areas of reentry and flux of individuals, mainly along SES north and south ways

of entrance. We have made 15 surveys, usually once a week, covering 13.67 km in a daily basis with a total of 205.5 km and 27.15 h of effort accumulated along the period considered. Four groups were observed, with size varying between 1 and 12 individuals. Two other individual dolphins in distinct events were observed out of effort in a smaller and inner part of the system, called São Vicente Bay. Most of the recorded groups seemed to be actively foraging for small fish schools. Apparently, estuarine dolphins have been using the area mainly in the early morning and late afternoon, but observations are not still enough to make stronger conclusions. In other coastal, though less impacted areas to the north of SES, groups of estuarine dolphins were reported to enter in the same fashion. We expect that an increase of field effort and growing of the database can elucidate the existence of a pattern of reoccupation for the species, reflecting a significant improvement of the environmental quality of the SES along the last decade.

Until the Whales Were Gone: An Environmental History of Whaling in Bermuda

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Bermuda was the first non-continental area of the Americas in which whaling was carried out by European residents. They initially concentrated on humpback whales (*Megaptera novaeangliae*), but as this species became scarce they shifted to sperm whales (*Physeter macrocephalus*). Interest of whales and whaling surged almost as soon as the islands were populated by the British in 1609 due to the discovery of a large piece of ambergris. Whaling in Bermuda was always a shore-based operation carried out by locals on a seasonal basis. Yet, Bermuda was also visited by a number of Yankee whalers in the nineteenth century. Several whaling stations were erected and the remains of a few are still in place. Initial whaling attempts were unsuccessful due to the lack of skills by British seamen. The first successful whaling season took place in 1663 and those operations intensified throughout the rest of the seventeenth century. By 1700 more than 200 humpbacks had been taken and additional landings in the eighteenth century resulted, by all accounts, on the depletion of the local population of humpbacks. Today sightings of humpbacks in Bermudian waters are rare and far from the most coastal areas they used to visit and where they were hunted. The figure of more than 200 animals killed in a relatively short period of time for a small area leading to the local extinction of this species, is consistent with those of Caribbean islands of similar size and similar exploitation patterns which lead to the same results from a populational viewpoint. Despite shifting to exploiting of sperm whales and the introduction of new tools such as harpoon guns, only few whales were taken in the nineteenth and twentieth centuries. Whaling techniques were exported to Trinidad, W.I., and from there to the rest of the Caribbean.

Why Cetaceans Stopped Being Fish and Became Mammals: An Analytical Interpretation of Biological Thought from Aristotle to Linnaeus

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Numerous authors including Aristotle and Renaissance naturalists recognized the unique nature of cetaceans which because of the anatomy of their reproductive system did not fit that of fishes. Yet, they were still classified as "fishes" until Linnaeus' 10th edition of his *Systema Naturae*, for which he created the Order Cete. We analyzed Linnaean and pre-Linnaean documents in order to understand the reasons behind this intellectual inertia. We also looked at Peter Artedi's work, (on which Linnaeus, a botanist, based his ichthyological classification) and tried to discern the reason behind Linnaeus's breakthrough by finally recognizing from a systematic viewpoint not only the characters that made cetaceans being part of mammals (or quadrupeds as known at that time) but also a group onto itself. We concluded that both scholasticism and tradition of classifying animals based on their environmental surroundings were the reasons for the intellectual inertia. Also, we believed that despite Artedi's influence, Linnaeus was completely original in his stance of creating not only the Class Mammalia, but including cetaceans within it in a separate

order. We suggest that cetaceans still represent a challenge in systematic biology not only because of their uniqueness as a natural group and evolutionary history, but also because of the high incidence of intergeneric hybrids within the group. We propose that a fresh look is needed at the species and genus concepts used in cetacean systematics.

Determination of the Feeding Areas of the Humpback Whales from the Winter Aggregation of Baja California Peninsula, México, Based on Stable Isotopes of C and N

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Humpback whales (*Megaptera novaeangliae*) make long annual migrations between higher and lower latitudes, summer feeding regions and tropical and subtropical wintering areas. Mitochondrial DNA analysis and individual photo-identification have proven a high level of fidelity of these whales to their feeding areas, and a mixture of whales from different feeding areas in their wintering grounds. In the Mexican Pacific, three wintering aggregations are recognized: the Revillagigedo Archipelago; the southern coasts of the Peninsula de Baja California; and the mainland coasts. Previous photo-identification studies indicated the coasts of California-Oregon-Washington as the main migratory destination of the Peninsula de Baja California and mainland aggregations. However, based on abundance estimations, more than half of these whales arrive from other feeding areas. In this work we analyzed the stable isotopes of C and N of 60 humpback whale skin biopsies sampled during the winter seasons of 1993, 1994, and 1996 off Los Cabos, BCS. Our results detected feeding differences among individuals. After correlating these results with the haplotype of each sample we found that the ¹⁵N and ¹³C of whales with E haplotype, indicate high latitude feeding areas, presumably, the Aleutians and Bering Sea, and a predominance of fish in their diet. The isotopic group with F haplotype define coastal and lower latitude feeding area, possibly the coasts of California-Oregon-Washington, and a predominance of krill in their diet. The isotopic groups with A⁺ and A⁻ haplotypes presented intermediate values, possibly the coasts of British Columbia and a more oceanic feeding area in the Gulf of Alaska. The isotopic ratios of ¹⁵N and ¹³C are useful tools to know about preys and latitudinal distribution of feeding areas. Together with genetics and photo-identification techniques, the analyses of stable isotopes help us to understand the population structure of the humpback whales in the North Pacific.

Comparative Morphology of the Epidural Circulation in Harbor Seals, Bottlenose Dolphins, and Florida Manatees

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We present the morphology of epidural arterial and venous structures in the harbor seal, bottlenose dolphin, and Florida manatee. When compared to similarly sized terrestrial mammals, these divers have substantially larger neural canals to accommodate large epidural vascular structures (and in manatees, fat) juxtaposed to the spinal cord, without a subsequent decrease in spinal cord diameter. Seal brains are supplied by internal carotid, vertebral, and epidural arteries. Dolphin brains are supplied by epidural retia, via thoracic retia fed by the supreme intercostal arteries. Manatee brains are supplied by internal carotid arteries and by epidural retia. Manatee thoracic retia are supplied by supreme intercostal arteries. The thin walls of the epidural veins may accommodate heat transfer when temperature differences exist between the spinal cord and venous blood. In seals and cetaceans the epidural vessels represent large thermal masses

when compared to adjacent spinal cord tissues. In manatees the epidural veins are substantial but relatively smaller than those of seals and dolphins. It has been suggested that epidural veins contribute the major venous return from the abdomen in axial locomotors because vessels in the neural canal are protected from the biomechanical pressures known to collapse the venae cavae. No known mammalian species has valved epidural veins, so blood flow direction depends upon local pressure distributions. Thus, enlarged epidural veins may allow substantial quantities of venous blood to flow to or from the head along the spinal cord. Mixing of this blood with cooled venous blood from the skin surface may allow considerable temperature regulation of the spinal cord, which may in turn affect diving physiology such as heart rate and vasodilation. To complement the valveless epidural system, we introduce a novel non-cardiac pump mechanism in the neck of the seal, which may produce flow from the post-capillary brain into the epidural veins.

Distribution of Dermal Collagen and Its Relationship to Blubber Thickness and Percent Lipid in the Bowhead Whale (*Balaena mysticetus*)

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Blubber is integral to the survival of arctic marine mammal species, including large whales, which employ it for a variety of uses. Bowhead whales have among the most extensive blubber described in cetaceans, reaching a thickness of up to 50 cm and representing nearly 50% of body mass. We described the baseline distribution of blubber thickness at six different sites on the whale (n=44). The distribution of collagen and lipid at each of these sites was investigated and an analysis of collagen and lipid at five depths at each of these sites was conducted. Blubber collagen percentage (BCP) did not differ significantly between spring and fall seasons, nor did it differ significantly between sites on the whale. The innermost blubber layer (closest to muscle) contained a significantly higher percentage of collagen than the other four depths. However, there was no difference in BCP found among the other four depths. Both gender group and age were found to affect BCP. Females and pregnant females were statistically indistinguishable; however both of these groups contained a significantly higher percentage of collagen in their blubber than their male counterparts. A linear relationship was found between age and BCP. Blubber thickness varied significantly between sampling sites. Pregnant females were found to have the thickest blubber, compared to non-pregnant females and males as averaged across all sampling sites. Blubber thickness increased significantly with age. Principle components analysis revealed a relationship between blubber thickness and BCP with a marked spatial separation between these two variables and lipid percentage. There was no correlation found between percent lipid and collagen or between percent lipid and blubber thickness, however there was a positive relationship noted between blubber thickness and BCP. The implications of these findings are discussed with respect to the collection of morphometric data and marine mammal health assessment.

Population Structure and Sex Biased Dispersal of Spotted Dolphins (*Stenella attenuata*) in the Eastern Tropical Pacific

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Samples from the spotted dolphin, *Stenella attenuata*, were collected in the Eastern Tropical Pacific (ETP) from Baja California to Ecuador. The control region of the mitochondrial DNA (mtDNA) was sequenced and used to examine population structure and sex-biased dispersal. One

hundred twenty two coastal individuals were sequenced for a 455 bp section of the control region. These sequences were added to a data set of previously sequenced coastal and offshore animals. A total of 129 unique haplotypes were found, and 16 of them were shared between offshore and coastal animals. Statistically significant differences were found when coastal and offshore animals were compared, suggesting that there is some restriction to gene flow between the two groups. Coastal and offshore animals were compared using F_{ST} , Φ_{ST} and χ^2 values, which yielded ten separate populations (nine coastal and one offshore) (overall $F_{ST} = 0.0677$, $p < 0.001$). Analysis was also conducted on each gender separately and F_{ST} and Φ_{ST} values detected more structure in the males than in females. MDiv was used in order to test for differential migration rates between the populations. Overlap was found within the 95% confidence intervals for all population comparisons, which suggests that all populations have similar migration rates. The results of this study point to the existence of nine coastal populations, which are genetically distinct from one another, and should be treated as separate units for management purposes.

Surface Activity and Transitions Among Pods of Humpback Whales (*Megaptera novaeangliae*) in the Wintering Grounds of the Mexican Pacific

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Understanding humpback whales wintering habits is important to understand both, their population structure and abundance. Here we analyse the transitions and surface behaviour among humpback whale pods in the breeding grounds of Bahía Banderas during 2002 (BB02) and in Socorro Island during 2003 (IS03). We accomplished a total of 267 hours of observation in BB02 and 164 hours in IS03 from elevated platforms at land using a theodolite. For individual animals, we recorded series of surface behaviour and breaths as long as possible in order to approach the breathing rate to a stable average and thus to interpret it as proportional to the relative metabolic rate. Breathing rate in both sexes varies rheostatically along winter and correlates with the intensity of competition among males for mating. This suggests that energy stores consumption of humpbacks during the winter is regulated by the unpredictable regime of competition. Competition between males changed along winter parallel to abundance. Competition was higher in IS03 but in BB02 it was higher in the same conditions of abundance. The rate of transitions, which measures pod instability, also decreased parallel to increments in abundance. In the same conditions of abundance, pods were more stable in IS03 compared to BB02. These differences may be explained by the same dynamics operating in different conditions of size and continuity of the winter aggregations. In regions of patched and thereby, dense aggregation (IS03), hierarchies among males may be established as the re-encounter rate is high. Competition and pod stability are then relatively higher. In a continuous large wintering region (BB02), animals may disperse and thus density and re-encounter rate are lower together with competition and pod stability. This may explain the different "functions" which have been proposed for singing, i.e., hierarchical ranking among males (e.g., Hawaii) and attraction to females (e.g., México).

Blood Barometers: Indicators of Nutritional Stress in Captive Steller Sea Lions

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Blood profiles are a critical tool to evaluate the nutritional status of wild animals. Unfortunately, changes in blood parameters are species-specific and depend partly on the duration and severity of nutritional stress. We examined changes in the blood profiles of captive Steller sea lions exposed to differing time courses of nutritional stress to determine which parameters changed consistently, and the sample sizes likely required to detect such changes among wild populations. During these experiments, Steller sea lions consistently lost 10-15% of their body mass. However, this loss was achieved over short (9 d), medium (14 d) and longer (29 d) time periods. We quantified the consistency and extent of changes in 34 standard clinical

aspects of blood biochemistry and hematology during these three periods. Regardless of the duration of the stressor, hematocrit increased and phosphorous decreased consistently. Decreases in calcium and glucose appeared to be indicators of rapid mass loss. Mass loss over longer periods was characterized by increases in red cell counts and hemoglobin levels (perhaps indicating hemoconcentration), and decreases in platelet counts, white cell counts and alkaline phosphokinase. Curiously, decreases in blood urea nitrogen were only observed in the 14 d trials; this was likely due to changes in protein intake more than tissue catabolism. The greatest changes in relative values were seen in serum iron, total bound iron, and gamma GT. Sample sizes required to detect differences between populations are a function of natural variation in healthy animals versus the magnitude of changes during nutritional stress. Certain parameters (red cell counts, hemoglobin, hematocrit, gamma GT, serum iron, phosphorous) required realistic sample sizes (<100), while others (white cell and platelet counts, alkaline phosphokinase, calcium, glucose) were more prohibitive. These studies demonstrate how simple, appropriate blood tests can be used to indicate and quantify nutritional stress in wild populations.

From North of the Equator to the Antarctic: Unique and Unexpected Movements for Humpback Whales off the Coast of West Africa and Throughout the Eastern South Atlantic Ocean

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In the Southern Hemisphere, the International Whaling Commission categorizes humpback whale distribution into six feeding areas around the Antarctic convergence and seven primary breeding areas in the tropics. Despite research over the last ten years, there is little information evaluating individual movements between different sites within breeding areas or establishing migratory connections to feeding grounds. From early July through October, the coastal waters of Gabon and the wider Gulf of Guinea are among the most important and best-documented humpback breeding areas off equatorial West Africa. To understand whale habitat-use and movements in this region, we attached Argos satellite-monitored tags to 15 humpback whales off Gabon during August/September 2002. All tagged whales showed considerable environmental heterogeneity in their preference for water depth and distance from shore. Eight whales spent periods of days to weeks in the continental shelf waters off Gabon before undertaking southbound migrations. Two whales were tracked for more than 5,000 miles to Antarctic feeding grounds, establishing a migratory connection for this population between breeding and feeding grounds for the first time. Interestingly, seven whales moved further north and west to different breeding sites in the Gulf of Guinea. Some of these whales moved through offshore island areas (São Tomé and Príncipe) that were well-known historical whaling areas; other whales showed movements to areas off Cameroon and Nigeria that have not previously been known for this population. One tagged whale moved more than 1000 miles west, but remained close to shore. Our results help identify: movements and breeding areas off Gabon and within the Gulf of Guinea, apparent use of oceanographic (Angola and Benguela Currents) and geological features (Walvis Ridge) during migration, and initial identification of Antarctic feeding grounds. These data coupled with genetic and photographic identification results aid in conservation planning for humpback whales in this region.

Habitat Use and Preferences by *Sotalia guianensis* in the Caravelas Estuary, Eastern Brazilian Coast

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Habitat use and preferences of the estuarine dolphin (*Sotalia guianensis*)

were assessed in the Caravelas Estuary and adjacent waters, in the eastern Brazilian coast (17°54'S - 39°21'W). Boat cruises were undertaken following routes designed to cover the study area homogeneously. During 238 surveys (2002-2004), 241 groups were sighted. The Arcview 3.1 software was used to create a GIS environment which included the distribution of dolphin sightings, a 5 km² quadrats grid, and a TIN model of the study area bottom. Each quadrat was characterized according to environmental variables such as depth, contour index, distance from sand banks, distance from the coastline, distance from coral reefs and riverine water influence. Kernel density was used to identify the core area of dolphins' use and the Neu's method was used to test habitat preference. The core area of dolphin's use was located at the Caravelas river mouth. Dolphins did not use the several classes of environmental variables homogeneously, showing preference for more shallow waters (used range: 0-15 m / preferred range: 0-6 m), closer to sand banks (used range: 0-12 km / preferred range: 0-6 km) and closer to the coastline (used range: 0-12 km / preferred range: 0-5 km). Dolphins also preferred areas with flatter bottoms (lower contour index). Preferred salinity ranged from 35 to 38 ppm, despite dolphins were sighted in waters 10 km inside the river. Although significant, the others variables were not easily interpretable and were probably of lower biological importance, pending a multivariate assessment. Dolphins used a wide range of habitat types but the Caravelas river mouth seems to propitiate better conditions for foraging strategies or concentration of prey. Intense barge traffic and dredging activities occurring inside the core areas of dolphins' use raises concern about possible negative effects on this population, and reinforce the need for long-term monitoring.

Epidemiologic and Pathologic Findings in Cetaceans from the 2004 Mid-Atlantic Unusual Mortality Event Along the U.S. Mid-Atlantic

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In 2004, a marine mammal Unusual Mortality Event (UME) was declared for the U.S. mid-Atlantic coast (New Jersey to Georgia). The UME that involved only cetaceans (n = 37) from four families, Delphinidae (n = 17), Kogiidae (n = 18), Balaenopteridae (n = 1), and Ziphiidae (n = 1), and 10 species, *Kogia breviceps* (n = 16), *K. sima* (n = 2), *Tursiops truncatus* (n = 8), *Delphinus delphis* (n = 3), *Grampus griseus* (n = 3), *Stenella* sp. (n = 2), *Globicephala macrorhynchus* (n = 1), *Balaenoptera acutorostrata* (n = 1), and *Mesoplodon bidens* (n = 1). The majority of strandings (86%) occurred in North Carolina (n=14; 43%), South Carolina (n=10; 31%) and Georgia (n=8; 26%). Mortalities occurred from July to September and peaked in August. Cases occurred in GA from 7 Jul to 29 Jul, NC from 30 Jul to 19 Aug, SC from 21 Aug to 12 Sept. There were evident family-based trends temporally, spatially, and histologically. The mean interval between strandings (MIS) of delphinids was 9 days. Kogiids exhibited a double mortality peak in GA (July) and SC (August) with a MIS of 12.3 days and 5 days, respectively. Meningoencephalomyelitis was observed in 81% (9/11) of delphinids with cases occurring in NC (66%, 6/9), SC (22%, 2/9), and MD (11%, 1/9). An etiology has not been determined to date. No kogiids displayed neurological disease, but 66% (10/15) had direct or indirect evidence of cardiomyopathy. The relative risk of neurologic disease was 13.5 times greater in Delphinids. This 2004 Mid-Atlantic UME may be best viewed as two concurrent mortality events with different spatial components and causes of mortality among two families. The overlap of these events may be the result of environmental conditions (climatic or oceanographic) or an indication of an as of yet

unidentified environmental or anthropogenic stressor.

Detection Antibodies to Toxoplasmosis, Brucellosis and Morbilliviral Infection in the Black Sea Aphalins (*Tursiops truncatus*)

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The Black Sea aphalin (*Tursiops truncatus*) has been entered in the International Red Book, and monitoring of the number of these animals is an important task. The last decades saw a decline in the number of these animals. This may be caused either by ecologic factors such as decrease in the feed resource or diseases that cause epizootics or influence the animals' reproductive functions. Morbilliviral infection causes massive death of many animal species, including dolphins. It is also known that toxoplasmosis and brucellosis cause fetal pathology, premature birth and stillbirth, besides, toxoplasmosis can cause encephalitis with fatal outcome. The goal work was the study of toxoplasma, brucella and morbillivirus circulation in the population of the Black Sea aphalins. The analysis was performed basing on the detection of specific antibodies to these pathogens. We used the ELISA for the detection antibodies to toxoplasmosis, brucella and morbillivirus. Sera of 40 animals from dolphinariums and those of 13 wild aphalins were analyzed. Antibodies to toxoplasmosis agents were detected in 42% aphalins living in dolphinariums. Pregnancy ended with stillbirth in four of the examined females with a high level of toxoplasma antibodies. The female that gave birth to a live calf showed a negative reaction for toxoplasmosis. Toxoplasma antibodies were detected in 7 of 13 wild aphalins, i.e. in 54% of animals; brucella antibodies were detected in 2 animals (15%), and morbillivirus antibodies were detected in 1 aphalin, i.e., in 8 %. Thus, toxoplasma, brucella and morbillivirus circulation was revealed in the population of the Black Sea aphalins. Taking into account the fact that morbillivirus causes massive death, and toxoplasma and brucella fatally influence the animals' reproductive system, we believe that, along with other factors, the above pathogens can be among the reasons influencing the size of the population of the Black Sea aphalins.

An Analysis of Overall Health and Distribution of Harp and Hooded Seals Along the United States Eastern Coast

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Researchers and fisherman in the Gulf of Maine have reported an increase in strandings and incidental captures of harp (*Phoca groenlandica*) and hooded (*Cystophora cristata*) seals, which are seasonal residents in the winter and early spring. In the winters of 2004 and 2005, free ranging, wild caught, healthy harp and hooded seals were captured along the New Hampshire and Massachusetts coasts. Lengths, weights, blood, fecal, skin and blubber samples were collected, and satellite tags were also deployed. This pilot study investigated potential pathogen exposure and/or infection, parasitology, spatial distribution, prey preferences, genetics and contaminant occurrence. A total of 42 animals were captured, 36 harp and 6 hooded seals, with data also gathered from stranded and deceased individuals. The presence of morbillivirus and herpes virus, as well as cryptosporidia and giardia was discovered. Distribution patterns from nine satellite tagged animals also indicate that juveniles tend to remain in southern New England for extended periods. This information may serve as baseline health and natural history data that will reveal how these animals utilize resources in the Gulf of Maine, and outline potential health risks these seasonal visitors may pose to native populations.

The ZFX / ZFY 5'-Exonuclease Assay, A New Tool for Sex Determination in Cetaceans

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Sex determination of cetaceans is essential for a more complete picture of their population ecology, but is limited in the field by hidden genitalia and lack of sexual dimorphism in most species. Developed in the 1970s, genetic methods initially involved histological staining of sex chromatin bodies, karyology, and Southern hybridization. In the 1980s-90s, the Polymerase Chain Reaction (PCR) advanced the use of sex-specific DNA sequences, such as ZFX/ZFY and SRY. Procedures were faster and more reliable, but typically produced PCR products from only a portion of the cetacean species, and were too long to amplify degraded DNA. We have developed a 5'-exonuclease fluorescent assay, based on the ZFX/ZFY gene orthologs, for rapid, highly sensitive, and unambiguous sex determination in cetaceans. The assay produces a small 105-bp PCR product, using primers for highly conserved regions designed from sequences representing seven cetacean families. The small PCR product allows high sensitivity and reliability, which maximizes the efficiency of amplification from degraded or low DNA quantity samples. The real-time fluorescence assay provides the sensitive and unambiguous fluorescence signals for sex determination. We have demonstrated sex specificity for 33 cetacean species across nine families, and find the assay to be simple, rapid, and more reliable than previous methods, especially for difficult samples.

Discrepancies in Sighting Data During Shore-Based Counts of Gray Whales

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Counts of gray whales have been conducted from shore stations in central California most years since 1967. Studies of the survey protocol provide information on reliability of the data, observer biases, and estimates of whales missed within the viewing area. The current study compares sighting data collected by observers working alone (on the standard watch, documenting all whale pods in the area) to pod-size estimates made by a team of two 'trackers' focusing on one pod at a time. Reliability of the tracking effort was tested by having two teams independently track the same focal pods (n=39 attempts). In this test, 15 (71%) of the 21 tracks rated as good concurred in pod size, 5 tracks had a discrepancy of 1 whale, and only 1 track had a discrepancy of 2 whales (pod size of 5 vs. 7). This indicates a fairly high but not absolute concurrence between separate tracking efforts. To test observers on the standard watch, there were 243 efforts to track whales. Only the best matches and tracks (n=83) were used for corrections to observers' pod-size estimates, based on *ad hoc* criteria such that tracks and visibility met certain quality levels, tracks consisted of >7 sightings per pod (0=39.7; SE=3.7; max=143), whales were tracked >0.27 hr (0=0.5 hr; SE=0.02; max=1.2 hr), and differences between location and time data in the observers' and trackers' records were within set limits. Trackers and observers agreed on pod-size estimates in 43% of the cases, but observers overestimated 9% of the pods and underestimated 48%. Preliminary results show that observer estimates of pod size=1, on average, represented 1.7 whales (SE=0.12; p<<0.001); pod size=2 represented 3.0 whales (SE=0.21; p<<0.001); pod size=3 represented 4.4 whales (SE=0.35; p<0.001); and estimates of pod size>3 were unbiased (p=0.59).

Genetic and Demographic Status of the New Zealand Subspecies, Maui's Dolphin (*Cephalorhynchus hectori maui*)

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The North Island population of New Zealand's endemic Hector's dolphin has been recently proposed as a subspecies, the Maui's dolphin (*Cephalorhynchus hectori maui*). This subspecies is geographically and genetically isolated from the more abundant South Island Hector's dolphin (*C. h. hectori*) population and is considered critically endangered as a result of incidental mortality from commercial and recreational net fishing. Here we review the demographic and genetic status of the Maui's dolphin and the potential for its recovery. A summary of sighting and stranding

records shows a severe contraction in the distribution of Maui's dolphins over the past 30 years, with the subspecies nearly disappearing from the southern half of its former range along the west coast of the North Island. Genetic analyses of biopsy (n = 66) and beachcast (n = 15) samples have revealed no diversity in the mitochondrial DNA control region and reduced diversity at microsatellite loci compared to the more abundant South Island Hector's dolphin. Capture-recapture estimates of abundance based on microsatellite genotyping suggest fewer than 100 individuals in the extant population. Mitigating against this bleak assessment are some positive indicators for recovery. Fisheries regulations in force from October 2003 have closed waters extending to 4 nm offshore to all set net fishing. Since promulgation of these regulations, no beachcast or net entangled dolphins have been reported. Finally, surveys of the Major Histocompatibility Complex Class II gene (DQB) show that functional genetic diversity has survived in the remnant population despite the loss of neutral diversity. It is too early to consider the fate of the Maui's dolphin sealed.

Acoustic Behavior of Bottlenose Dolphins (*Tursiops truncatus*) in the Big Bend region of Florida

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Florida's Big Bend region remains one of its most acoustically pristine coastal environments, due to low population, relatively few registered boats, and the absence of commercial shipping lanes. Yet historically this region's dolphin population has not been studied, leaving a gap in our knowledge of acoustic behavior of bottlenose dolphins found in acoustically pristine locations. Here we examine the acoustic behavior of coastal bottlenose dolphins (*Tursiops truncatus*) in the Big Bend region and compare it to other populations found in similar habitats. As a part of photo-ID and habitat-use surveys, recordings were collected and split into fall, winter, and spring seasons based on water temperature. Overall, whistle rates were relatively low in fall and winter, but much higher in spring, even when normalized for group size. Interestingly, burst pulses were only found during spring, and pops rarely occurred. Echolocation rates were higher for fall and spring than in winter, and as group size increased, the amount of echolocation/dolphin/minute decreased. These differences in vocal production rates may be influenced by behavior; for example, socialization rarely occurs in winter, when whistle and echolocation rates are low. The fall echolocation and whistle rates are lower than those reported for the bottlenose dolphin population of New Port River Estuary in North Carolina (Jacobs *et al.* 1993). This evidence of seasonality in vocal production suggests that sampling should occur across seasons to accurately represent the acoustical behavior of a population.

Cetaceans of the Bohol Marine Triangle Area, Bohol, Philippines: Assessment and Monitoring

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The Bohol Marine Triangle is one of the key conservation sites in the Philippines covering the islands of Balicasag, Pamilacan, and Panglao. It is host to many endemic and endangered species, and home to various cetaceans, the latter being exploited for tourism. Assessment of cetacean diversity, distribution, relative abundance and species associations were conducted in 2002-2004 using line transect method. Initial 8-month monitoring was conducted utilizing trained enumerators from whale watching organizations to obtain information on species present, peak tourist season and revenues generated from this type of nature-based tourism. Nine species of marine mammals were sighted during the period September 2002 to May 2003. Results recorded 323 trips from September 2002 to August 2003. Months of April, May, and June showed higher number of trips relative to the other months with May as the peak season (92 trips). Gross revenues of Php 707,500.00 (US\$ 12,634) were derived within one year with May obtaining the highest (Php 204,800.00 = US\$ 3,657). Starting 2002, annual surveys were conducted during October and November and March-May 2004. Distribution was found to be concentrated on the east-southeast-southern area of Balicasag and Pamilacan Islands with depth gradient of 300-500 meters. Annual sighting rate for all species showed an increasing trend. Cetacean encounter rate around Pamilacan Island was 62 per 1,000 km of active search whereas that of Balicasag was 52. Spinner dolphins were often encountered in pure pods. Fraser's dolphins and melonheaded

whales were mostly seen with other species (88% and 68% association rate, respectively). Though hunting of cetaceans was already stopped, other threats include: incidental takes, commercial fisheries, heavy boat traffic and habitat degradation such as mining effluents as a result of recent restoration of several mining operations.

Synchronous Breathing in Wild Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*): A Preliminary Analysis

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Synchronous breathing, synchronous surfacing for breath, has been observed in many marine mammals. Synchronous breathing seems necessary to keep group swimming. Some researchers have suggested that dolphins express affiliation by synchronous movement. However this behavior has not been studied in detail. We studied synchronous breathing of wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) at Mikura Island, Tokyo, Japan. We video-recorded 1409 episodes of synchronous breathing by 156 identified individuals and 67 mother – calf dyads underwater and quantitatively analyzed these records. In Most synchronous breathings, a pair of dolphins faced in the same direction (97.8%), and the second individual breathed within one second (average of 0.62 s) after the first individual surfacing diagonally backward of the first dolphin (72.7%). In synchronous breathing of mother - infant dyads and mother - juvenile dyads, mothers tended to breathe in advance of their calves (81.4%). The result suggests that calves synchronized their breath to those of their mother. Time lags of mothers' breaths and infants' breaths (average of 0.49 s) during synchronous breathing were shorter than that of mothers' and juveniles' (average of 0.67 s). This is probably because infants swim closer to the surface than juveniles; swimming position differs between infants (echelon position) and juveniles (infant position). Dolphins of the same sex in the same-age classes tended to conduct synchronous breathing most often. This result suggests that dolphins tend to swim together with individuals of the same sex in the same-age classes. Relative distance between individuals during synchronous breathing significantly varied with pair combination. It increased in the following order: mother and calf pairs, female - female pairs, and male - male pairs. These results suggest that the distance among individuals during group swimming, or "personal space", differs depending on pair combination. Further research of synchronous breathing would reveal more precise social relationships of dolphins.

Spatial Variability in Fatty Acid Profile from Sea Lion Pups (*Zalophus californianus*) in the Gulf of California

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Scat and nitrogen and carbon isotopic analysis indicate that diet of California sea lion *Zalophus californianus* in the Gulf of California, vary significantly between locations but form a spatial pattern of feeding habits at the regional scale. In this study we utilized the fatty acids (FA) profiles to test if this method would be useful to define spatial pattern of feeding habits and whether this pattern is consistent to those previously obtained with other methods. We used 10 samples from plasma and subcutaneous fat (blubber) from sea lion pups (less than 2 months of age) of 7 rookeries in 2000. The samples were analyzed by gas chromatography with flame ionization detection (FID) and FA profiles were obtained for each pup and location. Cluster and principal components analysis were applied to plasma and blubber FA profiles to identify spatial patterns. The majority of the 35 FA compared, including those associated with diet, showed significant differences between plasma and blubber in the seven rookeries (Kruskal Wallis test, $p < 0.05$). The FA profiles in plasma varied highly and do not provided a clear spatial pattern, but FA in blubber formed five groups of sea lion rookeries with a coherent spatial pattern: 1) Los Islotes, in the south Gulf of California; 2) San Pedro Mártir and San Esteban, Center-South; 3) El Partido, Center-West; 4) Granito and Cantiles, Center-North, and 5) Los Machos, in the West Gulf. This spatial array was very

consistent to previous patterns based on scats and isotopic analyses, indicating that FA analysis is a good tool to define spatial feeding patterns. This study also supports the notion that both, resource partitioning and differential geographic distribution of fish fauna and squid, control the strong regional pattern of feeding habits of sea lions in the Gulf of California.

Effects of Human Activities on the Reproduction of Humpback Whales (*Megaptera novaeangliae*) in Bahía Banderas, México and Their Predation by Killer Whales (*Orcinus orca*)

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Bahía Banderas in the Mexican Pacific is a breeding region for humpback whales important because of their abundance, births and historical dispersal processes. Whale watching in this area has increased since the last decade creating several conservation and social problems. Winter occurrence of killer whales in this region has also increased since the late nineties and four humpback whale calves were observed to be predated by killer whales between years 2000 and 2004. We conducted research on marine mammals in Bahía Banderas since early eighties and have estimated humpback whale birth rate by year *ca.* 12% with no obvious trend in time. Average annual number of calves per female is 0.57 and the average interval between births is 2.2 years with a trend to increase. During the last decade, there is a clear shift in the distribution of humpback whale cow-calf pairs in which these pods tend to be more disperse and to occupy less protected areas. During the eighties, there is a high occurrence of marks by killer whales on humpback whale flukes which has no temporal relationship with the low occurrence of killer whales in Bahía Banderas indicating that predation of killer whales on humpbacks is intermittent and occurred mainly along migration routes or feeding areas of humpbacks. Since late nineties, we observe a new wave of killer whale marks on humpback whale flukes which has a temporal profile similar to killer whale occurrence in Bahía Banderas suggesting that attacks occur more in breeding areas. Changes in humpback whale reproduction may result naturally from the apparent population growth of this species but our results also suggest that the unorganized growth of whale watching in Bahía Banderas is shifting the nursering areas of humpback whales to less adequate sites exposing them more to predation by killer whales.

Temporal and Spatial Variation in Feeding Habits of the Galapagos Sea Lion (*Zalophus worlbeaeki*)

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The Galapagos sea lion *Zalophus worlbeaeki*, is one of the most conspicuous marine mammals in the Galapagos Archipelago. Sea lion population size is around 18,000 individuals distributed in 70 rookeries with scarce information regarding temporal and spatial variations of feeding habits. In this study we used scat analysis to determine potential spatial and temporal variability of Galapagos sea lions diet from 1997 to 2001. During this period, fishes constituted 96% of the diet followed by cephalopods (3%) and from the 34 families of fish identified Clupeidae, Myctophidae, Chlorophthalmidae, Serranidae and Mugilidae comprised 70% of the diet. Using principal component analysis, a temporal change in prey composition was found, where 1999 and 2000 separated from 1997, 1998 and 2001 (>85% of accumulated variability in the first 3 components), probably an influence of change in prey availability produced by warming including the 1997-1998 ENSO event. In most of the sea lion rookeries, increasing trends in prey diversity (1.4 to 1.6 H') and abundance of cephalopods (11-26%) were evident from 1998 to 2000. No spatial pattern was identified in feeding habits of the Galapagos sea lion, probably to a lack of specific feeding areas. The importance of Myctophidae in the diet suggests that nocturnal foraging in Galapagos sea lion is probably more common than previously suggested.

Fatty Acid Signature Analysis of Spotted and Spinner dolphins from the Eastern Tropical Pacific Suggests Gender and Species-specific Feeding Habits

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In the Eastern Tropical Pacific (ETP), spotted (*Stenella attenuata*) and spinner (*S. longirostris*) dolphins frequently travel together and commonly associate with yellowfin tuna and sea birds. It is not known why these multi-species associations occur, although foraging efficiency, protection from predators and orientation in the "pelagic void" have been suggested (Perrin and Hohn 1994). Published data suggest that spotted dolphins consume small epipelagic fish, squid, crustaceans, and mesopelagic animals taken at depths of 50-200 m. Spinner dolphins feed primarily on small mesopelagic fishes, squids and sergestid shrimps diving to 200-300 m. Published stomach content analysis has suggested significant differences in prey composition by season and geographic region indicating that these species are flexible in their diet. Blubber samples were obtained for the present study between November 1999 and August 2001 from 34 spotted (16 male, 18 female) and 24 spinner (8 male, 16 female) dolphins collected in the ETP. Fatty acid methyl esters were analyzed using temperature programmed gas liquid chromatography and identified by comparison with known standard mixtures and secondary external reference standards. Classification and regression tree analysis (CART in S-Plus) indicated distinct differences both between species and between genders in a given species. Only two dolphins (2/58, $p=0.03$) were misclassified to the wrong species using CART analysis. Within a given species, all spotted dolphins were correctly classified as males or females (0/34 misclassified) and only 2/24 (1 male, 1 female) ($p=0.08$) spinner dolphins were misclassified. There was a suggestion of seasonality with samples collected in July and August being distinct from samples collected over the balance of the year. These analyses are consistent with similar conclusions for common (*Delphinus capensis* and *D. delphis*) and bottlenose dolphins (*Tursiops truncatus*) and suggest that species that travel together are not necessarily feeding on the same prey.

Interpreting Short-Term Behavioral Responses to Disturbance Within a Longitudinal Perspective

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We documented short-term behavioral responses of individually identified bottlenose dolphins (*Tursiops* sp.) to vessel activity in Shark Bay, Australia. Using a before/during/after design, we conducted experimental vessel approaches at two sites where dolphins had different histories of exposure to vessels: concentrated research and tour vessel activity (impact site) versus limited research vessel activity (control site). Based on photo-identification analysis, there was complete segregation of individual dolphins between the two sites. Canonical variate analyses demonstrated that experimental approaches elicited changes in response measures related to group sociality and movement consistency. Regarding sociality, during approaches, dolphin groups were more compact and had higher rates of change in membership; regarding movement, during approaches, dolphin groups had more erratic speeds and directions of travel. Although approaches elicited behavioral change at both sites, responses of control site dolphins were stronger, more prevalent, and longer lasting. Taken out of context, the more moderate responses of impact site dolphins could be misconstrued to indicate that behavioral habituation to vessel activity had taken place. However, we were able to interpret these findings within a broader framework provided by long-term research on the impacts of vessel activity on Shark Bay dolphins. Based on this longitudinal perspective, the moderated responses of impact site dolphins were better explained by the displacement of sensitive individuals away from the region of greater vessel activity prior to the onset of this assessment. Thus, documentation of a more moderate response to disturbance likely resulted from a biased sample in which one subset of the study population had already departed

the region of disturbance. Our findings challenge the traditional assumption that short-term behavioral responses are sufficient indicators of the impacts of human disturbance on wildlife. Nonetheless, short-term responses, if documented at periodic intervals, can be valuable indicators of the long-term impacts of disturbance.

Beyond the Individual: A New Method for Quantifying the Contribution of Rescue and Rehabilitation Programs to Long-Term Population Dynamics

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Rescue and rehabilitation programs have traditionally measured success by the survival of individual animals; however, for endangered species, ultimate success will be measured by the impact of the rescue and rehabilitation program on the long-term persistence of the population. Here we propose a methodology to assess the contribution of a rescue and rehabilitation program to population persistence. The essence of the method is parallel simulation of the population with and without the rescue program, using a stochastic population model suitable for the species in question. The parallel structure allows focus on the effect of the program, while controlling for stochastic effects and uncertainty. The relative metrics (like the odds-ratio for the effect of the program on quasi-extinction probability) are expected to be more robust to uncertainty than absolute metrics (like quasi-extinction probability itself). The challenge is estimating the effects of the program on life-history parameters, specifically, the survival rate of animals if not rescued, and survival and reproductive rates of released animals. Where such information is not available, we provide assumptions that can be used for preliminary analysis. This method can be extended to explore other questions, like the impact of specific release practices, by incorporating more detail in the model. To demonstrate this methodology, we applied it to an assessment of the Florida manatee rescue and rehabilitation program. We used a stochastic matrix model that incorporated multiple sources of variability: demographic stochasticity, environmental stochasticity, catastrophes, and uncertainty in parameter estimates. Rescues and releases were partitioned by year, sex, age, and region. Over the period 1990-2004, the USFWS manatee rescue, rehabilitation and release program had a positive effect on population dynamics, but the magnitude of the effect varied by region. By focusing on measures that are relevant to recovery planning, quantifying the effect of rescue and rehabilitation efforts on population dynamics enables overall recovery programs to allocate resources where they have the most impact.

The Linear Measurement Approach and the Ontogeny of Sexual Dimorphism in Otariids: A Comparative Analysis Among *Arctocephalus australis*, *Callorhinus ursinus* and *Otaria byronia* (Pinnipedia: Mammalia)

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Adult phenotypes arise through ontogeny. Changes in ontogeny within an evolving lineage therefore ought to produce changes in phenotype. Our aims are to analyze the conservation of ontogenetic trajectories of *Arctocephalus australis*, *Callorhinus ursinus* and *Otaria byronia* over time, between sexes and between species; to characterize growth trajectories and, finally, to compare them among taxa with respect to isometry. Skull's trajectories are characterized using PCA analysis and then compared through calculations of the angles between allometry vectors. We combined the ontogenetic series of all species to determine if the species diverge over time, retain at a constant distance away or yet converge towards a similar endpoint and we compare individual coefficients of vectors after calculation of bootstrapped confidence intervals. The allometry vectors for all species were significantly different from isometry and in all species the first principal component ordinated the specimens according to overall size. Dimorphism in the allometric vector is observed only in *O. byronia* and the difference between males

and females of the fur seals are related with adult body size. We detach that the allometric vectors of females and males presented a correlation of more than 0.97, they differ significantly but they are yet more similar than expected by chance. It seems counter intuitive for such a high correlation to be no greater than expected by chance, but this is often the case in studies based on traditional morphometric data (and this is why it is important to take care when we infer allometry based only in the correlation of a set of linear measurements and the linear measurement that represents general size). The comparisons species/sex groups revealed similar vectors (any significant shape disassociation are verified in the inter-specific analyzes), suggesting lower plasticity of the ontogenies.

Temporal Trends in Small Cetacean Diets: Links with Fish Abundance and Derivation of Functional Responses

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The functional responses of predators to their prey are key components of ecosystem dynamics. Predators are expected to modify their diets in response to changes in the abundance of the energetically most profitable prey. However, even if data can be collected on all the parameters, simple optimal foraging models rarely perform well in complex natural environments and empirical data are necessary. Using stomach contents data collected over approximately 15 years on dolphins and porpoises in the NE Atlantic years, we review possible analytical approaches for relating diet to fish abundance. Firstly we attempt to extract signals for interannual variation in prey importance, by factoring out effects of season, sex, maturity, etc. Secondly we examine relationships with indices of fish abundance. We use redundancy analysis and Generalised Additive Models (GAMs), and both GAMs and dynamic factor analysis to identify and determine the functional form of relationships between annual dietary importance and fish abundance indices.

Vocal Learning and Cultural Transmission in Southern Elephant Seals

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Vocal learning in mammals is sparsely documented, and there are few published evidences of vocal learning in wild mammalian populations. In particular, there is no information of intra-specific copying of natural, socially relevant, sounds, based on longitudinal data about vocalizations of recognized individuals, even in well-studied species in which vocal communication is a core aspect of sociality. We present this kind of information for the southern elephant seal (*Mirounga leonina*). We studied male agonistic vocalizations in a small breeding population of this species in the Falkland Islands over 8 years (1995-2002). We recorded ~2,400 vocalizations from ~285 different males, including many recorded over more than 1 breeding season (55 males were recorded for more than 2 season and 29 were recorded throughout their vocal development). We demonstrated that: (1) vocalizations are a key element of male agonistic behaviour in this species, the world's most highly polygynous of all vertebrates; (2) young males present plastic, non stereotyped vocalizations; (3) mature males vocalizations are structurally complex, stereotyped, and individually distinctive (each male emits only one kind of vocalization, as identified by the specific arrangement of syllables and syllable parts); (4) a limited number of vocal types exists, as recognized from visual inspection of waveforms and spectrograms, and these types present also large differences in the fine acoustic structure (temporal, frequency, intensity features) that enable their reliable classification; (5) the relative frequencies of vocal types in the population change over the years; (6) the trends of increase or decrease of the different vocal types is well in accordance with a process of vocal imitation by young peripheral males of the vocal types of harem holders.

An Assessment of Jeffreys Ledge as a Fall and Winter Feeding Habitat for North Atlantic Right Whales (*Eubalaena glacialis*): 2003 and 2004 Survey Results

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Little is known of the movements of North Atlantic right whales (*Eubalaena glacialis*) between their departure from summer feeding grounds in the Bay of Fundy, Canada, and their winter arrival in southeastern U.S. calving grounds and Cape Cod Bay feeding grounds. In 2003 and 2004, we conducted vessel-based surveys for right whales around Jeffreys Ledge, an area of high topographic relief off the New England coast. Twice-weekly surveys were conducted between September and December on three tracklines that surveyed the shallow waters of the Ledge, as well as the deeper basins to the east and west of the Ledge. In 2003, right whales were sighted on 13 of 23 surveys (56.5%), with up to six whales per day. Whales were seen on one to six surveys each (median=1), with a maximum occupancy period of 42 days. In 2004, whales were seen on nine of 26 surveys (34.9%), with up to 14 animals per day. Surface skim feeding was seen on four days in November 2004. Plankton tows completed near feeding whales indicated that the copepod *Calanus finmarchicus* were the primary prey in 2004. No surface feeding was seen in 2003, but behavior indicated likely feeding on a deep-water prey resource. In this year, *Pseudocalanus* dominated surface plankton, but we do not know if this was the whale's primary prey. Four mother-calf pairs were seen in each season. In both years, at least one pair was sighted on Jeffreys Ledge that was not seen in the Bay of Fundy feeding area. Autonomous acoustic recording devices indicated that right whales were present past the completion of the surveys. Our results indicate that Jeffreys Ledge is an important feeding habitat for North Atlantic right whales at a time when their distribution has, to this point, been poorly understood.

Using Remotely Determined Length Measurements to Monitor Changes in the Size Distribution of Harbor Seals at a Glacial Haulout in Alaska

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Significant seasonal shifts in harbor seal abundance have been documented at glacial haulouts in Alaska. For example, at the Bering Glacier (60° 5' N, 143° 30' W) harbor seal abundance increases over a six-week period from 150 to a peak of 1000 seals in September. To determine if this large increase in numbers could be attributed to an influx of juveniles, we estimated the distribution of size classes based on remotely determined length measurements. To estimate seal length from photographs taken during aerial surveys, we first developed a predictive equation by photographing flat panels of known size from a helicopter flying 205 - 230 m above and 260 - 430 m distant from the panels. Images were imported into ArcView 3.2 GIS, a line was digitized along the length of the panel and the arc length was recorded. The resulting equation (Length = 6.215 + 0.007[distance] - 0.010[altitude] + 1.116[arc length]; R² = 0.94, n = 67) was then used to estimate the dorsal length (tip of nose to tip of tail) for 393 harbor seals hauled out during 4 aerial surveys conducted before, during, and at the time of peak abundance. The average length of seals did not change significantly as the number of seals at the Bering Glacier haulout increased, as would have been expected if immigration was driven by juvenile seals. Repeated measurements of individual seals from different photographs had a coefficient of variation of 6% (n = 92), which is only slightly greater than that determined for repeated measurements of live-caught seals (2 - 4%). This suggests that this method could be used to increase the statistical power of studies that require standard length measurements by allowing researchers to remotely measure large numbers of animals without the need for capture.

Do Bottlenose Dolphins Use Voice Cues to Recognize Whistles of Other Individuals?

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Playbacks to temporarily restrained, free-ranging bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, FL, determined that dolphins can recognize signature whistles of other individuals (Sayigh *et al.* 1999; Anim. Behav. 41:41-50). However, we do not know the specific cues in whistles to which dolphins are attending. Two possibilities (not mutually exclusive) are: 1) the individually distinctive frequency modulation patterns of whistles; and 2) voice cues caused by the individually distinctive anatomy of the vocal apparatus. Whether frequency modulation patterns of whistles are used as cues was addressed by Janik *et al.* (see abstract in this volume). We are now carrying out playback experiments to address whether voice cues are used by dolphins to recognize whistles. We are using the playback design of Sayigh *et al.* (1999), in which temporarily held wild dolphins in Sarasota Bay, FL, listen to 30-sec sequences of the whistles of a close relative and of a known conspecific of the same sex and similar age. In playbacks, we attempt to match the recent level of association between the target dolphin and the two individuals whose whistles are played back, using coefficients of association calculated from sighting data. The two whistle sequences are separated by 5 minute intervals, and the number of times each dolphin turns towards the speaker in the 5.5 minutes after the first stimulus in each sequence is compared. Stimuli are natural variant (non-signature) whistles, which are highly variable in contour. If dolphins are capable of discriminating among variant whistles, then they must be using voice cues for this recognition. Preliminary analysis of ten playbacks showed no difference in responses to variant whistles of kin as opposed to non-kin (Wilcoxon signed ranks test, $p > 0.05$). These preliminary results suggest that voice cues are likely not used by dolphins to identify whistles of other individuals.

Management Strategies to Reduce the Impacts of Wildlife Tourism

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Managing the activities of commercial operations for viewing marine wildlife includes restricting the number of industry participants, coupled with regulating their activities. Dolphin-swim and dolphin-watch tours in southern Port Phillip Bay, Victoria, Australia, focus on a coastal population of bottlenose dolphins (*Tursiops* sp.). The dolphin-swim tour operators approach dolphins, remain stationary and place humans in the water to interact with free ranging dolphins. This procedure can be repeated multiple times during one encounter with dolphins. In this study we report on operator compliance with regulations regarding the manner in which boats must approach schools of dolphins. The only legal approach type allowed in this region is the Parallel approach. The principle researcher was present on 128 commercial dolphin-swim trips lasting a mean time of 234 min (SD = 28.9 min). These were studied from September 1998-April 1999 and September 1999-April 2000. Results indicated that approach selection (legal versus illegal) changed with season. The proportion of legal approaches were elevated during Summer (peak holiday season) when compared with Spring and Autumn (non-peak holiday season), possibly because of the presence of enforcement officers during Summer. It was documented that dolphin-swim tour operations tended to become illegal after five swims. We recommend that the number of dolphin swims be limited to a maximum of five to reduce disturbance. We also recommend that regulations be realistic in the field and readily enforceable. We suggest several changes to the existing regulations to improve the legality of operations and minimise the impact of this tourist industry on the local dolphins. This is the first study to provide a numerical value to managers on maximum swim number and is fundamental to the management of the dolphin-swim industry.

Modeling the Effects of Different Parameters on the Precision of Harbor Porpoise Density Estimates

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Harbor porpoises (*Phocoena phocoena*) are among the most difficult cetacean species to investigate in the wild. They are small in size, inconspicuous in their acoustic as well as visual behavior, occur in small group sizes and spend the main part of their lives under water. However, to estimate the impact of human induced mortality, such as by-catch, or to monitor the effect of conservation methods, managers often need to know how many porpoises are in a specific area. To do this, precise estimates of abundance are required as a base for detecting trends, or the lack of such. For porpoises line-transect distance sampling conducted from plane or vessel has proven to be, so far, the best method to get abundance estimates. To determine how survey area size, as well as animal density and distribution effects the precision of such abundance estimates a model was developed. Our model simulated a quadratic area in which different numbers of porpoises were placed. In addition to density we varied also the distribution of porpoises on the area. In the simplest model porpoises were randomly allocated, whereas in the other models we included a social component ('aggregation') as well as ecological attractors. Finally, we modeled the sampling schedule by varying the number of (evenly spaced and parallel) transects as well as the effective strip width (ESW). The results show that below certain combinations of effort (% area covered) and porpoise density such investigations are unlikely to provide reliable results. Aggregations of animals due to social and/or ecological factors further decrease the precision of abundance estimates. Managers often chose survey areas independent of size or the general density or distribution of porpoises. Based on the results of this model recommendations for the selection of study areas and monitoring scheme are given.

First Summary of Coastal Sea Surveys Done off the Mediterranean Coast of Israel Between the Years 1999-2005

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Cetacean research carried out during the last decade in Israel and in the easternmost Mediterranean as a whole, has centered on species, gender and age determination, morphological, pathological, toxicological and genetic investigation of beached and by-caught carcasses. In 1999, a donation of a semi-inflatable Zodiac research boat allowed us to initiate dedicated open sea surveys with the aim of a local ecological characterization of coastal cetaceans in our study area. The present report summarizes the results of 162 half-day surveys, totaling 537 hours at sea, performed with the research boat and with a 13 m. yacht. The surveys were carried out in seas under Beaufort 3 and up to 6 nautical miles off shore. During the surveys we collect navigational and observational data. The data is analyzed and presented using GIS software. The bottlenose dolphin (*Tursiops truncatus*) was the only species sighted. Encounter rate was only 42%. In 45% of the encounters the dolphins were interacting with bottom-trawl boats. The non-trawler encounters occurred mainly within the first 3 nautical miles off shore. The average pod size was 4.6 (2.6 SD), and seasonally dependent. 34% of photo identified individuals have been determined to be skinny. Individual identification was performed using the Photo-ID method, a total of 85 different individuals were identified. Accumulation rate of new individuals to the catalogue is still 3-4 per survey, implying that we are not yet nearing complete identification. The research so far suggests a small stable bottlenose dolphin population with annual migration events during early spring, at which time large pods are seen. The high percentage of skinny dolphins and the clear interaction with bottom trawl fishery suggest a nutritional stress. Research on free-ranging dolphins in Israel is still in its cradle, with much to be uncovered, yet it is a mandatory prerequisite for any conservation plan of action in this region.

Seasonally "Resident" Gray Whales off the Southern Coast of Vancouver Island: Seasonal and Inter-Annual Variation in Occurrence

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Several hundred "seasonal resident" gray whales annually return to feed during summer months in coastal waters from northern California to southeastern Alaska. We examined seasonal and inter-annual variation in numbers of gray whales off southern Vancouver Island based on near-daily surveys from May to October of 1998-2004. Identification photographs and data were taken during the operation of a water taxi service along the West Coast Trail between Port Renfrew and Bamfield, a distance of ~81 km of coastline. This regular and consistent effort provided a unique opportunity to observe and document gray whales across a number of years and throughout their season of residence. Data were limited to full transits during favorable weather (701 surveys). The annual number of sightings ranged from 181 groups (300 whales) in 2001 to 946 groups (1,997 whales) in 2003. During surveys, up to 58 whales were recorded in a single transit. Using photographs taken through 2003, a total of 198 unique whales were identified, with 46-102 unique individuals identified each year. Individuals were seen in one to six years (including 19% which were seen in four or more years), with frequent re-sightings (an average of 7.25 times per year). Using all seven years of data, we found gray whales began arriving in early May and encounter rates steadily increased until the peak in early July. The number of sightings remained high through early August, and then declined to low rates by late September. There was substantial inter-annual variability, with the peak occurring from early June through late July in different years, and one year (2002) having a second peak in early August. The consistent annual presence of this high number of gray whales makes this one of the most heavily used areas by "seasonal resident" whales along the entire west coast of North America.

Simultaneous Use of Auditory Evoked Potential (AEP) and Behavioral Methods to Determine Hearing Abilities in a Bottlenose Dolphin

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Auditory evoked potentials (AEP) permit the hearing abilities of marine mammal to be tested with little or no training. However, AEP thresholds may deviate from more accepted behavioral estimates by up to 25 dB. Differences in the sound source, stimulus type and duration may partially explain these discrepancies. To determine the agreement between behavioral and AEP threshold estimates when these parameters are held constant, a bottlenose dolphin was trained to beach out of the water for simultaneous behavioral and AEP hearing tests. Sinusoidal amplitude-modulated (SAM) tones were projected via a transducer embedded in a suction cup placed on the dolphin's lower jaw. SAM tones were 19 ms in duration with a presentation rate of ~50/s, an amplitude modulation rate of 1 kHz, and were tested across frequencies from 10 to 115 kHz. Passive electrodes were used to record the electrophysiological responses. Evoked responses were averaged 500 times yielding a total trial time of ~10 s. Near the end of each trial, a light turned on for a 2-s interval. This delineated a response window within which the dolphin could whistle to indicate that it heard a stimulus or remain quiet to indicate that either no stimulus was presented or none was heard. Stimuli were randomly presented to the subject using the method of constant limits, with 50% no-tone trials. Threshold was defined as the 50% correct detection point. In general, behavioral thresholds were slightly lower though this trend was not significant. Differences between AEP and behavioral thresholds were within ±5 dB, except at 10 kHz (12 dB) and 20 kHz (8 dB). The results provide the first audiograms collected using simultaneous behavioral and AEP techniques using the same sound source, stimulus type, and duration. When these parameters are held constant, there is very good agreement between the two methods.

Comparisons of Lunge Feeding Behavior Between Blue, Fin, and Humpback Whales

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Blue, fin, and humpback whales have all been shown to forage on aggregations of krill. Foraging dives have been described as a series of vertical excursions at depth where lunge feeding presumably occurred. We examined how foraging strategies and behavior differ in relation to species using data collected from three tag types (all included time-depth and acoustics) deployed on blue whales from 1999-2004 (n=26), fin whales in 2003 (n=7), and humpback whales in 2004 (n=6). The average maximum depth of lunge feeding dives varied by species with blue whales on average diving to 154 (±SD 74) m, fin whales to 251 (±SD 18) m, and humpback whales to 140 (±SD 27) m. Blue whales averaged the largest vertical offset per lunge (32 m, ±SD 15), and the smallest number of lunges per dive (mean=2.4, range =1-5). Compared to blue whales, there was a progressive increase in number of lunges and decrease in vertical offset for fin whales and humpback whales respectively. Surface intervals and rates of ascent and descent were also examined. We also determined (using pitch and roll angle and sound levels) that blue and fin whales were making feeding lunges on some dives in the absence of vertical excursions. Our data on blue whales indicated deeper dives than previously reported (up to 335 m), with 18% of foraging dives having a maximum depth of greater than 250 m. Previous studies examining shallower dives concluded that high energetic costs of lunge feeding may limit dive duration of blue whales. Our larger dataset that included these deeper dives revealed blue whales diving deepest (>250 m) were extending their dive times to spend a similar time at depth (and similar number of lunges) as whales feeding shallower but that they also required a longer recovery time at the surface.

A New Underwater Portable 4-Channel Acoustic/Video Recording Unit to Study Echolocation and Communication of Individual Wild Dolphins

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Although much research has been done on the echolocation and cognitive abilities of captive dolphins, still relatively little is known as to how dolphins echolocate and communicate in the wild. This is mainly due to the difficulties associated with recording dolphin signals accurately in the wild: (1) The broadband nature of dolphin whistles and clicks, with some frequencies extending over 200 kHz; (2) The directional properties of dolphin signals, with only signals recorded from the center of the acoustic beam remaining undistorted; (3) The difficulty of identifying which and how many dolphins produced the recorded signals, making it hard to associate individual dolphin behaviors with acoustic signal features; (4) Being confined to recording equipment aboard a vessel, which complicates the recording of significant behaviors. Although some of these difficulties have been addressed in previous studies, the device developed in this study is the first to combine solutions to each of these. This battery-operated digital recording unit can be taken underwater by a diver and is capable of capturing acoustic signals up to 220 kHz on 4 channels, in combination with simultaneous video. It consists of a custom-made underwater housing, containing two batteries, a digital camcorder, tv-screen, and an acoustic recording unit with custom-made signal conditioning board, 4-channel PCI data acquisition card, a PC/104-plus single board computer and power supply, and notebook hard disk. Using differential signal conditioning increases the signal-to-noise ratio of recordings. Data acquisition and storage is accomplished using a custom-written Labview program. Attached to the housing is a 4-hydrophone star array, so that signals recorded within 15 m can later be accurately localized in 3-D and attributed to individual dolphins on the video. Thus, acoustic signal features can be correlated with different echolocation behaviors and communicative signal exchanges among dolphins can be assessed.

Where Do They Spend Their Time? A Focus on Water Column Use by Juvenile Steller Sea Lions *Eumetopias jubatus*

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Predominant use of portions of the water column may reflect differential prey availability to individual diving animals. Foraging efforts dispersed throughout the water column are likely to include a proportion of search time. Previous analyses of satellite telemetry data have calculated focus with maximum dive depth counts. This novel approach uses time spent at all depths to analyze for focus. Our objective was to assess focus in juvenile sea lion foraging behavior using this technique. We monitored dive behavior of twelve temporarily captive and five free-ranging juveniles (1-3 yr.) using satellite telemetry (mean duration \pm sd = 70 ± 57 d). Data were transmitted in varying seasons and locations in Prince William Sound, AK, and adjacent areas. Six hour periods with > 30 min spent at depths > 9 m were analyzed for focus using time-at-depth data. The expected time spent in each time-at-depth bin was calculated based on width of bins and depth. This calculation was then modified to reflect water column use and dive duration from published values for juvenile Steller sea lions. Randomized dives were simulated using these parameters to estimate expected time spent in each time-at-depth bin per 6-hour period. Expected time was compared with observed values to assess level of focus. Water column use differed significantly between winter (n=8) and summer released (n=9) juveniles ($p < 0.05$), with increased focus in shallow portions of the water column (9-33 m) in summer and deeper portions of the water column (41-150 m) in winter. Focus did not differ significantly between males and females although there was a correlation of mass with focus at 61-150 m ($\rho = 0.53$). This method of assessing for focus can be applied to dive behavior on many different scales, from the individual foraging trip to over-all water column use by individuals.

Long-Range Movements of Offshore Killer Whales with Comparisons to Other Killer Whale Eco-Types

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Three distinct eco-types of killer whales occur in the Eastern North Pacific termed residents (fish eaters), transients (mammal eaters), and offshores (probable fish eaters). To examine home range size and movement patterns, we compared photographs of individual offshore whales collected between 1989 to 2004 from California (230 whales/35 sightings), Washington (105 whales/6 sightings), and Alaska (158 whales/8 sightings). Although not all whales were identified from each sighting, multiple matches were found within and among all three regions. These data indicate seasonal movements of individual whales from California (winter) to Alaska (summer). Fifty-five whales were matched between California and Alaska. Two matches occurred between Newport Beach, CA and the Bering Sea, - a distance of 5,418 km. This represents the longest movement described for any delphinid, exceeding the range previously published for four transient killer whales (2,660 km) out of a population of at least 300 frequently sighted transient whales. Resident whales which frequent Puget Sound, Washington are known to range from the Queen Charlotte Islands, B.C. to Monterey Bay, CA (2,259 km). However, this represents the extreme limits of their range, as they were sighted in these areas only one and two times respectively since intensive effort began in Monterey in the late 1980's. Thus, the overall distance routinely traveled by offshore whales is considerably greater than that reported for residents and transients. Despite fewer overall offshore sighting records, more long-distance matches have been made for offshores compared to residents or transients. This implies that long-range movements of resident and transient whales may occur only rarely, whereas the long-range movements described for offshore whales may be more common, implying a relatively large home range. We suggest that prey type and availability dictate the

size of that range.

Finback Whale (*Balaenoptera physalus*) Recurrence on Jeffreys Ledge in the Gulf of Maine 1996-2005

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Jeffreys Ledge is a 54-km long rocky ridge in the Gulf of Maine off the northeast coast of the United States that is known locally for its abundance of marine life including several endangered whale species. Productive upwelling currents and the seasonal abundance of prey fish (herring and mackerel) attract a variety of cetacean species, including finback whales (*Balaenoptera physalus*) during the warmer months of the year (May-October). Observational sightings data were collected daily from commercial whale watch vessels departing from several ports nearest to Jeffreys Ledge. All sightings of marine mammals were recorded by trained researchers or naturalists. Finback whales were photo documented whenever possible and distinct individuals were identified based on natural markings (dorsal fin shape, chevron pattern and scars) when photo quality allowed. During this study period (1996-2005) a minimum of 130 finback whales were observed on Jeffreys Ledge. Preliminary results of this study indicate that many individual finback whales (n=16) were observed on Jeffreys Ledge during three or more seasons validating the importance of this feeding area for endangered marine mammals and demonstrating the need for increased protection of the resources. It was also noted that several finbacks used both Jeffreys Ledge and nearby Stellwagen Bank during the feeding season suggesting that finbacks use several areas within the Gulf of Maine for feeding purposes. Jeffreys Ledge is a 54-km long rocky ridge in the Gulf of Maine known for an abundance of fish, whales and other marine life. Productivity due to upwelling currents and the abundance of prey fish (herring, mackerel and pollack) attract a variety of cetacean species. As few published studies have been undertaken on this area, the collection and analysis of data on Jeffreys Ledge and nearby waters can enhance understanding of the importance of this area to endangered humpback and finback whales. Observational sightings data were collected aboard four commercial based on natural markings. Preliminary results of this study indicate that many individual finback and humpback whales are observed regularly on Jeffreys Ledge. The area is currently managed for commercial fishing of groundfish, but additional protection should be considered in the future based on the importance of Jeffreys Ledge as a feeding area for endangered whales.

Tracking of Biogenic Hydrodynamic Trails in Harbor Seals

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The wakes of fishes persist for several minutes, thus representing trackable hydrodynamic trails of considerable length. For harbor seals it has been shown that they can use their mystacial vibrissae to detect and track hydrodynamic trails of considerable length generated by a miniature submarine. Here we show that this is also true for biogenic trails left by a swimming conspecific. Starting always from the same position, the trail generating seal was trained to dive one of nine different linear courses through an outdoor pool. After the trail generator had left the water, the blindfolded test animal (tracker) was allowed to start its search from a position close to that where the generator started. Particle image velocimetry (PIV) was used to investigate the flow in a seals' wake. Hydrodynamic trail tracking was successful in 90 % of the trials. The rate of successful trials was independent from the nine different courses. However, video analysis revealed that the tracking seal followed a trail using two different strategies: An almost linear course with a high degree of congruence to the trail, and an undulatory course, crossing the trail repeatedly in a sinuous pattern. The choice of strategy appears to depend mainly on the angle of the trail relative to the tracker's swimming path at the point of trail encounter. These results provide first proof that harbor seals can detect and utilize natural hydrodynamic trails, and suggest that

seals can use hydrodynamic trail following for finding conspecifics under the non-visual conditions they often encounter in their natural environment.

Contingency Learning in Animal Sound Production: Vocal Control and Plasticity in the Walrus

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Classical ideas about acoustic communication in nonhuman mammals are based on the notion that most vocal communication is ritualized and non-modifiable, with emotional constraints, anatomical limitations, and genetic predispositions the most significant features in mammalian communication systems. More recently, this view has been challenged by the discovery that some cetaceans, like humans and some birds, are capable of vocal learning through mimicry. Further, there is evidence that the natural vocalizations of some mammals can be operantly conditioned, that is, they come to reliably occur in the presence of specific arbitrary stimuli and typically do not occur in the absence of those stimuli. The significance of operant conditioning, or contingency learning, in vocal development was highlighted in studies showing that the songs of male cowbirds are shaped through social feedback from conspecific females. These studies were recently extended to show that the vocal development of human infants can also be influenced by a process of selective shaping using social reinforcement. Thus, contingency learning using biological or conditioned reinforcers extends models of vocal development based on innate/emotive sound production and imitative learning. The current study examines the extent to which sounds produced by captive walrus are subject to operant control and selective shaping. Walrus are unique subjects for such experiments due to their natural potential for social learning during an extended period of maternal dependency, their large sound repertoire, and their multiple modes of sound production which include manipulation of the larynx, lips, mouth, nose, tongue, and pharyngeal pouches. Selective shaping using food reinforcement resulted in the acquisition of at least eight discriminative vocal operants in two adult walrus and revealed a degree of vocal plasticity previously unreported for mammalian species. These findings are relevant to the role of contingency learning in the evolution of communication systems including human speech.

An Epidemiological Framework for Analyzing Spatial and Temporal Health Trends for Free-Ranging Bottlenose Dolphin Populations Along the Southeast U.S. Coast

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Bottlenose dolphin (*Tursiops truncatus*) Unusual Mortality Events linked to epizootic disease, marine biotoxins, and potentially, exposure to chemical pollutants, have occurred along the US coast. Such events, and the concern that the disease and toxins affecting coastal dolphin populations could also affect humans, indicate a need to establish baseline health information, develop an understanding of spatial and temporal trends, and determine correlations of dolphin health with environmental

variables. We present an epidemiological framework that uses standardized protocols and common health and exposure endpoints across multiple dolphin capture-release studies to allow for the conduct of meta-analyses. The collective data provide for the assessment of spatial trends, but also increase effective sample sizes and broaden gradients of exposure, thereby increasing statistical power for testing correlations. We define a number of health panels (e.g. hepatic, renal, immune, endocrine) based on select subsets of haematology, blood chemistry and endocrine parameters, then combine data (N=172) from bottlenose dolphin capture-release studies in six coastal sites (St. Joseph Bay, FL; Sarasota Bay, FL; Charleston, SC; Holden Beach, SC; Beaufort, NC; Cape May, NJ) to establish baseline distributions. As an example application of the framework, we examine differences between study populations based on the number of individuals having scores above or below our established baseline percentiles for one or more panels. We find that hepatic panels suggest impaired liver function for many of the dolphins sampled near Cape May, NJ and immune panels suggest a higher level of parasitic infection or inappropriate immune response in the St. Joseph Bay population, for which 82% (CI=48%-98%) of the sampled individuals present eosinophil counts above the baseline 90th percentile. We further discuss the correlation of health panel scores with specific exposure endpoints and plans to expand dolphin health assessments in order to document health trends along the entire southeast US coast.

Bayesian Estimation of Richards Growth Curve Parameters for the Florida Manatee (*Trichechus manatus*)

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Growth curve models provide information on differences in life-history strategies, environmental conditions, and exposure to toxins. They can also, in a limited capacity, estimate age from other morphometric data, such as length or weight. However, growth curve parameters for large mammals can be biased, particularly when age estimation contains error. Bayesian analysis, allowing for the incorporation of age estimation error and prior information, was used to assess Richards growth curve parameters for the Florida manatee to fulfill two objectives: describe regional and gender differences in manatee growth curves, and provide a model to estimate carcass age from length. Body lengths and ear bone age estimates of 1,661 carcasses collected from 1978-2003 were used. Only eight carcasses of known true age were available and used as prior information. Process error was additive and normally distributed with $\mu = 0.0$ and unknown variance. Age estimation error was multiplicative and lognormally distributed with unknown mean and variance. Priors were uniform, restricting unknown age error to 0.5-2.0. Results showed ear bone ages generally underestimated true age. Incorporation of age estimation error led to an increase in growth period, but no other parameters were affected. Posterior distribution of the Richards shape parameter indicated little-to-no preference for any simplified form of the Richards curve. In general, Atlantic animals have a shorter growth period, and males have a shorter asymptotic length than females. Atlantic and Northwest males may be shorter at birth compared to other groups. Since the sample was of dead animals, apparent gender and regional differences could be confounded by the relationship between age, length, and cause of death. Although the ability to determine age from length varies for each group, lengths > 250 cm generally provide poor resolution. An increase in the number of carcasses of known age would greatly improve parameter estimates.

Manatee Population Trends in Sarasota County: Analysis of Aerial Survey Data from 1987 to 2004

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We analyzed aerial survey data from Sarasota County, Florida to assess temporal and spatial trends in manatee counts between 1987 and 2004. Surveys generally occurred twice per month. Three primary regions were

surveyed consistently: Sarasota Bay Region (designated as SBR and including Sarasota Bay proper, plus Roberts, Little Sarasota and Blackburn Bays; N=324), Lemon Bay (N=339), and Myakka River (N=328). Analysis of variance (ANOVA) indicated that season significantly affected manatee counts ($p < 0.0001$ for all three regions). For both SBR and Lemon Bay, summer and fall counts did not differ significantly (Tukey's HSD, $p = 0.88$), but summer/fall counts were higher than counts during both the winter ($p < 0.0001$) and spring ($p < 0.0001$). The pattern was reversed for the Myakka River (including Warm Mineral Springs-WMS), which had higher counts in winter/spring than in summer ($p < 0.0001$) or fall ($p = 0.0014$). In both SBR and Lemon Bay, counts steadily increased beginning midway through the survey period (1996) continuing until 2001 when they began to decline. At their peak (2001), the mean summer/fall count for SBR ($x = 46.7$, 95% CI = 37.7-56.8) was more than double the mean count from early survey years of 1987-1995 ($x = 19.2$, 95% CI = 15.7-22.9). However, winter counts for SBR remained low over the 18-year period ($x = 4.12$, 95% CI = 2.57-5.86), with no significant difference between years ($p = 0.81$). The trend in summer/fall manatee counts coincides with documented expansion of seagrass coverage in SBR through the 1990's, followed by a decrease in seagrass extent between 2001 and 2004. No temporal trend was seen in the Myakka River for any season during the study period. Sarasota County's manatees appear to utilize open bays primarily in the warmer months and such usage seems influenced by resource availability. Conversely, usage of the Myakka River peaks in cold winter months when manatees seek warm-water refugia such as WMS.

Juvenile Steller Sea Lion Movements of the California Current Ecosystem

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Movement and fidelity of juvenile Steller sea lions to haulout sites has important ecological and management implications. We have studied the movements of juvenile Steller sea lions in the California current ecosystem since 2001. Observers travel the coast monthly to survey haulout sites with high powered optics to resight marked juvenile sea lions. This effort has led to over 3,500 individual resights of sea lions ranging from Eureka, California to the south to Kenai Fjords, Alaska to the north. We have found that most juvenile Steller sea lions disperse from their natal rookeries to distinct haulout location or regions of haulouts. Juvenile Steller sea lions from Northern California and southern Oregon rookeries are most commonly observed at Sea Lion Caves. This site appears to be an important winter haulout site due to its sheltering from harsh winter conditions. Other sites where juveniles are frequently observed included the Sea Lion Gulch area in northern California and the southern British Columbia and northern Washington sites around the Strait of Juan de Fuca. The results of this study have three important ramifications. One it increases the efficacy of future studies of juvenile Steller sea lions of the US west coast. Two, through our analysis of resights, we have contributed to the definition of essential coastal habitat for juvenile sea lions which is important for the future protection of this poorly understood species. Third, this baseline information will be very important in the future the eastern stock of Steller sea lions has the catastrophic declines seen in the Alaskan Steller sea lion population.

Evidence for Population Subdivision in the Pacific Harbor Seal (*Phoca vitulina richardii*) in California Based on Mitochondrial and Microsatellite DNA Analysis

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Estimates of the number of populations within a species and the level of connectivity among them are needed to assess the potential effect of threats

to local population units. Habitat destruction, reduced food availability, disturbance by human activities, and mortality from incidental fishery bycatch are a few of the anthropogenic factors that marine species face that negatively impact their ability to survive and reproduce. The objectives of this study were to investigate the genetic structure, genetic variability and gene flow in California harbor seals, *Phoca vitulina richardii*, which ranged from Point Reyes to San Diego. This research represents the first comprehensive baseline study of population structure in harbor seals along the coast and bays of California. Using 269 individuals from five locations, we sequenced 659 base pairs of the mitochondrial control region and analyzed ten microsatellite loci. Utilizing both molecular markers provided more information about population structure, migration, dispersal and the influence of males and females on population structure than analysis of either marker type alone. A significant amount of genetic differentiation and high levels of variation were detected using both markers. Microsatellite F_{st} estimates were lower ($F_{st} = 0.027$, $p < 0.001$) than mitochondrial F_{st} estimates ($F_{st} = 0.108$, $p < 0.001$) but both were highly significant. A number of unique haplotypes and alleles were found in each of the five regions sampled. Thirty variable sites in the control region defining 33 unique haplotypes were identified, along with 84 distinct alleles among 10 microsatellite loci. Although exclusive geographic partitioning was not obvious, these results imply a pattern of restricted gene flow throughout California. Evidence of isolation by distance suggests that gene flow is occurring primarily through neighboring populations. Because the region appears to contain a significant amount of genetic subdivision, caution must be taken in the conservation and management of harbor seals in California.

Lipid and Fatty Acid Profiles as a Forensic Tool for the Identification of Marine Mammal Oils

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Lipid and fatty acid profiles were used to confirm that "sperm whale oil" offered for sale on Ebay and obtained by NOAA Fisheries Enforcement in a "buy bust operation" was in fact authentic sperm whale (*Physeter macrocephalus*) oil. This identification provided evidence in a case that concluded with penalty assessment for the individual involved. Although unlawful under the Endangered Species Act, the possession and sale of sperm whale oil still occur in the United States, likely due to the unusual and highly desirable properties of the oil as a lubricant. In addition to the traditional uses of sperm whale oil in candle making and as lamp oil, it has been used in the leather tanning process, as an ingredient in cosmetics, by gunsmiths and is said to be unsurpassed in performance as an automatic transmission fluid. The identification of this oil sample was based on comparisons of lipid and fatty acid profiles with those of authentic whale oil standards and products commonly substituted for sperm whale oil following the ban on whaling products. A variety of lipid analytical techniques including thin-layer chromatography with flame ionization detection, gas chromatography and mass spectrometry were used to produce a series of profiles from sequential separations of the oil components which provided multiple points for comparison. While DNA and Isoelectric Focusing analyses provide species identification for many types of samples, these techniques are not applicable to oils that most often contain no DNA or protein. Therefore lipid techniques provide an important forensic tool to assist in the protection and conservation of marine mammals.

When Size Matters : Acoustic Cues Used in Male Vocal Contests in Southern Elephant Seals

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The acoustic characteristics of animal vocalizations have been postulated to provide information about many important attributes of the vocalizer, including its size, age, sex, reproductive status and emotional state. In the context of a strong intrasexual competition, such production-related cues provide receivers with strategic information to assess rivals and choose

mates. Vocal contests have indeed been described in many species of polygamous pinnipeds. Previous data on southern elephant seals, *Mirounga leonina*, showed that males assess the size of an opponent on the basis on its calls. However, little is known on the nature of acoustic cues that encode such information. Despite the common claim that voice fundamental frequency provides an acoustic indication of body size, repeated investigations have failed to support such a relationship in many vertebrates including humans. Resonance frequencies (formants), which should be constrained by the length of the vocal tract, have recently been proposed to be a more reliable cue. In this study, we analysed calls from male southern elephant seals to assess which parameters provide a good indicator of body size and reproductive success. We also investigated the adaptive function of the trunk as a way to elongate the vocal tract, allowing callers to exaggerate their perceived body size by decreasing vocal-tract resonant frequencies. A detailed acoustic analysis was conducted on an extensive database of male threat vocalizations produced during male voice contests, in a free-ranging population on Kerguelen island. Linear predictive coding analysis was used to determine vocal tract resonance frequencies. Males presented stereotypical vocal displays, with clear individual variation. We showed that fundamental frequency, but also formant dispersion, are correlated to body size, trunk size and reproductive status. The results presented here show that in addition to primates and ungulates, pinnipeds use formants to encode information in vital vocal exchanges.

‘Dancing’ in Humpback Whales, *Megaptera novaeangliae*, at Silver Bank, West Indies

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Cetaceans spend some 70% of their time underwater and, due to other research priorities and the difficulties of studying free ranging cetaceans, subsurface behaviour has not been the focus of many observations. In the present study, subsurface behaviour related to reproductive activities in humpback whales is documented via individual follows. Silver Bank, West Indies is a major breeding area for the North Atlantic humpback whale. A previously undocumented subsurface behaviour in male and female humpbacks, termed ‘dancing’, was observed there on three occasions during March 2005. This behaviour is described in detail and video and photographic evidence was obtained. Pec and tail slapping on the surface preceded dancing on two occasions and may be associated activities. Although copulation has not been reliably observed in humpbacks, penis extrusion was seen and recorded during dancing. The display of synchronised movements in dancing males and females may be a precopulatory courtship activity. Indeed, dancing may play a role in mate choice and sexual selection.

Review of Blue Whale (*Balaenoptera musculus*) Photoidentification Distribution Data in the North Atlantic, Including the First Long-Range Match Between Iceland and Mauritania

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At least two discrete populations of blue whales (*Balaenoptera musculus*) can be found in the North Atlantic. One ranging from West Greenland to New England but centered in eastern Canadian waters. The other centered in Icelandic waters and extending South to Northwest Africa. Most recent North Atlantic data on blue whale distribution and dispersal has come from St Lawrence where 27 field seasons have yielded a catalog of nearly 400 individuals. This database includes opportunistic sightings from the Scotian shelf and Gulf of Maine. In Icelandic waters blue whale sighting data was collected from whaling ships between 1969-88 and dedicated marine mammal surveys from 1987-2001, however, no dedicated effort for blue whales had been carried out there until 1996. From 1996-2003 89 blue whales were photo-identified off western and southwestern Iceland during a total of 39 field days. The 24 blue whales presently photo-identified from the Azores have all been observed between April and July,

with individuals appearing to pass by the Azores quickly on their way North. Though one two week dedicated study was carried out in 2002 most photographs and observations were taken from whale-watching vessels operating out of Faial and Pico from 1997-2005. In addition three blue whales have been photo-identified from northern Spain, two from the Canaries and three off of Mauritania first reported here. The latter yielded the first match between Iceland and any other region, the longest to date in the North Atlantic for this species at an estimated 5,200 km. No matches have been found to date between Icelandic eastern Canadian and New England waters or between these areas and the Azores.

The Conservation Process for Franciscana

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The Franciscana, *Pontoporia blainvillei*, is perhaps the most impacted small cetacean in the western South Atlantic mainly because of high levels of bycatch during at least the last four decades. Until recently, the effects of bycatch could not be assessed due to the lack of studies on stock structure and, therefore, lack of stock-specific data on life history, abundance and accurate estimates of bycatch. In the early 1990s effort was dedicated to identify the fisheries affecting Franciscana. Coastal gillnetting was considered the most harmful fishery to the species. A fleet monitoring program started by the mid 1990s allowed for estimating annual bycatch as well as for collecting biological sample used in preliminary studies on stock identity (through molecular analysis) and life history. During the same period, an aerial survey was conducted for estimating the abundance of the Franciscana stock inhabiting southern Brazil and Uruguay. Between the late 1990s and the mid 2000s more comprehensive analyses using improved parameter estimates allowed for the first assessment of the status of Franciscana. Population viability analysis suggests that this Franciscana stock cannot sustain the current levels of bycatch. Parameter uncertainty was taken into account and did not change the overall conclusion that the stock is declining. In order to identify factors increasing Franciscana’s vulnerability to gillnetting, the probability of catching at least one franciscana in a net setting was calculated for different locations, seasons and net mesh sizes. The results indicate that Franciscana is more vulnerable to nets targeting croaker and the risk of entanglement increases during spring and in shallower waters to the north of the fishing ground. Management decisions to mitigate bycatch should take these findings into account. The next step for the long process of Franciscana conservation is defining and implementing scientifically based management strategies.

Population Histories of Right Whales (Cetacea: *Eubalaena*) Inferred from Mitochondrial and Nuclear DNA Sequences of Their Whale Lice (Amphipoda: *Cyamus*)

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Right whales carry large populations of three ‘whale lice’ (*Cyamus ovalis*, *C. gracilis*, *C. erraticus*) that have no other hosts and no free-swimming life stages. We used mitochondrial and nuclear DNA sequences to ask whether the divergences of the three nominally conspecific cyamid species on North Atlantic, North Pacific, and southern right whales (*Eubalaena glacialis*, *E. japonica*, *E. australis*) might indicate their times of speciation, and whether levels and patterns of cyamid nucleotide variation might contain information about the long-term population sizes of the cyamid species, and hence also those of right whales. North Atlantic and Southern Ocean populations of all three cyamid species are reciprocally monophyletic at mitochondrial loci but not at nuclear loci, with divergences that suggest complete reproductive isolation beginning around 5 MYA and ongoing lineage sorting at nuclear loci. These patterns are broadly

consistent with recent analyses of right-whale mitochondrial and nuclear sequence data by Sasaki *et al.* (*Syst. Biol.* 54, 77-90, 2005) and Gaines *et al.* (*Proc. R. Soc. B* 272, 533-542, 2005). North Pacific *C. erracticus* is well separated from North Atlantic and southern *C. erracticus*, but the mitochondria of North Pacific *C. ovalis* form a clade inside the southern *C. ovalis* mitochondrial gene tree. This implies that at least one right whale has crossed the equator in the Pacific Ocean within the last 1-2 MY, but that such exchanges are very infrequent. Levels and patterns of cyamid nuclear polymorphism suggest that all three right whales have had consistently large population sizes since speciation, as did their common ancestor for some time prior to speciation. The mitochondrial polymorphism of southern right whales also suggests a continuously large population size.

Diving Activity of Eastern Hudson Bay Belugas (*Delphinapterus leucas*) in Relation to the Diving Lactate Threshold

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Aerobic dive limit (ADL) is defined as the diving duration that results in depletion of oxygen reserves and an increase in blood lactate levels above resting levels. Since it is unlikely that an animal reaches this point, many studies refer instead to diving lactate threshold (DLT). Among pinnipeds and seabirds most dives are less than DLT. Little is known about DLT among cetaceans, but a similar relationship to other groups would be predicted. Satellite transmitters were deployed on nine belugas in Eastern Hudson Bay during summer 2003 and 2004. Daily information on location and diving activity were collected for a mean duration of 166 days (range 67-283 d). As expected only a small number (6%) of all dives (n=36,359) exceeded the estimated DLT of 9-10 minutes. Of those, 96% were from four animals for which tags were still transmitting during winter. In fact, 84% of the dives exceeding the DLT occurred on the winter grounds. A significant (p<0.0001) positive relationship between dive duration and subsequent surface duration was observed for all winter dives (r=0.490; n=7,774), but not for dives exceeding 10 min (r=0.05; n=1,251). The reasons for this are not clear, but may be related to the pattern of blood lactate accumulation and subsequent reduction. The great proportion of dives exceeding DLT during winter, combined with an observed increase in dive depths from summer to winter habitats, is likely related to favourable feeding conditions in deeper waters within this region.

Artificial Tail Flukes 2 - Design and Analysis

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A female bottlenose dolphin (*Tursiops truncatus*) named Fuji, which has been under human care at Okinawa Churaumi aquarium since 1976, lost most of her tail flukes due to a serious disease in 2002. Since then, Bridgestone Company, collaborating with the aquarium and the institute of cetacean research, started feasibility study on designing prosthetic fins for the dolphin. The basic requirements of the prosthetic fin were to assure its attachability, durability, and proper hydrodynamic performances. The choice of materials and the structure was of importance to achieve the goal. The design procedure was based on laboratory and field tests, as well as computer simulation. Using several prototypes, hydrodynamic forces acting on the fins were measured in series of water tank tests. The test results showed how the hydrodynamic performances of the fin were affected its shape, structure, and the method of attachment. Especially, it was understood that the bending stiffness of the fin should be optimized to maximize the propulsive force. The prototype fins, used for field tests, were composed of silicon rubber reinforced by a core plate. Foamed rubber sheets were pasted inside of the fin to prevent scratching the skin of the dolphin. A fastening plate, made of CFRP, was used to attach the fin to the dolphin's body with bolts and nuts. Finite element analysis was used

to design the core plate, one of the key factors to assure the performances of the fin. A special configuration made of hybrid glass and carbon fiber reinforced plastics was adopted so that the plate has proper flexibility and durability. The field tests showed that the dolphin almost regained her swimming ability as before with the prosthetic fin.

The Spectacled Porpoise *Phocoena dioptrica* in Antarctic Waters

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The spectacled porpoise (*Phocoena dioptrica* Lahille 1912) is one of the least known cetacean species. The scarce knowledge on the biology and ecology of this species is largely depended on stranded specimens. Its distribution is based on less than fifteen confirmed live sightings in the wild, and published photographs of live animals in natural condition are also very rare. In this study we summarize 27 recent live sightings mainly from the IWC-IDCR/SOWER cruises (from 1985 to 2004) in Antarctic and sub Antarctic waters. These sighting data supported the suggested circumpolar and offshore distribution of this species. The southernmost sighting was further south than previously known and was 64°34'S. The sea surface temperature recorded at the time of each sighting ranged between 0.9 and 10.3°C, and the majority of sightings (52.0%) were occurred between 4.9 and 6.2°C. Group sizes were small, averaging 2.1 animals. A total of six cow and calf pairs was observed, and all pairs were accompanied by one or two adult porpoises which always included one mature male. From close observation at sea and reviews of new photographs of live animals, a pale "saddle" around their dorsal fins was noticed. The animals showed fast swimming when the vessel approached, which resemble swim behavior observed on harbour porpoise.

Distribution and Abundance of Cetaceans from the Northern Coasts of the State of Veracruz, Mexico

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The distribution and abundance of marine mammals along the US coast of the Gulf of Mexico are well documented, but similar studies for the Mexican coast of the Gulf are lacking. Ours is the first formal study of marine mammal distribution and abundance for a part of the Mexican coast of the Gulf of Mexico. Our goal is to determine the species of marine mammals that inhabit the northern coast of the state of Veracruz, Mexico, and to determine their distribution and abundance. Mainly boat-based surveys are carried out, but we are doing aerial and passive acoustic surveys as well. For the boat-based surveys a 7 m *panga* powered by an outboard 65 HP engine is used. Aerial surveys are done with a MAULE MXT-7-180 airplane. For the acoustic surveys, we use autonomous recording equipment that we designed. Boat-based surveys are being carried out weekly (weather permitting), and last around 5 hours. Aerial surveys are flown twice a year covering the entire study area on each flight. So far we have identified four cetacean species: bottlenose dolphins (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), spinner dolphins (*Stenella longirostris*), and a sperm whale (*Physeter macrocephalus*; found stranded). Results from the surveys suggest that coastal bottlenose dolphins are established in at least three separate populations in the study area. We have not seen well defined distribution patterns for the other species that we have encountered.

Distribution and Movements of Short-Finned Pilot Whale (*Globicephala macrorhynchus*) in Canary Islands

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Short-finned pilot whale, *Globicephala macrorhynchus*, exhibits a wide distribution in warm and tropical waters of all the oceans. In the Canary Islands, this species, with the bottlenose dolphin, represents one of the main targets of the whale-watching industry, particularly off the south west coast of Tenerife island. The aim of this research was to know the possible movements of the species between the islands. Since 1999 we have collected information on distribution and photo-identification of short-finned pilot whales around the Canary Islands. In this period, we have completed 257 field days, 1,636 hrs and 10,134 nautical miles of boat effort. All pods of pilot whales were identified and a comparison was made with the catalogues produced in 1990-1991 by James Boran and in 1992-1993 by ourselves on the short-finned pilot whales community of the south west of Tenerife. From 1999 we have had 53 encounters with the species, 18.5 % of the cetacean species encountered. The results of this research highlights a wide range of movements between the islands of this archipelago, mainly Tenerife-Gran Canaria and Tenerife-La Gomera, with records of movements between islands over a period of up to 10 years. The record of the same animal groupings is a direct indication of long term association within social groups. There is a surprising permanence of some scars (*i.e.*, tooth marks) for a long period of at least 10 years.

Probabilistic Approach to the Estimation of Marine Mammals Number Based on Data from Airborne Survey by Transects

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One of the main ways to estimate marine mammals is an airborne survey conducted by parallel transects over the whole study area. To estimate the number of marine mammals different methods are used, which are based mostly on the calculation of mean density of distribution in the swath of continuous or discrete aerial surveys, which subsequently is extrapolated for the whole survey area that can entail a rather big error of the estimation. There is a need for higher precision in the estimation of marine mammals number taking into account their distribution pattern. For this purpose, in the present paper it is proposed to use the probabilistic approach to the estimation of number of biological objects in the airborne surveys, the basis for which is the Monte Carlo method. All primary data from the airborne survey is used to make a table of density distribution of marine mammals registered by position including zero values. The distribution of densities obtained is divided into categories and the probability of a number of marine mammals per unit area that fall within one or another category is estimated. The area over which the marine mammals are estimated is divided into squares corresponding to unit area of densities. Then, in each square, except for squares with primary data, the probable number of marine mammals is determined. Taking into account the type of marine mammals distribution (aggregated, grouped or uniform) by using weight functions, the probability of each density category is calculated by squares. Next, having applied the Monte Carlo method, the category of density and probable number of marine mammals are determined. By summing over estimates in all the squares we arrive at the probable estimate of marine mammals number over the whole survey area. The estimation described above is repeated many times and the mean number of marine mammals and standard deviation are estimated. To implement the above method of estimation of marine mammals number, the author has developed an original program, brief description of which and examples of application are demonstrated in this paper. The paper also gives comparative estimations of marine mammals number using the proposed probabilistic and traditional methods on the basis of mathematical models and data from airborne surveys of the harp seal molting grounds in the White Sea in April 2005.

Milk Mineral Values in Free-Ranging and Captive Bottlenose Dolphins (*Tursiops truncatus*)

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Data on the mineral content of dolphin milk are scarce. The quality of milk provided to nutritionally dependent calves may affect calf survivorship. In captive facilities, reports of hypocalcemic and anemic calves demonstrate health concerns involving the mineral content of dolphin milk. This study established baseline values for phosphorus, calcium, potassium, sodium and magnesium in dolphin milk. Wild and captive populations were studied. Twenty one samples were collected from free-ranging bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Twenty four samples were collected voluntarily from captive dolphins housed at Dolphin Quest facilities. Captive dolphin milk mineral concentrations ranged as follows: 0.068-0.146% phosphorus, 0.042-0.113% calcium; 0.082-0.263% potassium, 0.01-0.484% sodium and 0.004-0.065% magnesium. Wild dolphin milks ranged from 0.11-0.144% phosphorus, 0.086-0.131% calcium, 0.218-0.278% potassium, 0.021-0.043% sodium and 0.003-0.011% magnesium. Mineral values were compared between the two populations, and all were significantly different. Phosphorus, calcium and potassium were higher in the wild population; sodium and magnesium were higher in the captive animals. Sodium values in the captive samples may be higher as a result of salt water contamination. Captive dolphin samples were compared between early, mid and late lactation. Phosphorus and potassium levels were significantly different between the lactational stages. Wild population samples were analyzed according to calf age and size. A one way analysis of variance indicated a significant difference between calf age and potassium values; linear regression showed potassium values decreasing with increasing calf age. There was no significant relationship for phosphorus, calcium, sodium or magnesium. In agreement with the findings on calf age, calf length was only correlated with potassium where values decreased with increasing calf length. Results of this study provide a reference of baseline milk mineral values for captive and wild populations; their application towards the diet of captive mothers will be considered.

Vocal Behavior of Free-Ranging Arctic Narwhals (*Monodon monoceros*)

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Acoustic studies of free-ranging narwhals (*Monodon monoceros*) help ascertain the function and importance of vocal behavior in foraging and social contexts. Here, a digital archival tag (DTAG) that samples audio at 96 kHz and depth and orientation at 50 Hz was used to tag two adult male narwhals in Admiralty Inlet, Baffin Island. This tagging was conducted in conjunction with satellite transmitter deployments used to monitor stocks, migration routes and critical habitats. The DTAG deployments lasted 2.5 hours for the first animal and 12 hours for the second; their deepest dives were to ~120 m and ~210 m, respectively. Data from the tag enabled determination of the vocal repertoire of each individual, along with the behavioral contexts of vocalization. The vocalizations of both individuals were all produced within ~110 m of the surface and fell into three general categories: (1) echolocation clicks; (2) burst pulse calls; (3) frequency modulated (FM) whistles. The burst pulse calls fell along a production continuum, ranging from slower series of pulsatile, broadband clicks lacking an additional FM component (inter-click interval (ici) > 0.3 s) to a more rapid series of clicks with a simultaneous FM component (ici << 0.1 s). We compared the temporal and spectral features of the whistles and found

significant differences between the two individuals ($P < 0.001$). For example, the mean frequencies of the whistles from the two animals were 3.6 ± 0.4 kHz and 1.0 ± 0.1 kHz. A separate, non-parametric measure that accounted for overall contour shape and absolute frequency content confirmed greater inter-individual compared to intra-individual differences. These data are consistent with the hypothesis that narwhals produce individually-distinctive signature whistles for social purposes, but more recordings are required to demonstrate this claim more rigorously.

Entanglement Scars on Fin Whales: An Examination of Fisheries Interactions in the Gulf of Maine

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Photographic suites from 183 individually and sexually identified fin whales from two study periods, 1991-1996 and 2000-2004, were analyzed for scarring from fisheries entanglements. The results were used to estimate the level and nature of fisheries interactions for this species in the Gulf of Maine. Of the individuals studied, thirty-one (23.5%) from '91-'96 and 11 (21.6%) from '00-'04 showed evidence of entanglement scars from photographs of the left and right flanks of the animal. Thirteen (7.1%) individuals were known from previous sightings, documented in the North Atlantic Fin Whale Catalogue, and analysis indicates that most scars for these individuals were acquired prior to the study period beginning in 1991. Photographic suites were considered complete when all eight areas of the left and right flanks were documented, including the chevron, back, dorsal, and caudal peduncle. Most photographic suites utilized in this study were incomplete, with only 38% of the individuals having more than four areas of the body captured. Sixty-seven percent of the sightings did not capture the caudal peduncle fully; meaning the photograph did not show at least 50% of the area longitudinally. Our results show that the majority of entanglement scars were found on the caudal peduncle (77%), followed by the back, dorsal and chevron respectively. Examination of the sex of scarred individuals indicated no significant difference between males and females with respect to entanglement scars, though more males were observed with entanglement scars between 1991 and 1996 while the 2000-2004 data exhibited more females with these scars. We estimate the actual percentage of Gulf of Maine fin whales involved in fisheries interaction, resulting in scars, at much higher than the average observed rate we found of 22% due to the under representation of the caudal peduncle area in photographic identification suites.

Atlantic Large Whale Disentanglement Network – 2004/2005

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Since its establishment in 1994, the Atlantic Large Whale Disentanglement Network has continued to expand its response capabilities. The Network, with support from NOAA Fisheries, consists of 827 marine professionals, including commercial fisherman, biologists, federal and state employees, trained at different levels of response. Twenty disentanglement teams from Quebec to Florida, working under U.S. or Canadian permits, receive training, equipment, and coordination assistance through the Network. In 2004, the Network saw a marked decrease in the number of reported entanglement cases, as compared with the previous five years, yet those reports represented relatively high species diversity. All told, 54 reports were called in to the network from the Gulf of Maine to Florida, 17 of which were confirmed as entangled whales (an additional five were confirmed as entangled sea turtles and sharks). Confirmed entanglement cases involved six North Atlantic right whales (*Eubalaena glacialis*), seven humpback whales (*Megaptera novaeangliae*), three finback whales (*Balaenoptera physalus*), and one minke whale (*Balaenoptera acutorostrata*). Entanglement reports were received from a variety of sources including commercial fishermen, whale watch operators, private citizens, and aerial surveys. Network units went to sea on over 20 occasions for entanglement reports, fully resolving six cases: one right whale, three humpbacks, one finback, and one minke. The Network is increasingly providing training, equipment, and consultation on cases to disentanglement efforts in other regions. In 2004, Network personnel equipped and trained teams at the Mingan Island Cetacean Study in

Quebec, provided advanced field training for a representative from the Western Australia Department of Conservation and Land Management, conducted training in British Columbia, and consulted with the government of South Africa on entanglement response. Activities from 2005 will also be included.

Harbour Seal Foraging Habitat off Eastern Scotland: Potential Conflicts with Offshore Energy Developments

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Until strategic environmental assessments around Britain in relation to the licensing of offshore oil, gas and wind farm activity were undertaken recently, knowledge of the offshore distribution, movements and behaviour of harbour seals was very limited. A previous study using VHF telemetry in the Moray Firth, northeast Scotland, showed that animals foraged within 60 km of haul-out sites (usually within 30 km in summer months). In this study, satellite telemetry was used for the first time to track the movements of harbour seals in the Moray Firth, ($n=10$) and in St Andrews Bay, southeast Scotland ($n=24$) to investigate foraging areas and their relation to human activities offshore. Locations were filtered and those near haul-out sites were excluded from further analysis. Speed of travel was used to determine whether animals were travelling or foraging at the remaining locations. Data were resampled so that each individual was represented equally and to give locations that could be treated as independent. The resampled foraging locations were subsequently modelled using a binomial generalized linear model, including a null model of accessibility and bathymetric and substrate features as explanatory variables. In both St Andrews Bay and the Moray Firth foraging activity was aggregated into 'hot-spots' of localised foraging activity between 10 and 70 km from the haul-outs, largely within the 60 m depth contour. Harbour seals selected sandy substrates with higher percentages of gravel and lower percentages of mud than available. This describes the burrowing habitat of sandeels, one of the main prey species of harbour seals in these areas. Animals travelled significantly further than previously thought, demonstrating important overlap between foraging and offshore human activities.

Dolphin and Porpoise Assemblages Observed near Carmel, California, Winters 1967-2002

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The coastal waters of central California provide foraging habitat for a variety of temperate and warm-water dolphins and porpoises. Near Carmel, submarine canyons penetrate the narrow continental shelf, in some places within meters of shore, providing a unique region where pelagic and nearshore species intermingle. From 1967-2002, 22 gray whale censuses were conducted near Carmel (December-February most years) during which time observers recorded the presence of other cetaceans. Pacific white-sided dolphins and killer whales were the only dolphin species identified prior to 1981. Since 1985, killer whales and white-sided dolphins continued to be reported as well as six other small cetacean species. Northward extension of the range of some species (common and bottlenose dolphins) occurred after the 1982/83 El Nino. Common dolphins were reported most frequently by shore observers followed by Risso's dolphins, bottlenose dolphins, harbor porpoise, Dall's porpoise and northern right whale dolphins. During aerial surveys, Risso's were reported most often followed by white-sided and common dolphins, northern right whale dolphins, Dall's porpoise, and killer whales. Sighting reports were expected to drop in January when gray whale counts are highest and observers focus on the target species, however, the opposite was found: commons (81% of reports), killer whales (90%), Risso's (76%), white-sided (75%), harbor (78%), and bottlenose (60%). Killer whale presence was found to correlate with number of newborn gray whale calves during the southbound migration ($R^2=0.72$, $p=1.59 \times 10^{-07}$). Over 65% of small cetacean sightings 0.7 nm (1.3 km) from shore observers were unidentified suggesting under-representation of pelagic species. During concurrent aerial and shore-based operations, Risso's comprised 34-100% of the aerial sample, 13-50% of the 25-power binocular sample, and 0-29% of the shore sample. Common dolphins displayed a narrow

bathymetric preference (91-183 m contour) regardless of survey platform, month, year, or time of day.

When Do Wild Dolphins Sleep?

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Studies of sleep in captive dolphins demonstrate these animals are capable of both lengthy periods of vigilance as well as deep full-brain sleep. In wild bottlenose dolphins, the need for vigilance to avoid predators and to maintain environmental awareness is a constant necessity. During continuous fine-scale tracking of tagged wild dolphins (*Tursiops truncatus*), we have been able to identify periods when the animals appear to be engaging in “half-brain” sleep, marked by slower speed transit swimming in a constant direction with relaxed respirations and surfacings. These behavioral observations were made both during day and nighttime, and the sleep intervals occurred when tranquil conditions existed during transits between foraging patches. The dolphins were seen foraging during day and night, and spent over half of their time engaged in transit swimming. Transit-sleep periods occurred during approximately 15% of these dolphin’s days, for short intervals typically lasting less than one hour at a time. During 214 hours of focal follows of tagged dolphins since 1995, we have not yet made an observation of a totally quiescent animal engaged in apparent deep sleep similar to that seen in captive animals. We suggest that dolphins in the wild do not have the luxury of sleep in a manner similar to the logging behavior noted in captive animals, probably because their constant movements between foraging patches are linked to tidal changes and associated prey activity levels.

Gray Whales and Marine Protected Areas: A Multi-Trophic Level Approach to Assessing Functional Ecological Association

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The time and space domain of large baleen whales make them an unlikely candidate for conservation via protected areas. If, however, network function and connectivity, two of the lofty ambitions of marine protected areas, can be brought into play, the likelihood of successful protection for large whales rises. Our objective for this research is to examine the ecological linkages between six marine protected areas that encompass summer foraging sites of gray whales (*Eschrichtius robustus*) on the west coast of Vancouver Island, Canada. To make those linkages we investigated three levels of the whale’s food chain. The primary productivity is examined through the systematic measurement and mapping of the distribution of chlorophyll a. The primary consumers are elucidated through molecular methods. The principal prey item, *Holmesimysis sculpta*, is patchy throughout the study area, yet the question of its spatial population structure is paramount. These invertebrate’s dispersal capability is at the heart of whether the sites are actually linked. The whales, at the top of these short food chains, are examined through photographic capture and subsequent recapture of animals moving amongst the foraging sites. The results of the research indicate ubiquity, as one might expect, at the foundation of the food chains. There is a strong preliminary indication of discontinuity in the middle of the food chain, caused largely by the spatially discrete nature of the whales’ major prey species. At the top of the food chain the whales move with alacrity between sites in a fairly typical patch foraging manner. Our most useful conclusion is that care should be taken using only one layer in a food chain for designation of protected areas will miss significant aspects of whales’ ecology and is insufficient for planning management strategies for MPA’s and whales.

Photo-Identification of Black Sea Dolphins: Abundance and Residence Patterns Along the Resort Coastline of Big Sochi, Russia

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To date, no reliable studies on abundance, distribution and migration of dolphins along Russian Caucasian coast have been conducted. Here we report on 3 boat-surveys (4 days in June 2004, 4 in October 2004, and 8 in April 2005; total 35hours) conducted in the region of Big Sochi. The study area covered 35km of coastline and 4km offshore. Water temperature, GPS position, time, species, group size and composition, and activity were recorded. For PhotoID we used Nikon D70 with 80-200 lens. Common dolphins (*Delphinus delphis*) and harbor porpoises (*Phocoena phocoena*) were sighted in the southern part of the study area. On the contrary, bottlenose dolphins (*Tursiops truncatus*) occurred regularly in the northern part. *Bottlenose dolphins*: usually we observed 30-40 animals (min estimate) in scattered groups of 6-12 animals with calves and juveniles, and smaller groups (3-6 individuals) of presumably males. In June 21 individuals were identified, in October – 9, in April – 37, of which 4 individuals were observed in all three surveys, and 8 – twice. We suggest that the studied population is local. Small male groups were not resighted and are presumably transient. *Common dolphins*: were also sighted regularly. They formed herds of >100 individuals dispersed over approximately 1sq km. Although we identified 70 individuals in three surveys, we didn’t find any cross-survey matches. The region is certainly very “popular” among common dolphins, but to date it is unclear whether the observed animals are local. *Harbor porpoises*: no PhotoID was done due to their elusive behavior. Porpoises shared the feeding area with common dolphins (distance between groups of these species didn’t exceed 1km), but came closer (<30m) to the beach of a town. The 40-50 animals sighted may be either local or transient; however, their “fearless” proximity to resort sea-front and boats indicates that they may be local.

Emerging Infectious Diseases of Free-Ranging British Columbia Sea Otters (*Enhydra lutris*)

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Sea otters (*Enhydra lutris*) play an important role in maintaining the health of the kelp ecosystem in temperate coastal regions. As a consequence of the fur industry, the Canadian population was extirpated by 1929. Translocation efforts were carried out between 1969 and 1972 with 89 animals from Alaska. The population numbered 2,500 by 1998 and has continued to expand. Because of their ‘threatened’ status in Canada, baseline information is needed on the health of individuals and threats facing the population. As part of a broader study, we conducted an evaluation of pathogen exposure of free-ranging sea otters that were live-captured near Bella Bella (2003; n=18) and Nootka Island, BC (2004; n=24). Otters were sedated with an intramuscular injection of fentanyl (0.22 mg/kg) and diazepam (0.07 mg/kg) and later reversed with naltrexone (0.44 mg/kg). Blood was collected and serum separated and frozen for subsequent serological testing. There was no evidence of exposure to *Brucella*, herpes virus or West Nile Virus, in the sea otters, the latter of which has yet to be detected in British Columbia. All of the otters were seronegative (IFAT) to *Sarcocystis* and *Neospora*, while two of the otters (2004) had low IFAT titers to *Toxoplasma gondii*. Eight of the 24 otters (2004) tested positive for canine distemper in a virus neutralization test. Given the roles that *Toxoplasma* and morbillivirus have played in mortalities of marine mammals elsewhere, our results suggest that these pathogens may represent an emerging conservation concern in BC sea otters. Collectively, results will prove useful as a reference tool for long-term monitoring of the health of the BC sea otter population, as a tool for rehabilitation and treatment in captive facilities, for comparison with sea otters being studied elsewhere in the North Pacific Ocean, and in assisting the Sea Otter Recovery Team in Canada.

Comparative Analysis of Vocalizations in Killer Whales from Different Regions of Far East, Russia

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Long-term investigation of killer whale (*Orcinus orca*) acoustic behavior in different parts of the world showed that each group of these cetaceans has a unique repertoire of discrete calls. Groups that share calls belong to the same acoustic clan descended from one matriline. Thus, comparing the repertoires of different groups it is possible to find out if they are related and represent the same acoustic clan or belong to different clans. The aim of our research is the description and comparison of discrete call repertoires of killer whale groups from Eastern Kamchatka, Kuril Islands, Sakhalin Island, Koryakia, Chukotka and Commander Islands. The acoustic data were collected during 1999-2004 period in the regions of Russian Far East, mentioned above. To reveal the repeated sightings of killer whales in different regions an individual photoidentification of killer whales based on the photo materials collected in 2001-2004 was used. The results of the research revealed the presence of shared discrete call types between killer whale groups encountered in the regions of Northern Kuril Islands, Eastern Kamchatka, Koryakia and Chukotka. According to the photoidentification data there were repeated sightings of killer whales between Northern Kuril Islands and Eastern Kamchatka as well as between different localities of the eastern Kamchatka coast. These results allow us to suggest that killer whales from these regions descended from one matriline and represent the same acoustic clan. All call types recorded near Southern Kuril Islands, Sakhalin and Commander Islands were unique. The individual photoidentification revealed some repeated sightings of killer whales between Commander Islands and Eastern Kamchatka. As it is known that groups from different acoustic clans can share one water area, we can suppose that killer whales from these regions form separate acoustic clans with unique vocal traditions and independent descent.

Analysis of Dolphin Strandings in the Mississippi Sound and Northern, Central Gulf of Mexico

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The bottlenose dolphin (*Tursiops truncatus*) of the Mississippi Sound and adjacent waters of the northern, central Gulf of Mexico (GOM) is a very important part of the ecosystem. Since it occurs near the top of the food chain, it could serve as a good sentinel for the health of the environment in which it inhabits (Malakoff 2001). The purpose of this study was to spatially and statistically analyze historical stranding data for bottlenose dolphins, conduct systematic surveys (searches) for dead stranded dolphins, and collect biological and environmental data on the stranding events. The biological and environmental data collected included carcass condition (known as occurrence code), morphometrics, gender, season, and oceanographic conditions. Historical data for stranding events from 1987 - 2003 were obtained from NMFS archives and systematic surveys to search for stranded dolphins were conducted by airplane, boat, ATV and beach walks of the mainland and barrier islands during 2002 - 2004. A total of 1,354 bottlenose dolphin stranding records were analyzed using ArcGIS and various statistical analyses. The stranding events were found to be seasonal, with most of the strandings occurring during spring months (March - May). The barrier islands of the MS Sound received the earliest and most numerous strandings during the year compared to mainland beaches. The spatial pattern of strandings correlated with prevailing physical, oceanographic and meteorological variables such as wind speed (WSPD), wind direction (WDIR) and wave height (WVHT). The significance of this study is that this area of the GOM had previously been understudied. The information collected for this project, will help direct future efforts for stranding response, research and management of the species.

Intrafiber Lipid Droplets in Swimming Skeletal Muscle of Stranded Cetaceans in Canary Islands

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The present study is focused on the analysis of swimming skeletal muscle samples (longissimus dorsi) from 15 different species of 86 stranded cetaceans in Canary Islands from 1996 to April 2004. The purpose of this study was to evaluate the presence of spherical intrafiber lipid droplets to explain the aerobic capacity of skeletal muscles under the hypoxic conditions of diving. The previously fixed tissue in 10% neutral buffered formalin solution was post fixed in 1% osmium tetroxide, dehydrated in graded ethanol series and embedded in paraffin. Sections (5 mm in thickness) were cut, treated with picric acid for 24 hours and stained with hematoxylin-eosin. As result 19 of the 86 animals (22%) belonged to 7 of the 15 species of cetaceans presented different degree of intrafibrillar droplets with the osmium tetroxide method. The percentages exhibited for each species were the following: *Globicephala macrorhynchus* (n=8) 38%; *Kogia breviceps* (n=5) 20%; *Kogia sima* (n=2) 50%; *Mesoplodon densirostris* (n=2) 100%; *Physeter macrocephalus* (n=7) 43%; *Stenella frontalis* (n=12) 8% ; and *Ziphius cavirostris* (n=10) 70%. According to the results described above we may conclude that swimming skeletal muscle of deep, long-duration divers species showed a greater amount of lipid intrafiber droplets that swimming skeletal muscle of short-duration divers species.

From Light to Green: The Potential for Light Level Sensors Carried by Diving Marine Animals to Provide Subsurface Profiles of Chlorophyll a

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In recent years with technological advances, instruments deployed on diving marine animals have been used to sample the environment in addition to their behavior. One basic water column measurement of significant biological importance is chlorophyll a concentration; it is essential in the calculation of primary productivity and has been linked to areas of concentrated prey resources. Chlorophyll a concentration can be derived from discrete water samples, fluorometers and light data. However, the light data must be of sufficient quality to estimate attenuation, from which chlorophyll can then be estimated. Here we report on a series of lab calibration and field validation experiments for the use of light level sensors already incorporated in animal borne loggers to derive chlorophyll a concentration. If validated this approach would not only increase the spatial and temporal resolution over which chlorophyll a is currently measured by satellites and other instruments but also provide data in areas satellites cannot, for example subsurface profiles and coastal areas. Existing light level sensors (470nm±50 FWHM) on Wildlife Computers MK9 TDRs were calibrated against a Hansatech Quantitherm light meter using 21 controlled light levels from a known light source. Two instruments from different production batches were calibrated with good agreement between instruments. Performance of the MK9s was validated in the field by comparisons with two optical instruments: a multi-channel hyperspectral radiometer and a WETLabs fluorometer. In April/May of 2004, casts to 200m were performed over the Monterey Canyon using a CTD array carrying MK9s, the Hydrolab light meter and fluorometer. Derived chlorophyll a profiles from all three sources were within reasonable agreement. Preliminary analyses suggest adequate accuracy of the sensors and provide an encouraging outlook for the increased resolution of productivity data, which should prove to be an important new tool in describing habitat use in marine animals.

Spatial Clustering of Harbor Seals in Glacial Fjords

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Glacial fjords are important habitats for harbor seals in Alaska, with about 10% of seals using fjords during the molting season. Many of these fjords face increasing cruise ship traffic, and proper assessment and mitigation of potential ship disturbance requires an understanding of the distribution of seals within fjords. We assessed possible clustering of seals within fjords based on K-statistics, a measure of crowding, with comparisons to simulated Poisson distributions. We also evaluated the relationship between seal density (and/or cluster location) and ice concentration (% of water covered by icebergs). Aerial surveys were flown at eight glacial fjords during 2001-2002, and large-format photographs were taken along transects using a belly-mounted camera. Virtual mosaics of the images were created to map the location of every seal and the areas of visually homogeneous "patches of ice," with (x, y) locations and distances standardized to body lengths of seals in the images. Seals were strongly aggregated into one cluster within each fjord, with a few dispersed seals not associated with the cluster. Seal clusters were 142-1,038 body lengths in radius and comprised 11-1,517 seals, including 63-99% of seals within seven fjords and 29% within one fjord. Seal clusters were located within the ice patch with the highest ice concentration available in a fjord (excluding a few very small patches of dense ice that were too small to host a seal cluster). These dense ice patches with seal clusters tend to be found near the glacier itself, placing seals at risk of possible inadvertent disturbance by cruise ships attempting to approach the glacier. Awareness of these patterns in seal distribution at fjords may help in the development of mitigation measures to reduce the risk of disturbance, if such measures are deemed necessary.

Photo-Identification of Gray Whales (*Eschrichtius robustus*) in Bahía Magdalena, Mexico and a Revision of Current Standards

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Bahía Magdalena, located in Baja California Sur, Mexico, is an important winter breeding and calving ground for the gray whale. The Center for Coastal Studies completed photographic-identification studies of gray whales in the bay in 1998, 1999, 2004 and 2005. These and subsequent photo-identification studies will provide information on site fidelity and habitat use within Bahía Magdalena. Studies utilized boat based photo-identification methods and the manual identification of individual whales by natural pigmentation and scarring. This included specific analysis to determine the number of "photographic recaptures", or organisms photographed multiple days. After 14 field sessions between February 17 and April 21, 2005, 53 individual whales were identified; 22 recaptures were made, with 13 individual whales photographically recaptured. The number of recaptures exceeded those in past seasons due to improved data collection and analysis. After analysis, 104 images from the 2005 season and 203 images from past CCS studies were selected and digitally stored in a central photographic database. This catalog of 307 images has been compiled for current and future collaborators and researchers at the Center for Coastal Studies. Each photograph in the catalog was compared to all others to determine if any whales were photographically recaptured in more than one breeding season. However, no matches have yet been found. The sporadic nature of past data collection as well as quality issues with the images led to difficulties in analysis and possibly unreliable results. It is proposed that a more standardized method for photo-identification of the gray whale be established in order to maximize the value of photographic data collected over the entire eastern Pacific gray whale habitat. Increased collaboration of photographic data between breeding lagoons as well as feeding grounds will lead to a greater understanding of site fidelity, movement and other information about individual whales.

Saimaa Seal Will Not Reach the Favourable Status of Population as Demanded by European Legislation

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Saimaa seal (*Phoca hispida saimensis*), is endangered according IUCN's classification. European Union legislation lays down that the Saimaa seal population needs to be strictly protected (Class 4a in Habitat Directive). Unless protection measures are applied, the Saimaa seal will face extinction due to the high mortality caused by seals getting tangled up in fishing tackle or due to abnormally high larval-mortality. The habitat of the seal Lake Saimaa is subdivided into smaller lakes, e.g., Kolovesi, Joutenvesi, Haukivesi and Pihlajavesi, which are separated from each other by narrow straits. The subdivision of Lake Saimaa does not suggest separate subpopulations. In 1990-2004, the estimated mean growth rate of the population has been 1.026, while the estimated growth rates differ a lot between sub-areas from 0.919 to 1.056. Population centres are in the central part of the lake. In 1990 ca. 20 % of the population occurred in the sub area of Pihlajavesi, and in 2004 ca. 30%. Correspondingly in 1990 ca 62% of seals occurred in four main breeding areas and in 2004 ca. 71%. The European Union and Finnish national legislation demand that the aim of the protection is a favourable state of conservation. Due predictable local extinctions in sub areas it seems to be impossible to reach this aim. In foreseeable future Saimaa seal will not face extinction, but a greater degree of protection may be needed.

Behavior and Social Interactions of Juvenile Southern Right Whales (*Eubalaena australis*) at Península Valdés, Argentina

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Juveniles represent a large proportion of all whales but we know little about their behavior and social interactions and how they develop social skills to become successful adults. The behavior of southern right whale juveniles (1 to 4 yr) was studied during the calving season (Aug to Nov) between 1997 and 2001 at Península Valdés. In 1,115 hourly scans, 1,651 juveniles represented 16 % of 10,331 whales counted (including resightings). A total of 29 females, 42 males, and 120 juveniles of unknown sex were observed during 283.4 h of continuous focal animal samples. Juveniles engaged in solitary, social and object play. Females played with mother-calf pairs significantly more often than males, who played more frequently with other juveniles (Fisher Exact test, $df=1$, $P=0.033$). Juveniles spent nearly half of the time socializing with age peers, followed by mother-calf pairs and adults. Females spent significantly less time with other juveniles ($t=-2.13$; $df=59$; $P=0.037$) and more time with adults ($t=2.27$; $df=59$; $P=0.027$) than males. Females and males actively maintained interactions with mother-calf pairs and with age peers, respectively. During social interactions, females spent significantly more time belly up than males (probably to avoid unwanted copulations) ($t=3.13$; $df=69$; $P=0.003$), and ended encounters more frequently by turning away from other whales. Over half of the groups where juvenile males engaged in sexual behavior contained only males. Juvenile right whales may use Península Valdés as a place to practice locomotory behavior and to socialize with conspecifics. Juvenile males may establish relationships with age peers that could be important during their adult lives. Juvenile females seek to interact with mothers and calves, possibly to learn maternal behavior by observing them. Sex differences in social interactions that are part of adult whale behavior begin to be established during the juvenile stage in southern right whales.

How Far Can Blue and Fin Whales Be Heard in the Southern Ocean?

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Blue and fin whales produce loud, low frequency calls that are well suited for long range propagation. To obtain source levels of whale calls the received level, range of the calling animal, and properties of the transmission

environment must be known. Calibrated acoustic recording packages (ARPs) were deployed off the Western Antarctic Peninsula. Calls of both species were commonly recorded and two different methods were used to determine locations and ranges to the calling whales. Blue whale calls are detected at longer ranges than fin whale calls and could be localized using the differences in call arrival times to three different instruments that were spaced between 100 and 180 km apart. Ranges to blue whales were also calculated from multipath arrivals of their calls and these results were verified with those obtained by the difference in arrival times method. The range to calling fin whales was determined using only multipath arrival difference. An environment favorable for long range propagation allowed blue whale calls to be heard at a distance of 200 km, while fin whale call range was determined to be 60 km. Calculated blue whale source levels ranged from 178-195 dB re: 1 μ Pa at 1 m and fin whales source levels from 172-190 dB re: 1 μ Pa at 1 m.

Using Reproductive Parameters to Examine Population Performance in the Western Atlantic Harbor Seal (*Phoca vitulina concolor*)

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In New England, estimates for the Western Atlantic harbor seal (*P. v. concolor*) suggest that the population size continues to exhibit exponential growth; indicative of below one-half carrying capacity ($\frac{1}{2}K$). The purpose of this study was to compare reproductive characteristics in Maine to other stable, northern populations. Parameters estimated included birth mass, growth rate and duration of lactation. We hypothesize that values from this study will be similar to those in other areas, indicating that the Maine stock remains below $\frac{1}{2}K$. Harbor seal pups were captured at pupping ledges of Penobscoot and Blue Hill bays in Maine during the 2004 and 2005 seasons. Pups were regularly relocated and captured to collect longitudinal data and to determine weaning. No significant sex differences were seen in birth mass (t-test: $p=0.07$) resulting in a pooled value of 10.4 kg ($n=35$; s.e. 0.23). The mean rate of mass gain was 0.45 kg/d ($n=32$; 95% C.I.: 0.38-0.52). There was no difference in mass gain between females and males (t-test: $p=0.48$). An average weaning age of 20.1d ($n=16$; s.e. 1.15; range 13.6d–24.1d) was obtained based on mother presence/absence data. Estimates of birth mass in this study tended to be lower than other reported values, however, the difference was not significant. Growth rate was significantly lower (0.45 kg/d; s.e. 0.034) than values reported on Sable Island, NS (0.54 kg/d) and in the St. Lawrence River estuary (0.59 kg/d). Weaning age was significantly lower (one sample t-test; $p<0.05$) than the value reported at Sable Island (25.5d). Within the population, lactating females incur the highest energetic costs and maternal investment is limited by available resources. The onset of density dependent effects, therefore, would likely be seen as depressed reproductive performance. Values in this study were lower than those reported elsewhere, suggesting that the population has exceeded $\frac{1}{2}K$.

Echocardiographic Evaluation of the Bottlenose Dolphin: Transthoracic and Transesophageal Approaches

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Historically, evaluation of the dolphin heart using conventional ultrasound technology has been limited by logistic, anatomic and behavioral challenges. However, the ability to evaluate the dolphin heart with ultrasound (echocardiography) would represent a valuable tool for marine mammal veterinarians and researchers. We recently developed a safe, reproducible and effective approach for evaluating the dolphin heart using echocardiography. We trained 4 adult male Atlantic bottlenose dolphins (*Tursiops truncatus*) for both transthoracic and transesophageal echocardiographic imaging, without the use of sedation. During the initial stages of this study, we noted that image quality transiently improved dramatically when the dolphins spontaneously exhaled. Subsequently, dolphins were conditioned to hold their breath following forced exhalation, and imaging proceeded during such behavioral breath holds. Overall, over

25 transthoracic and 100 transesophageal echocardiographic studies were performed, including both two-dimensional imaging and color Doppler mapping. Transthoracic imaging yielded only fair-moderate quality images of the left ventricle and mitral valve, with only moderate reproducibility. However, transesophageal, but not transthoracic imaging improved dramatically with behavioral breath holding on exhalation. High quality, reproducible images of the entire heart (mitral, tricuspid, aortic and pulmonary valves, atrial and ventricular septae, left and right ventricles, and ascending aorta and pulmonary artery) were obtained consistently using transesophageal imaging in conjunction with this behavior. Color Doppler mapping demonstrated mild tricuspid regurgitation in all dolphins, and mild aortic regurgitation in one dolphin found to have a pedunculated mass arising from the sinutubular junction just above the aortic valve. There were no complications. In summary, we have demonstrated that the heart of the bottlenose dolphin can be safely, effectively and reproducibly evaluated using transesophageal echocardiography in conjunction with behavioral breath holding following forced exhalation. This approach, and the normative echocardiographic data obtained from this work, may be useful for future echocardiographic studies of aquatic mammals.

Fatty Acid Compositions of the Skin, Blubber, and Potential Prey Organisms of Walruses, *Odobenus rosmarus*

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Blubber biopsies were collected from 17 adult male walruses from Svalbard, Norway. The biopsies were taken vertically at a point mid dorsally about 60 % of the length of the animal from the cranial end; they were comprised of the skin and the entire blubber layer down to the muscle. The fatty acid (FA) compositions of the skin, the outer blubber layer, the inner blubber layer and various potential prey organisms (*Mya truncata*, *Chlamys islandica*, *Hiattella arctica*, *Buccinum* sp., *Myoxocephalus* sp., *Hyas* sp., *Sclerocrangon boreas*, *Pagurus* sp., *Liparis* sp., *Arctica islandica* and *Phoca hispida*) were determined. The skin (20-40 mm thick) had a very different FA composition compared to the blubber, and the outer blubber layer had a significantly different FA composition compared to the inner blubber layer. Generally, the outer blubber layer contained more short-chained monoene FAs, while the inner layer contained more long-chained monoenes and saturated and polyunsaturated FAs. This layering is similar to what is observed in other marine mammal species. The layering of FAs in the blubber of walruses is however less marked than in most other species, probably because walruses do not experience the same extreme degree of annual variation in blubber thickness that most other pinnipeds do. The FA composition of the potential prey organisms was different from that of the blubber of the walruses, but the inner blubber layer did share some similarities in composition with the potential prey species.

Small-Scale Variability of Cetaceans Associated with Oceanographic and Topographic Features Along the Mid-Atlantic Ridge

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An exploratory study of potential fine-scale cetacean habitat structures (chord length < 100 km) was carried out using recent large-scale synoptic oceanographic and sightings data collected along the entire length of the northern Mid Atlantic Ridge (MAR). Synoptic oceanographic and sighting data collected during the 2004 G.O. Sars survey and the Icelandic Redfish surveys in 2001 and 2003 were used as a basis for the analyses. The 2004 G.O. Sars cruise provided the first opportunity to correlate oceanic

distributions of cetaceans with synoptic fine-scale 3-dimensional potential habitat features, including hydraulic model output (ROMS 5 km 3D model), acoustic sampling of current velocities (from surface to 700 m) and detailed bottom topography. Specific scale-dependencies in relation to various topographic and hydrographic features were analysed using geo-statistical analyses, and the output from these analyses were then used to select the features of potential importance. In spite of the large area surveyed the sightings data for most species typically exhibited a strong small-scale spatial structure (range parameter 20-50 km) indicating strong affinities with cross-seamount or cross-frontal structures. Potential cross-seamount and cross-frontal habitat structures with a diameter between 20 and 50 km were classified from the bathymetric, model and measured hydrodynamic data. Cross-frontal characteristics included not only horizontal property gradients but also detailed dynamics of the thermocline. Partial least squares analysis were used to derive the primary predictors of each species' distribution. The findings suggest that quasi-permanent frontal processes of the Sub-polar Front and the differences in specific diving capacities largely determine the location of aggregations of cetaceans in this sector of the North Atlantic. Further studies are encouraged to evaluate the three-dimensional habitats of cetaceans, also on a fine-scale, on the basis of detailed studies of fluid dynamics associated with oceanic ridges.

Assessing Dietary Differences of River Otters Living in Marine Versus Freshwater Habitats - Which Environment Provides Optimal Foraging Opportunities?

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River otters (*Lontra canadensis*) are unusual in that they live in both marine and freshwater habitats. There is debate regarding which environment is optimal in terms of foraging success and profitability. We are investigating this question by comparing the diet of an inland population from creeks in Rochester NY to a coastal population with similar latitude along the Pacific coast of British Columbia. This study has conservation purposes, with applications being geared toward re-introduction programs. We searched for latrine sites in NY where river otters were recently re-introduced, and in BC where we regularly observed their activities. Scat was filtered through stacked sieves (2.4 mm, 0.2 mm) and indigestible hard part remains were washed for identification under a dissecting microscope. Bulk analysis of scats by volume displayed a range of 48%-100% centrarchids, 18.5%-51.6% cyprinids and 2.5% osmeridae in NY; with the entire diet relying on teleosts. In the marine habitat 1.7-100% of the scat volume was teleost, 10-99% crustaceans and 3.7-20% mollusks. A frequency analysis demonstrated the presence of bony fish in 100% of scats collected inland and on the coast, however 25% of the marine samples also contained mollusks, and 50% contained crustaceans. The marine diet was more diverse, with a minimum of six different prey species from three phyla, as compared to three species of prey inland from only one phylum. Inland fish scales ranged in size from 1 mm to 2 cm, while marine fish scales ranged from 0.5-7 mm, mollusk parts from 7 mm-1 cm, and crustacean parts ranged between 1.5 mm and 6 mm in length. From this data it appears that marine prey may be less profitable in terms of size and energy content than inland prey. Further work will apply the optimal foraging theory to more accurately compare dietary differences.

Residency Patterns and Regional Associations Among Atlantic Bottlenose Dolphins, *Tursiops truncatus*, in the Cape Romain National Wildlife Refuge, South Carolina, USA

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From Murrells Inlet to Charleston, SC, there is an 80 km gap in information about estuarine bottlenose dolphins (*Tursiops truncatus*). This study aims to narrow this gap, and to identify trends in seasonal abundance of bottlenose dolphins within part of the Cape Romain National Wildlife Refuge, SC. Study results will contribute to on-going, long-term collaborative research aimed at understanding the population structure of coastal bottlenose dolphins in the mid-Atlantic. Surveys are being conducted from a 5 m flat-bottomed skiff with a 30 hp outboard motor. Dolphin sighting locations are marked with a Garmin GPS, and attempts are made to photograph the dorsal fin of each individual using a digital Nikon D100 camera with a 70-300 mm lens. Ten to twenty hours of monthly data have been collected since September 2003, and collection will continue through August 2005. Data on water temperature, salinity, and prey types are also collected, in order to examine ecological variables affecting dolphin distribution in this area. Observed dolphin prey items include striped bass (*Morone saxatilis*), red drum (*Sciaenops ocellatus*), and mullet (*Mugil spp.*), identified during instances of strand feeding or prey flight. Preliminary data analyses suggest the presence of year-round and seasonally resident dolphins. Over 84 individual dolphins have been identified; of these, 42 have been identified in multiple seasons, and six in all seasons. Two individuals have been matched to photos in the Mid-Atlantic bottlenose dolphin catalog from Charleston, SC, which is approximately 60 km to the south. Two individuals have been matched to North Inlet and Winyah Bay, SC, respectively, approximately 60 km to the north. Further comparisons with photographs from other sites will contribute to a better understanding of seasonal movements of individuals along the mid-Atlantic coast.

What Do Harbor Seals Eat in New Jersey? A First Report from the Mid-Atlantic Region (USA)

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Determining what marine mammals eat is crucial in understanding their trophic role. Harbor seal diet varies with location. This is the first report on the diet of harbor seals (*Phoca vitulina concolor*) wintering in the Mid-Atlantic region (USA). We focused on prey composition, relative proportion, and size. Scat samples were collected in Great Bay, from a site with a small wintering colony over five seasons (1996-2002; benign method). Samples were elutriated; otoliths were identified, paired, classified, and measured. Seal diet results were compared to known assessments of prey available (trawl data). Seal diet included at least 13 species of fish. The two most abundant prey types were Spotted hake and Atlantic herring (71% combined); less abundant types included Winter flounder, redfish, unknown species and Windowpane flounder (11%). Hake was the most abundant prey species in four seasons (contributing 35-92% of collected otoliths across all years), with herring most abundant in the remaining season (8-50%). Otolith size indicated most prey were small fish. The ranks and relative abundance of prey consumed did not match those of prey available in most years, implying diet selection was not necessarily a function of prey availability. Trawl data showed Bay anchovy and Little skate to be most abundant (45% together), with Atlantic herring, alewife, rock crab and blueback herring to be less abundant (summed over five years). Only Atlantic herring were in the top three ranks in both diet and trawls. The diet of seals wintering in New Jersey did not match diet results from more northern areas (New England, Canada). Our results suggest that predation by harbor seals is unlikely to have a large effect on fisheries in the Mid-Atlantic area. This effect is additionally limited because the seals are in the area only part of the year (late fall to spring).

Conservation Priorities for Hector's Dolphin: Implications of New Bycatch Estimates and Population Survey Data

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Hector's dolphins off New Zealand's South Island (n = 7270, CV 0.16)

and North Island (111, CV 0.44) come into contact with gillnet and trawl fisheries. An observer programme in 1997-98 off Canterbury (about 1/3 of the South Island's east coast) estimated 18 dolphin captures in commercial gillnets. This catch rate (per dolphin, per km of gillnet, per year) was used to estimate past and future population sizes. The population model took the form: $N_{t+1} = N_t [1 + (\lambda_{\max} - 1)(1 - N_t/K)] - N_t C_t$. Where N_t = population size at time t , λ_{\max} = maximum population growth, K = population size in 1970 and C_t = proportion of population killed in gillnets. Observer coverage was too low to estimate bycatch for trawlers. Likewise, there is no reliable estimate of dolphin bycatch in recreational gillnets. In 1970, before a major expansion of commercial gillnetting, most Hector's dolphin populations were at least three to four times their current size. In 2100 several populations may still be heavily depleted, with most below half of their 1970 population size. Source/sink dynamics are evident for adjacent areas with different levels of fishing. Two existing protected areas both need to be extended to ensure sustainability of the local population. At Banks Peninsula 82% of the local population is inside the protected area in summer. In winter this drops to 39%. This protected area would need to be extended to 15 nautical miles offshore and 30 n. miles north and south to reduce bycatch to PBR levels. More than 80% of the total Hector's dolphin population lives in areas where bycatch is not controlled or monitored. Further observer programmes are urgently needed to improve the catch rate estimate.

Another Severe Population Decline: Harbor Seals in the Aleutian Islands

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The population declines of Steller sea lions, northern fur seals, and sea otters in the Bering Sea and Aleutian Islands region during recent decades have prompted substantial efforts to identify the causes of the declines, conserve and manage the species, and interpret marine ecosystem dynamics. Yet, the population status of a common pinniped, the harbor seal, has not been assessed adequately across its extensive range in the Aleutian Islands. A growing body of anecdotal observations indicates that harbor seals, considered relatively abundant in the Aleutians during the 1960s and early 1970s, may have declined substantially. Our primary objective was to assemble count data that could be used quantitatively to compare the relative past and present abundance of harbor seals in the Aleutian Islands region. We determined that vessel-based surveys of birds and mammals conducted during the summers of 1977-1982 could provide a baseline estimate of harbor seal abundance, and we calculated the sum of counts from all haul-out sites surveyed for each island. We then compared that baseline estimate to the sum of counts from an aerial survey of the same islands in 1999. Based on surveys of 75 islands in the western and central Aleutian Island region (*i.e.*, Samalga Pass west to Attu Island), we estimated that the number of harbor seals declined approximately 70% between the earlier period (1977-1982) and 1999. The aerial surveys were conducted on dates and at tide heights when a relatively high proportion of seals would be hauled out (compared to the earlier vessel-based surveys) and we used the highest aerial survey count from each site, possibly introducing an upward bias in the estimate from 1999. Thus, we believe that a 70% decline is likely an underestimate. The decline of harbor seals may be the next urgent conservation challenge in the Aleutian Islands.

Beluga Whale (*Delphinapterus leucas*) Summer Use of Cumberland Sound Estuaries

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During summer months the majority of the Cumberland Sound beluga whale (*Delphinapterus leucas*) stock, considered a distinct genetic population, uses the northwestern estuarine habitat of Clearwater Fiord and Millut Bay (Demarche *et al.*, 2001, P. Richard, unpublished data). Other, smaller groups of belugas have been observed in adjacent estuaries, mainly during summer months. Existing hypotheses for beluga summer use of estuaries include moulting, calving, feeding, reducing risk of killer

whale (*Orcinus*) predation, and avoiding humans. I used local data and a Geographic Information System to explore the alternative estuary-use hypotheses and affective behaviour factors. Results show beluga habitat and contribute information required to designate critical habitat as part of building a management plan for beluga whales in Canadian subarctic regions. *References: Report for Department of Fisheries and Oceans (DFO) Canada, Species at Risk, October.*

Evaluating Methods to Estimate Whale Density and Detection Function Parameters

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What aspects of a visual line transect survey can one capture in a computer model, and what may such a model be used for? Working with a suite of C/C++ programs, we have created simulated "sightings files" meant to resemble those from actual shipboard line transect surveys. Whale groups were positioned in an "ocean" according to userspecified spatial distributions. As a simulated ship moved through this ocean, userspecified detection functions determined the probability that each team of observers on the ship would see a whale group surfacing at a given distance and bearing from that ship. Survey aspects captured in different model runs have included density gradients; clustering of whales; asynchronous and synchronous diving patterns; animal movement in response to the ship; closing and passing search modes; three sighting teams on one ship, each with a different detection function; and detection biases due to whale group size, weather conditions, and initial cue. Output from such model runs can be used to assess accuracy, bias and robustness of different analytical methods for estimating whale density by applying those methods to simulated sightings files where "actual" density is known. We have also used model output as raw material in developing a new way to estimate a two-dimensional detection function from data containing only first sightings. Here again, because true parameter values are known, results can shed light on prospects for fitting parameters to real data. Using an iterative Matlab procedure incorporating "minisimulations" and an accurate dive time distribution, we found that, based on the C model's "sightings file" output, we could estimate parameter values close to the "true" values set in the C model, at least in constrained cases. The modeling approach described thus offers a useful testbed for assessing at least two kinds of estimation methods important in determining abundance.

Male Humpback Whales Sing More While Escorting Females than with Other Males

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Humpback whale song is thought to have a role in mediating interactions among conspecifics. However, whether song is directed more towards other males for male-male competition, towards females for mate attraction or both is not known. We examined interactions between singing whales and conspecifics during migration off the east coast of Australia during 2002 - 2004. Singers were tracked acoustically using a static five-hydrophone array, while both singers and other whales were tracked visually from land and observed from a small boat. Clear visual and acoustic tracks were obtained for 105 singers, 31 (30%) of which were observed not to interact with other whales, whilst 74 (70%) were involved in interactions. The two most common groups of interactions were with lone adults (N=38) and lone female/calf pairs (N=19). Singers were further differentiated by whether they were actively joining, or being joined by, another whale (N=53). A significant difference was found in the frequencies with which singers were joining or being joined by pods of different compositions ($p < 0.0001$). Lone adults joined singers, whereas singers were actively joining lone female/calf pods, both at a much higher frequency than expected at random. The sex of 13 lone adult joiners was determined (6 genetically and 7 behaviourally) of which all were male. Singers spent significantly more time escorting lone female/calf pairs (127 ± 15 min) than with lone adults (57 ± 8 min) ($p < 0.001$). When actively singing in the company of other whales (N=26), singers were also found most often

escorting a lone female and calf (73%). This demonstrates for the first time that while other males join singers, singers are joining, spend more time with, and sing more in the presence of females. We hypothesize that a potential strategy for males to find females may therefore be to join singers. This has important implications for our understanding of the function of humpback song.

First Census of Northbound Migration of Gray Whales (*Eschrichtius robustus*) from Goleta, California

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From the late 19th century into the early 20th century, a shore-based whaling station operated from Goleta on what is now the University of California, Santa Barbara. Gray whales have recovered sufficiently from exploitation to be removed from the endangered list, yet the species faces many hazards as whales migrate north from Mexico along the heavily populated California coastline. Natural, historical threats in the Santa Barbara Channel include killer whale predation and potential contamination from natural, oil seeps. Now, the whales risk unprecedented exposure to human-engineered perils of noise, chemical pollution, entanglement, and traffic in the near-shore waters, which a number — especially cows and calves — choose as their route north. The goal of this census was to establish baseline population-data to begin to quantify usage of a particular northbound-migration route: near-shore through the Santa Barbara Channel. From the Coal Oil Point Natural Reserve in Goleta, the all-volunteer effort (33 participants; 964.25 hours) was on-station for 100 days from 10 AM to 4 PM daily, January 29 through May 8, 2005. 406 gray whales, including 81 calves (20%), were observed migrating north. The census also recorded observation-data on sea otters and all other cetaceans, including gray whales traveling south, humpback whales, and bottlenose, common, and Pacific white-sided dolphins. Tallies were updated daily on the ACS Channel Islands website and the Journey North website, which then distributed our data to schoolchildren across the country. At Coal Oil Point, volunteers distributed information about the whales, our census process, and the data, which over time and when compared with similar data from other census stations beyond the Santa Barbara Channel, may contribute to a better understanding of population dynamics and behaviors of a species at risk.

A Library of Marine Animal Sounds: Proof of Concept

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After three years of archival and database development, the Marine Collection at the Macaulay Library, Cornell Laboratory of Ornithology, is now in a proof of concept phase as a research resource for the marine bioacoustics community. The recent release of an online interface to explore the Marine Collection brings the work of many individual researchers and institutions directly to scientists, educators, and the general public. A demonstration of the new online library will include the search and audition features and the online spectrogram tool. We will also provide an update on the progress of the collection and future developments planned and under progress for the online application, including annotation tools, feature extraction, automatic detectors, and map-based searches.

Proposed Long-Term Ecological Study of McMurdo Sound and the Southern Ross Sea

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For several decades, the southern Ross Sea and McMurdo Sound have been the focus of a number of independent studies that have collected time-series information on a variety of components of the marine food web, and on some physical and hydrographic properties. For example,

satellite imagery has been used since 1979 to assess variations in ice concentrations, a factor considered to be the primary control of phytoplankton production in the Antarctic. The biomass of phytoplankton in the southern Ross Sea has also been synthesized to evaluate any long-term mean. Similarly, estimates of the biomass and reproductive success of Adélie penguins and Weddell seals have also been compiled since the 1960s. Trends in these parameters suggest that the Ross Sea is changing, and in ways markedly contrasting with those observed in the Antarctic Peninsula. For minke whales and killer whales, trends relative to ice conditions are unknown. Because no complete assessment of key components of the food web presently is available, the ecological and oceanographic responses of the Ross Sea to long-term change, or even to shorter changes (such as those imposed by episodic events imposed by large, grounded icebergs or increased fishing pressure), cannot be adequately predicted. A plan to improve our understanding of the food web of McMurdo Sound is presented. If invoked (possibly as a Long-Term Ecological Research program), this plan will foster continuation of critical time series, facilitate the establishment of new necessary time series, and provide an improved basis in which the integrated interannual and long-term changes in various trophic levels can be understood relative to environmental change. Such a program would best be interdisciplinary and international to effectively focus food web research in the southern Ross Sea and to increase our quantitative understanding of the complex relationships among various functional groups of the region.

Visual-Acoustic Survey of Cetaceans During an Academic Seismic Study in the Southeast Caribbean Sea, April–June 2004

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Lamont-Doherty Earth Observatory's monitoring and mitigation program during a marine seismic survey in April–June 2004 was the largest systematic cetacean survey effort undertaken to date in the Southeast Caribbean, and the only documented survey effort west of 68°W. Shipboard surveys occurred during the seismic study involving a large (6947 in³) 20-airgun array that operated day and night from the R/V *Maurice Ewing*. Over 10,000 km (>900 h) of visual observations (>99% daytime) were made from the *Ewing* and R/V *Seward Johnson* (support vessel) operating in water 15–6000 m deep. At any one time, one or two observers were on watch on each vessel. Most (63%) visual observations occurred without seismic (mainly from the *Seward Johnson*); 37% of observations were made from the *Ewing* while airguns operated. In addition, >7300 km (>800 h) of passive acoustic monitoring for vocalizing cetaceans was conducted from the *Ewing* via a towed 250 m hydrophone array that was monitored nearly 24 h/day (92% with seismic). A total of 1294 cetaceans in 47 groups were seen from the two vessels, and 78 acoustic detections were made from the *Ewing*. Nine cetacean species were identified visually: *Delphinus capensis*, *Stenella frontalis*, *S. coeruleoalba*, *S. longirostris*, *S. attenuata*, *Tursiops truncatus*, *Globicephala macrorhynchus*, *Physeter macrocephalus*, and *Balaenoptera edeni*. Only sperm whales (*P. macrocephalus*) were positively identified by acoustic monitoring alone; the remaining acoustic detections were of unidentified dolphins or delphinid species. At least 17 sperm whales were seen and/or heard around islands and atolls of the Caribbean Archipelago near the 1000-m contour and deeper. Three Bryde's whales (*B. edeni*) were seen near Margarita Island, Venezuela. Highest cetacean densities occurred in intermediate water depths of 100–1,000 m. Acoustic encounters with delphinids ($n = 69$) were more common at night (11.5/1,000 km) than during the day

(7.4/1,000 km).

Immuno-Microbiological Correlates in Steller Sea Lion (*Eumetopias jubatus*) Pups from the Kamchatka Peninsula and Commander Islands

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In recent years heightened consideration has been given to the problem of the Steller sea lion (*Eumetopias jubatus*) decline in Russia. This situation became very serious in both Russia and the United States and the species was listed as endangered in both countries. One of the possible causes could be a decrease of the immune status of the animals resulting in a heightened susceptibility to pathogens which are present in their natural habitat. This can cause increased morbidity and mortality, especially among the pups. This immuno-microbiological investigation was conducted during June and July of 2004 on the Kamchatka Peninsula and Commander Islands in Russia. Twenty six pups from Medny Island and 14 pups from Kozlov Cape between the ages of 2-5 weeks old were sampled. Indices of phagocytic activity of leukocytes were studied using a strain of *Staphylococcus aureus* ('25923 American Typical Cultural Collection) as "test microbes". Additionally, the composition of microbe associations with the pups was investigated. The correlation between indices of phagocytosis and indices of the quantity and specific composition of microbes in the animals was observed. The results of the study show that indices of phagocytic activity of leukocytes in all animals sampled was decreased. Microorganisms possessing pathogenic factors (e.g., virulence, toxicogenic and hemolytic properties) capable of causing pathological processes in the host organism were isolated from biological material of all sampled pups. Seven species of microflora were found: *Streptococcus parauberis*, *Staphylococcus epidermidis*, *Escherichia coli*, *Hafnia alvei*, *Serratia marcescens*, *Proteus penneri*, *P. vulgaris*.

Acoustic Monitoring of Odontocetes using High-Frequency Towed Arrays and HARPS

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Recent technological advances have enabled the long-term recording of high frequency, broadband acoustic data. High sample rate recordings allow a broad range of odontocete calls to be recorded, including clicks, burst pulses, and whistles. New instruments have been developed including High-frequency Autonomous Recording Packages (HARPs) which can sample continuously at 200 kHz for up to two months, and a four-element towed hydrophone array which samples real-time at 200 kHz. Long-term species-specific acoustic monitoring of odontocetes requires visual and acoustic correlations. Coordinated visual and acoustic surveys were conducted in the Southern California Bight and the Gulf of California using the towed hydrophone array to obtain visual-acoustic correlations of calls. To date, acoustically and visually detected odontocetes include sperm whales (*Physeter macrocephalus*), short-beaked common (*Delphinus delphis*), long-beaked common (*Delphinus capensis*), Risso's (*Grampus griseus*), Pacific white-sided (*Lagenorhynchus obliquidens*), striped (*Stenella coerulescens*) and bottlenose (*Tursiops truncatus*) dolphins. Analysis of long-term HARP data reveals odontocete clicks occur more frequently than whistles, despite the further propagation expected for the lower frequency whistles. Long-term monitoring will allow assessment of species-specific calling patterns, including diel and seasonal variations, and modeling of acoustic presence with environmental correlates.

Amplification of MHC Loci from Genome DNA and mRNA in Cetacean Species

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The Major Histocompatibility Complex (MHC) is one of multigenes, which is closely concerned with the immune system in vertebrates. Its variation is known to be extremely high in terrestrial mammals, and is proposed to be an index in conservation genetics. We have analyzed MHC DQB loci exon 2 (172bp) in some cetacean species to evaluate genetic diversities within and among species. The heterozygosity (he) of each species had wide variation, for instance, Antarctic minke whales (13 alleles from 49 animals with an he of 0.79) and melon-headed whales (9 alleles from 141 animals with an he of 0.81) with relatively high variation; Stejneger's beaked whales (2 alleles from 61 animals with an he of 0.26) and Common minke whales (1 allele from 50 animals) with low. It suggested that cetacean MHCs may be affected by not only differences of infection and parasite pressure but also population history, population structure, and/or differences in the number and organization of loci among species. To survey what affects the variation of cetacean MHC, we conducted a further study. MHC is known to have pseudogenes processed through the duplication of loci. Then we experimented to extract mRNA of the target region to confirm expression of this gene at first. Fresh blood was taken from two finless porpoises reared in aquarium. Total RNA was extracted and the target sequence was amplified by RT-PCR using poly T primer which attaches to the end of the mRNA. Detected 4 alleles were all known in the previous study and amplified sequences from genome DNA and cDNA were matched, suggesting that an evidence of functionality on the target gene.

Measuring Field Metabolic Rate in Pinnipeds: A Direct Validation of the Doubly Labelled Water Method

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Estimates of the field metabolic rate of free-living pinnipeds are essential in order to understand and model interactions between them and their environment. Field based studies using the doubly labelled water method (DLW) give long term average values for energy expenditure that are well above the levels of expenditure achieved in the laboratory, even when seals appear to be working at their short term capacity. The DLW method has not been validated over meaningful time scales in any marine mammal. We tested the hypothesis that DLW estimates of FMR are erroneously high. We performed simultaneous measurements of the energy expenditure of grey seals using DLW to estimate carbon dioxide production and indirect calorimetry (measurement of oxygen consumption and carbon dioxide production by respirometry) under quasi-realistic conditions, over periods of 5 days with simulated foraging. We carried out measurements on 6 grey seals over a variety of body masses, at two work rates (high and low) and at deposition and withdrawal stages of fat dynamics. These have shown that there is no significant difference between estimates of energy expenditure using the two main methods. In addition, the very fine-scale, long term records of behaviour, heart rate and gas exchange that we have obtained over the course of these experiments have illuminated some interesting temporal patterns in metabolic rate that suggest that diving seals may be deferring some metabolic costs, possibly those associated with digestion, until extended surface resting periods, many hours after periods of diving and feeding.

Behavioral Response of Pacific Walrus to Extreme Cold: Ramifications for Surveys

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Pacific walrus (*Odobenus rosmarus divergens*) overwinter in the pack ice of the Bering Sea. These homeotherms maintain an internal temperature of about 36.6°C even as ambient air temperatures drop below -30°C. Walrus accomplish this thermoregulatory feat through a combination of physiological and behavioral means. Physiological adaptations to cold include large body size, thick blubber layers, and vaso-control of peripheral blood flow. Behavioral adaptations include changing posture to regulate the amount of exposed surface area and control the rate of heat loss. During aerial walrus surveys in the Bering Sea from 31 March to 11 April 2005, we collected digital photographs and thermal images of walrus groups over a range of environmental conditions, including an extreme cold event of -

20°C with winds of 7 kt (wind chill -28°C). We documented a behavioral response of walrus to extreme cold that has long been known to Alaska natives. Hunters from St. Lawrence Island, Alaska, relate that walrus enter the water during periods of intense cold, especially in strong winds. In agreement with their Traditional Ecological Knowledge, we found that under extremely cold conditions, a greater proportion of resting walrus occurred in the water, instead of on the ice, than on warmer days. Walrus resting in the water either used their tusks to hang on to the ice edge, or floated face up, probably using their pharyngeal air sacs for flotation. Skin surface temperatures of hauled-out walrus during extremely cold conditions, as measured by a thermal scanner, ranged from +2 to -2°C. During warmer days, skin surface temperatures ranged from +9 to +13°C. We suggest that escape into water during extremely cold conditions indicates that the limits of walrus thermoregulatory abilities have been reached. This behavioral response may reduce the number of walrus on the ice and available for counting during aerial surveys.

The Physiological and Behavioural Development of Diving in Australian Fur Seal Pups (*Arctocephalus pusillus doriferus*)

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The transition to nutritional independence may be especially challenging for pinnipeds as weaned pups must develop hunting skills independently and may not have the physiological capacity to exploit the most productive resources. The Australian fur seal (*Arctocephalus pusillus doriferus*) has a breeding distribution restricted to Bass Strait, a continental shelf region of fairly uniform depth (60-80 m) and low marine productivity. Previous studies have shown adult females are almost exclusively benthic foragers which implies the region has insufficient mid-water prey for the species. This "all or nothing" need to reach the benthos may be physiologically taxing to newly-weaned pups and may lead to low juvenile survival. The physiological and behavioural development of diving was examined in Australian fur seal pups to determine whether weaned individuals are capable of exploiting the same resources as adults. Total oxygen stores increased from 21.5 ml·kg⁻¹ at 1 mo to 25.2 ml·kg⁻¹ just prior to weaning (58.4% of adult values). Haematocrit, Hb, blood volume and Mb all increased throughout pup development. However, muscle oxygen stores were slow to develop in contrast to blood oxygen stores (21% and 90% of adult values, respectively, just prior to weaning). Pups spent little time in the water (<4 % time) in the first two months and no diving was observed. Following the moult, however, pups spent more time in water (25.6% at 5 mo) and made mid-water dives (max 46.5 ± 2 m) with durations of 0.35 ± 0.03 min. By weaning, pups regularly dived to the benthos but with durations still significantly shorter than those of adults. The results suggest that while weaned Australian fur seal pups are able to reach the same depths as adult females, they may not have the physiological capacity to remain there long enough to exploit them as efficiently.

The SPLASH Project: An International Collaborative Study of Humpback Whales in the North Pacific

SPLASH Research Team

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SPLASH (Structure of Populations, Levels of Abundance and Status of Humpback whales) is a collaborative 4-year international effort using individual identification and tissue sampling to determine the status, trends, and population structure of humpback whales across the entire North Pacific and identify potential human impacts to this population. The project has received broad international government support including from the governments of the United States, Mexico and Canada as well as financial backing from number of private foundations. During the first two years of SPLASH effort (2004-05), surveys were conducted by more than 25 research groups using a wide variety of platforms from coast-based small boats to larger ships. This effort obtained photographic identifications and biopsy samples in all known winter breeding and summer feeding areas in the North Pacific. In Summer 2004 a 4-month

ship survey in coastal and offshore waters of British Columbia and Alaska covered many areas where humpback whales had not been studied since commercial whaling. Good quality identifications of over 2,500 different whales were obtained in summer 2004 in feeding areas from California to Russia. More than 1,500 different individuals were identified in both 2004 and 2005 on winter grounds in Asia, Hawaii, Mexico, and Central America, and Although still underway this study has already revealed new information on migratory movements of humpback whales including documenting the movements of humpback whales from winter breeding areas in Asia to summer feeding areas in Russia. When completed it will provide the first comprehensive determination of the status of humpback whales in the entire North Pacific.

Review of Marine Mammal Unusual Mortality Events in the United States: 1992-2005

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Since the enactment of the Marine Mammal Health and Stranding Response Program in 1992, 32 marine mammal Unusual Mortality Events (UMEs) have been formally declared and investigated in the United States. Of these, 43% involved only cetaceans, 28% only pinnipeds, 13% only manatees, 3% only sea otters, and 13% have involved more than one species or taxa. Bottlenose dolphins are the most common species involved, followed by California sea lions and manatees. Many (34%) of these UMEs are of unknown etiology. Nonetheless, numerous etiologies have been found including infectious diseases (e.g., morbillivirus), environmental factors (e.g., changes in prey abundance in near-shore habitats), and biotoxins associated with harmful algal blooms (HABs). Since 1996, over 50% of UMEs have been associated with HABs, and the most prevalent of these have included repeated events of manatees and brevetoxin in southwest Florida (n=4), bottlenose dolphins and brevetoxins (n=2) along the Florida Panhandle, and California sea lions and domoic acid on the west coast (n=4). HABs are increasing in frequency and geographic coverage. Research is needed to investigate the immediate impacts of HABs on morbidity and mortality in marine mammals, as well as the long-term effects of repeat or continuous low-dose exposure on marine mammal populations through effects on health, survival and reproduction. Investigations continue to be hampered by difficulties in accessing carcasses and their decomposition. The investigation of UMEs continues to be impeded by slow deployment of trained investigation teams and prolonged diagnostic efforts including insufficient access to techniques, tools and laboratories. Efforts are underway to develop better response protocols, detection and diagnostic capabilities, and partnerships with other federal, state, and non-governmental organizations.

Location, Location, Location: Acoustic Evidence Suggests Three Geographic Stocks of "Pygmy" Blue Whales in the Indian Ocean

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The Indian Ocean Sanctuary (IOS) was established in 1979 by the International Whaling Commission to "provide an ecologically coherent area where whale populations are protected..." Blue whales (*Balaenoptera musculus* spp.) are currently represented there by 3 subspecies. Here we present data on long-term acoustic monitoring of blue whales that provides novel information on their presence in this area. Most reported sightings and all previous recordings (including Antarctic-type calls) of blue whales

in the IO occurred during austral winter. Three distinct call types have been attributed to "pygmy" blue whales in the IO from Sri Lanka, Madagascar and Western Australia, respectively. We used acoustic detections from hydrophones of the International Monitoring System to determine the seasonal and geographic occurrence of these calls. Data were collected between January 2002 and October 2003 from two stations near Diego Garcia and a third southwest of Cape Leeuwin, Australia. Each hydrophone recorded continuously from 1 to 120 Hz and data were scanned for each of the three calls using the automatic detection method of spectrogram correlation. Sri Lanka calls were the most commonly recorded blue whale call and were detected July-February (peak Sep-Dec). Madagascar-type calls were only recorded on the northern Diego Garcia hydrophone May-June and Australia-type calls only on the Cape Leeuwin hydrophone. The number of these calls increased from February-May then dropped off sharply in June. Based on differences in the geographic and seasonal patterns, these three call types may represent separate populations of pygmy blue whales with different seasonal calling patterns. There are currently two subspecies designations (*brevicauda* and *indica*) from the IO; acoustic differences suggest there could be a third. This acoustic diversity of blue whales provides additional evidence of high diversity of blue whales in the Indian Ocean, and suggests that it may be even higher than previously thought.

The Ins and Outs of Cetacean Genomes: Sequences of Nuclear Introns for Cetacean Molecular Ecology and Evolution Studies

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Genetic markers are used to infer phylogenetic relationships and taxonomic status, effective population size and structure, kinship and individual identity. To date, mitochondrial DNA (mtDNA) sequence and nuclear microsatellite loci have been the most common genetic markers for questions at the population level. However, both markers are subject to limitations; mtDNA is maternally inherited, restricting its use to questions of female mediated gene flow; microsatellites, although biparentally inherited, evolve rapidly resulting in size homoplasy and potentially underestimating population differentiation. Nuclear introns, by comparison, are biparental but evolve relatively slowly, probably conforming to the Infinite Allele Model of mutation. Here we report on a survey of previously published mammalian exon-anchored primers for use in cetacean molecular ecology and evolution studies. Of the 42 primer pairs screened, we successfully amplified and sequenced 10 autosomal, one X-linked and five Y-linked introns from representative species of the major cetacean families. Interspecific divergence was assessed between several species of Delphinidae and Balaenopteridae. For example, autosomal intron length varied from 160bp to 1370bp and divergence varied from 0.7% to 7.3% with a weighted mean of 3.1% for the Hector's dolphin (*Cephalorhynchus hectori*) and the humpback whale (*Megaptera novaeangliae*). Intraspecific diversity was assessed for an additional five autosomal introns for three species of mysticetes. For example, of the 15 total autosomal introns screened for the humpback whale (2-15 individuals each intron) 10 were found to be variable. Identification of variable sites provides a basis for assays of single nucleotide polymorphism (SNP's). These results contribute to the characterisation of a minimum 'universal' set of nuclear introns for comparative studies of genetic diversity and divergence of cetaceans, complementing that of mtDNA.

Pectoral Muscle Development in Free-Ranging Steller Sea Lions (*Eumetopias jubatus*)

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Nutritional stress has been hypothesized and debated as a likely cause behind the decline of the endangered western stock of Steller sea lions (SSL's). The eastern stock is stable. In a previous study on harbor porpoises, *Phocoena phocoena*, starvation impacted muscle morphology,

biochemistry and ultrastructure. Morphologically, fast twitch fiber diameters from muscle of nutritionally deprived porpoises were 31% smaller and slow twitch diameters 14% smaller, which resulted in a 15% increase in area of slow twitch fibers relative to that in robust animals. If nutritional stress is effecting the survival of SSL's, then it is likely that there would be evidence of the latter phases of starvation, or muscle catabolism, which often leads to death. In order to assess whether there are morphological changes in muscle due to nutritional stress, it is important to first understand the foundation of how muscle develops in a stable population. Pectoral muscle biopsies were collected from free-ranging SSL pups (3-11 months old) and juveniles (12-29 months old) in both western and eastern regions. For preliminary muscle development indices, the stable, eastern stock samples were analyzed for 5, 17, and 29month old animals (n=6). Based upon myosin ATPase histochemical analyses, fast and slow twitch fiber diameters showed the largest increase during the first 12month period of 39% and 44%, respectively, which was slowed during the next 12 months to increases of 11% and 14%, respectively. Also, 29month old animals had 15% more slow twitch fibers than 5month old animals, with the largest increase of 9% occurring during the first 12month period. These results provide the basis of muscle development for SSL's and will allow future comparisons of the declining and stable populations to determine possible effects of nutritional stress. Research supported by NOAA/ NMML, NMFS Permit #358-1564-07 and ADF&G ACUC #03-0002.

Killer Whale Rake Mark Scarring on Humpback Whale Flukes: A Demographic and Temporal Analysis of the California-Oregon-Washington Feeding Aggregation

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The ecological significance of killer whale predation on large cetaceans has been the subject of recent debate. Rake mark scars on the bodies of whales are evidence of non-lethal killer whale attacks. The prevalence of rake marks on the flukes of humpback whales that feed off California-Oregon-Washington is known to be twice as high as any other feeding area. We examined differences in the incidence of these scars among animals of known age and sex in this region. We tracked animals observed since they were calves to evaluate when scars were acquired. We also examined differences in the incidence of rake marks on whales by migratory destination. Overall, 20% of 1,282 individual humpbacks identified between 1986-2002 had rake marks on their flukes; no differences were found between known males and females. Eleven percent (13 of 116) of animals that were first observed as calves had rake marks on their flukes; for seven of these, the scarring was so severe that flukes were damaged. The proportion of calves with rake marks appeared to decrease in more recent years; 15% (9 of 59) of calves born between 1986 and 1995 and 7% (4 of 57) of those born between 1996 and 2002 had these scars. Of those calves seen in later years (n=70), animals with rake marks were as likely to be resighted as those without suggesting that attacks did not affect their long-term survival. Seven percent of these resighted animals acquired new rake marks after their first sighting on the feeding area; their minimum age when attacked ranged from 1-8 years old. Our data show that while most humpbacks were attacked as calves, as many as a third of whales were attacked after their first year.

A Comparison of Range and Associations Determined from Short-Term Radio Tracking Versus Long-Term Photo-Identification Monitoring of Bottlenose Dolphins near Charleston, SC

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Photo-identification monitoring surveys to determine distribution and abundance of bottlenose dolphins within waterways near Charleston, SC have been conducted at varying levels of effort over the past 11 years. Such methods provide essential information on long-term and seasonal

movements and distribution within the survey area. However, in most cases several years of monitoring are required in order to obtain reliable estimates of range and social affiliations of individuals. In contrast, radio-tracking allows the researcher to obtain information on fine-scale movements of individual animals over a relatively short period of time. In August 2003, 47 dolphins were captured in the Charleston area, and 12 of these animals were fitted with VHF radio tags. From August through October 2003, 40 boat-based radio-tracking surveys totaling over 280 hours of survey time were conducted. Having data derived from the historical and ongoing photo-identification surveys, as well as from the 2003 radio-tracking effort, we compare movements and associations determined via the brief but intensive tracking efforts in contrast to information derived from the longer term photo-identification efforts. We focus on several select radio-tagged animals to illustrate similarities and differences in conclusions drawn with regard to individual range and associations. For all of the focal males, the short-term movements determined via tracking were indicative of individual long-term ranging patterns, although several extralimital sightings were obtained during the radio-tracking period. In contrast, the range for a pregnant female with a dependent calf was limited to a single river and adjacent creeks during the tracking period, while two years of follow-up photo-identification monitoring proved her range to be more extensive. We found that stable associations determined via the long-term study were corroborated, but some existing less frequent associations were not observed during the tracking period. We conclude that radio-tracking is an effective complement to our long-term monitoring efforts.

Impact of Tourism on Nursing Female Indo-Pacific Bottlenose Dolphins off the South Coast of Zanzibar

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We investigated the impact of tourism activities on both group and individual level of Indo-Pacific bottlenose dolphins, *Tursiops aduncus*, off the south coast of Zanzibar. The behaviour, movement- and dive patterns of nursing females were investigated between January and March 2000-2002. Statistical comparisons were made of observations collected during tourism activities of different intensity and without tourism activities. Behavioural data were collected using scan sampling of groups and focal individual follows of five female dolphins with calves. The movement patterns of dolphin groups were not affected by the presence of a few (1-2) tourist boats without swimmers. However, the groups had a significantly larger proportion of non-directional movements as tourism activities increased and swimmers were present. The behaviour of focal females was also affected when tourist boats were present. Females travelled more frequently as tourism activities increased which may have a negative effect on the time available for females to nurse their calves. The proportion of active dives also increased as tourism activity increased. Intense non-regulated dolphin tourism activities in this area may lead to a shift in habitat use by nursing females. It is therefore crucial that the guidelines issued by the Department of Fisheries and Marine Products, Zanzibar, are implemented in order to ensure sustainable dolphin tourism activities.

Estimating Pup Production and Population Size of the Northwest Atlantic Harp Seal (*Phoca groenlandica*)

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The Canadian and Greenland hunt for Northwest Atlantic harp seals is the largest marine mammal harvest in the world. Therefore, it is important to monitor abundance and population trends to ensure that these removals are sustainable. Since 1980 abundance has been estimated using a two-parameter population model that estimates unreported mortality (i.e., natural mortality plus unreported hunting mortality) and an initial abundance to fit to independent field estimates of pup production using data on removals and age specific reproductive rates. Estimated pup production has doubled from less than 500,000 in the late 1970s to almost 1 million in 1999. Recent estimates of pup production were obtained from photographic and visual aerial surveys flown off Newfoundland and in the Gulf of St. Lawrence during March 2004. After correcting for pups

born after the survey dates and misidentified by the readers, total pup production was estimated to be 991,400 (SE = 58,200, CV = 5.9%). This is not significantly different from that estimated in 1999 (997,900, SE = 102,100, CV = 10.2%). A population model incorporating pup production estimates since the late 1970s, reproductive rates since 1960 and human induced mortality (catches, by-catch in fishing gear and struck and lost) since 1952 was used to estimate total abundance for the period 1960 - 2004. The harp seal population declined during the 1960s to a low of 1.75 million in the early 1970s, and then increased steadily to 1996. Since then the population has remained relatively stable at the highest values in the time series, and possibly its highest level since commercial exploitation began in the 1700s. The estimated total population size in 2004 is 5.9 million (95% C.I. 4.6 - 7.2 million) harp seals.

Disease and Health Monitoring in Juvenile Stellar Sea Lions (*Eumetopias jubatus*) Held in Temporary Captivity

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In August 2003, the Alaska SeaLife Center implemented a new research program focused on free-range juvenile Steller sea lions from the endangered western stock. This project combines the ability to study wild animals for up to three months of collaborative research in a specialized quarantine facility, after which time the animals are returned to the wild. A major objective of this program is a comprehensive health and disease monitoring protocol was developed to assess or evaluate entry and exit health and disease, as well as comparison to free-range control juvenile Steller sea lions collected from the same geographical location. To date 20 juvenile sea lions (age 1-2 years) have completed temporary captivity with additional samples collected from 34 free-ranging juveniles. Serum was tested at capture and prior to release in temporary captive animals for exposure to infectious diseases including herpesvirus, morbillivirus, *Brucella* sp., *Leptospira* sp., and *Toxoplasma* sp. Nasal, rectal and preputial/vaginal swabs were screened for normal and potentially pathogenic bacteria. Additional sensitivity testing was performed on *Escherichia coli* isolates cultured from rectal swabs to assess whether antibiotic resistance developed over the course of temporary captivity. All animals tested to date have shown no evidence of exposure to any of the pathogens tested. Additionally, all *E. coli* isolates have shown no resistance upon admission or release to ten commonly used antibiotics. In summary, these results show that sea lions held in temporary captivity for up to three months remained healthy and did not show evidence of exposure to disease or develop antibiotic resistance that would likely place free-ranging Steller sea lions at risk for disease following their release.

The Use of an Individual-Based Model of Seal Movement to Investigate the Spread of Phocine Distemper Virus Within Local Populations

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Phocine distemper virus (PDV) was responsible for the death of around 23,000 common seals in 1988 and 30,000 in 2002 in Europe. The 2002 epidemic, in particular, provided an opportunity for relevant information to be collected for the estimation of epidemic parameters such as contact and mortality rate. However, there remains uncertainty surrounding a number of parameters and several hypotheses have been proposed to explain observed differences in mortality between regions and epidemics. We used an individual-based model of seal movement in real space to run factorial experiments to test the influence of ecological and epidemiological parameters on the spread of PDV, and to compare the predictions of the

different hypotheses. We used satellite telemetry data from regions within the UK to estimate the probability that a seal will move between haulout sites, and how distance between sites affects this probability. The best-fitting model contained an inverse distance function and a constant probability of return to the last-used haulout. The resulting probabilities were used to parameterise movement within the individual-based simulation model. We have performed two experiments: one to investigate epidemiological parameters (length of infectious period, contact rate, case mortality) and another to investigate ecological parameters (foraging trip length, time of epidemic onset, population size). All parameters had a significant effect on the probability that an epidemic would actually occur. However, each parameter had a different effect on overall mortality, peak mortality date and epidemic duration. Contact rate had an over-riding influence on the other epidemiological parameters. The results show that regional differences in foraging behaviour and population size have a significant effect on mortality rates and the overall duration of the epidemic. These models have enhanced our understanding of the consequences of uncertainty in the epidemic parameters and of regional differences in seal movement on the spread of PDV.

Sexual and Colony Segregation in Northern Fur Seals (*Callorhinus ursinus*)

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This paper explores colony and sexual segregation in foraging between juvenile male and parturient female northern fur seals (*Callorhinus ursinus*) captured on St. Paul Island, Alaska. Fur seals were equipped with satellite transmitters, satellite dive recorders and/or time depth recorders. A directional analysis and a regression tree model were used to examine differences in foraging parameters between colonies and between sexes. Two fur seal colonies (Reef and Vostochni) foraged in distinct regions of the Bering Sea, as did juvenile males and parturient females. Juvenile males foraged farther in distance ($0 = 365 \pm 31.6$ km vs. $0 = 208 \pm 21.1$ km; $t = 3.9$, $df = 31$, $p < 0.001$) and longer in duration ($0 = 18.0 \pm 1.6$ d vs. $0 = 6.9 \pm 0.7$ d; $t = 5.8$, $df = 31$, $p < 0.001$) than their parturient female counterparts. Dive density (number of dives/10 km²) results suggested that the foraging habitat may be more optimal for juvenile males traveling greater than 282.5 km from their departure colony. The lower dive densities within parturient female foraging habitat and the level of habitat segregation between the colonies and sexes suggests that spatial variability in habitat conditions can effect specific northern fur seal colonies.

Lévy Flights: Optimal Search in Minke Whales (*Baleanoptera acutorostrata*)

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Traditional foraging models optimize target contact rate without explicitly describing the search process. We analyzed minke whale movement patterns in the context of an optimal search strategy, a Lévy flight that maximizes the number of "sites" visited. Minke whales were studied the Strait of Juan de Fuca, WA, USA, from 1980-1984 and 1997-2000. Tracks were constructed from a sequence of step lengths each calculated from the last surfacing location in sequence i to the first surfacing of sequence j . Tracks within and between feeding areas did not correspond to the null correlated random walk model. Between feeding areas tracks were linear having a higher net displacement and vector length of turn angles than sinuous tracks within feeding areas. Lévy flights are random walks whose step lengths have an infinite second moment. They are optimal if: (1) targets are sparse; (2) step lengths are large relative to perception distance and (3) foraging is non-destructive (regenerated resources). These conditions were met in our study. Within a feeding area the Lévy parameter μ_{within} was 2.07. The predicted optimal Lévy parameter was $\mu_{\text{opt}} = 2.0$, indicating a good match between observed behavior and that predicted by the model. A foraging whale can visit and re-visit sites within a limited area (the "random walk" phase) then move a large distance to a new part of the feeding areas (the "second moment" phase). These are adaptive

strategies since a single Lévy flier maximizes the number of "sites" visited compared to other movement patterns and will visit "sites" not previously visited by other Lévy fliers. At larger spatial scales, minke whales made directed tracks between known areas within which prey distribution was heterogeneous in space and time. Search is a critical component of foraging and minke whales have adopted strategies to maximize foraging efficiency.

Foraging Habitats and Behavior and Population Vitality of Hawaiian Monk Seals

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Hawaiian monk seals (*Monachus schauinslandi*) breed at six primary colonies in the Northwestern Hawaiian Islands (NWHI) and several scattered sites in the Main Hawaiian Islands (MHI). The species numbers around 1,300 seals and is declining overall owing to poor survival of juveniles perhaps related to poor foraging success. The movements and diving behaviors of 157 Hawaiian monk seals were documented throughout the Hawaiian Islands Archipelago (HIA) with satellite-linked dive recorders as descriptive proxies of foraging habitat. We summarize those data here and evaluate the null hypothesis that foraging patterns did not vary with age and sex of the seals or among colonies and, correlatively, that the vitality of seals or colonies were unrelated to foraging patterns. Seals in the NWHI foraged extensively within barrier reefs and on the slopes of reefs and islands at all colony sites but also ranged widely to seamounts and submerged reefs and banks along the HIA submarine ridge. Most dives were less than 150 m deep, though some exceeded 550 m. Foraging patterns varied substantially with age and sex of seals and among colonies. In the NWHI, foraging ranges of seals increased from the eastern colony at French Frigate Shoals to colony at the western end of the HIA at Kure Atoll. Seals in the MHI foraged in shallow habitats closer to haul-out sites compared with seals in the NWHI. Foraging patterns also correlated with body condition of seals and demographic structure of monk seal colonies. These data suggest that there may be fundamental differences in prey abundance or community dynamics among colonies but particularly between the NWHI and the MHI which may be limiting population recovery of monk seals in the NWHI but adequate to support population growth in the MHI.

A Novel Sound Recorded in Association with Bottom Feeding in Humpback Whales

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Acoustic studies of baleen whales are becoming increasingly common. However, a minority of studies combine acoustic data with technologies that allow sound production to be placed in a behavioral context. Non-invasive digital acoustic recording tags (DTAGS) were attached to humpback whales (*Megaptera novaeangliae*) on the western North Atlantic's Great South Channel feeding grounds during July 2004 to study foraging and acoustic behavior. Acoustic records totaling 48.4 data hours from four attachments were aurally and automatically analyzed, and a novel sound was identified. The sounds are repetitive, complex bursts, consisting of two components (approximately 50 ms each, peak frequencies between 50 and 400 Hz), and produced at an average rate of 1.6 (\pm SD 0.25 s) pulsed pairs per second. The bursts were heard in bouts ranging from 0.5 to 79 seconds (mean 17 s). These sounds were recorded from all four tagged whales, totaling 344 clear bouts of pulses. Acoustic properties were consistent among the four individuals, though there was some variation in bout duration. Acoustic analysis was combined with virtual behavioral study using GeoZui4D and other track visualization software to investigate whether the sounds were associated with foraging behavior. The bursts only occurred during portions of the dive cycle greater than

60m in depth (mean depth 77 m, \pm SD 3.7 m), usually within a few meters of the sea floor. Bouts often began upon reaching the foot of a dive, or were associated with animals sharply rolling on their side. Passive recordings of these sounds could indicate geographical locations of subsurface feeding by humpback whales. However, the frequency range and received levels (subsampling indicated a maximum sound pressure level of approximately 145 dB peak re 1 μ Pa — substantially lower than humpback whale song) overlap with sounds from commercial shipping, suggesting that the signals could be masked by ocean noise.

Indexing Blue Whale Condition Photogrammetrically: Do I Look Fat in this Picture?

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Changes in nutritive and reproductive condition of large whales produce changes in their shape, and these changes are detectable in measurements made on vertical aerial photographs. In previous large cetacean studies, we have examined the relationship between total length and maximum width as an index of individual or population condition. Although this technique has proven effective for both gray whales and north Atlantic right whales, the widest spot on the whale may not be the most informative site to make these measurements. For this study, we measured the widths on vertical photographs of blue whales at nine sites along the whale's body. The location of each successive site was separated by 10% of the animals total length. We used a principal component analysis to determine the site at which width was most variable, presumably the location along the whales length where changes in condition resulted in the greatest change in width. We found that width was most variable at 50% of total length, not at the widest point, which was well forward of the 50% point. We compared residuals from a regression of length (x) on width (y) at 50% of length for a sample of 107 blue that we photographed between the California Channel Islands and the coast of Peru, and found that lactating females (the group you would expect to have the least fat reserves) were significantly thinner than other whales. We classified animals as lactating females based on their close association with a calf. As reports of more morphometric studies of cetacean condition have come to light, it is clear that selection of sites measurements should be based on the what sites communicate the most information rather than on arbitrary points.

Biological Data Obtained from a Mass Mortality of Common Dolphins (*Delphinus* sp.) in the Hauraki Gulf, New Zealand

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The biology and life history of common dolphins in northern hemisphere waters has been comprehensively studied. This is especially true in the north-east Atlantic, where studies have been facilitated by the regular by-catch of this species in commercial fisheries. However, despite their abundance in New Zealand waters, and their incidental capture in the Jack mackerel fishery, no study to date has examined the biology of New Zealand common dolphins (*Delphinus* sp.). Here we present the first biological data to result from a mass mortality of common dolphins from New Zealand waters. In December 2004, three separate live-stranding events occurred in the Hauraki Gulf, a large shallow bay on the north eastern coastline of New Zealand. Over a five-day period, six dolphins

were re-floated and released, three dolphins were euthanased, and a further nine beach-cast carcasses recovered. Post-mortem examination and sampling were conducted on eight individuals using standard protocols adapted from published autopsy procedures. Sloughed skin samples, measurements and photographs were additionally collected from all released animals. Gender was determined in the field and confirmed by genetic analysis. All adult dolphins examined post-mortem were female, the majority of which were pregnant and/or lactating ($n=5$), suggesting a nursery group. Preliminary analysis of the mitochondrial DNA control region has revealed at least ten haplotypes. Only one examined stomach contained freshly ingested prey, the remainder were either empty ($n=2$) or contained eroded beaks and/or otoliths ($n=5$). Prey items identified include arrow squid (*Nototodarus* sp.), garfish (*Hyporhamphus ihi*), mullet (*Mugilidae*) and false trevally (*Lactariidae*). The overall body condition of adult carcasses was considered poor, in relation both to weight and blubber thickness. This coincided with marked muscle atrophy and elevated creatinine phosphokinase levels in selected individuals. No evidence of infectious disease was apparent except for a parasitic infection of the mammary glands associated with *Crassicauda* sp.

Changes in Antimicrobial Resistance of Fecal *Escherichia coli* During Rehabilitation of Northern Elephant Seals (*Mirounga angustirostris*)

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Certain commensal bacteria, such as *Escherichia coli*, are known to acquire and disseminate antimicrobial resistance. Antimicrobial resistant bacteria are a concern because they may increase mortality, morbidity, and cost of treatment of both humans and animals. Concern over the potential for use of antimicrobial drugs in marine mammal rehabilitation facilities to increase the prevalence of antimicrobial resistant bacteria in the marine environment has developed following the detection of drug resistant bacteria in free ranging marine mammals. This study examines if rehabilitation increases antimicrobial resistance of fecal *E. coli* isolated from northern elephant seals (*Mirounga angustirostris*). Rectal swabs were performed on 103 juvenile northern elephant seals at admit and release from The Marine Mammal Center (TMMC) and on free-ranging seals. *E. coli* were isolated from swabs using standard techniques and tested for antimicrobial resistance. At admission, *E. coli* isolates from 60 animals showed no antimicrobial resistance, whereas isolates from the remaining 43 animals were resistant to one or more antimicrobials. At release from rehabilitation, 75% of seals (96/103) had an increase in the number of antimicrobials to which their *E. coli* isolates were resistant and 45.8% of the seals had *E. coli* isolates that were resistant to four or more antimicrobials. Neither antimicrobial treatment during rehabilitation, nor duration of rehabilitation affected the likelihood of *E. coli* developing resistance. Despite the increased prevalence and number of antimicrobials bacteria were resistant to in seals being released from rehabilitation, there was little antimicrobial resistance in *E. coli* isolates from free-ranging seals (8.5%, $n=165$). The impact of releasing marine mammals back into the wild that are shedding antimicrobial resistant bacteria is not known and therefore antimicrobials should only be used in wild animals when necessary.

Seasonal Distribution of Three Hector's Dolphins (*Cephalorhynchus hectori hectori*) in the Banks Peninsula Region of New Zealand as Revealed by Satellite Telemetry

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Three Hector's dolphins (*Cephalorhynchus hectori hectori*), two female and one male, were caught in the waters surrounding Banks Peninsula, New Zealand, in March 2004, and were released following the attachment of lightweight satellite transmitters. Prior tagging work on this species was limited to suction-cup VHF tags, making this the first time satellite technology had been applied to Hector's dolphins. A complete health assessment was conducted on each captured dolphin prior to tagging and release, providing for the first time, extremely valuable baseline health data for this species. A modified SPOT3 tag manufactured by Wildlife Computers, Inc. was utilized for this study. Tags were attached to the dorsal fin using two POM pins inserted into a bionutral silicone sleeve and secured with corrosive nuts and washers. All three satellite tags were duty cycled and transmitted for more than three months, providing detailed information on the seasonal home range of each dolphin. All data were collected through the ARGOS satellite system. The three animals seemed to remain near where they were captured, tagged and released. One animal on the northern shore of the Banks Peninsula the other two on the south western shore. During the study period mean activity radii were less than 14 km with maximum distances from mean center less than 34 km suggesting high site fidelity. Collectively the tags provided 1,100 good quality positions (ARGOS location codes 3,2 and 1) with 1,771 total positions. There was no evidence that the dolphins experienced deleterious health impacts from the tagging, nor did they exhibit disruption to normal behaviours. The results from the tagging exceeded our expectations, and provided unprecedented insights into the movements of the Hector's dolphin.

Using Longline Fishing Vessels as Research Platforms to Assess the Population Structure, Acoustic Behavior and Feeding Ecology of Sperm Whales in the Gulf of Alaska

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In the eastern Gulf of Alaska, depredation of demersal longline fishing gear set for sablefish, (*Anoplopoma fimbria*) by sperm whales (*Physeter macrocephalus*) has occurred since at least the mid 1970s. The fishery was year round until the early 1980s when fleet expansion resulted in a shortened season. In 1995, a quota system was implemented reducing overall effort while having an 8 month season. This allowed more opportunity for whales to depredate longline gear and reports of depredation increased, which caused economic loss to fishermen. No sperm whales were seriously injured. In 2003 and 2004, the North Pacific Research Board funded a collaborative study among fishermen, scientists and managers to collect quantitative data on longline depredation. The goal of the study is to eventually recommend deterrents or changes in fishing behavior to reduce depredation, hence decreasing the economic loss to fishermen and reducing entanglement risk to whales. Researchers and fishermen collected acoustic, fishing, behavioral and photographic data. Whales were present near the vessels one-third of the time and 65% of the hauls had evidence of depredation (lips or shredded fish remaining on hooks). Usually, one to 7 whales were found near the fishing vessels during the haul. Whales were seen less often during the set and soak. The whales were nearly constantly vocal (see A. Thode's abstract for the 2004 acoustic component). We found single whales diving repeatedly along the shelf edge with no vessel nearby indicating that whales feed normally in this area. Genetic results determined the whales were male and 40 sperm whales were individually photo-identified across both years. A mark-recapture closed model (Chapman estimator) estimated 127 (72, 256; 95% confidence interval) sperm whales present in the study area. This initial phase proved successful in monitoring sperm whales near

fishing vessels and evaluating the magnitude of the depredation.

Swimming Speed and Body Posture as a Function of Age in a Captive Neonatal Killer Whale (*Orcinus orca*)

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It was the goal of this project to assess age-related changes in the behavior of a single female killer whale born at Marineland of Canada. The swimming speed and orientation of the new calf were sampled in real time every minute over ten minute sessions, conducted twice weekly every other month for one year. The neonatal whale swam almost continuously for the first 10 weeks of life. There was then a dramatic decrease in swimming speed with increasing age, while, conversely, the proportion of time spent without forward motion gradually increased from 3% to 35% ($r(26)=0.516$, $p<0.01$). There was also an age-related change in orientation. The calf was observed in a normal, dorsal-up position 81% of the time during the first 30 weeks of age. That proportion then dropped to 60% as she rather suddenly came to adopt alternative body orientations ($X(1)=18.1$, $p<0.001$). At least three benefits can accrue from the provision of normative data of this type. In the first place, the developmental time course of young animals helps open a window into the natural history and behavioral ecology of a species in ways that would otherwise be inaccessible from observations in the wild. Additionally, the establishment of norms may aid wildlife researchers in gauging the age of young animals which they observe. Lastly, such findings can establish landmarks of development against which the staff of seaquariums can appraise the development of subsequent newborns.

Scaling Tidal Lung Volumes of Young Gray Whales, *Eschrichtius robustus*

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Tidal lung volume (VT) measurements of active animals are important components in calculating field metabolic rates and daily energy requirements. However, direct measures of VT of large, unrestrained marine mammals are difficult, so VT has often been scaled from conveniently measured body dimensions. Mean VT scales directly to body mass (and to the cube of body length, L^3) for many mammals over a wide mass range. However, such simplified scaling provides no useful means for measuring inherent variability in VT in different animals or activity states. To establish a basis for estimating VT of individual expirations for active and non-restrained young gray whales over a range of body sizes, several series of direct measurements of expired VT of two captive (Gigi in 1973, $L=8.1$ m; and JJ in 1997-8, $L=5.9-8.4$ m) and two temporarily restrained young gray whale calves ($L=4.8$ and 5.8 m) were made using a differential pressure pneumotachograph. For 8 individual series of measured expirations (mean $n=24.8$), VT was found to be largely a function of TE, the time duration of the expiration (mean $r^2=0.80$), and increased with increasing body length (L) between 4.8 and 8.4 m. In young unrestrained gray whale calves in winter lagoons, mean TE determined from recorded expiration sounds increases as a direct function of L at least to age 3 months, or $TE \sim L$. When measured TE is then multiplied by L^2 , the 8 individual regressions of VT on TE collapse to a combined regression explaining almost all the observed variability in VT: $VT = -6.06 + 2.12(TE \cdot L^2)$; $r^2 = 0.91$. These results support the contention that VT of young gray whales does scale directly to L^3 , similar to other mammals, and provides a practical basis for measuring breath-by-breath variability in VT between different individual gray whales in various activity states.

An Assessment of the True Damage Caused by Grey Seals, *Halichoerus grypus*, in the Swedish Baltic Net Fishery After Atlantic Cod, *Gadus morhua*

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The conflict between grey seals, *Halichoerus grypus*, and the Swedish cod fisheries in the Baltic Sea has steadily increased during the past 10 years. Seals locate the fishermen's nets, damage the catch and tear holes in

the nets. In this study we investigated the damages caused by seals on the net fishery for cod *Gadus morhua* in the central Baltic Sea. Damage includes both the visible damage and the hidden damage *i.e.* the fish that are taken whole without leaving any visible trace. To gather the required data we joined two professional fishermen for a period of three months in 2005. During that period all catch were recorded together with any visible damages. On one link of nets, fish caught in the net were marked without being removed from the net. The net was reset and when retrieved again the number of damaged or lost marked fish was noted. Corrections to the data were made to account for fish that spontaneously fall off. At 42 out of 52 observed fishing occasions damaged fish were found. Damaged fish was most often found as small remains or with only the head of the fish left. At 18 out of 25 occasions when fish were left in the net, marked fish were missing or found damaged. 39 percent of the marked cod were removed from the nets without leaving any visible trace, and an additional eight percent were damaged. Our findings show that the damage to the cod fishery caused by seals is larger than expected. Damages can not only be estimated by observing and counting retrieved damaged fish. The hidden damage is significant and should be taken into account when calculating expected catch losses due to seals.

The Conservation and Management of a Small Endangered Population of Irrawaddy dolphins *Orcaella brevirostris* (Owen in Gray, 1866) in Chilika Lagoon, India

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Chilika is a highly productive wetland ecosystem in Northeastern India which supports more than 150,000 fishermen from 140 villages. Chilika is also home to an isolated population of 60-80 Irrawaddy dolphins which frequent the outer, central and southern regions of the lagoon. The local fishing community consider the dolphins to be a symbol of good fish catch and hence of their own social well being. The main anthropogenic influences on the survival of the dolphin population are changes in fishing techniques and unmanaged tourism activities. The dolphins' support a local tourism industry of 360 dolphin watching boats from 3 villages. Dolphin watching has become one of the biggest and easiest sources of income and this has benefits and drawbacks in the socio-ecological perspective. Another source of disturbance in the system is the introduction of new fishing techniques by a few individuals in dolphin rich areas of the lagoon, which also has adverse affects on the socio-economic well being of the traditional fishing community. Knowing that the fates of traditional fishermen and the Irrawaddy dolphins are intricately linked, community driven conservation through capacity building, incentive programs and alternate livelihoods for relevant stakeholders is the strategy being employed for ensuring the survival of the Irrawaddy dolphin in Chilika.

Comparisons of Hunted and Photographed Beluga Whales: Insights into Hunting Biases and Life History Traits

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Beluga whales (*Delphinapterus leucas*) are an important subsistence resource for many aboriginal peoples across the subarctic and Arctic. Biological samples have been collected from harvested whales for further understanding of the life history traits such as age, growth and reproduction. Because hunters are not able to randomly harvest animals, the results from biological sampling could be biased. We examined hunting biases and life history traits of belugas in the eastern Chukchi Sea by comparing average lengths and length structure of harvested whales with those measured on vertical aerial photographs. Average lengths were greater in harvested whales whereas length structure comparisons varied between years. In 1996, the

length structure was similar between harvested and photographed belugas. In 1998, the harvest consisted entirely of large adult males while photographs were taken of many smaller animals in mixed sex groups. Hunting biases may be caused by the accessibility of only a certain subset of the beluga population to hunters, hunting method, or hunter choice. Our results indicate that care must be taken when extrapolating results from biological sampling of hunted animals to the larger population from which there were taken. Hunting biases may exist in some years or in some specific situations. Results from samples collected in subsistence hunts should be appropriately qualified. We also extracted basic life history information for this population from the vertical photographs. We estimated length at birth to be about 157 cm and length of disassociation of calves and mothers to be about 246 cm, at about two years old.

Co-Occurrence of Bubbling and Calling Varies with Age and Group Size in the Killer Whale (*Orcinus orca*)

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Emission of bubbles has been widely used as a visual cue for detection of a calling cetacean. Fripp (2005, Marine Mammal Science, 21[1]:29-44) found that whistles collected from bottlenose dolphins (*Tursiops truncatus*) while emitting bubble streams represented a biased sample by age and social context. We studied the effect of age and social context on bubble emissions of killer whales (*Orcinus orca*). Calls were collected through an array of hydrophones with simultaneously-recorded video at Sea World San Diego from known individuals. Bubble emissions consisted of streams, rings, and clouds. Other data from the facility have shown that calls co-occurring with bubbling make up 4% of all calls produced. In a sample of more than 200 attributed bubble emissions, 76% of bubbling corresponded with calls. Percentage of bubble emissions with calling varied by (1) bubble structure, (2) social state, (3) age, and (4) call type. Bubble streams were most likely to co-occur with calling (99%). In the data from a single adult male whale, 3% of bubbling occurred without calls. A mother and calf produced 9% of bubble emissions without calls, while a trio of socializing whales produced 42% without calls. Rate of bubbling with calls changed with age. As a calf born in 2001 aged from 7 to 13 months, the amount of bubbling without calls decreased from 46% to 10%. Pulsed calls (43%) were often associated with bubbling but clicks (1%) and whistles (0%) rarely. As previous research suggested, our overall results showed dependency on age and group size along with bubble structure and type for the co-occurrence of bubbling with calls. [Supported by SeaWorld, Inc., and The Hubbs-SeaWorld Society]

Urine Concentrating Ability in Cetacean Species

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In order to examine how cetaceans balance internal osmolality being limited by water availability, we performed physiological and immunohistochemical studies investigating uric osmotic properties and expression of aquaporin 2 (AQP2) in the kidney in bottlenose dolphins *Tursiops truncatus* and Baird's beaked whales *Berardius bairdii*. Based on the measurement of urine osmolality, we found that there were different ways in which salt and urea nitrogen are excreted between the two cetacean species. Urine in bottlenose dolphins had greater osmotic pressure (1716±279 mmol/L, max: 2741 mmol/L, number of individual (N)=5, sample number (n)=243) than that of Baird's beaked whales (837±294 mmol/L, max: 1351 mmol/L, N=10, n=10). Concentrations of electrolytes were also much higher in the urine of the bottlenose dolphin than in that of Baird's beaked whale; however in both species, not salinity, but urea was the main factor for which urine osmolality was observed to be high. In order to gain further knowledge on the ability of the two species to excrete concentrated urine, we investigated the expression of AQP2. AQP2 is known to have urinary concentrating ability based on the selective

transportation of water molecules where it is expressed in the renal collecting duct in terrestrial mammals. Using an antibody for rat-AQP2, we stained regions expressing AQP2 protein in the renal tissues. It was found that AQP2 was expressed at a higher density in kidney tubules of bottlenose dolphins than in those of Baird's beaked whales, and that the tubules of the former had smaller diameters than those of the latter. Kidney tubule features and the strong intensity of AQP2 expression in bottlenose dolphins were similar to the case of sand rats that have high ability to concentrate urine. In contrast, characteristics in Baird's beaked whale were similar to those of rats that excrete moderate concentrated urine. These results suggest that urine concentrating ability, the structure of the kidney tubules, and patterns of AQP2 expression are intrinsically related, and that urine concentrating ability is variable between cetacean species.

Concept of the Long Term Study and Directions for the Conservation of Bottlenose Dolphin (*Tursiops truncatus*) in the North-East Adriatic Sea

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The bottlenose dolphin (*Tursiops truncatus*) is the only regularly found Cetacean species in the North Adriatic Sea (Notarbartolo di Sciarra and Bearzi 1992), the area that is particularly degraded with shallow waters and great human pressure. From the year 1998, we have organized a research project in the area of Trieste bay and Istrian peninsula for defining the status of the North Adriatic population and the potential threats that could cause a declination of the Cetacean population. These years of work has provided us with the basic concept for the long term study on species management and helped us to define and propose appropriate strategies for their conservation (according to the objectives of UNEP, RAC/SPA, Action Plan for the Cetacean) through the evaluation of the optimal method for estimation of population density in the area (observations from the platforms of opportunity, 52 days from 1998 to 1999), defining appropriate methodologies of distance sampling, transect lines method combined with the mark recapture, photo ID (32 days of planned survey: sailing boat and aerial survey - pilot study in period from 2001 to 2003), all together 815 hours of survey and 89 sightings; monitoring of the interaction between Cetacean population and fishery (research vessel and other available motor boats, 50 days and 448 hours of monitoring in years 1999 and 2003); the stranding network formed through the years 2001 to 2004 that has identified 6 bottlenose dolphins (*Tursiops truncatus*) and 1 stranded fin whale (*Balaenoptera physalus*). The laboratory results of the stranded bottlenose dolphins (*Tursiops truncatus*) have not identified any particular injury that would apply the direct human impact (Svetina and Pogacnik in press).

Do You Hear What I Hear: Are Odontocete Mandibular Fat Bodies Bilaterally Symmetrical?

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Understanding mechanisms for sound reception in the aquatic environment is important for interpreting how animals respond to environmental stimuli. The mandibular fat bodies of odontocetes are thought to serve as part of the acoustic pathway followed by received sound. Isovaleric (*i-5:0*) and isolauric (*i-12:0*) acids are unusual branched-chained fatty acids found in high concentrations in odontocete mandibular fats. Within the mandibular fat bodies, these lipids exhibit a complex three-dimensional distribution that is believed to form a channel, focusing sound to the ear. Thus the arrangement of these lipids may play a critical role in odontocete hearing. Odontocete melons are asymmetrical in both morphology and lipid composition, which has been shown to influence outgoing high-frequency sounds, but to date there have been no studies of symmetry in lower jaw lipids. We examined inner and outer mandibular fats of six specimens (330 total subsamples), *Mesoplodon bidens*, *M. europaeus*, *Stenella attenuata*, *Phocoena phocoena*, and two *Tursiops truncatus*, for evidence of bilateral symmetry in lipid composition. Across all specimens, lipids in the inner mandibular fat showed evidence of bilateral symmetry. Patterns in the outer mandibular fat were far less consistent, showing

symmetry in *P. phocoena* and the *Mesoplodons* but not in the dolphins. For example, in *T. truncatus* mean *i-5:0* concentrations in the left and right inner mandibular fats were 25.33±3.18 % and 25.17±2.76 %, respectively; but levels in the outer fats were 36.30±18.90% (left) and 21.29±7.49 % (right). Of the 69 other fatty acids identified in *Tursiops* jaw fats, *i-5:0* was the only fatty acid exhibiting asymmetry. Further work is necessary to establish whether this pattern is characteristic across delphinids, and if so, whether outer mandibular fat asymmetry would offer an acoustical advantage or is merely a consequence of the osteological and soft tissue asymmetry in the dorsal part of the head.

Variables Affecting Hard Part Recovery from Scats and Spews of California Sea Lion (*Zalophus californianus*)

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Rates of passage and percentage recovery of prey otoliths of two adult male California sea lion (*Zalophus californianus*) were assessed. Sea lions were individually enclosed in a 2.44-m tall, 6.1-m diameter tank with an internal haul-out. The first adult (CSL G) was fed 5 different single-species meals, 2 large meals, and 1 mixed meal; the second (CSL H) was fed 6 different single-species meals, 2 big meals, and 1 mixed meal. Each meal type was fed 3 times. Each animal was monitored for 12 hours per day and scat collected when observed. The tank was drained every 24 hours to collect remnants. Prey species fed to both sea lions included northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), Pacific whiting (*Merluccius productus*), and adult pink salmon (*Oncorhynchus gorbuscha*). In addition, steelhead salmon smolt (*Oncorhynchus mykiss*) was fed to CSL H. Times of initial and final appearance of otoliths did not differ significantly among prey species, between sea lions, single and mixed meals, or small and big meals. Average first appearance for otoliths for CSL G occurred 22 hours after feeding. Otoliths continued to appear until 97.3 hours. Average first appearance for CSL H occurred at 20.25 hours, and otoliths continued to appear until 149.5 hours. Average passage rate of pink salmon otoliths between the sea lions had a difference of 21 hours. Percentage recovery did not differ significantly among prey species or between sea lions. Meal size did not affect percentage recovery of otoliths. Mean recovery of otoliths from mixed sardine meals was 32.2%, significantly greater than the single sardine meal of 15.8%. The results from 8 sea lions will be used to develop correction factors for sampling wild California sea lions to better determine diet.

Preparing for the Big One! Lessons Learned from Right Whale Stranding Response

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A large whale stranding is one of the most challenging events encountered by the marine mammal stranding network. The required human and material resources can stretch stranding organizations to the limit. Despite the difficulties, there is a critical need to provide immediate and thorough examinations of whale mortalities. These examinations offer unique opportunities to assess species' health and provide vital information for evaluating the effectiveness of strategies to mitigate human impacts on whale populations. There is no better example from a species perspective than the northern right whale, *Eubalaena glacialis*. A critically endangered species, the right whale is found along the entire Atlantic coastline of the U.S. from Florida to Maine. Since the beginning of 2004, the Virginia Aquarium Stranding Response Program has been involved in responses to four right whale strandings. Necropsy team leaders and excellent necropsy protocols are available for right whale strandings, but what about the responsibilities of on-site stranding response coordinators? These responsibilities are less clearly defined and can include: (1) determining suitable landing, necropsy and disposal site(s); (2) recruiting and organizing response personnel; (3) locating transport vehicles and heavy equipment; (4) coordinating accommodations, acquisitions of supplies

and on-site safety for response personnel; (5) coordinating data collection from all aspects of the stranding response; and (6) managing information flow to and from response personnel, outside researchers, and the media. Many of these responsibilities can best be managed by pre-planning for large whale stranding events. From our experiences with right whale strandings in a variety of situations, we have developed a checklist and response guidelines that may be useful to local stranding responders in preparing for the next important large whale response.

Steller Sea Lion (*Eumetopias jubatus*) and California Sea Lion (*Zalophus californianus*) Interactions with Vessels in Pacific Rim National Park Reserve: Implications for Marine Mammal Viewing Management

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Sea lion viewing is an integral component of whale watching trips in the Broken Group Islands (BGI), Pacific Rim National Park Reserve (PRNPR). Pinniped viewing has become a management concern in PRNPR and viewing guidelines have been created to prevent potential disturbance by vessels. Effective management of sea lion viewing requires understanding how sea lions react to vessels and subsequently mitigating aspects of vessel activity that cause disturbance. The objective of this study was to evaluate the effectiveness of the Park's Pinniped Viewing Guidelines (PVG) in preventing sea lion disturbance. Vessel approaches were controlled for predetermined measures of distance, speed, vessel types and numbers. Scan samples were conducted when no vessels were present to establish the behavioural state of sea lions. The number of sea lions engaged in 5 mutually exclusive behaviours were counted during each scan and vessel interaction. Analysis included comparing behavioural responses during vessel interactions with behavioural states during scans. Significant change in behaviour was tested for each category of distance, speed, vessel type and number. This study is the first to systematically test and quantify sea lion behaviour in response to all these elements of vessel interactions. A total of 160 scan and interaction pairs were sampled during 38 days over two seasons. Thirty-nine (24%) of vessel interactions resulted in disturbance. Variance in behaviours was significant for vessel approaches within 0-25 m (n=79; 38%); vessels approaching 'fast' (n=16; 47%); for motorized vessels under 5 tons (n=107; 30%), and for both 1-vessel (n=113; 23%) and 2-vessel (n=18; 39%) interactions. The results of this research demonstrate that PRNPR's PVG are effective in preventing sea lion disturbance in the BGI when vessel operators follow the prescribed approach distance and speed guidelines. It is hoped that Parks Canada will consider and incorporate these results into its PVG.

Grouping of California Sea Lions *Zalophus californianus californianus* Rookeries in the Gulf of California Using Metal Levels in Bone

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Sea lions, as top predators, may reflect environmental characteristics and their temporal changes. Genetic, biological and ecological studies of California sea lion (*Zalophus c. californianus*) in the Gulf of California, have suggested the existence of a geographic clustering of rookeries, probably related with differences in feeding areas and habits. This study addressed the question whether metal levels in animal's bone, may also identify potential geographic differences. Eleven metals (aluminum, arsenic, cadmium, cobalt, copper, iron, lead, mercury, nickel, selenium and zinc) were recorded in skull bone of adult sea lions at 10 of the 13 rookeries, accounting for a total sample of 64 individuals. Zn had the highest incidence with a mean of 74.1±25.29 ppm, followed by Al (64.3±25.59 ppm) while metals with the lowest concentration were Hg and Cd. We selected the 5 more important metals according to their contribution to the explained variance in a PCA: Al, As, Hg, Se and Zn, and then explored

the rookeries aggregation using multivariate analysis (PCA and cluster analysis). Four groups were identified: 1) the Northern region, characterized by high levels of Al and Zn, and low As; 2) North-center, with high levels of Al, Hg, and Zn, and no Se nor As; 3) Center, with high levels of every metal, but no Hg; and 4) Center-South characterized by no Hg and high levels of As, Se and Zn. We also analyzed the levels of the three most toxic metals (As, Pb and Hg) using a scaling comparative procedure. Higher levels were found in 3 rookeries of the north-central Gulf. We discuss this regional pattern in relation to oceanographic features of the Gulf and differences of sea lion feeding habits with the aim to provide a spatial categorization of rookeries with differential level of health risk.

Preliminary Results of Multi-elementary Micro-Analyse of Dentine Using Laser Ablation ICP-MS: A New Tool For The Observation of Individual And Small Cetacean Population Life History?

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During toothed whales' life, a succession of hydroxy-apatite layers is laid down in tooth dentine and can be observed in a longitudinal section. During their formation, these structures called "Growth Layer Groups" (GLG) accumulate trace elements which would depend on environmental and/or physiological factors. Because of its large spatial resolution (µm) and low detection limits (ng.g⁻¹), Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry has been previously used to determine temporal variations of trace elements in similar structures such as shellfish shell and fish otoliths. The aim of this study was to perfect a protocol allowing the analysis of trace elements in the different GLGs and thus compare and date the variations. Teeth of 33 common dolphins *Delphinus delphis* were collected, 22 of which belonging to a single mass stranding, and 11 others stranded along the French Atlantic coasts. Because of a lack of reference materials, hydroxy-apatite pastilles were made with dolphin teeth ground, sifted and enriched with a solution containing eleven elements (Zn, Sr, Cu, Mn, Pb, Ba, U, Sn, Cd, Mo, Hg). All the elements except Cd, Cu and Sn exhibited several different profiles. Three main patterns could be identified: no peak (1), one to several peaks (2), numerous peaks at regular intervals all along the individual lifespan (3). Mo and Sr varied simultaneously in all the teeth and seemed to be linked to the lactation and weaning periods. Zn increased at the very beginning of the lactation. Ba, Hg, Mn and Pb exhibited the three patterns and must probably be linked to external factors and thus related to migrations and/or diet changes. Similarities between individuals are scarce and only two individuals of the mass stranding exhibited the same profiles for all the elements. This preliminary study is promising and teeth can probably be considered as recordings of individual historical events.

Contaminant-Related Disruption of Thyroid Hormones and Their Receptors in Harbour Seals: A Biomarker Approach

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There is an urgent need for biologically meaningful and non-invasive biomarkers to assess the exposure to an ever-increasing array of environmental contaminants found in marine mammals. Persistent organic pollutants (POPs) are ubiquitous environmental contaminants which readily accumulate in high trophic level marine mammals, such as harbour seals (*Phoca vitulina*). Elevated levels of POPs have been implicated in the disruption of thyroid hormone (TH) physiology in marine mammals. TH functions mainly by binding to nuclear thyroid hormone receptors (TRs) in target tissue and by modulating gene expression related to thyroid

physiology. Despite the central role that TH plays in normal development, little is known about the mechanism by which POPs target TH action. We developed and applied gene expression techniques to characterize thyroid hormone physiology using skin/blubber biopsies collected from free-ranging harbour seal pups (age 3-5 weeks) in British Columbia, Canada and Washington State, U.S.A. An inverse correlation between total thyroxine (TT4) concentration in circulation and blubber TR α expression ($r^2=-0.481$, $p<0.05$) revealed an as yet uncharacterized relationship between these related endpoints. We observed a contaminant (PCB)-related increase in blubber TR α ($r^2=0.679$, $p<0.01$) and a concomitant decrease in circulating TT4 concentrations ($r^2=-0.711$, $p<0.01$). Our TR α results provide evidence of a contaminant-related disruption of thyroid hormone physiology at the gene transcription level. This first documentation of gene expression in blubber using a biopsy-based approach in a small, manageable marine mammal (*i.e.*, harbour seal) provides a basis for minimally-invasive studies of more challenging species (*i.e.*, large cetaceans). Our finding of a metabolically active blubber layer, and a contaminant-related disruption of blubber TR α expression, suggests that, in addition to developmental toxicities, contaminants may influence such critical life processes as energy storage, thermoregulation, and buoyancy in marine mammals.

Amyloidosis in Two Stejneger's Beaked Whales (*Mesoplodon stejnegeri*)

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Amyloidosis is a disease characterized by the tissue deposition of autologous extracellular fibrillar proteins pressing adjacent tissues. Amyloidosis is well recognized in a wide variety of animals including mammals, birds and reptiles, but there is only one report (Cowan 1995) of amyloidosis in cetaceans (whales, dolphins and porpoises). During 2 years from 1999 to 2000, we necropsied 12 Stejneger's beaked whales (*Mesoplodon stejnegeri*) that stranded dead along the coast of the Sea of Japan. Amyloidosis was found in 2 of these (case A: 498cm, male and case B: 520cm, female), approximately 17%. Two animals were considered physically and sexually mature based on body length, external features and observations on the gonads and whole skeletons. Livers were particularly swollen, fragile and pale (yellow-brownish) on gross examination and large deposits of amyloid were found in Disse's spaces with marked atrophy of hepatocytes. Numerous granulomatous foci including many nematoda (*Crassicauda* sp.) as well as deposition of amyloid were found in the kidneys. We also detected amyloid in heart, spleen, adrenal gland and pancreas. The amyloid of both cases was identified by typical morphology on H&E staining, and its typical affinity for Congo red, displaying apple green birefringence under polarized light with resolution into yellow and blue on rotation of the plane of polarization. Electron microscopy displayed a typical feltwork of fine fibrils measuring about 11 nm in diameter. Here we report the first study of amyloidosis found in two Stejneger's beaked whales (*Mesoplodon stejnegeri*), stranded at the coast of the Sea of Japan. *References:* Cowan, D.F. 1995. Amyloidosis in the bottlenose dolphin, *Tursiops truncatus*. *Vet Pathol* 32: 311-314.

Intestinal Microflora and Chemical Compositions of Bottlenose Dolphin (*Tursiops truncatus*) Reared in Japan

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Many intestinal infectious diseases of cetacean have been reported. However, intestinal microflora are known to play beneficial roles in the health of animals, from humans to domestic animals. In addition, animal feces are known provide considerable information about organisms, and can serve as a very important barometer for animal health conditions, especially those in captivity. However, such processes in cetaceans are poorly understood. This study was therefore undertaken to examine intestinal microflora by a culture method using nineteen kinds of media (nonselective and selective for family or genus aerobic or anaerobic bacteria and fungi) and chemical components such as the moisture content, pH, lactate and short-chain fatty acids (SCFA; acetate, propionate, butyrate, isobutyrate, valerate and isovalerate) concentration, electrical conductivity (EC), exchangeable cation (Na⁺, K⁺, Ca²⁺ and Mg²⁺) contents, and cation exchange capacity (CEC) of the intestinal contents (fecal) of 25 bottlenose dolphins (*Tursiops truncatus*) reared in six aquariums in Japan. Total bacterial counts ranged from 103 to 105 per ml of intestinal contents, up to counts 103 for the majority of family or genus selective plates, or were undetected in a few samples. In Addition, Lactobacillus was not detected in any individuals. Variation of microflora in individuals was independent of feed and habitat. Moisture contents more over 70%. All intestinal contents samples were alkaline, with some individuals demonstrating more than pH 8.0. The individual SCFA concentration ratios in the intestinal contents differed from published data for marine and land mammals. Ca²⁺ showed the highest concentration among the cations examined. Although these results do not identify significant relationships between microflora, chemical components, and specific conditions, such as feed and habitat, however they do provide further information about functions of the intestinal tract of dolphins. The our works are processing molecular ecological analysis of intestinal microflora.

Optimizing Analyses of mtDNA Sequence Data to Maximize Power to Detect Population Structure

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Many marine mammal populations have experienced large recent declines in abundance and maintain high genetic diversity. Ironically, this presents problems in detecting population structure when sample sizes are small and many haplotypes are represented by a single individual (singleton). The U.S. Marine Mammal Protection Act bases management on demographically independent units where internal population dynamics are far more important than external dynamics. Consequently, the units meriting separate management under the US MMPA often exchange dispersers at relatively high rates (far more than one disperser per generation and up to 1%/year). Frequency comparisons using, for example, F_{ST} and c^2 , are the most powerful statistics to detect population structure with high expected dispersal rates. However, singleton haplotypes contribute little to no population structure information to frequency-based statistics. We use simulations to show that, due to its influence on the number of singleton haplotypes, the choice of sequence length strongly effects statistical power when diversity is high: short lengths result in low power, medium lengths in the highest power and long lengths in reduced power resulting from the high proportion of singleton haplotypes. We develop and test a method to optimize analyses of sequence length data by sequentially removing base pairs causing the highest number of singleton haplotypes. We test this new method for bias and illustrate its utility using empirical data from common dolphins and Steller sea lions.

Pre- and Post- Evaluation and Monitoring of a Newly Regulated Manatee Refuge

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Injuries resulting from collisions between watercraft and the Florida manatee (*Trichechus manatus latirostris*) continue to be one of the major known causes of mortality for this endangered species. For the past 20 years, manatee refuges in the form of boat speed regulatory zones have been used as a management tool to reduce manatee mortality. However, as the number of manatee refuges has increased, watercraft-related mortality has also increased and remains at comparable proportions. Historically there have been no studies to investigate whether speed zones effectively protect manatees. The primary goals of this study are to assess manatee behavior, relative abundance, distribution, and boat interactions in a proposed refuge and in an adjacent control area prior to and following posting of regulatory signs. To address these goals, we monitored manatees using focal animal follows from an aerial platform. A total of 330.7 flight hours were logged during 88 aerial surveys from 18 July 2002 through 30 June 2004. A mean of 29.3 (SD 19.7) manatees were sighted per survey with highest counts documented in the fall (43.3, SD 14.6). Video focal animal follows were conducted, resulting in 2,423.9 minutes of behavioral observations. Traveling was the most frequent behavior noted (40.3%), and the habitat used most frequently was shallow (65.1%) with a substrate covered by dense seagrass (27.6%). Boat interactions (passing within 20 manatee lengths of the focal animal) were noted every 15.0 min, and boat disturbances (passing within 5 manatee lengths or a directed behavioral response documented) were noted every 49.5 min. Initial analysis following regulatory posting indicates that the number of interactions may be decreasing. This is an ongoing project that will continue to monitor the study site during the post-regulation phase. Results of this study will allow managers to evaluate the effectiveness of refuges and refine future management strategies.

A Portable System to Evaluate the Auditory Condition of Stranded Marine Mammals

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There is growing concern about the increasing amounts of acoustic pollution in our oceans. Anthropogenic noise sources such as shipping, geophysical surveys, oil and gas drilling, and military sonar span a large range of frequencies and amplitudes. The extents to which these noise sources adversely impact marine mammals is poorly understood yet are of particular significance given that the acoustic environment is crucial for many aspects of marine mammal life, such as foraging and finding mates. Past and present experiments have addressed the effects of different sounds on the hearing capabilities of captive dolphins. However, only a few individuals from a small number of species have been tested. We have created a portable system that is capable of measuring the hearing thresholds of marine mammals. This system was designed for the purpose of testing the auditory health of stranded marine mammals being cared for in rehabilitation centers around the world. A tone is played and the resulting brainstem responses of the subject are gathered using gold electrodes embedded in flexible, rubber, suction cups. These auditory evoked potentials (AEPs) are then measured for a range of frequencies and decreasing amplitudes. The significance of this portable system is that the resulting AEP measurements will aid in diagnosing any potential hearing damage of stranded animals, which can greatly promote the efficiency of treatment, and decisions concerning their release. In addition, the resulting auditory thresholds can determine the possible range of hearing for otherwise inaccessible species.

Assessing Reproductive Rates of Branded Steller Sea Lions (*Eumetopius jubatus*)

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The western Steller sea lion stock is classified as endangered, the eastern stock, threatened, and no consensus exists as to why the species is declining. Reproductive rates were last calculated for this species from dissections of animals collected in the 1970's and 1980's and need to be recalculated for the current population. The Alaska Department of Fish and Game branded 362 female pups at the eastern stock's Forrester Island Rookery Complex in 1994 and 1995. From 2000 to 2004, 1777 sightings have been made of 114 branded females with and without pups. These data are

being used to estimate current reproductive rates for the eastern stock. Steller sea lion reproductive status and location are highly associated. Females who reproduce spend the first few post-partum weeks on land and return to the same rookery throughout much of the summer to nurse their pups. Females who do not pup usually frequent haulouts. Only one of the 167 pups sighted was at a haulout. Due to practical necessities, there is also an association between location and resighting effort. Resighting effort and number of cow sightings is higher at rookeries (1963 hours, 1636 sightings) than haulouts (412 hours, 139 sightings). Thus resighting effort and reproductive status are associated with each other, because they are both location specific. As a result, apparent reproductive rates (27-68% per cohort per year) are expected to overestimate actual reproductive rates. I designed a multinomial model to describe the complex interaction among reproduction, location and sightability in branded Steller sea lions. Data were simulated according to this model and were analyzed using Markov chain Monte Carlo methods. I evaluated the performance of a series of models of increasing complexity to determine the best method to disentangle this interaction given the sample size constraints of the actual data.

Tenure and Reproductive Success in Steller Sea Lion (*Eumetopius jubatus*) Males at Chiswell Island, Gulf of Alaska

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A novel approach has been developed at the Alaska SeaLife Center in Seward, Alaska to study a Steller sea lion rookery in the endangered western stock. In this study, breeding season tenure (1999-2004) and reproductive success (2001-2004) of Steller sea lion males were examined using remote video cameras at Chiswell Island. The objective of this study was to test the hypothesis that territory features influenced male Steller sea lion copulation success. Nineteen individually recognized males copulated at least once (average = 5.4 per year) over the 6-year period from 24 May to 15 July (average date = 21 June). Inter-annual tenure ranged 1 to 4 years (average = 2.4 yrs) and copulation success increased over the first 3 years of tenure on the rookery ($r^2 = 0.4904$, $P = 0.005$). Territory sizes were 36 m² to 225 m² (average = 144 m²) and copulating males held territories 9 to 62 days (average = 42.1 d). Territory size and number of births per territory were the best predictors of a male's copulation success but not the number of days they held a territory (stepwise multiple regression; $P = <0.0001$, $r^2 = 0.496$). Males in some territories had a significantly greater copulation success than others ($P = 0.001$) regardless of male turnover, suggesting females preferred territorial features over specific males. Eighty-five percent of copulations with identifiable females produced a pup the following year and overall reproductive success did not vary significantly between years ($P = 0.81$, $s^2 = 0.08$). Our long-term monitoring of Steller sea lion reproductive behavior will help to define limits of male reproductive success throughout their lifetime.

Echolocation Behaviour of a Wild Harbour Porpoise During Diving

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Thousands of harbour porpoises are by-caught yearly in bottom set gillnet fishery throughout their distribution. Little is known about the echolocation behaviour of wild harbour porpoises and thereby their ability to detect gillnets. For the first time (June 2005) a subadult male harbour porpoise in the Danish Belt was equipped with an acoustic datalogger (A-tag), a dive recorder, a VHF radio and a satellite transmitter. The animal was accidentally trapped in a pound net. The satellite transmitter was mounted to the dorsal fin and the acoustic datalogger, dive recorder and VHF

transmitter was attached with a suction cup in front of the dorsal fin. The suction cup detached after 4.5 hours and was retrieved the following day. In total about 70,000 clicks grouped into 1,650 click trains were recorded. Each train included at least 5 clicks and lasted on average 2.1 second (SD=2.4) with an average click interval of 70.5 ms (SD=41). During these 4.5 hours the porpoise made 132 dives between 3 and 24 m and spent 42% of its time in the upper 0-2 m. The bathymetry below the satellite track (7 positions) indicate that the animal dove to the bottom on most dives. The dive pattern was similar to that recorded from 14 previously tagged harbour porpoises carrying satellite dive recorders (28 dives/hr to a mean depths of 30 m spending 50% of the time in the upper 0-2 m in June). The porpoise regularly stopped using its sonar for periods of seconds as also shown in finless porpoises in the Yangtze River, China. Maximum period of silence was 222 seconds, but 90% of silent periods lasted less than 15 seconds. If porpoises stop echolocating in areas with no apparent obstructions or direct their signals towards the bottom, gillnets will not be detected resulting in possible entanglement.

Acoustic Size Estimation of Sperm Whales Revisited – A Robust Method Using Generic Clicks

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Estimation of size in marine mammal species plays an important role in stock assessment and group composition. Reliable estimates of size are inherently difficult in the field, especially for deep diving species that spend little time at the surface. The sperm whale, producing multipulsed usual clicks, offers a unique way to estimate the body length. However, the technique has only been used in a few preliminary studies and never applied on a broad scale. One of the main reasons might relate to the fact that clicks seldom displays the regular multipulsed structure required for assessing the size of the spermaceti organ and subsequently the length of the whale. Recent findings on sperm whale sound production show that pulse structure of usual clicks varies with the recording aspect of the clicking whale and that the pulse delays are variable and not directly related to the length of the spermaceti organ. Exploiting this modified bent-horn model for sperm whale clicks, we provide a unique method, based on Cepstrum analyses of a large number of generic clicks from individual whales in unknown recording aspects, to estimate individuals' body lengths. Analyses of long click sequences show that the classical inter-pulse interval (IPI) is given by the upper limit of random pulse intervals. The corresponding average values of the Cepstrum for all clicks in a dive give a clear peak in correspondence of the IPI, allowing for a robust estimation of the size of the spermaceti organ with just one hydrophone. The method could be applied when recording sequence of clicks from diving sperm whales during acoustic surveys and size of several individuals in a group could be estimated even if the orientation of the whales is unknown.

Distribution, Movements, and Foraging Behaviors of California Sea Lions (*Zalophus californianus*) in the Lower Columbia River of Oregon and Washington, USA

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Since 1997, California sea lions have been captured and marked at Astoria, Oregon to monitor their abundance, distribution, and movements in the lower Columbia River and its tributaries. This study was undertaken to examine sea lion foraging activities in these inland waters and to evaluate any impact they might have on threatened and endangered salmonids of the Columbia River Basin. The sea lions were branded and equipped with a combination of flipper tags, numbered visual patches, VHF radio tags, and satellite-linked transmitters. To date, 809 sea lions have been captured and 545 individual animals have been permanently marked. Tracking of individual movements has been accomplished primarily by visual observations of marked animals; documented sightings now total more than 15,000, ranging from Vancouver Island, British Columbia to San Nicholas Island, California. Seven and 46 individually marked sea

lions have been re-sighted while foraging on adult migrating salmonids below fish passage facilities at Willamette Falls (128 miles upriver) and Bonneville dam (145 miles upriver), respectively. Individual animals have made as many as five round trips per year (February-May) between Astoria and Bonneville Dam (290 miles minimum) to forage for salmonids. During spring 2005, nearly one-half of all sea lions observed foraging for salmonids at Bonneville Dam were marked individuals. Since January 2004, 8 satellite-linked radio tags have been deployed on 7 individual sea lions. The movements of these animals were tracked throughout the lower Columbia River, in the near-shore ocean off Oregon and Washington, and during the southward migration to summer breeding grounds in California. This information on seasonal and annual foraging patterns of known individuals has provided important insights into the behavior and habitat use of California sea lions in the Columbia River area and may prove useful for mitigating the affects of pinniped predation on threatened and endangered salmonids.

Assessment of a Number, Seasonal Distribution and Determination of a Species Composition of Sea Mammals in the Barents Sea by Results of Air and Vessels Observations in 2002-2004

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Investigation of trophic interrelations of organisms is one of the main topics in studies of marine ecosystems. For the rational planning of the exploitation of the Barents Sea biological resources, the information on the role of sea mammals in the ecosystem is of high profile. Assessment of a number of sea mammals inhabiting the Barents Sea is difficult because of the differences in the character of their distribution over the area in various seasons. A role of sea mammals in the Barents Sea ecosystem increased sufficiently with the growth of the population abundance. Increase of sea mammals' number in the Barents Sea is a result of the long-term ban against the commercial hunting of cetaceans and a reduction of hunting for the mass species of Pinnipedia, harp seal and hooded seal. Warming of the climate in the North Atlantic areas and in the West Arctic turned apparently to be a reason of the increase of the time duration of sea mammals' migrations in the Barents Sea. The results of observations carried out from the board of the aircraft laboratory AN-26 "Arktika" and vessels in autumns from 2002 to 2004 within the frameworks of the annual joint trawl-acoustic Russian-Norwegian investigations of sea mammals in the Barents Sea are summarized in the paper. The aim of the air surveys was the determination of a character and a pattern of the spatial distribution of sea mammals over the Barents Sea, as well as finding of its dependence on distribution of fish resources, first of all, mass pelagic fish species of the Barents Sea, namely, capelin and polar cod.

Source Levels and Communication Ranges of Harp Seal Underwater Grunts

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Source levels of a common underwater call (Type 14 - "Grunt") of harp seals (*Pagophilus groenlandicus*) were measured in the Gulf of St. Lawrence, Canada. A two hydrophone array (Cato, D.H. 1998 Simple methods of estimating source levels and locations of marine animal sounds. J. Acoust. Soc. Amer. 104: 1667-1678) was deployed within the main herd at 7 locations in early March. Source levels were calculated when the seal was < 100 m away. Calls were 157 ± 12.6 dB re $1 \mu\text{Pa}$ at 1 m (mean \pm S.D.; range 123 to 184 dB re $1 \mu\text{Pa}$ at 1 m, N = 231). Source levels were not related to calling depth (5 - 84 m), frequency (134 - 1,870 Hz), number of elements in the call (1 - 5) or total call duration (0.08 - 7.89 s). The unmasked communication range, where the sound level reaches the detection threshold, would be 2.8 ± 6.3 km (maximum > 14.5 km). Calls would be clearly detectable (i.e., 20 dB above the unmasked detection threshold), at 224 ± 292 m (range 0.1 - 2.0 km). At calling rates > 75 calls/min, background noise masking from other seal calls would limit the clearly detectable range to 159 ± 251 m. If a ship is moving through heavy pack ice within 1 km, the clearly detectable calling range

would fall to 61 ± 90 m. Masking seal and ship noises were irregular and some grunts would be clearly detected by listeners 800 and 350 m away respectively. Most calls would have a functional communication range that is far below the theoretical maximum.

Optimal Foraging Predictions of an Index to Patch Quality Applied to Juvenile Steller Sea Lions in Prince William Sound

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Mori and Boyd (2004) used an optimal foraging approach in calculating an Index to Patch Quality (IPQ) for Antarctic fur seals that related the transit, foraging and recovery times of a dive cycle to the variation in the expected net energetic gain obtained while foraging at the bottom of the dive. Under the assumption that divers optimize their bottom time while foraging in a prey patch, the IPQ controls for variation in transit time (depth) and animal diving capacity, and estimates the quality of the prey patch in terms of the expected rate of energy gain. Here we apply that method to examine variation in IPQ during bouts and across seasons for a sample of juvenile Steller sea lions foraging in Prince William Sound, Alaska. We used data from 17 sea lions equipped with satellite-linked dive recorders in 2003-2005 that relayed time, depth, dive duration and interdive intervals, as well as dive shapes and bottom times. Results were consistent with our predictions that IPQ would decline during dive bouts due to prey depletion and dispersion caused by foraging in a prey patch, and that there would be seasonal shifts in IPQ reflecting the changing depth distributions and behavior of likely target species.

Evo-Devo Research and Marine Mammals: Evolutionary Perspective on Hind Limb Loss in Dolphins during Development

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Ontogenetic studies of marine mammals are of great interest for evolutionary biologists because marine mammals have altered many of the developmental constraints that are part of the original mammalian body plan. For example, many cetaceans have more teeth, more phalanges, and more vertebrae than the mammalian archetype, and they lost such characteristic mammalian features as a haircoat, precise occlusion, and strongly regionalized vertebrae. The cetacean body is also more asymmetrical than most other mammals. Cetacean developmental data are also important because they complement the excellent series of fossils that document the origin and early evolution of Cetacea collected in the past 15 years. Evolutionary hypotheses inspired by developmental data can thus be tested against what actually happened in evolution as documented by a series of intermediate fossils. In order to initiate a research program on the evolutionary aspects of development in cetaceans, my lab collaborated with the Natural History Museum of Los Angeles County to study a large collection of embryos and fetuses of *Stenella attenuata*. After staging the collection, the first research project involves an immunohistochemical investigation of the genes that control the reduction and loss of hind limbs in *Stenella* embryos. To this end, we studied gene expression at the protein level in the limb buds of *Stenella* embryos in the first gestational month. We identified several deviations in gene expression patterns of *Stenella* when compared with generalized tetrapod limb development. Put in an evolutionary context by using fossils, we conclude that major developmental changes in limb patterning did not occur in cetaceans until after the hind limbs had lost their function in locomotion. Ongoing work on forelimbs and the dentition may further elucidate the developmental constraints that acted on the first ten million years of cetacean evolution.

Trophic Transfer of a Biomarker Through the Arctic Marine Food Web: Benthically-Derived Fatty Acids in Polar Bears (*Ursus maritimus*)

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Accurate information on predator diets is essential for an understanding of Arctic ecosystems, where environmental changes are significantly affecting marine food webs. Fatty acid (FA) analysis is an important means of collecting such dietary information. Non-methylene interrupted fatty acids (NMIFAs) are unusual FAs synthesized by mollusks and other benthic marine invertebrates, and have recently been identified in pinniped species that are direct consumers of these organisms in the Bering Sea: bearded seals (*Erignathus barbatus*) and Pacific walrus (*Odobenus rosmarus divergens*). Thus, we looked for NMIFAs in the adipose tissue of polar bears (*Ursus maritimus*) and their marine mammal prey across the Canadian Arctic to examine the possibility that NMIFAs may serve as trophic biomarkers transferred from near the bottom to the very top of the marine food web. Ringed seals (*Phoca hispida*), harp seals (*P. groenlandica*), hooded seals (*Cystophora cristata*), beluga whales (*Delphinapterus leucas*), and narwhals (*Monodon monoceros*) had trace or undetectable levels of NMIFAs. These FAs rarely accounted for more than 0.1% of total FAs harbour seals (*P. vitulina*) but were approximately tenfold more abundant in bearded seals across the Canadian Arctic and in Atlantic walrus (*O. rosmarus rosmarus*) in Foxe Basin. In agreement with earlier findings from the Bering Sea, bearded seals and walrus in the Canadian Arctic differed in their relative proportions of NMIFAs and 22:2D7,15 was unique to bearded seals. All 6 NMIFAs we identified were present in polar bears and 22:2D7,15 appeared to be directly incorporated from bearded seal prey. Variability in the abundance of 22:2D7,15 indicated that bearded seals are most often consumed by large, adult male polar bears and least often by immature bears. Consistent with previously published data, polar bears in western Hudson Bay appear to consume bearded seals more frequently than bears in the Beaufort Sea.

Acoustic Behavior of Sperm Whales in the Gulf of Alaska in the Presence and Absence of Longline Fishing Activity

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Historical whaling records indicate that sperm whales off southeast Alaska incorporate fish into their diets, particularly black cod (*Anoploploma fimbria*). Since 1995 this fact has become relevant to fisheries concerns in the form of increased depredation encounters between longline fishermen and at least 40 individual sperm whales. Since 2002 the SE Alaska Sperm Whale Avoidance Project (SEASWAP) has been studying this phenomenon using fishermen reports, photo-ID, and biopsies (see related abstract by J. Straley *et al.*). In 2004 and 2005 both passive acoustic towed arrays and autonomous recorders mounted on longline deployments have provided an opportunity to both monitor and track sperm whale acoustic activity, whenever fishing vessels were present and absent. By using acoustic multipath the range and depths of foraging whales can be determined from a single hydrophone (see related abstract by C. Tiemann *et al.*). Findings to date indicate that whenever fishing vessels are absent, sperm whales are foraging at mid-depth in the water column (e.g., 250 m in 500 m deep water), and that their dive cycle durations are similar to those reported in other areas. Whenever animals are around fishing vessels, however, the dive cycles are typically much shorter (e.g., 15 minutes or less) and position fixes on vocally active animals tend to be much shallower (e.g., 50 m). The characteristics of the acoustic sounds also change, one prominent feature being a reduction in the inter-click interval (ICI). There is increasing evidence that distinctive acoustic cues made by hauling longline vessels attract the animals to longline activity, whenever the animals are less than 10 nautical miles range from the site. These cues do not seem to be associated with sounds made by specialized longline equipment, but

rather relate to how the vessel is handled during a longline haul. [Work supported by the North Pacific Research Board]

Organohalogenated Contaminants in UK Harbour Seals – Relationships with Thyroid Hormones and Phocine Distemper

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Organohalogenated contaminants in blubber biopsies from harbour seals (*Phoca vitulina*) from different populations around the UK coast were investigated in 2003 (n=60). Significant regional differences were found (p<0.0001) with seals from southwest Scotland having the highest levels of polychlorinated biphenyls and seals in eastern England having the highest levels of polybrominated diphenyl ethers. Animals from the north of Scotland (Moray Firth and Orkney) had the lowest levels of all contaminant groups studied. Significant relationships between blubber contaminants and total triiodothyronine concentrations were found in the harbour seals, after controlling for the effects of confounding factors (location, sex, age and condition). PBDEs (p=0.007) and pesticides (p=0.008) were the most significant predictors and in all cases the relationship was a positive one, with higher levels of triiodothyronine being seen with increasing concentrations of contaminants. This finding is in line with our previous studies on grey seal pups where hyperthyroid effects were related to blubber levels of PBDEs. This was not due to sampling pregnant females who have increased triiodothyronine levels in their blood. We also investigated the difference between contaminant concentrations in harbour seals that died of PDV during the 2002 epidemic with concentrations in the survivors. We found significantly higher concentrations of PCBs (p=0.005), but not other contaminants, in the seals that died of PDV than the animals that survived the epidemic. Of the survivors 55% had seropositive PDV titres. Again we controlled for other factors (such as sex, age and size) that might have been driving this finding. PCB levels in the dead animals were also above the estimated threshold for effects on the immune system of marine mammals, as were the levels in live animals from Islay/Jura where no exposure to PDV (animals did not have any antibodies) was seen in 2002.

Movements, Dive Behavior, and Survivability of California Sea Lions (*Zalophus californianus*) Post-Rehabilitation for Domoic Acid Toxicity

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Domoic acid is a neuroexcitatory toxin that can cause gastrointestinal and neurological problems if ingested. California sea lions (*Zalophus californianus*) were first noted displaying clinical symptoms of domoic acid toxicity in 1998 along the central California coast. Behavioral and physical symptoms included head weaving, unresponsiveness, ataxia, scratching, seizures, and lesions within the hippocampal region of the brain. In 1998, animals were admitted to The Marine Mammal Center (TMMC) for treatment and released back into the wild, however, behavior and survival of these animals were unknown. Starting in 2003 we used satellite telemetry to monitor dive behavior, migration, and survival of California sea lions after rehabilitation at TMMC in Sausalito, CA for domoic acid toxicity. Before the animals were released, satellite relayed data loggers (SRDLs) were attached between the scapulae with Devcon® 5 minute epoxy or Loctite® 422. To date, 9 animals have been released and tracked for up to 130 days. Two of the eight animals re-stranded and were euthanized and one animal's survivability was questionable due to the last transmitted location being half way between Monterey Bay, CA and Hawaii. Five animal's survivability was unknown due to premature tag failure and the inability to re-sight the animals after transmission ceased. Although survivability of these animals was unknown, all of them displayed abnormal behavior such as disorientation, isolating themselves while hauled out, and not reacting to humans and dogs as they are

approached. The ninth animal is currently being tracked; therefore, it is too early to assess the success of this animal. These data will be compared to a control group of sea lions unaffected by domoic acid toxicity. Preliminary data, however, indicates California sea lions inflicted with domoic acid toxicity cannot be successfully rehabilitated.

Effects of Water Temperature on Swimming Metabolic Rate and Foraging Efficiency in Sea Lions

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Despite being poorly insulated, several sea lion species forage in cold water over much of their range. It is likely that thermal considerations strongly influence their swimming (SMR) and field (FMR) metabolic rates, which constrain dive durations and foraging capabilities and influence energy requirements. Mass specific differences in SMR and FMR may lead to very different foraging efficiencies and influence the profitability of different prey distributions for different size classes of sea lions. Laboratory estimates of SMR for sea lions are hard to reconcile with current models of mass specific metabolism, and appear to have widely differing functional forms. For instance, SMR appears to increase linearly with swim speed for Steller sea lions in 10°C water. In an attempt to reconcile the disparate experimental SMR/swim speed relationships we developed a simple model of swimming incorporating the costs of overcoming drag and both passive and forced convection heat losses. We fitted the model to empirical data from a wide size range of sea lions in different thermal conditions. We verified the model by comparing its predictions with FMR data from Hooker's and Australian sea lions, foraging in summer and winter. Model predictions were within 9.8% of the estimated FMR for both species. The model predicts that: a) at low temperatures mass-specific SMR scales to M^{0.67} over a wide range of swim speeds; b) for small animals, at low temperatures, MR scales almost linearly with swim speed. There is therefore no achievable minimum cost of transport speed. Swim speed is likely limited by other mechanical considerations; c) that recently weaned sea lions may be unable to meet their metabolic requirements in prey densities that adults can exploit effectively; d) thermal effects may be sufficient to explain delayed weaning times and that delayed weaning may be an indication of higher available resource levels rather than an indication of food stress.

Attendance and Distribution Patterns of Southern Right Whales at a Summer Feeding Ground in St Helena Bay, South Africa

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Southern right whales (*Eubalaena australis*) are usually portrayed as annual migrants between summer feeding grounds in the Southern Ocean and winter breeding grounds in coastal waters of southern continents. While in coastal waters right whales are assumed to feed rarely, if at all. Recent observations indicate that this pattern may not hold true for the west coast of South Africa, where right whales seem to utilize the waters of the St. Helena Bay area in summer as a feeding ground. How long individual whales remain in the bay is one indication of the relative importance of this feeding ground. In September 2001, 3 satellite-tagged whales moved into St Helena Bay and remained in the vicinity for between 48 and 100 days. In a further study of attendance patterns, VHF radio capsule tags were deployed sub-dermally by crossbow in 9 right whales between September and November 2004, and their transmissions monitored automatically over 24 hours through a 4-antenna array mounted on a hilltop about 150 m ASL. Each antenna was scanned 8 times per second and the relative signal strength at all 4 antennas logged, providing directionality for the incoming signal. Each tag's frequency was monitored continuously for 15 mins, so that when all 9 tags were deployed, each was monitored for a total of 2 hours 40 mins every 24 hours. Some 28,000 transmissions were logged, of which 3,632 had sufficient antenna gain to be considered unequivocally as signals from whales. Attendance patterns varied between "residents" (virtual continuous presence over 46-66 days) and "transients" (present for only 17-43% over 44-76 days). These are minimum residence times, as whales were already in the bay when tagged.

The distribution of bearings showed a similar usage of the bay as that illustrated by the satellite-tagged whales in 2001.

Validity of Classifying Individual Dives in Longitudinal Dive Records Using Southern Elephant Seals as a Model

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Most studies of pinniped diving behavior manually place dives into categories based on their shape and dive parameters such as depth and duration. Not only has this practice been criticized for its subjectivity, diving behavior possibly represents a continuum of different shapes/behaviors, making it invalid to separate dives into artificial groups. We tested the validity of classifying dives using the 5 typical dive types found for elephant seals. We firstly undertook a manual classification of the dive records of three individuals seals' post-moult foraging trips (16,010 dives), using two different human classifiers. While the overall agreement between observers was high (96%), the majority of this agreement (98%) was for foraging dives which made up 93% of the dive records. The agreement for the other dives types was much lower, some as low as 60%. Using a training set of the dives where the two classifiers agreed, we developed a quadratic discriminant function (QDF) to classify the full dataset using several dive parameters. The training set performed well, with 85 % overall agreement with the human classification. All dives had high agreement except for 'V-shaped' dives (65 % agreement). Using the QDF to classify the whole dataset produced high agreement for foraging dives but the rarer dive types had low agreement. We also performed the analysis using the mean depth of 20 equally spaced dive depth readings as the variables, including three dive parameters: bottom time, maximum depth and duration. This training set performed better (95% agreement) with all dive types performing well. On the full dataset the overall agreement was around 90% although the accuracy of the rarer dive types was still low. The human classifiers had higher agreement between each other than they did with the model. The disagreement between statistical and manual classifications indicates that it is possibly not valid to classify dives into discrete types.

Model-Based Passive Acoustic Tracking of Sperm Whale Foraging Behavior in the Gulf of Alaska

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Since 1995, incidents of sperm whales depredating longline fishing operations off southeast Alaska have been increasing, thus raising the concerns of local fishermen and managers. The Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) began studying this behavior in 2002, and in 2004 it introduced the use of passive acoustics to help monitor whale behavior. Acoustic data from autonomous recorders mounted directly on longlines provide an opportunity to test a new method of tracking animal motion underwater while providing insight into whales' foraging behavior. The localization method exploits multipath arrival information from recorded sperm whale clicks and has advantages over some standard geometric or hyperbolic techniques. Based on a ray-trace acoustic propagation model, it can account for all waveguide propagation physics such as interaction with range-dependent bathymetry and ray refraction. The method does not require acoustic ray identification (*i.e.*, direct path, surface reflected, *etc.*) while still utilizing individual ray arrival information, and with sufficient knowledge of azimuthally-dependent bathymetry, a 3-D track of whale motion can be obtained using data from just a single hydrophone. The algorithm matches the evolution of multipath arrival patterns from a train of sperm whale clicks to range-, depth-, and azimuth-dependent modeled arrival patterns in order to generate an estimate of whale location. Several tracks of whale activity have been created using data from both one and two hydrophones, each about 15

minutes long and out to 1 km in range, including two dive profiles. Typical foraging depth for the whales is found to be between 200 to 400 m, no closer than 50 m from the bottom. A discussion of changes in the acoustic foraging behavior of whales when near fishing vessels is provided in another presentation.

Alternative Diet Specializations in the Southern Sea Otter: Energetic Implications of a Behaviorally-Mediated Foraging Polymorphism

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Alternative diet specializations have been reported for many terrestrial wildlife populations, but logistical constraints have precluded detection of diet polymorphisms in most marine mammal species. We investigated diet and foraging behavior of southern sea otters (*Enhydra lutris nereis*) to characterize patterns of variation and evaluate energetic implications of dietary specialization. From 2001–2004 we collected longitudinal data from 60 radio-tagged otters at two locations, Monterey and Cambria, CA, recording 38,500 prey captures during 1,781 hours of direct observation. Detailed dive profiles were collected simultaneously using archival time-depth recorders (TDR). Sea otters were dietary generalists at the population-level, preying on more than 24 major taxa, but specialists at the individual-level, with most individual diets dominated by 2–6 taxa. Using cluster analysis to test for repeated patterns of specialization we found three distinct diet types, all represented proportionally among sexes and locations: type 1 specialists were characterized by large prey (*e.g.*, cancer crab and abalone), type 2 by intermediate size prey (*e.g.*, bivalves and worms) and type 3 by turban snails. This classification scheme effectively distinguished otters by diet (discriminant analysis jack-knife classification accuracy = 93%) and multivariate contrasts of behavioral variables and dive parameters also showed differences among diet types. We suggest that the three diet types represent alternative foraging strategies. We used a boot-strap analysis of individual foraging bouts to estimate mean and variance in the rate of energy gain: this was generally low compared to values reported for other sea otter populations, but showed a high degree of within- and between-individual variance. Type 1 specialists had the highest mean rate but also the highest within-individual variance, type 2 specialists had the lowest mean rate and the lowest variance, while type 3 specialists had intermediate mean and variance. We discuss some possible causes and fitness implications of diet specialization.

A Five-Year Examination of Baleen Whale Trophic Dynamics in the Gulf of Maine Using Stable Isotopes

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Stable isotope analysis (SIA) was used to examine variations in trophic dynamics between and within four baleen whale species found in the Gulf of Maine. Stable isotope measurements were conducted on 195 skin biopsies collected by three institutions spanning 1999 through 2003. Multivariate techniques, using $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ together as an isotopic "signature", were used to analyze the effects of a number of independent variables derived from associated demographic data. Species was a strong predictor of isotopic signature ($F = 0.4658$; $df = 6,380$; $p < 0.0001$), suggesting a trophic hierarchy of humpbacks (*Megaptera novaeangliae*) and minke whales (*Balaenoptera acutorostrata*) (both piscivorous) > finback whales (*B. physalus*) (piscivorous/planktivorous) > northern right whales (*Eubalaena glacialis*) (planktivorous). Few gender effects were observed, although humpback whale nursing mothers were trophically higher than other male and female conspecifics ($p = 0.0071$). Trophic position decreased between calf and adult life history stages in both humpbacks ($p = 0.0009$) and finbacks ($p = 0.0412$). Isotopic signatures were not consistent annually, with substantial changes seen in 2002

suggesting a trophic downshift for humpbacks ($p = 0.0083$) and finbacks ($p < 0.0001$) to more planktivorous-based diets. Field observations associated with this shift, perhaps linked to anomalies in the North Atlantic Oscillation, included lower humpback whale sighting frequencies in comparison to previous years for at least one inshore habitat, and unusual sightings of krill-eating balaenopterid species. A statistically significant interaction between year and location of sampling ($p < 0.0001$) suggested that not all areas were equally affected by this oceanographic shift. Our results illustrate the potential of applying SIA techniques to ecosystem-scale questions of foraging ecology and trophic dynamics, and provide initial insight into questions of resource and habitat partitioning between seemingly sympatric species, revealing a complexity both between and within species that has not been previously described.

Photo-Identification Study of Sperm Whales in the Kumano Sea off the Pacific Coast of Central Japan (1997-2004)

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Commercial sperm whale (*Physeter macrocephalus*) watching has been in operation in the Kumano Sea off the Pacific coast of Kii Peninsula since 1990. We conducted a photo-identification study of sperm whales from watching vessels during late April to September from 1997 to 2004. For every sperm whale cluster encountered during a total of 300 on-board research cruises, we took photographs of the fluke and the right and left sides of dorsal fin of as many individuals as possible. The encounter rate of sperm whales (number of cruises that encountered sperm whales / number of all watching cruises) through the season of eight years ranged from 27.1 to 55.0% (average: 37.5%). Monthly encounter rate tended to be highest in May (average: 66.7%) and to decrease after June (40.4%) to September (14.1%). By analyzing a series of the photographs taken, we identified a minimum of 236 individuals (121 identified from the flukes, 236 from the left and 181 from the right side dorsal). Thirty-nine of the identified whales were resighted within the same season in the same watching area, and for 14 of 39 (35.9%) individuals the intervals from the date of the first sighting to the last were over one month (up to 91 days). Ten whales identified were resighted in the different years from those when they were first sighted with the longest interval of seven years (1997-2004). As our previous study suggested (Yoshioka *et al.*, 1999; 13th Conference in Maui), at least part of the sperm whale population visits the study area every year and may remain there over a month.

Validation Studies of Blubber Quantitative Fatty Acid Signature Analysis (QFASA) with Captive Steller Sea Lions (*Eumetopias jubatus*)

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Reliable estimates of diets of marine mammals are vital for understanding their role in the ecosystem, but current quantification methods are often imprecise and biased. QFASA has been developed to estimate the species composition of marine mammal diets from the fatty acid (FA) signatures of their blubber and that of their potential prey. We conducted captive feeding studies (1-20 months each) on seven juvenile female Steller sea lions (SSL) to evaluate QFASA's ability to identify known diets and to provide information on FA turnover time, deposition, and FA calibration coefficient (FA-CC) data required for QFASA. For each animal, 4-9 sequential full-depth blubber biopsies ($n=56$) were collected mid-flank, following periods of controlled diet, including 1-12 week pulses of salmon, capelin, eulachon, pollock, pilchard or Atka mackerel, or 35-63 days of a consistent multi-species diet. Fish FA signatures varied among the 12 prey species tested (FA mean CV=0.83, range 0.2-3.7, $n=515$). Within prey species, CVs averaged 0.35 (range=0.19-0.45). Low variability (CV=0.18)

was observed in 10 SSL FA-CC calculations ($n=5$ SSL) where herring diets exceeded 200 days. We subsequently ran QFASA using a mean SSL FA-CC and a new subset of 39 fatty acids. QFASA tracked 63% of eight long-term (>1 month) single species diet switches, performing best for animals on strict herring diets prior to the diet switch. Predictions of short-term and multi-species diet switches correctly identified herring as a major diet contributor, and also certain new diet items, but results were inconsistent, particularly in discerning between herring and small shoaling prey (e.g., capelin, pollock, squid). Species identification depended on the modeling parameters used — thus further optimization is required to reduce species misidentification levels. Sigmoidal decreases in the proportion of herring predicted by QFASA in 3 long-term diet switches showed that 90% of the FAs in blubber turned over within 3-4 months.

Seasonal Distribution and Relative Abundance of Bottlenose Dolphins *Tursiops truncatus* Along the US Mid-Atlantic Coast

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A complex of resident and migratory coastal bottlenose dolphin (*Tursiops truncatus*) stocks exist along the US mid-Atlantic. To help understand this complicated distribution pattern we analyzed geo-referenced data collected during aerial surveys conducted in 2000-2002 to describe the distribution and relative abundance of bottlenose dolphins. Two sampling designs were used: (1) onshore/offshore surveys extending to 35 nm from the coast, conducted during winter from Georgia to Virginia; and (2) coastal surveys conducted throughout the year in North Carolina. Sightings ($n=494$) made during the onshore/offshore surveys occurred significantly more frequently in Raleigh Bay (between Cape Hatteras and Cape Lookout, NC), than in other regions. Almost half (45.7%) of these sightings occurred between the shoreline and 3 km from shore. The year-round, coastal surveys in North Carolina yielded 5,431 sightings; circular statistical analyses revealed a strong influence of season on dolphin abundance ($r = 0.436$, $p = 0.006$). Relatively few bottlenose dolphins were observed in late spring, summer, and early autumn, with increased numbers from late autumn through early spring. In all seasons but summer, the number of dolphin sightings was highest in Raleigh Bay. Thus, the results of both surveys highlight the importance of Raleigh Bay to bottlenose dolphins. Dolphins may preferentially use these waters in response to changes in prey distribution and/or abiotic factors such as water temperature. During winter, more dolphins use the waters near Cape Hatteras, resulting in competition for prey resources and habitat, as well as conflicts with seasonally increased fishing activity in this area. Our results demonstrate a pattern of seasonal movement along the US Atlantic coast which appears to be correlated to annual changes in water temperature and prey availability.

Marine Mammal Strandings Associated with Toxic Algal Blooms along the Southern California Coastline in 2002

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Domoic acid (DA) is a neurotoxin produced during blooms of *Pseudo-nitzschia* spp. that has been associated with severe neurological disease and death in several marine species. During 2002 there was an observed increase in the number of marine mammal strandings along the southern

California coast. The objectives of this study were to evaluate the temporal associations between *Pseudo-nitzschia* spp. blooms and marine mammal strandings during 2002 and to characterize the frequency, sex, and age distributions of species that stranded in 2002 to those in 1999, as a baseline level of expected strandings. Time series cross-correlation analysis was performed to test for temporal association of strandings and *Pseudo-nitzschia* blooms. In 2002, 80% of all strandings in California occurred between San Luis Obispo and San Diego counties, substantially more than the proportion of strandings occurring in Southern California in 1999. The highest increase in strandings in southern California in 2002 was observed from April through June. A significantly higher proportion of adult female California sea lions (*Zalophus californianus*) and male common dolphins (*Delphinus* spp.) stranded in 2002 compared to 1999. Highly significant temporal correlations of strandings and blooms were identified with notable differences among species. These differences are probably due to variation in preferred prey species, foraging habits, and habitat. These species differences result in variable effects of DA-producing blooms on marine mammal populations in California. Further data on the health, demographic, and ecological effects of toxic algal blooms are needed to determine the potential long-term effects on marine mammal species.

Lost in Migration: Lack of Correlation Between Geomagnetic Anomalies and Cetacean Strandings in the Caribbean

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Whether cetacean strandings can be attributed, at least in part, to coastal geomagnetic anomalies has been a source of controversy for many years. Data has yielded ambiguous results which have been interpreted as the consequences of different geologies of the studied areas. To test this hypothesis we analyzed all available cetacean stranding data for the Caribbean ($n = 286$) (north South American coasts, Atlantic Central American coasts, including the Yucatan Peninsula), and the Antilles. We tested this hypothesis using two approaches: (1) matching locations of strandings events versus the presence or absence of geomagnetic anomalies and (2) matching areas of geomagnetic anomalies versus the occurrence or not of cetacean strandings for those localities. In both cases we look at binomial equality between the data. In neither case we found any correlation between anomalies and stranding events. However, our data had a bias that was not present in previous studies (UK, USA, and New Zealand). The availability of stranding data is highly dependant from a geographic viewpoint because areas for which comprehensive studies have been carried out (e.g., Puerto Rico, Venezuela) there is an abundance of data while for others (e.g., Cuba) data is almost non-existent, probably because the lack of local research efforts and unavailability of data in general. We suggest that indigenous scientific development is a major factor in these kinds of meta-analyses. We also propose the creation of area-based databases for regions like these so data is easily available and encourages further research.

Sighting Patterns of Bottlenose Dolphins (*Tursiops truncatus*) in Their Northern Range Along the US Atlantic Coast

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To date, few data have been collected on bottlenose dolphins (*Tursiops truncatus*) at the northern end of their range along the Atlantic coast of the United States. These animals are migratory, spending the warmer half of the year in New Jersey (NJ) and the cooler months off the coast of North Carolina or other southern regions. Factors influencing the timing of migration and habitat-use patterns along the NJ coast remain unknown. Therefore, we conducted photo-identification surveys covering 72.5 km of southern New Jersey coastline in the summers of 2003 and 2004. A total of 44 boat-based surveys were conducted; on 35 of these trips, 86

dolphin groups comprising 980 animals were encountered. Time spent with each group ranged from 1-89 minutes (mean=27min) depending on the behavior of the group and the successful capture of all fins within the group. Approximately 6,400 photographs were taken and 116 individuals identified. Of these, 10% ($n=12$) were sighted only along a 27 km stretch of habitat within the study area three or more times in both 2003 and 2004; 19% ($n=22$) of the animals were sighted 1-2 times in both 2003 and 2004 throughout the entire study area and 49% ($n=57$) of individuals were sighted one time in either 2003 or 2004. Future research will utilize the photo-identification catalog, the corresponding physical, behavioral and environmental data as well as biopsy samples to investigate their is summer residency, short-term transience, or a combination of both along coastal New Jersey.

Behavioural Reactions of Harbour Porpoises to Underwater Noise from Pile Drivings

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Although pile driving is among the most powerful sources of underwater noise and strong reactions may be expected from marine mammals, this issue has been given little attention. Here we document behavioural reactions of harbour porpoises to pile drivings during construction of an offshore Wind Farm (Horns Reef, North Sea). Eighty steel pipes with a diameter of 8 m were driven into the sandy seabed in shallow water (app. 10 m). Deterrent devices (seal scarers and porpoise pingers) were deployed prior to each operation to protect seals and porpoises from injury. Source level of impulse sounds was estimated from measurements to 235 dB re 1 μ Pa (peak-to-peak) and transmission loss 18 log r . During visual ship surveys, the surface behaviour of porpoises was categorised before, during and after the period of pile drivings. In the months before and after there was no correlation of behaviour with distance to construction site, with circling as the predominant behaviour. During periods with pile drivings there were significantly more travelling and fewer circling porpoises in the area within 15 km from the construction site. Acoustic dataloggers (T-PODs), recording echolocation activity continuously, were placed inside the construction area and at 8 km and 25 km distance from the construction site. Porpoises were present in the construction area throughout the construction period. However, a silent period without porpoise activity of on average 4.5 hours (compared to 45 minutes on average in periods between pile drivings) followed each pile driving, indicating that porpoises left the area (most likely) or at least remained silent. Echolocation activity returned to normal levels after 4.5 hours. The response was the same at all T-POD stations, indicating that the zone of behavioural disturbance may extend considerably beyond 25 km. Funded by the Danish Energy Authority.

Consistent and Objective: A New Protocol for Evaluating Stranded Marine Mammals for Evidence of Human Interaction

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Evaluating marine mammals for evidence of human interaction requires consistent, objective examination by trained personnel. We have developed a new protocol and accompanying training program to provide stranding responders with the tools necessary to conduct thorough human interaction examinations. The datasheet is divided into two sections: an objective data collection section and a more subjective final evaluation. The primary goal of this protocol is to determine whether evidence of human interaction is present on a stranded animal. A positive score for signs of human interaction is the result of an objective evaluation of the animal or carcass. The initial examination does not attempt to determine whether the signs of human interaction occurred before, during or after a stranding event and does not attempt to qualify the severity of the interaction. The secondary, and more difficult, goal is to determine whether these human activities contributed to the stranding event. This final human interaction evaluation takes into account the findings of the initial examination, the physical condition of the animal, the necropsy findings, and the circumstances

surrounding the stranding event, and then indicates the likelihood that human activities caused the stranding. This second, more subjective section, should be scored as a consensus among the initial responders, experienced evaluators and veterinary staff. Determining the cause of death is not the goal of this protocol. Further evaluation, such as histopathology analyses, and review by veterinarians, pathologists and/or other experts, are necessary to definitively determine the exact reason for stranding and cause of death. *Development of this protocol was funded by the John H. Prescott Grant Program through NOAA/NMFS/OPR.*

Temporal Trends in the Distribution of Polar Bears in Western Hudson Bay During the Ice Free Period

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Every year the sea ice on Hudson Bay melts completely and forces the Western Hudson Bay polar bear population ashore for 4 months (July-November) where they depend on fat reserves for survival. Adverse effects of warming temperatures have already been documented on some physical and reproductive parameters of this population, however, it is unclear how their distribution might have responded to this environmental change. The objectives were to describe the temporal and spatial patterns of polar bear distribution relative to age-sex-and reproductive class and to examine both local (*i.e.*, sea ice break-up) and global (*i.e.*, North Atlantic Oscillation, NAO) scale environmental indices relative to distribution. Using long term mark-and-recapture data, we examined 19 years (1986-2004) of capture locations (N=2,304). Distance from the coast (east-west) and from a north-south baseline were used as distribution metrics. We found that adult males, solitary adult females, and family groups had shifted northward and eastward but subadult males only shifted northward and subadult females only shifted eastward. The timing of sea ice break-up was positively correlated with coastal distribution while the NAO was negatively correlated with north-south distribution. The timing of sea ice break-up was related to the spring NAO index (May-June). Segregation was still evident and was found between all age-sex-and reproductive classes except for adult males with subadults. Based on our results, the distribution of polar bears in western Hudson Bay has changed over time, which is related to both sea ice break-up and the NAO suggesting that climate change may also influence distribution. Our study provides a better understanding of the spatial and temporal distribution of polar bears in western Hudson Bay relative to climate change and will allow for the development of effective management strategies and conservation measures.

Ontogeny of Echolocation in Bottlenose Dolphins (*Tursiops truncatus*) During the First Six Months of Life

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Vocalizations involved in human speech, birdsong, primate calls, and dolphin whistles undergo a variety of developmental changes before becoming functional (Marler, 1970; McCowan & Reiss, 1995; Oller, 1980; Seyfarth and Cheney, 1997). The sounds produced when dolphins echolocate are thought to serve a variety of functions including communication, navigation, and foraging. However, little is known about the ontogeny of dolphin echolocation. Infant dolphins may begin life with rudimentary echolocation skills that develop by observing the mother and/or through practice. However, it is also possible that dolphin calves possess an innate ability to produce functional sonar clicks at birth. The present study investigated the ontogeny of dolphin echolocation by analyzing overlapping click trains of ten bottlenose dolphin mother/calf pairs from birth until 6 months of age. Overlapping click trains were those in which a click train from the mother and a click train from the calf overlapped one another, and were the most frequent type of click train produced by young calves. After mother and calf click trains were separated, inter-click interval, click duration, train length, and relative peak frequency were analyzed to better determine the developmental path of infant dolphin echolocation. Mothers seemed to cue their calves to echolocate by initiating a click train, which frequently resulted in calves

beginning to echolocate on an object shortly after the mother had begun. In addition, calf clicks and click trains showed developmental patterns suggesting that both learning and maturation are involved in the acquisition of a functional echolocation system.

Localization of Calling Killer Whales (*Orcinus orca*) Using a Hydrophone Array in a Reverberant Environment

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In studies of wild killer whales (*Orcinus orca*) stereotyped call repertoires usually cannot be attributed to individuals. Identifying individual callers allows researchers to track call development, dialect acquisition, and call context. At SeaWorld of California an array of eight hydrophones and software designed by BAE Systems (ORCA) were used to localize calling whales. Software performance was tested using simultaneously-recorded video and audio data. The test pool (39.2 m x 29.3 m x 11.0 m) was broken into six sections (S1 to S6) to quantify whale location using the video data. For each call in a sample of more than 250, the following data were collected: (1) location of the hydrophone reporting the highest energy (sound exposure level [SEL]), (2) whale behavior, and (3) number of whales present. When behavioral cues alone were used to attribute calls to whales, only 4% could be localized from video. Using the location of the hydrophone reporting the highest SEL to locate callers, 60% correct attribution was obtained. Highest localization accuracy was found in S6 (86%) due to one whale's preference for hanging over this hydrophone. S2 and S3 yielded the most reliable locations overall (84% and 60% of calls, respectively). In S4, identification was correctly assessed only 11% of the time, while S1 and S5 were not populated with working hydrophones. ORCA identified a calling whale correctly at a higher rate when the whale was still (72%) versus swimming continuously (41%). Location accuracy was greater when only one whale was present (70%) versus two whales (37%), most likely due to movement. Reverberations in the pool from the protective hydrophone niches, rockwork, and walls probably contributed to difficulties in localization. Despite limitations, localization using simple amplitude cues outperformed earlier efforts to attribute calls with a single hydrophone and video by 57%. [Supported by SeaWorld, Inc. and The Hubbs-SeaWorld Society]

Quality of Oceanographic Data Obtained Using Animal-Borne Data Loggers

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In order to understand how marine predators interact with their physical environment, oceanographic information needs to be associated with an animal's position and/or behavior. This process suffers from a lack of consistency between the spatial and/or temporal scales at which oceanographic and behavioral data are obtained. To overcome this issue, animal borne oceanographic sensors have been developed to gather data at the exact operational scale of the animals. This approach allows for a characterization of water masses as animals move through them. For this purpose, elephant seals are ideal carrying platforms, as they are deep divers who migrate over extensive oceanic areas. Unlike data obtained directly from ship-based operations, the quality of data obtained through telemetry generally cannot be verified. It is thus crucial to determine their reliability. We tested the use of temperature and salinity electronic recorders on Northern and Southern elephant seals, with several types of instruments including SMRU Satellite Relayed Data Loggers, Wildlife-Computers MK9 and Lotek time-depth recorders, and Alec Conductivity-Temperature recorders. These tests were completed from 2003 to 2005 and they involve in-lab calibration work, translocation experiments of 17 juveniles, and several months' deployments on 15 free-ranging females. Our goal was to assess the absolute vs. relative accuracy of these measurements, and to highlight the potential pitfalls and benefits associated with the method. Our results show that temperature and conductivity data can either be

reasonably accurate, or suffer serious drift or offsets. These alterations affect absolute values significantly, but generally permit analysis of uncorrected data on a relative basis. The quality assessment of remotely obtained data is thus of primary importance. We further explore and present various methods to accommodate calibration offsets, sensors drift, and appropriate data analysis techniques.

Vocal Playback Studies on Male Australian Fur Seals

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Australian fur seals, *Arctocephalus pusillus doriferus*, are colonial breeders congregating in dense social groups. During breeding, males establish and defend territories through physical conflicts, stereotyped posturing and vocalisations. While vocalisations are suggested to play an important role in male recognition systems, they have received little attention in the literature. Neighbour-stranger discrimination, whereby territorial animals are able to discern and respond differently to the vocalisations of intruding stranger males compared to those of neighbours, also known as the dear enemy effect. This recognition system has significant advantages as it reduces the need for costly fighting and vigilance. In the present study, vocal recordings of nine adult male Australian fur seals were made during the 2000 and 2001 breeding seasons at Kanowna Island (39° 10'S, 146° 18' E), Bass Strait, Australia. The in-air bark vocalisations produced by these seals were used to characterise the Bark Call and to determine whether males produce individually distinct calls, which could be used as a basis for vocal recognition. Both Bark Series and Units were reliably classified to the correct caller in 83% and 68% of cases respectively, indicating that the Bark Series was more reliably classified to the correct caller. Discriminant Function Analysis and the Potential for Individual Coding technique were used to determine which variables contributed most to individual distinctiveness. These call features were then modified to confirm their importance in recognition. Vocal playback studies were conducted on up to 29 territorial male Australian fur seals on Kanowna Island during the 2004 breeding season. Results indicate that males were more responsive to the calls of strangers than to calls produced by neighbours. There was also an increase in response from males when there were more than five Bark units present in a playback, highlighting the importance of repetition in neighbour-stranger recognition.

Field Tests of Barium Sulphate Gillnet and Rope to Reduce Cetacean Mortalities

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Marine mammals are increasingly caught as fishing by-catch throughout the world. Gillnets comprised of barium sulphate and nylon have been developed to reduce by-catch of harbour porpoise (*Phocoena phocoena*). Results of three years of field tests demonstrate its utility as a silent, more easily applied replacement to acoustic pingers in groundfish gillnet fisheries. The barium sulphate net's attributes include increased target strength and stiffness, plus it is more easily integrated into fishing operations than pingers. The net's opacity has also led to reduced seabird

by-catch. In certain components of their gear, fishermen sometimes use strong 3/8 inch rope of 2,200 lbs breaking strength even when hauling gillnets typically places 300 lb of tension on the ropes. Weak rope (3/8 inch diam., 1,100 lbs breaking strength) comprised of barium sulphate and polypropylene has been developed to be used as gillnet headrope, which will break more easily upon whale entanglement. Fishermen in the Bay of Fundy have evaluated the rope over two seasons and surmised it could substitute conventional rope. Breaking strength data on the barium sulphate rope to date reveals it can withstand the fishing conditions and hauling process, thus making it appealing to fishermen. Rope buoyancy and number of floats used in headrope is being investigated. The combination of barium sulphate gillnet with weak rope, in a single set, is an attractive suite of alternative gear to reduce marine mammal by-catch.

Northern Fur Seals: Are They Nutritionally Stressed?

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The Pribilof Islands population of northern fur seals has declined by over 70% since the mid 1950s. Over-hunting of adult females can explain most of the decline that occurred through the 1960s. However, the decline that has occurred since the late 1970s has not been explained. Measures of the nutritional status of mammalian populations include changes in body size, newborn mortality, and duration of foraging trips. We compared body lengths of fur seals we took in recent subsistence harvests (1995-2005) with records of body size archived during the historic commercial harvests (1915-1983). We found that average lengths of fur seals decreased from the early 1900s to the mid-1940s as the population increased and approached carrying capacity. However, body lengths increased through the 1950s and 1960s while the population was being reduced by hunting. Measurements taken since 1995 indicate that fur seals (which now number only 30% of their former abundance) have again experienced stunted growth comparable to when the population was last at carrying capacity in the 1940s and 1950s. Other measures of the nutritional status of northern fur seals indicate that foraging trips by lactating females were shorter, that mortality of pups on shore was lower, and that pups were bigger during the 1980s and 1990s compared to the 1970s. All told, the available data suggest that lactating females were able to obtain adequate nutrition in the Bering Sea during summer, but that juvenile fur seals (from weaning to 3 years of age) had difficulty obtaining sufficient resources. Whether the nutritional stress they appear to have experienced was associated with inadequate quantities or qualities of prey is unknown — nor is it yet clear whether it occurred in the Bering Sea during the fall, or out in the open Pacific during winter and spring.

Community Structure of Cetaceans in the South West of the Gulf of California

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The southern Gulf of California is characterized by tropical and temperate mass waters, being one of the many possible factors of the presence of a high cetacean diversity. Although this makes the research of cetacean community structure dynamics very attractive, such studies have been scarce and of limited coverage. Our goal in this study is to analyze and compare changes in the cetacean community of two areas: La Paz Bay and the waters surrounding Los Cabos, B.C.S., México. The diversity and distribution of cetaceans were recorded in transect surveys every month from December 2004 until May 2005. In order to determine the cetacean community structure, we estimated the relative biomass of each species (total biomass of the species sighted per hour of effort) and the diversity (Shannon-Weiner index). In La Paz Bay a total of seven odontocete species were registered, being the sperm whale (*Physeter macrocephalus*) the species with the higher biomass (66,037.7 kg/hour). From the five species of mysticetes registered, the blue whale (*Balaenoptera musculus*) was the species with the higher biomass (84,589.0 kg/hour). Although the higher cetacean diversity was found in May for La Paz Bay, we didn't find a statistically significant difference between surveys (ANOVA; $P = 0.556$). In Los Cabos a total of seven species of odontocetes were registered with higher biomass for the bottlenose dolphin (*Tursiops*

truncatus) (15,994.3 biomass/hour). For the five species of mysticetes registered, the humpback whale (*Megaptera novaeangliae*) was the species with the higher biomass (151,409.9 biomass/hour). The higher diversity for this area was also found in May with no statistically significant difference between months (ANOVA; $P = 0.234$). We compare the diversity values observed between both areas without significant differences ($P = 0.241$).

Killing of the River Dolphin *Inia geoffrensis* in the Amazon: A New Technique

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(1) Foundation Omacha

(2) Institute Sinch

During the last years negative interactions have been documented between river dolphins and local fisheries in the Amazon basin. With the decreasing of catches of catfishes in the Amazon, a new target species got commercial importance: the scavenger fish called locally mota (*Calophysus macropterus*). For this reason, during 2004 and 2005 an evaluation of the mota fishery was made in the River Amazon, accounting the catches in Leticia harbor, where approximately 95% of the river fisheries is trade (including a large area of Brazil, Peru and Colombia). Almost 90% of the catch comes from Brazil, particularly from the upper Solimões, where frequently people kill river dolphins and black caimans to sale them to fishermen to be used as bait. Surveys and questionnaires showed that in the Colombian area cattle wastes are used instead of dead river dolphins, while in the Brazilian area researchers of the Mamiraua Sustainable Development Institute founded that about 30 river dolphins are killed by season only in 10 human communities. Due that the mota fish is only commercialized in Colombia, a campaign was launched during 2005 working with local environment authorities in Colombia to pressure traders to stop this fishery or to promote alternatives to stop the killing of endangered species. So far the laws that protect and penalize people that kill river dolphins are being spread along the River Amazon, and the propose of an origin certificate where fish caught in areas where river dolphins are being killed will not be commercialized, encouraging multilateral cooperation between the countries involved. If capture of river dolphins persists, a big campaign focused in the mota consumers will be hold in the main cities of Colombia to stop this fishery; this would be the last strategy choice considering the equilibrium between conservation and the local economy in the region.

“Scammon Lagoons” for the Western North Pacific Gray Whales?

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According to the IUCN, the western North Pacific population of gray whale (WGW) is a critically endangered population. Even thought to be extinct in 1970s, it is known to survive today and has been studied since 1994 on their feeding grounds off northeastern Sakhalin Island, Russia. In comparison, winter grounds of this population remain unknown to date. WGW face multiple anthropogenic threats throughout their range. Thus, the discovery of their winter grounds is essential for the overall conservation of the population. Literature and Internet reports were reviewed to determine the research area. In February of 2005, International Fund For Animal Welfare (IFAW) conducted a survey to discover the winter grounds of WGW in the South China Sea. Local knowledge interviews with fishermen of Hainan and Guangdong provinces were completed to learn information regarding WGW. Forty questionnaires were completed, interviewing over 50 fishermen from 17 locations. Most fishermen reported seeing whales but did not remember any specific features. Some of the interviewees gave descriptions of what seem to be minke, humpback and sperm whales. Two witnesses from the Wai-luo harbour village recognized a gray whale as one of the species of whales they use to hunt till the end of 1970s. According to the fishermen, whales are most frequent along the east coasts of the Guangdong and the Hainan provinces from December to July. Whales were also frequently sighted around the Qizhou islands, between Xi Sha and Nan Sha islands and in Qiongzhou gulf. In summary, collected data on general distribution of the large whales in the South

China Sea and found evidence of WGW presence in the region as recently as late 1970s. Further efforts needed to discover the winter grounds of this critically endangered population.

Segregation in Dietary Niches of Harp (*Phoca groenlandica*) and Hooded (*Cystophora cristata*) Seals: Age-Class, Temporal and Spatial Variation of Fatty Acid Profiles

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Harp (*Phoca groenlandica*) and hooded (*Cystophora cristata*) seals differ in body size, diving behaviour and migration patterns; thus we predicted they would occupy different dietary niches in the North Atlantic ecosystem. Adult harp seals are essentially monomorphic, whereas hooded seals are sexually dimorphic, with males being about 1.5 times larger than females and 2.5 times larger than harp seals. Sex differences in diet have been documented in other size dimorphic pinnipeds and have been linked to differences in body size and energy requirements. Harp ($n=345$) and hooded seals ($n=80$) of all ages were sampled from inshore and offshore locations of Newfoundland and Labrador from 1994 to 2004, a decade which saw increasing populations of seals and large changes in the distribution and abundance of both pelagic and benthic fishes. We examined blubber fatty acid (FA) profiles of individual seals, as FAs provide time-integrated estimates of diet. Hypotheses were tested using MANOVA and discriminant analysis. Within harp seals, there were no sex differences in FA profiles in any age class. However, there were significant differences among age-classes (young-of-the-year, juveniles and adults) of harps, with a significant effect of body size. There was also significant interannual and inshore and offshore variation in FA profiles, suggesting these were important determinants of diet potentially reflecting spatial and temporal variation in the prey base. Within hooded seals, FA profiles differed significantly between juveniles and adults and between adult males and females. There was no overlap in the FA profiles between harp and hooded seals of any age-class, within any year. Thus as predicted, there appears to be little overlap in the dietary niches of these abundant marine carnivores. Ecological segregation of these species appears to occur along multiple dimensions.

Local Weather Affects the Degree of Polygyny in Breeding Grey Seals (*Halichoerus grypus*)

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Individual variation in reproductive success is a major driver of sexual selection and determinant of population genetics. We examined variation in male grey seal mating success in relation to weather conditions at the island colony of North Rona (Scotland) over 9 successive annual breeding seasons (1996-2004). Based on previous studies we hypothesized that reduced rainfall during the breeding season would limit availability of pools of water, close to which females prefer to pup. This would increase spatial clustering of females within the colony, permitting greater monopolization of females by fewer dominant males, thus increasing mating skew. Contrary to expectations, we found that annual mating skew was less extreme under drier conditions (Adj. $R^2 = 0.82$, $df = 7$, $p < 0.001$). Female distribution patterns also failed to show the expected increased clumping with less rain. However, we found that females were more mobile under drier conditions (Adj. $R^2 = -0.83$, $n = 6$, $p < 0.05$). As female grey seals show strong inter-annual site-fidelity, we conclude that females typically return close to previous pupping sites, irrespective of weather conditions, presenting similar spatial distributions across years. Having pupped, females tend to be 'tied' to the pupping location. If a season proves to be atypically dry, females without access to pools will be forced to commute, sometimes relatively long distances, to gain access to this important resource, subsequently returning to their pups to nurse. This

increased mobility of females, we argue is the reason for the decreased ability of dominant males to monopolise matings, allowing a greater number of less dominant males to gain matings. These findings imply that long term population genetics may be strongly influenced by rare weather events. We discuss these results in the context of changes in recent UK weather patterns and projected future patterns resulting from climate change.

Extreme Diving Behaviour of Beaked Whale Species *Ziphius cavirostris* and *Mesoplodon densirostris*

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We used sound-and-orientation recording tags to study deep diving beaked whales of two species, *Ziphius cavirostris* (Zc) and *Mesoplodon densirostris* (Md) that echolocate for prey in mesopelagic habitats. We tagged 7 individual Zc for a total of 60 hours, with 28 deep foraging dives > 500 m, and 70 shallow dives between 20 and 500 m. We tagged 3 individual Md for a total of 36.7 hours, with 16 deep foraging dives > 500 m, and 102 shallow dives between 20 and 500 m. Acoustic behaviour indicates they select and attempt to capture about 30 prey/dive. This food source is so deep that the average foraging dives of these two species are deeper (Zc=1,075m, Md=864m) and longer (Zc=60min, Md=47min) than reported for any other air-breathing species. After each deep foraging dive, the beaked whales made a series of shallower dives, apparently to recover from an oxygen debt resulting from foraging dives lasting almost twice the estimated aerobic dive limit. The average interval between foraging dives was 63 min for Zc and 91 min for Md. Recent indications of a decompression syndrome in beaked whales stranded during naval sonar exercises have led to the hypothesis that their deep-diving behaviour may somehow make them especially vulnerable. We use current models of breath-hold diving to suggest that their natural diving behaviour is inconsistent with known problems of nitrogen super-saturation and embolism. If the assumptions of these models are correct for beaked whales, then an abnormal behavioural response to sonar is more likely to lead to decompression problems.

Comparing Biological Transport of Shelf Carbon in Whale Biomass with Abiotic Mechanisms of Carbon Flux in Offshore Jets of the California Current System

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Carbon budgets for productive upwelling boundary current ecosystems often lack complete pathways for carbon flow through apex predators. In particular, the effects of foraging whales are often missing in models of trophic cascades and carbon flux. Ekman upwelling filaments are known to be important abiotic mechanisms of cross-shelf transport of carbon. Here, we examine the role of whales in the trophic transfer, sequestration, cross-shelf transport and export of shelf carbon off Oregon (41.9 – 44.7° N) during the upwelling season of 2000. Line-transect surveys of cetaceans were conducted in passing mode across the shelf and slope from May 29 – June 13 and July 27 – August 12 during multidisciplinary GLOBEC Northern California Current investigations. Early in the upwelling season, during May-June, humpback whales *Megaptera novaeangliae* on the slope ingest up to 2,204 metric tons Carbon (mt C). By August, humpback whales have moved onto the shelf, especially at a submarine bank (Heceta Bank, 43.9 – 44.7° N). There, they forage on high densities of euphausiid and fish prey, removing large amounts of carbon from productive coastal waters, and sequestering carbon in whale biomass. For the combined shelf and slope region, an estimated 222 humpback whales ingest 2,172 – 5,860 mt C over the full 4-month season. The amount of carbon ingested by humpback whales is equivalent to the amount of carbon transported offshore by a meandering filament or jet of the California Current System (e.g., 2400 mt C per event, Barth *et al.*, 2002). The ingestion of carbon by humpback whales is therefore comparable to a major known physical

mechanism of cross-shelf carbon transport. That endangered populations of whales can contribute significantly to carbon sequestration, transport and export, suggests that organic carbon pools and factors controlling trophic balance within shelf ecosystems are vastly altered from that of the pre-whaling era, when whales were numerous.

Nonlinear Dynamics in North Atlantic Right Whale (*Eubalaena glacialis*) Vocalizations

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Nonlinear dynamics have been reported in vocalizations of humans, nonhuman primates, birds, dogs and manatees. This common occurrence suggests that nonlinearities have a communicative role, though their exact function is still under debate. Some studies suggest that they may convey information about individual identity, stress level, and/or illness. In this study, North Atlantic right whale (*Eubalaena glacialis*) vocalizations were analyzed for occurrence of nonlinearities to further investigate the possible communicative role these phenomena may play. 180 vocalizations collected from 10 whales by a multi-sensor digital acoustic recording tag (DTAG) attached non-invasively to animals in the Bay of Fundy, Canada in 2001 and 2002 were analyzed for evidence of nonlinear dynamics. Due to vessel and tag interference, only clear, high signal to noise ratio calls were isolated and analyzed. Vocalizations were inspected for nonlinear dynamics including subharmonics, biphonation, deterministic chaos and/or frequency jumps by visual inspection of spectrograms and plotting power spectra from points within the call using Avisoft SASLab Pro[®] and Adobe[®] Audition[™]. Over 80% of calls analyzed contained at least one type of nonlinearity. Deterministic chaos was most common appearing in 69% of calls, with subharmonics, biphonation and frequency jumps occurring at much lower rates (6%, 7%, and 19% respectively). Occurrence of nonlinear dynamics varied by individual. One whale displayed frequency jumps in virtually half of its calls (49%, n=41) while all others displayed chaos most frequently. For individuals who produced biphonations more than once (n=2 individuals), all of the biphonations occurred in rapid succession. Most animals sampled were engaged in foraging behavior, though social groups were present in the area. This frequent occurrence of nonlinearities further supports the idea that these signals may play a communicative role and that they warrant further investigation.

Skin Sloughing of Gray Whales *Eschrichtius robustus* in the Sea of Okhotsk

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Photo-ID results for 2002 – 2004 for gray whales *Eschrichtius robustus* in feeding areas on the northeast shelf of Sakhalin Island identified 121 distinct individual whales. During the processing data for 2003, skin damage that had not been observed in 2002 was noted in nine whales. With the exception of one animal, all the whales with various degrees of skin sloughing were observed in nearshore Piltun area. Some whales were encountered over a period of several days. Skin sloughing appeared to begin from the dorsal surface of the backbone in two cases. Skin sloughing progressed noticeably on one whale in a single day, from 24 August to 25 August 2003. The whales was observed a few days later with no sign of skin sloughing. The picture was similar for another whale. This sloughing or skin-shedding processed in stages starting again at the dorsal surface of the backbone (m1, or molt stage1) and progressing downward on the body toward the ventral surface (m2) until all dead or damaged skin was sloughed and the whale was observed with no sign of skin sloughing (m3). Four whales with signs of skin sloughing were classified as “thin” (≥class II). Individuals with signs of severe sloughing or skin damage were observed most frequently in August. In 2004 we were able to identify two whales with such skin damage (m1). One of them proved to be foraging cow RGW052, which had similar damage in 2003, but in a more advanced stage (m2). Of the nine whales with skin sloughing sighted in 2003, we were able to re-identify seven during the 2004 season. Of these seven individuals. Six whales showed no deviations from normal skin condition,

and one whale (RGW052) had the sin damage described directly above.

Use of New Technologies for Estimating Walrus Populations on Sea Ice

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We conducted a trial survey to estimate the number of walrus hauled out on sea ice in a region around Saint Lawrence Island, using high altitude thermal infrared imagery to detect groups of walrus on strip transects and low altitude digital photography to determine the numbers of walrus in a sample of detected groups. We used data from the photographed groups to fit a generalized linear model for estimating group sizes from infrared signatures of detected groups that were not photographed. The total number of hauled-out walrus for the region was estimated from the sizes of detected groups by summing separate ratio estimators of the totals for each stratum. The use of infrared imagery in combination with digital photography offers the potential to cover a much larger portion of a region and more accurately enumerate groups than was previously possible, but estimating the total number of walrus in a region would also require information about the proportion of the population that was hauled-out on the ice and therefore detectable by the infrared scanner. Data for estimating this proportion could be obtained from a sample of walrus fitted with satellite transmitters containing sensors that measure the proportion of time a walrus is in the water. We extended our estimators to incorporate the additional information that would be provided by such transmitters and propose a survey method that incorporates all three technologies to estimate the size of the total Pacific walrus population.

Artificial Tail Flukes 1 - Symptoms and Medical Treatments

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A female bottlenose dolphin *Tursiops truncatus* named "Fuji" (transported into captivity in 1976, ca. 34 yrs old, BL 271 cm, BW 220 kg) suffered acute progressive necrosis in both distal parts of tail flukes in October 2002. Based on hematological and biochemical examinations, we diagnosed that the necrosis was caused by complex of infection and circular insufficiency although we could not identify disease germ. The necrosis spread more than half area of the flukes within a week. We alternately administered several kinds of antimicrobial agents (ISP, CPDX-PR, CAM, LVFX, CTRX, CFS and MEPM) to the dolphin by oral and intravenous administration. After the dolphin improved from the infectious disease, we excised the necrotic parts with an electric scalpel under local anesthesia on the 10th and 23th days of a course of medication. Necrotic areas lacking flow of blood had been confirmed by thermography. We stopped administration of the agents on the 90th day of treatment and finished disinfectant of surgical cuts on the 200th day. Cut surfaces thoroughly closed up and Fuji recovered her health, however, she lost approximately 75% parts of flukes. Due to the loss of flukes, Fuji could not swim properly. She put on weight from shortage of exercise and blood total cholesterol level increased. To compensate for the lost part of flukes, we developed artificial flukes and achieved it. As a result of everyday swimming wearing artificial flukes for training purpose, she became well and slim with decrease of the total cholesterol levels to the normal range after 74 days from the start.

Acquired Marks and Desquamation in the Blue Whales Observed in the Gulf of California: Effects on Photo-Identification

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Identification of individuals via natural marking has been used for several ecological studies. For better results, these marks should be stable with time. Blue whales, *Balaenoptera musculus*, observed in the Gulf of

California are photo-identified using a dorsal fin categorization and the pigmentation pattern on their flanks, and when exhibited, the ventral pigmentation and marks on their flukes. Pigmentation pattern remains constant from birth but acquired marks do not. From a data set of 188 individuals, we found marks that range from small oval and circular holes to linear scars, protuberances and missing portions. Changes with time were observed most commonly as addition of marks than lost ones. Changes occur at low annual rates of 0.2 for the flanks and 0.7 for the flukes. Nevertheless, some marks remain visible for several years. Significant differences in abundance of the different marks were found between age-class; more adults (10 years or more) were marked than young individuals (1-9 years) ($\chi^2=22.06$, $p<0.05$), or calves ($\chi^2=26.95$, $p<0.05$). Certain small oval and circular holes, attributed to cookie-cutter sharks were observed on the calves' flanks suggesting these are acquired in subtropical waters. Desquamation or sloughed skin, observed as light grey or dark coloured spots masking the natural pigmentation, was also analyzed. Although minor coverage by desquamation was noted in 82% of the observations, it was more frequent on nursing females than on solitary individuals ($\chi^2=59.84$, $p<0.05$). Overall, changes of marks do not cause problems when matching photographs; moreover, their stability with time aids in identifying blue whales, especially those individuals in which light coloration prevails. Despite the low occurrence of extensive desquamation coverage, this may represent a potential error on photo-identification of nursing females because sometimes large portions of the natural pigmentation are masked and therefore difficult to observe for positive identification.

A New Xenorophoid Cetacean from North Carolina and the Origin of Odontoceti

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A skull of an early odontocete was discovered at Onslow Beach, North Carolina, and is derived from underwater outcrops of late Oligocene age. This specimen includes lower jaws, auditory bullae and periotics, but no teeth. The skull is similar in size to *Xenorophus sloani* and *Archaeodelphis patrius*, but is more complete than the type specimen of either. The specimen is missing the anterior end of the snout. The anterior borders of the nasals are posterior to the antorbital notches. The nasals, premaxillae, and frontals are posteriorly telescoped over the frontals, which are only visible in dorsal view posterior to the nasals and at the dorsal borders of the orbits. Much of the orbits are formed by the greatly enlarged lacrimals, a characteristic of *Xenorophus* and its close relatives. The intertemporal region includes a sagittal crest formed by the parietals, and is bounded posteriorly by a nuchal crest formed by the parietals, squamosals, and supraoccipitals. This specimen represents the first extension of the range of Oligocene cetaceans of the east coast outside of South Carolina, and will help resolve some of the questions regarding the early diversification of Odontoceti and the origins of modern odontocete clades. Previous phylogenetic analyses have shown that xenorophoids and other related taxa form a clade that is the sister taxon to the rest of Odontoceti. As such, study of this group is pivotal to determine the pattern of early odontocete evolution. Additional studies of the periotics of early odontocetes using high resolution CT scans, have shown that all early odontocetes have the ability to perceive high-frequency sound, and presumably the ability to echolocate. These observations and other show that the most apomorphic of odontocetes are quite derived relative to their archaeocete predecessors, quite unlike the earliest mysticetes, which are very similar to basilosaurid archaeocetes in many ways.

Ice-Entrapment of Killer Whales in the Sea of Okhotsk

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February 7, 2005, ice-entrapment of 11 to 12 killer whales (*Orcinus orca*) occurred at Aidomari in Shiretoko Peninsula, Eastern Hokkaido, Japan. Nine of the carcasses were examined and the pod consisted of one adult

male, five adult females and three calves. It is supposed that brash ice, broken ice into pieces between 30 cm and 2 m, separated from the main ice floe played a key role in this mass stranding. The seashore was stuffed with brash ice closely from the sea surface to the bottom, the pod could not escape to open sea. They were suffocated and stranded in the sea ice debris. Our first idea was the event was a very rare happening. A few weeks after of the happening of Aidomari, one similar ice-entrapment occurred off Etorofu Island, in the southern Kurils. We reviewed various sources and obtained six ice-entrapment events and photographs from 1925 to 2005 in the southern area of the Sea of Okhotsk. The all events occurred between February and mid March, and number of individuals in each pod were 6 (2005, Reidovo, Etorofu Is.), 8 (1977, Uen-nai, Esashi), 11-12 (2005, Aidomari, Rausu), 13 (1925, Menashi-tomari, Esashi and 1943, Tannemori, Etorofu Is.) and unknown (ca. 1930-40, Shari). In this paper, the relationship between sea ice behavior and stranding events will be presented with detailed observation, videos, photos, and satellite pictures.

Performance of a Compact High Resolution Acoustic Survey Device for Monitoring Group Behavior of Small Cetaceans

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Finless porpoises and river dolphins are adversely impacted by human activities causing water pollution, lack of food and denial of migratory paths. Proper survey and management of their populations has become necessary. Visual-based surveys are very tedious, labor intensive, and have limited accuracy. These cetaceans produce characteristic echolocation pulses that make them acoustically visible, night or day. Acoustic-based survey methods are found to be indispensable for surveying finless porpoises that do not exhibit visually dramatic behavior like the dolphins. This paper reports the design and performance of an innovative compact and portable acoustic survey device designed for observation of groups of small cetaceans. The acoustic sensor system is housed in a "bird-cage" structure containing 3 hydrophones forming a vertical array, together with two more hydrophones forming a 3-element horizontal triangle array. It weighs 25 kg and is 3.6 m tall, 30 cm in diameter, and is deployed vertically with a buoy and a weight. A high-speed multi-channel data acquisition system records the sounds from all hydrophones. Signal processing algorithms have been developed for automatic detection and discrimination of echolocation clicks from other underwater sounds, localization of sound sources, and tracking individual animals. The design provides for a typical resolution of 2 m in range and 25 cm in cross-range at a distance of 100 m from the vocalizing animal. One major feature is the depth resolution of the order of 15 mm for a source distance of 100 m that provides for clear observation of individual vertical movements including nodding behaviors. The device has been tested in a quasi-natural environment with a group of bottlenose dolphins. The results confirm the capability of the device permitting several vocalizing animals to be precisely tracked and even segregated on the basis of depth differences alone. This novel tracking system will be used to survey populations of finless porpoises in coastal precincts.

Determination and Characterization of Fin Whale Habitat in the Gulf of California

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An estimated 500-600 fin whales (*Balaenoptera physalus*) inhabit the

Gulf of California, Mexico. They are found in the southern Gulf during winter and spring and show marked declines in abundance during the summer, when other baleen whales are known to migrate to high latitude feeding areas and when krill, their primary prey, are least abundant. These observations have led to the hypothesis that fin whales migrate out of the Gulf. Yet, recent genetic evidence suggests that these whales might be residents. If this is the case, it is unknown which region of the Gulf they use during the summer. To answer this question, we tagged 11 individuals in the southern Gulf of California during 22-31 March, 2001, and related their movements to remotely-sensed chlorophyll values from Gulf SeaWiFS. Argos satellite tags were attached with a 68-kg Barnett compound crossbow from a 7 m boat; they remained attached to the whales 54.3±50.1 days (end of spring and beginning of summer). All tagged whales stayed inside the Gulf and traveled 36.8±22.7 km per day. Three whales remained tagged for 142.3±50.1 days, spending the summer in the mid-riff islands, the northern Gulf. Chlorophyll values in the Gulf were highest in the mid-riff islands at the end of spring and throughout the summer, and the movements of the tagged whales to the most productive area of the Gulf coincided with a diet shift from krill to sardines. During winter and spring of 2005, chlorophyll values were typically low in the southern Gulf and highest in the mid-riff islands, and fin whales were not observed in the southern Gulf but in the midriff islands, feeding on krill. Results indicate that fin whales are residents of the Gulf and effective at finding and exploiting its most productive regions by moving long distances and shifting their diet.

Bring Out Your Dead: Using Photo-Identification to Identify the Origin and Ranging Patterns of Stranded Bottlenose Dolphins

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Samples from stranded marine mammals yield significant information on the life history and health status of individual animals, but the origin and ranging patterns of stranded animals are rarely known, limiting inferences drawn from post-mortem examinations. However, if images of stranded marine mammals are compared to regional photo-ID catalogs it may be possible to determine their identity. We used this approach to examine ranging patterns of bottlenose dolphins recovered in North Carolina and Virginia (UNCW and VA stranding programs) by comparing dorsal fin images of stranded dolphins to the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC). We evaluated images for quality and fin distinctiveness, although distinctiveness could not always be scored because of decomposition or post-mortem trauma to the fin. We examined 116 and 89 stranding records with dorsal fin images from UNCW and VA, respectively. Images of 37 dolphins from each of the UNCW and VA stranding records (a total of 74 images) met our criteria for comparison to the MABDC. Eight dolphins from UNCW (22%) were matched to the MABDC; matches were made only to southern NC. In contrast, no matches were made between stranded dolphins from VA and any other regional catalog. This difference may reflect the large population size and migratory nature of dolphins in Virginia, and the high degree of residency in southern NC. Six stranded dolphins in southern NC had more than 15 sighting records over multiple years. Such retrospective analyses are useful to field researchers and those examining the tissues of stranded dolphins, but require an exchange of information between stranding networks and

photo-ID catalogs. An examination of ranging patterns, in combination with genetic analysis, can provide a significant amount of information about stock boundaries, life history, and exposure to anthropogenic sources of mortality. This work was supported by the Prescott Grant Program.

Magnetic Resonance Imaging and Morphology of the Ringed Seal (*Phoca hispida saimensis*)

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Saimaa ringed seal (*Phoca hispida saimensis*) is a rare subspecies of about 270 individuals endemic to lake Saimaa in Finland. Magnetic resonance imaging (MRI) is a modern method which can be applied to both living and dead individuals. It has excellent capacity to distinguish tissues and tissue margins, normal anatomy and pathological changes without intervention. The aim of this study was to create a practical application of MRI to study post-mortem diving-related morphology of the Saimaa ringed seal and to describe its normal macroscopic MRI anatomy. A young Saimaa ringed seal cadaver, which was found dead in a fishing net, was imaged using a General Electric 1.5Tesla CV/i human magnetic resonance imaging equipment (Milwaukee, USA). For comparison it was afterwards cut into slices and photographed. All main anatomical structures were identified from the images. As the seal dives, blood from superficial tissues and non-vital organs enters the inner regions of the body and is stored in the hepatic sinus and vena cava posterior. Normally flow into the thoracic portion of the inferior caval vein and to the right side of the heart is prevented by a sphincter system at the level of the diaphragm. In the MRI the most voluminous structures in the abdomen were the dilated venous sinuses and vena cava posterior which were full of coagulated and non-coagulated blood. The same mass continued in the vena cava posterior through abdominal sphincter to the mediastinum and to the right side of the heart extending to pulmonary arteries. The right ventricle and the chamber were extremely enlarged. However, the lack of ruptures indicated great elasticity and capability to withstand this expansion. Also in the larynx the soft epiglottis still covered the trachea tightly. The arteries were generally narrow while the venous system was more obvious.

Florida Manatees and Industrial Discharges: When Attractive Nuisances Collide?

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Florida's beloved/despised manatee (*Trichechus manatus* sp.) has, over the past 60 years, become attached to the hip to coastal and riverine industrial warm-water discharges. These sites have displaced cold-intolerant manatees from natural warm water refuges to the extent that more than 60% of Florida's 3,142+ endangered manatees now rely on them during cold, winter months. Many of the extant sites have been in operation for 40 or more years and will become obsolete in the very near future. Our limited experience with the loss of industrial sites suggests that resident manatees will remain on site even after shutdown and that a significant number of cold-related manatee deaths will occur. The conceivable loss of two-thirds of the Florida manatee population has significant implications for species recovery. As such, Florida's manatees must be safely transitioned through the shutdowns and must be provided with suitable short-term and long-term warm-water alternatives, especially in light of the fact that many natural warm-water sites have been lost or degraded. The Florida Manatee Recovery and Implementation Team's Warm-Water Task Force has recently proposed a management and research strategy to safely guide these transitions. Strategies include developing on- and near-site warm-water alternatives (such as solar-heated basins), improving and protecting natural warm-water systems, devising techniques to encourage manatee emigration to alternative sites, etc. Decision-making

will be facilitated through use of adaptive management techniques that rely upon a warm-water model. Our presentation will describe efforts to characterize, define, and remedy the potential loss of this endangered species.

Fisheries and Their Potential Impact on Pinnipeds in Peru

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Peruvian Pinniped (S.Am. fur seals *Arctocephalus australis* and S.Am. sea lions *Otaria byronia*) populations in Peru are presently significantly reduced after the severe ENSO of 1997/98. Here we relate the available information on Pinniped distribution in Peru to information available for the large scale industrial and artisanal fisheries to identify potential refuge and conflict areas for these populations. With the largest fishing effort focused on small pelagic fish (the seals' preferred type of prey) and operating in areas overlapping seal foraging and transit areas, the potential for conflict between Pinnipeds and fisheries in Peru is great. Fortunately, almost all FSs and most SLs (85%) are now found in Southern Peru, south of 13°S, where industrial fishing activities are low (11% of the total capture) and where artisanal fishermen are relatively few (18% of the national fleet). However, recent border conflicts with Chile have led to an increase in fishing effort and to new legislation allowing industrial scale fishing closer to shore (linked to competition for transboundary distributed resources) very near Punta Coles, the largest FS colony with around 50% of the population since the 1997/98 ENSO. With a current population of less than 10,000, this situation poses a significant conservation threat to FSs in Peru. A further cause of concern is the development of a new type of semi-legal fleet of medium-sized purse-seiners targeting small pelagic fish in very close to shore areas. This fishery operates still mostly in northern Peru, but is rapidly expanding south and invading areas traditionally used by the small scale artisanal fishery and Pinnipeds. Future research and conservation efforts should focus on evaluating Peruvian Pinniped use of marine areas, changes in these patterns and colony displacements linked to warm events and how all these relate to fisheries use of space and resources.

Isotopic Evidence for Diverse Feeding Locations of Southern Right Whales (*Eubalaena australis*) from Argentina and Lack of Isotopic Fractionation Between Mothers and Calves

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Stable-isotope studies can provide insights into the feeding ecologies of migratory species whose feeding cannot be observed directly. We describe a stable-isotope analysis of southern right whales designed to a) estimate the number and location of feeding areas and b) determine whether calves are at higher trophic level than their mothers as a result of lactation. Skin biopsy samples taken from free ranging right whales in 2004 at Peninsula Valdés, Argentina were analyzed for stable isotopes of carbon and nitrogen. Forty-two samples from adults clustered in four different groups suggesting that southern right whales could be using four different feeding areas. The locations of those areas are currently unknown, but the range in $\delta^{13}\text{C}$ (-23‰ to -17.5‰) agrees with values previously reported for southern right whale baleen plates and estimated to represent feeding at or north of the Subtropical Convergence. The skin $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ from 20 calves did not differ from the values of their mothers ($\Delta_{\text{c-m}} \delta^{15}\text{N} = 0.152 \pm 0.449$; $\Delta_{\text{c-m}} \delta^{13}\text{C} = -0.239 \pm 0.639$). The lack of enrichment in $\delta^{13}\text{C}$ can be interpreted as a result of consumption of lipid-rich milk that is ^{13}C -depleted. The lack of enrichment in $\delta^{15}\text{N}$ is more difficult to understand because the nitrogen ratios are greatly influenced by physiological processes. However, it is speculated that during anabolic states, such as during calf growth, the redirection of amino acids from oxidation/excretion to tissue synthesis and an increase in urea salvage could cause low $\delta^{15}\text{N}$ values. This study is currently under way. More skin samples are being analyzed and collected from right whales in different bays at Peninsula Valdés.

The Effect of Passive Acoustic Array Configuration and Element Aberrations on Cetacean Localisation

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Hyperbolic location is a common technique for passive acoustic localisation of marine mammals. The final source location (SL) is a result of several values implicit in the type of passive acoustic array configuration, including the aperture-size, the array geometry, and the number of elements used. The element aberrations, on the other hand, are unpredictable, but can be estimated by analysing the positioning error of the element and its effects on the SL. The time required for an acoustic signal to travel between receivers plays an important role in the determination of the time-differences of arrival (TDOA). Every TDOA measurement defines a unique three-dimensional hyperbolic surface called hyperboloid. A sufficient number of intersecting hyperboloids determines the SL. The discontinuities in the source track profile are often the result of the loss of one of the TDOA measurements or a non-intersection of one of the hyperboloids. By increasing the aperture-size of the array, a better accuracy on the tracking plane XY and depth location is obtained. The array geometry can be classified in three different categories, linear, planar and volumetric. The number of possible array combinations increase according to the number of elements used. The main factor in deciding which array geometry and how many elements are the most appropriate to use is the accuracy measurement of the final SL. This paper describes how a software simulator designed in Matlab can be used to analyze the precision and accuracy of SL for an arbitrary passive acoustic array geometry. These tests assume a spatially homogenous sound speed profile, but the model could incorporate a non-linear profile. The motivation behind this analysis is to make an easy-to-use MATLAB tool that anyone can use and to provide some insight into what array geometries would be best for investigating certain species.

Mating Tactics in an Aquatic Mating Pinniped, The Bearded Seal, Over 16 Years

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Studies of aquatic mating tactics in long lived mammals are rare due to the difficulties involved in gaining repeated information on individuals over multiple years. This is particularly when studying Arctic species. Acoustic array recordings were used as a tool for studying the mating tactics of bearded seals over 16 years off Point Barrow, Alaska. Males produce underwater vocalizations during the mating season that exhibit clear individual differences. Vocalizations were analyzed over six years (1985, 86, 92, 93, 2000 and 2001). For each vocalization 17 parameters were measured and each was localized in space. Classification tree analyses showed that 100 individuals were present over the six years. Between 22 to 40 individuals were present within the study site during a single year. Individuals showed clear site fidelity with 13 to 25 males returning over consecutive years. Six males were present over the 16 years. Kernel home range analyses showed that male mating tactics were either territorial or roaming. Home ranges ranged from 0.32 to 3.2 km² (95%) for territorial males (N = 34) and from 5.3 to 16.3 km² for roaming males (N = 66). Factors allowing us to determine individuals by their vocalizations were duration, frequency change and the number of steps. Duration appears relatively flexible, with two males switching mating tactic by increasing their call duration. Similarly, the six males present over the 16 years gradually increased their call duration, whilst other identifying parameters remained stable. Male mating tactics show strong site fidelity and periods of tenure that cover most of their adult life span, with the flexibility to alter tactics as circumstances change.

The Behavioural Responses of Lactating Weddell Seals and their Pups (*Leptonychotes weddellii*) to Pedestrian Approaches

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Although guidelines exist for approaches to Weddell seals (*Leptonychotes weddellii*) in Antarctica, there has been no scientific assessment of the effectiveness of these guidelines in minimising disturbance to the seals. This study examined the immediate behavioural response of lactating Weddell seals (and their pups) to approaches on foot, and the factors affecting the seals' response. Most lactating Weddell seals and lone pups responded to visits on foot (from 20-5 m from the seals) by becoming alert. Using proportional odds regression models we developed contour maps which showed that the separation distance at which the cows became alert was dependent upon the approach type (a single person or group of people), the distance a cow was from the water, the distance she was from a conspecific, and whether her pup was exposed (*i.e.*, whether the pup was between the approachers and the cow). In all but one scenario, the proximity of the cow to a conspecific was important in determining the stage of approach that people could reach before seals responded. The proximity of water in affecting seal responses was also inconsistent, but results nonetheless indicated that distance to water can influence Weddell seal response. The influence on response (of the cow) of the position of the pup is not obvious and therefore does not allow specific 'pup exposure' oriented guidelines to be developed. The relative importance of these factors indicated that the seals perceived pedestrians to be a threat, but that the level of threat was low. These associations have implications for the development of management guidelines and can therefore be incorporated into visitor guidelines in order to increase their effectiveness and sensitivity.

Precautionary Regression-Based Determination of Protective Boundaries for Migratory Corridors of Large Whales

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Large whales often partition annual activity patterns into spatially and temporally isolated foraging and reproductive phases connected by migratory corridors. Conservation of such species may require protection plans specific to foraging areas, migratory corridors, and reproductive areas, respectively. Locations and timing of foraging and reproductive phases for large whales are often well known and amenable to protective actions, but migratory corridors are often poorly known and unprotected. We propose use of linear regression to define protective boundaries for corridors used by migrating animals, based on telemetrically collected geolocational data. Linear regression of longitude on latitude (or *vice versa*) defines the central tendency of corridor location, and variance of data about the line defines geospatial confidence bands. Determination of confidence bands can reflect any desired percentile, minimizing tendencies toward subjective criteria for protected area designation, allowing application of precautionary protocols scaled to uncertainty in the data, and fostering objective consideration of management interests. We utilize telemetric data on humpback whales in the South Atlantic (Zerbini *et al.*, this conference) to illustrate configurations for migratory corridor protection based on varying percentile selection for confidence bands. Telemetrically tagged humpback whales departed the tropical Brazilian coast in austral spring and early summer, arriving in feeding grounds near South Georgia and the South Shetland Islands in late spring and summer, with migration lasting 40-60 days and ranging to 7568 km. Whales migrated poleward on a mean heading of 170° and traveled a relatively direct, linear path from wintering to feeding grounds. Regression lines followed a similar path, with correlation coefficients > 0.9 and relatively narrow confidence bands regardless of designated percentile. A general result of our approach is that cases of migratory data with high variance about fitted lines will require wider (more precautionary) protective boundaries overall, as compared to cases with low variance.

The Spatio-Temporal Distribution and Oceanographic Correlations of Atlantic White-Sided (*Lagenorhynchus acutus*) and Common Dolphin (*Delphinus delphis*) Strandings in Cape Cod Waters, Massachusetts, USA

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We investigated whether oceanographic and physical conditions may influence the occurrence of mass and single strandings in a series of sub-regions around Cape Cod, located in the Gulf of Maine, US. For the entire region 55 Atlantic white-sided and common dolphin mass strandings and a further 316 single strandings from a 35-year period (1968 - 2003) were analysed in a spatio-temporal context, while oceanographic correlations were explored in those occurring between 1998 - 2003. In Eastern Cape Cod Bay, especially Wellfleet, which continues to be a sub-region of local stranding hotspots, 46 mass strandings and 227 single strandings took place during the entire study period. Mass strandings peaked in winter for *D. delphis* and in spring for *L. acutus*, during storms that were mainly Nor'easters, while single strandings appeared to be more linked to southwesterly winds, although this pattern was equivocal. Cape Cod Bay single strandings were different from strandings in other Cape Cod regions as in that area they are likely to be influenced in a similar way to mass strandings. Single strandings elsewhere were more random in the environmental variables affecting them. The majority of *L. acutus* single strandings appeared to be in animals under 5 years old, as suggested by St. Aubin and Geraci (1979) to imply social segregation, age-related mortality or both, with possibly a lesser ability to cope with environmental stressors in an area such as eastern Cape Cod Bay. Our results therefore strongly suggest that hotspot single and mass stranding events occur in association with particular oceanographic, meteorological, physical and ecological conditions and that stranding trends may be influenced by large-scale natural environmental variability in the Gulf of Maine.

Dusky Dolphin and Australasian Gannet Feeding Interactions in New Zealand

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There is increasing overlap between feeding habitats of marine mammals and seabirds and the human interests of fishing, aquaculture, and recreation. A better understanding of foraging ecology and interactions between apex predators will facilitate advice on management/conservation strategies. Feeding interactions between dusky dolphins (*Lagenorhynchus obscurus*) and Australasian gannets (*Sula serrator*) in the Inner Admiralty Bay, New Zealand provide an opportunity to study multiple-species use of habitat, and interaction dynamics. This study examines habitat use, feeding tactics, and feeding interactions of dusky dolphins and Australasian gannets in the Inner Admiralty Bay. Information from boat-based research indicates that while dusky dolphins feed on schooling fish (mainly pilchard, *Neopilchardus* sp.) during the Winter in Admiralty Bay, gannets represent the most commonly-present bird species. As in Argentina, groups of dusky dolphins in Admiralty Bay surround schools of fish, apparently herding them into tighter aggregation to increase foraging efficiency. Australasian gannets are often observed circling above and diving into these fish aggregations. It is possible that the dolphins and birds work together, forming a commensal relationship, and using one another to more efficiently find and/or capture prey. Alternatively, the relationship may be a kleptoparasitic one, in which the gannets and other bird species make use of the prey resources made more available by the hunting activity of the dolphins, but with little or no advantage to the dolphins. We compare estimated costs and benefits of feeding alone versus in multispecies aggregations for dusky dolphins and Australasian gannets. Data used in this analysis include prey capture rates, dive and success rates, length of feeding bouts, and the numbers of dolphins and gannets present when the

two species feed together versus alone.

Glutathione Content Protects Seal Tissues Against Dive-Derived Ischemia/Reperfusion

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In terrestrial mammals, ischemia/reperfusion is a potentially hazardous situation due to the production of reactive oxygen species (ROS) and concomitant oxidative damage. In marine mammals, ischemia/reperfusion is a direct consequence of the diving response and is involved in ROS production but apparently not in oxidative damage. High content of enzymatic and non enzymatic antioxidants seems to be the key to tolerate dive-derived ischemia/reperfusion. Reduced glutathione (GSH), a non enzymatic antioxidant that scavenges singlet oxygen and hydroxyl radical, is used by glutathione peroxidases in hydrogen peroxide removal and is regenerated from oxidized glutathione (GSSG) by the action of glutathione reductase (GR) at the expense of NADPH. Total glutathione content (GSHt), reduced glutathione equivalents (GSH-Eq), GSSG, the ratio GSSG/GSH; GR and glucose-6-phosphate dehydrogenase (G6PDH) activities; lipid peroxidation (TBARS) and carbonyl proteins were measured in ringed seal (*Phoca hispida*) heart, kidney, liver, lung and muscle samples obtained incidentally to subsistence hunting near Barrow, AK. Results show significant differences ($p < 0.05$) in all the measurements between ringed seal tissues. Highest GSHt content and GR activity were found in heart and kidney, which also present the lowest TBARS and carbonyl protein levels. Lowest GSHt content and highest TBARS concentration was found in the liver. The highest GSSG/GSH ratio was found in muscle. These results suggest that in ringed seal heart and kidney GSH content and recycling are important antioxidant mechanisms contributing efficiently in ROS removal and ameliorating lipid and protein damage; thus, protecting ringed seal heart and kidney against dive-derived ischemia/reperfusion.

By-Catch Mortality of the Ladoga Seal Population

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The population size of the vulnerable Ladoga ringed seal (*Phoca hispida ladogensis*) at the beginning of the 20th century was about 20,000 seals. The current population is 3000 to 5000 seals. The distribution area has also diminished, since the 1990's seals have not been observed in the southernmost part of the lake which is the Bay of Petrokrepost. Statistics suggest that the total harvest in 1950-1974 can be roughly estimated at some 10,000 - 20,000 seals. The official culling of seals was terminated in 1975 and nowadays the ringed seal is protected by law. Rough estimates are that late into the Soviet era during the 1980's around 200-400 seals died due to fishing tackle. We interviewed 54 fishing crew leaders, mainly fishing ship captains in 2003. From the southern part of the lake 30 crew leaders informed us that at least one seal was involved in a by-catch and correspondingly in the northern part of the lake only four. According to the crew leaders around 480 seals at least had been tangled up in fishing tackle during 2003, while official statistics from the same year are only 60 by-catches in Lake Ladoga. At present the mortality rate of seals in fishing tackle is most likely the main cause of death for seals in Lake Ladoga. Fishing probably will pose a serious threat to the seal population in the long run.

Categorical Matching of In-Air Calls by a Juvenile Beluga (I Say Potato, You Say Potato, I Say Tomato, You Say Tomato...)

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The ability to modify and shape the structure and context of vocalizations through learning plays a key role in the social interactions of many species. The investigation of categorical matching, an aspect of contextual vocal learning, is the first step toward determining how contextual learning plays a role in the use, comprehension, and categorization of sounds in the wild. To this end, I conducted a study at the Vancouver Aquarium to test the ability of a juvenile female beluga, Qila, to respond to playbacks of two different types of in-air beluga calls (a scream and a pulse-train) with vocalizations that match the category of call played. I first tested Qila with random sequences of the same version of the two vocalizations with which she had been trained. She performed above chance in response to the training scream and pulse-train playbacks combined, and this was supported statistically, but her average success was low (67%), surpassing 80% accuracy in only 2/12 test sessions. I next played random sequences of six novel pulse-trains and seven novel screams, which Qila had not been trained with. Qila performed significantly above chance in response to the transfer playbacks combined, although her mean success rate was lower than for the training trials (63%). These results indicate that Qila was able to change the context of her vocalizations (the new context being the playback), and that she could distinguish, but with difficulty, between two categories of sounds that these captive belugas produce in air. Her near-chance performance may reveal that these animals' perceptual capacity of sounds broadcasted in air is poor. I will next test Qila's ability to match underwater playbacks to determine if her categorical perception improves markedly underwater.

Ontogeny of Extreme Fasting Abilities in Subantarctic Fur Seal Pups

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At Amsterdam Island (Southern Indian Ocean), lactating subantarctic fur seals (*Arctocephalus tropicalis*) undertake the longest maternal foraging trips of any otariid seal (average 27 days in winter, with records up to 50 days), forcing their pups to repeatedly endure exceptionally long fasting durations throughout lactation. Little is known of the physiological and behavioural adaptations that enable these pups to survive such long periods of nutritional deprivation while sustaining growth and development. The physiological responses of pups to fasting, and how they change through development, was investigated in 20 naïve (first fast) and 20 pre-moulting pups (2 month-old) throughout one whole fasting cycle (5.2 ± 0.4 days and 13.9 ± 0.6 days, respectively). Body mass decreased exponentially in both cohorts with an initially high daily mass loss decreasing rapidly thereafter. However, specific daily mass loss was 25% lower in pre-moulting pups during the first 5 days of fasting and eventually plateaued at the lowest level (19.1 ± 0.7 g.kg⁻¹.d⁻¹) after 4 days in the older animals, suggesting a shift to Phase II fasting that could not be detected in naïve pups. Correspondingly, pre-moulting pups had a lower mass-specific resting metabolic rate during the first 5 days of fasting (12.9 ± 0.3 vs. 14.1 ± 0.3 mL O₂.kg⁻¹.d⁻¹ in naïve pups) that decreased to 11.0 ± 0.4 mL O₂.kg⁻¹.d⁻¹ thereafter. In both groups, protein catabolism (15.1 ± 1.7 g.d⁻¹) contributed to only 8.7% of total energy expenditure. Consistently, plasma urea/creatinine ratio was low in naïve pups and decreased in older pups during early fasting while β -HBA concentration increased in all pups. These results suggest that subantarctic fur seal pups are able to adopt a protein-sparing strategy with preferential mobilisation of lipid reserves. However, higher metabolic requirements and limited body reserves may limit resistance to extended fasting in the youngest animals.

Genetic Isolation and Morphological Divergence of Black Sea Bottlenose Dolphins

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The bottlenose dolphin (*Tursiops truncatus*) is one of three species of cetaceans living in the Azov-Black Sea basin. Despite considerable research on bottlenose dolphins elsewhere, the full extent of human impact on the Black Sea populations is unknown. The lack of studies on Black Sea cetaceans is the largest reason why previous attempts to award special conservation status to these populations have failed. This study used genetic and morphological data to assess ecological and evolutionary divergence between the Black Sea and Mediterranean bottlenose dolphins. The mitochondrial DNA control region was sequenced from 99 bottlenose dolphins from the Eastern Atlantic, Aegean, Liguria seas, Israeli coast and the Black Sea and seventy-six adult bottlenose dolphin skulls from the Black Sea, Mediterranean Sea and Atlantic Ocean were sampled for 31 cranial measurements. Black Sea bottlenose dolphins were found to be smaller than Mediterranean specimens (MANOVA, $p < 0.001$) and also possess a unique skull shape (ANOVA on principal components, $p < 0.001$). The Black Sea population is also genetically distinct from other populations ($0.19 < F_{ST} < 0.89$; exact test $p < 0.003$), and have relatively low levels of mtDNA diversity ($H_d = 0.58$, $\delta = 0.002$). Our analyses suggest that Black Sea bottlenose dolphins have limited gene flow with the Mediterranean due to historical isolation, likely for thousands of years.

About Another Lone and Sociable Bottlenose Dolphin in Brazilian Waters

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From March 2003 on, a lone bottlenose dolphin (*Tursiops truncatus*) started to approach vessels and divers in Ubatuba (23°40'S), northern coast of São Paulo state, southeastern Brazil. No contacts with humans were reported. The bottlenose dolphin was easily recognisable through the absence of the top of its dorsal fin. Its size was estimated in around 3 metres, and it was not possible to ascertain its gender. In July, the same individual moved southwards to Bertioga (23°56'S), where it started to interact with swimmers. From August on, it was found in many different occasions in the following counties: Praia Grande, São Vicente and Santos (approx. 24°00'S). Surfers usually reported the presence of the solitary dolphin in local beaches. In the austral summer, the lone and sociable dolphin was observed in different occasions interacting with humans. No accidents were reported. On 7th July 2004, the lone and sociable bottlenose dolphin was found dead inside the estuary of Santos. It was a 318cm long female. It was found with two deep cuts along its womb, with part of its intestine shown off, and with its skull damaged in a few pieces. The area where this dolphin was found was usually used by a high number of boats on a daily basis, and onlookers told it was common to observe the sociable dolphin around that area before its death. However, it was not possible to be sure if the accident occurred before or after its death. Stomach content analyses revealed the presence of mullets (Mugilidae) in decomposition. This is the third known case of lone and solitary dolphins in Brazilian waters, the second with bottlenose dolphins. Only in this case the solitary dolphin was found dead. In the two others, both dolphins disappeared. All cases occurred along São Paulo state coast.

First Records of Skin Lesions in Coastal Dolphins off Southern Chile

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Since the austral summer 2003, the ecology of coastal dolphin species,

and the potential threats affecting them, are being studied in the Chilean southern fjords, where intense aquaculture activities are developed. The main objective of this study was to detect skin lesions in coastal dolphins in southern Chile. The presence of skin lesions on Chilean (*Cephalorhynchus eutropia*), Peale's (*Lagenorhynchus australis*) and bottlenose dolphins (*Tursiops truncatus*), and Burmeister's porpoises (*Phocoena spinipinnis*) were assessed by examining digital photographs obtained during 103 marine surveys conducted between January and May 2003 and 2004 in two fjords of southern Chile (42°28'S, 72°28'W). Approximately 350 pictures have been examined: 128 images of 13 identified Chilean dolphins, 173 images of 45 identified Peale's dolphins, 15 images of two bottlenose dolphins and 34 images of several unidentified Burmeister's porpoises. Skin lesions were only detected in *T. truncatus* and *C. eutropia*. Remains of tattoos and tattoo-like lesions were observed on 3 adults *C. eutropia*, caused by a still uncharacterised poxvirus. A calf *C. eutropia*, tracked from 11 January to 22 February 2003, exhibited several blister-like lesions that grew over time. These invading lesions may be of mycotic origin, possibly a lobo's disease caused by *Loboa lobo*. The calf had obvious difficulties in breathing and swimming, possibly reflecting lung infection and general health decline. A female bottlenose dolphin presented lesions similar to "ring lesions", an earlier form of tattoo disease. Although tattoo lesions affect several species of small cetaceans worldwide, no skin lesions had ever been reported in Chile. Aquaculture activities in the study area generate intense organic enrichment producing important eutrophication and release of antibiotics, which are potential threats to marine animals. These first evidences on skin lesions in dolphins may be related to a degrading environment, probably associated with aquaculture activities, which should be considered in future research and management.

"Discovery of Sound in the Sea" Website: An Educational Resource

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In recent years, the scientific community and the general public have become increasingly aware of, and concerned about, underwater sound. There is interest in learning about the sources and uses of sound, and the potential effects of sound on the surrounding environment. Underwater sound is a complex topic and there is a shortage of resources available at an introductory level. The "Discovery of Sound in the Sea" website (<http://www.dosits.org>) has been designed to provide scientific information at a general public level. It includes three major sections: (1) Science of Sound in the Sea, (2) People and Sound in the Sea, and (3) Animals and Sound in the Sea. These sections provide a thorough introduction to the physical science of underwater sound and how people and animals use it to accomplish everyday tasks. The Animals and Sound section also includes an in-depth discussion on the current state of knowledge of the effects of underwater sound on marine mammals and fishes. This interactive web site also has three galleries highlighting sounds in the sea (Audio Gallery), current scientific investigations (Scientist Gallery), and scientific equipment (Technology Gallery). As the web site has progressed, advanced level content has been added that is appropriate for high school physics classes or undergraduate science classes. Further additions to the web site are ongoing: scientists with recordings of sources that have not been included in the Audio Gallery are encouraged to contact the authors. A limited number of CDs of the web site will be available to interested conference participants.

A Research-Action Project on Environmental Education for Conservation of Marine Mammals and Whalewatching in the Central Coast of Venezuela

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The central coast of Venezuela is habitat for Atlantic spotted (*Stenella frontalis*) and bottlenose (*Tursiops truncatus*) dolphins, as well as Bryde's whales (*Balaenoptera edeni*). Dolphins are present year-round, while Bryde's whales occur here from October through February every year. Cetacean encounter rates are over 60%. On the basis of previous research results, SEA VIDA presented a proposal in 2001 for developing responsible whale-watching in the region. The basic premises for this proposal included scientific research, legal authorization, training of human resources, environmental education and participation-development of the local communities. In order to increase awareness of marine mammal conservation and achieve local participation and support for whale-watching related activities, a research-action project was implemented with high school students participating as field assistants. Action-research is a type of research intended to find solutions for a problem through a participatory and interactive way. Lectures, videos (first phase) and ecological games (second phase) about the cetaceans of the region were presented in five elementary schools during March-April 2005. The primary audiences of these activities were children of 7th, 8th and 9th grade and their teachers. Secondary audiences included local NGOs, businesses, and politicians. At this time, the sensitized audience includes at least 200 children, 15 teachers, and 15 stakeholders. As a result of these activities, a special committee was created in order to design and organize a tourism festival about the dolphins of the region. Although awareness at a local level has increased, more efforts are needed to further encourage local communities to participate in conservation efforts and in whale-watching related activities.

Foraging Areas and Diving Behavior of Galápagos Sea Lions (*Zalophus worrellbaeki*) of Caamaño Island, Galápagos

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While the Galápagos sea lion is considered a vulnerable species yet little is known about their at-sea habitat requirements. The objective of our study was to describe the diving behavior and foraging range of female Galápagos sea lions. For that purpose, satellite tags and time-depth recorders were deployed on nine female Galapagos sea lions at Caamaño Island, Galápagos. Tags were recovered after 10 - 12 days. Seven out of nine females exhibited a bimodal distribution of dive depths, with shallow and deep dives. Shallow dives were between 13 - 36 m and deep dives ranged between 51 - 234 m. Maximum dive depth recorded was 373.5 m. Dive durations ranged between 1 and 8.71 min. Maximum dive duration was 10.3 min. Six females presented diving bouts of 12 hours, which were consistent from 0600 - 1800 hrs and from 1800 - 0600 hrs. The other females presented diving bouts ranging from 4 - 20 hrs without a consistent pattern. Diving bottom time ranged from 10 sec - 3.43 min. Dive shapes exhibited were both epipelagic and benthic, with individual females showing both types. Four out of nine females foraged within 16 km from the island, traveling distances from 14 - 43 km from the rookery. The other 5 females foraged at distances ranging between 18 - 50 km from the island and traveled distances of 35 - 77 km from the rookery. Females that foraged closer to the island exhibited the shallowest of the deep dive depths, suggesting that they are foraging in the continental shelf. Foraging trips were east, west and south of the island; none of the females went north. Galápagos sea lions presented individual variability in their diving behavior, as well as foraging areas, which suggests that each individual is using different strategies to exploit a unique set of habitats around the rookery.

Seasonal Haulout Patterns of the Southern Most Colony of European Grey Seals: Combining Individual and Population-Based Studies

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We investigated year-round haulout site use by grey seals in the Molène archipelago, France, the southern limit of the species' range in the Eastern Atlantic. We combined longitudinal and cross-sectional approaches to examine seasonal variations in haulout use in order to understand how these population patterns emerge from individual movements in a colony at the extreme of the species' range. Monthly censuses (n=49) showed that the number of seals hauled-out in the archipelago peaked during the moult, and was at a minimum during reproduction. However, the sex ratio was highly biased towards males during the moult (from 3 to 5:1), but close to 1:1 the rest of the year. Photo-identification indicated high inter-annual site fidelity for both sexes, ranging from 70 to 95% (1998-2000). Mbutultistate mark-recapture analysis suggested lower site fidelity for females than for males from summer through to the late winter moult. Individual movements were assessed by fitting 16 seals with Satellite Relay Data Loggers (SMRU, UK) during May-November in 1999, 2002 and 2003. Mean tracking duration was 104 days. While 56.8% of their tracking time was spent within the Molène archipelago, fourteen seals also hauled out away from the archipelago. Nine of these used sites in the Isles of Scilly, Cornwall, Wales, and Channel Islands up to 400 km away. Long-distance movements increased from September to November, just prior to breeding. We suggest that male and female grey seals use the haul-out site of the Molène archipelago during summer in the vicinity of their foraging grounds in order to replenish their reserves for breeding. However, most of them then breed elsewhere while a significant proportion of males return for moulting. A smaller proportion of male and female seals may remain in the archipelago during breeding and moulting, but virtually all known individuals come back during summer.

Social Structure of a Mass-Stranded Common Dolphin (*Delphinus delphis*) Pod Inferred from a Combination of Mitochondrial and Nuclear Genetic Markers

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The delphinid social structure of coastal populations has been well documented based upon long-term studies. Comparatively, little is known of pelagic dolphins as they are generally less accessible to behavioural investigations. The present work was aimed at investigating group structure of the pelagic common dolphin, *Delphinus delphis*. Tissue samples from 53 individuals representing a recent mass stranding event and presumably a single social unit were combined with samples from 112 individual strandings to comprise the sample analyzed in this study. The mass stranding event occurred in 2002 on the French coast of the English Channel, whereas the individual strandings were collected between 1993 and 2003 along the western coast of France (Bay of Biscay and English Channel). We analyzed genetic (mtDNA D-loop and cytochrome B, nuclear microsatellite loci) variability within the mass stranding pod and compared it to dolphins chosen at random. Analysis of coding and non-coding mitochondrial DNA fragments showed that intra-group variability was similar to inter-group variability. Moreover, the social unit was composed of two genetically distinct clades. Preliminary results from 4 microsatellite loci support mtDNA analyses findings, as no differentiation was detected between the mass stranded pod and the rest of the samples. Nevertheless, one of the two clades identified with mtDNA showed significant differentiation from individuals taken at random, which also suggests heterogeneity within this social unit. Lastly, average relatedness obtained from nuclear loci was not significantly different from the overall sampled population suggesting that individuals within the social unit had no closer kin relationships than animals taken at random from different social units. However, additional loci are required to confirm these results, since several loci appeared to exhibit deviation from Hardy-Weinberg equilibrium.

Finally, these results suggest that common dolphins constituting a social unit are not genetically related and they do not support a matriarchal structure.

An Attack of Killer Whales (*Orcinus orca*) on a Mother-Calf Pair of Western Gray Whales in the Waters of Northeastern Sakhalin Island, Russia

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A mother-calf pair (MCP) of Western gray whales (WGW), pursued by 9 killer whales (KW), was sighted about 600-700 m offshore south of the mouth of Piltun Bay (MPB), northeastern Sakhalin, on August 1, 2004. MCP was striving for the shore but, trying to hinder them, three KW stayed between the coast and MCP: a large male accompanied by a female (~150 m offshore) and another male (~300-350 m offshore). Nevertheless, for 1 min 40 sec from the beginning of observations, MCP approached the shoreline as close as ~350 m where KW surrounded and blocked their free movement. KW males constantly circled around them reminding mostly on the surface, while the females continually dived in different directions, sometimes almost vertically from the surface. At least two persistent, but unsuccessful, attempts of MCP to break out were noticed. However, a further 1.5 min after MCP had been surrounded, they managed to escape. MCP swam quickly underwater accompanied by significant disturbance at the sea surface. KW chased the pair vainly and 40 sec later grays surfaced at a distance of ~50 m from the shoreline. KW stopped pursuing them, moved offshore as far as ~500 m, divided in 4 groups and stayed for 9 more minutes, then re-congregated into one pod. After a further 5-minute wait they abandoned their interest in MCP and started moving northward while grays slowly advanced south along the coast within the surf zone. Similar avoidance reaction of WGW, surrounded by KW, was observed by E.I. Sobolevsky and A.N. Rutenko in 1999 and 2001, also south of MPB. Given the small number of WGW, predation of KW may be an essential negative factor in the potential recovery of this critically endangered population. At the same time, this observation testifies that WGW females can escape from KW and save their calves.

Distribution of Western Gray Whales (*Eschrichtius robustus*) in the Waters of Northeast Sakhalin, Russia, in 2004

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Western gray whales (WGW) were surveyed during the summer-fall months of 2004 in the Okhotsk Sea off northeastern Sakhalin Island under the Russian program of WGW studies. Aerial and vessel-based survey data showed that their numbers in the offshore feeding area (OFA), located within 25-40 km from the island coast, sharply decreased compared to previous years - from 12 to 3, and from 50 to 9 individuals, respectively (maximum recorded numbers in single counts, 2003 vs. 2004). Most WGWs left this habitat for the near-shore Piltun feeding area (PFA). Aerial, vessel- and shore-based surveys showed considerable increases in their numbers there - from 27 to 49, from 47 to 61, and from 70 to 122 individuals, respectively (maximums in single counts, 2003 vs. 2004). Neither deterioration in benthic resources nor human-related impacts were recorded in the OFA in 2004 and the main cause of the observed WGW redistribution was, the most likely, an unusually high concentration of easily accessible food in the PFA. The majority of WGWs (60-70%) stayed in its northern part during the whole season. Their significant aggregations were also constantly present at a distance of 6-8 km offshore in unusually deep waters for this feeding ground (>20 m), and were presumably also tied with abundant prey items available there. The main feeding season of WGWs in Sakhalin waters lasted 2 months (from the end of July to late September). All mother-calf pairs were encountered in the shallows within 3 km offshore, basically - at depths of 5-7 meters. Most of them stayed inside of larger WGW groups near the mouth of Piltun Bay and in the northern part of the PFA. Based on the results obtained, WGW feeding

aggregation off northeastern Sakhalin is currently in a stable state and is not impacted by oil-extracting activity in the region.

Differences in Age at First Reproduction and Reproductive Rates of Northern Sea Otters (*Enhydra lutris kenyoni*) in Alaska

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Life history theory predicts that populations experiencing different environmental conditions such as resource availability and/or predation rates will have different reproduction and survival rates. Therefore the examination of variation in these life history parameters should provide insight into the external forces shaping population trajectory in areas such as southwest Alaska, where sea otter populations have declined over 75% since 1992. To determine if age at first reproduction (AFR) and reproductive rates (RR) for northern sea otters (*Enhydra lutris kenyoni*) varies between populations and if variability can be used to interpret differences in resource availability and predation, we examined reproductive tracts (ovaries and uteri) from stable otter populations in southeast and southcentral Alaska over the past decade (1994-2005; n=56) and from otters in stable populations in the Aleutian Islands, between 1967-1971 (n=1,155). AFR and age specific RR were determined by examining ovaries for evidence of current pregnancy (presence of a corpus luteum or fetus) and past pregnancy (presence of a corpus albicans or placental scar). The average AFR in contemporary sample was significantly lower (3.11 ± 0.22 years, 95% CI; n=45) when compared to Aleutian otters from 1967-71 (4.29 ± 0.27 years; n=692), and the reproductive rates of mature females (> 6 years) was slightly higher (77%, n = 13) in modern samples, than those collected 1967-71 (73%, n=757). Why southeast and southcentral Alaskan sea otters are currently reproducing at a younger age, and reproducing more often, than were otters in the Aleutians during the late 1960's is unclear, but indicates modern sea otters may be experiencing increased predation pressure or relaxed food limitations than Aleutian otters 40 years ago. Predictive models that define relations between population status and reproductive parameters should provide explicit tests among competing hypotheses related to causes for change in the status of populations.

Satellite Tagging and Acoustic Detection Leads to Discovery of Unprecedented Concentration of Rare North Pacific Right Whales

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The North Pacific right whale, *Eubalaena japonica*, is one of the most endangered species of whale in the world. Since illegal takes by Soviet whalers in the 1960s sightings of right whales have been extremely rare in the Bering Sea and Gulf of Alaska. On 10 August 2004, right whales were acoustically located in the Bering Sea using directional sonobuoys. Satellite tags were deployed on two right whales; one tag functioned for 39 days. This whale moved throughout a large part of the SE Bering Sea shelf, including areas of the outer shelf where right whales have not been previously seen in summer in recent decades. Near real-time information provided by the tag was used to direct the NOAA RV/McArthur II, conducting a cetacean survey, to a location near the last known position of the tagged whale in the SE Bering Sea. Directional sonobuoys were again able to detect right whales, leading to multiple encounters over 3 days (7-9 September 2004). The observers' best estimate was that 23 right whales were seen. An analysis of photo-identification data confirmed at

least 17 individual whales were photographed. Genetic analysis confirmed that 17 individuals were biopsy sampled, consisting of 10 males and 7 females. In contrast, the greatest number of individuals detected in any previous year was 6 from photographs in 2000 and 6 from genetics in 2002. The detection of 7 females was significant; of 10 individuals previously identified from genetics, only 1 was a female. Observers also reported 3 possible cow/calf pairs. Only one cow/calf pair had been seen in all previous surveys. Although this population is clearly critically endangered and its future is uncertain, the discovery of additional females and the observation of cow/calf pairs give some hope that this population may still have the capacity to recover.

Dietary Differences Between Sex and Age Classes of Steller Sea Lions (*Eumetopias jubatus*)

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Determining the diet of adult female and juvenile Steller sea lions is a major step in testing the nutritional stress hypothesis as a cause of the Steller sea lion decline. The study objective was to quantify the dietary differences between genders and age classes using a combination of hormone assays and hard part analysis. From 2001 to 2004, over 3500 scat samples were collected from haulouts and rookeries in Alaska and Russia. Undigested hard parts from scats were used to determine diets of populations sampled. Fecal elutriates were analyzed using corticosterone radioimmunoassay (RIA) following high pressure liquid chromatography (HPLC) of scat extracts. Resultant fecal glucocorticoid (FG) immunoreactivity profiles were used to determine if an individual scat came from an adult male, an adult female, or from a juvenile of unknown sex. Samples collected in 2001 from one haulout and one rookery have been analyzed. Adult female scat collected on both sites contained primarily species associated with open waters, i.e., Atka mackerel (*Pleurogrammus monopterygius*), salmon (*Onchorynchus* sp.), Northern smoothtongue (*Leuroglossus stilbius*), and walleye pollock (*Theragra chalcogramma*). In addition to Atka mackerel and salmon, scats from rookery bulls primarily contained prey commonly associated with shallower, near-shore waters and tidepools, i.e., greenlings (*Hexagrammos* sp.), gunnels (Pholididae), and small sculpins (Cottidae). Adult males from the haulout and juveniles from both sites had a higher level of diet diversity than adult females or rookery bulls. The former also consumed species associated with both near-shore and off-shore waters. Size class of prey items consumed by different genders and age classes varied by prey species, but in general, adult males and juveniles consumed smaller prey items than adult females. Combining hard-part analysis with RIA/HPLC-FG analysis allows for a greater depth of understanding in prey selection for this species, contributing information essential to addressing the nutritional-stress hypothesis.

Growth Patterns and Cranial Ossification of the Gray Whale, *Eschrichtius robustus*

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There has been little investigation of the growth of mysticetes from birth to adult, comparing ontogenetic stages. This study utilizes a larger data set than previously available for comparison and description of growth and classification of ontogenetic stages among selected extant and fossil species. Ontogenetic stages were defined as calf (birth to one year), yearling (one to two years of age) and two years or older. In mysticetes, the bones of the braincase are tightly sutured compared to the loose sutures of the rostral bones. *E. robustus* calves (n=5) have open occiput sutures, while these same sutures in yearlings (n=6) are closed, indicating that the occiput has completed ossification by one year of age. Based on eight cranial measurements and the total body length, it is possible to develop growth curves of *E. robustus* from neonate to physical maturity, paying close attention to the rate of growth at each ontogenetic stage. The growth patterns of *E. robustus* (n=26) suggest biphasic growth of bones of the occiput and braincase, increased rate of growth during the calf stage and after two years of age for a few years until the approach of physical maturity, while zygomatic width exhibits a monophasic growth pattern

through all ontogenetic stages. Previous studies found biphasic growth of total body length in mysticetes, but the difference in growth patterns has not been previously described. These results indicate that nursing calves focus cranial ossification and growth to the occiput and braincase regions while yearlings concentrate growth to total body length, condylobasal length, and zygomatic arch width. It is common for mammals to express biphasic growth, especially a change in growth after weaning while adjusting to new feeding strategies. The monophasic growth of the zygomatic width may be associated with the development of jaw musculature and feeding mechanics.

QFASA : Software (FASCALC) and Coefficients

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Iverson *et al.* (2004, Ecological Monographs 74:211) describe QFASA a means for obtaining quantitative dietary prey information from blubber fatty acid signatures (FAS). The protocol requires; a library of potential prey FAS; a set of correction coefficients (from feeding experiments) for each fatty acid to compensate for differences between the prey FAS and what is deposited in the blubber; and a means to process the data (the paper describes routines which need to be written and linked to a minimisation function of S-plus). For some species, feeding experiments are not always convenient or easy to perform. However dietary data may be available from other sources such as faecal analysis. This data (if considered reliable) could be used to calculate a set of coefficients for use in QFASA. Thus, coefficients were calculated in this manner for grey seals of Eastern Scotland from 1997. These coefficients were then applied to blubber profiles for other years (1996-2004) and to seals from France and Sweden. For the QFASA calculations, a stand-alone Windows based program FASCALC was developed. The results were compared with results calculated using both published and unpublished coefficients (from feeding experiments) and also with some published data on fish stocks. Faecal analysis had showed that sandeels plus various flatfish and gadoids were the main components of the diet in Eastern Scotland. The different coefficients tested in QFASA all identified sandeels and the annual changes were comparable with each other and to fisheries catch data. However, the results were not so comparable with the flatfish and gadoids. The published coefficients tended to identify herring as a significant dietary item which conflicts with the faecal data. Thus, one set of coefficients may not be universally applicable to all members of a given species and further work is required to optimise their use.

Comparison and Accumulation of Mercury Concentrations in Bottlenose Dolphin (*Tursiops truncatus*) Populations Along the Southeast Atlantic Coast

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Mercury contamination in the marine environment has raised concerns because of its persistence, biomagnification and bioaccumulation through the food chain. It also has potential adverse health effects and has been widely reported in stranded marine mammals. Bottlenose dolphins as long-lived and long-term residents in bays, estuaries and sounds can serve as prospective indicators of contamination. The present study examined mercury levels in skin samples from bottlenose dolphins (*Tursiops truncatus*) collected during capture-release health assessment studies in Charleston (CHS), South Carolina and the Indian River Lagoon (IRL), Florida in 2003 and 2004. Mercury levels were determined using a direct mercury analyzer. Preliminary data shows significantly ($p < 0.01$) higher mean mercury levels in skin of dolphins from the IRL ($7.71 \pm 6.53 \mu\text{g/g}$, range = $0.33 - 30 \mu\text{g/g}$ dry weight, $n = 63$) than those captured from CHS ($1.65 \pm 0.96 \mu\text{g/g}$, range = $0.65 - 4.88 \mu\text{g/g}$ dry weight, $n = 56$). These mercury levels were within the range of other studies in skin of marine mammals from Mediterranean and Atlantic ($0.27 - 19.9 \mu\text{g/g}$ dry weight) with few exceptional dolphins from IRL. Mercury concentrations in skin samples significantly increased with increasing age ($p = 0.007$) and length ($p = 0.002$) of dolphins from CHS but not in those from IRL. No significant relationship was found between mercury levels and weight of dolphins at either sampling locations. Skin samples of dolphins collecting in 2005

summer will be presented in similar comparison stated above. Future research includes measuring mercury in the environment and dolphin prey species to explore trophic transfer pathways. Additionally, correlation of mercury concentrations in dolphins with other health parameters, such as immunology will be determined for identifying potential health risks.

The Finless Porpoise (genus *Neophocaena*) Is Not Monotypic

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There are great concerns about the conservation status of finless porpoises (genus *Neophocaena*) because substantial mortality in fishing nets is suspected throughout their distribution. However, due partly to the considerable taxonomic uncertainties within *Neophocaena*, efforts to assess the impact of fisheries on finless porpoises, especially in Chinese waters, have been ineffective. Although the most widely accepted taxonomic arrangement is that of a monotypic genus with three subspecies, this hypothesis has been challenged. The purpose of this study was an attempt to bring some clarity to the alpha-level taxonomy of finless porpoises by analyzing external morphology, mitochondrial DNA control region sequences (294 bp) and microsatellite DNA (nine polymorphic loci) of finless porpoises from Chinese waters that includes areas where two morphological forms (*i.e.*, the dorsal surface either possessing a “wide-groove” or “narrow-ridge”), occur in sympatry. Morphological assignments and genetic analyses of 60 finless porpoises were performed using a double-blind design before the results were compared. Morphological assignments were unambiguous. Although mtDNA did not reveal fixed differences between the two forms, differences in microsatellite DNA were clear, consistent with the morphological data and indicated there was no detectable gene flow between the two sympatric forms of finless porpoises. According to the Biological Species Concept, these forms of finless porpoises represent distinct biological species. These results support a recent osteological study that found only two major groups of finless porpoises and challenged the most widely accepted taxonomy of finless porpoises. Based on previous morphological descriptions, finless porpoises with the “wide-grooved” morphology should be referred to as *Neophocaena phocaenoides* (G. Cuvier, 1829) while those possessing the “narrow-ridged” morphology should be called *Neophocaena asiaorientalis* (Pilleri and Gehr, 1972). Whether further species-level divisions exist within each of these groups requires further study. This study provides clear evidence that the genus *Neophocaena* is polytypic.

A Passive Acoustic Monitoring Method Applied to Determine Movement Direction of Free-Ranging Finless Porpoises

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The present study aimed at determining the possibility of an acoustic observation system to determine movement direction of free-ranging finless porpoises under local riverine conditions and compare the results with sighting observations. Two parallel arrays with a distance of 400 meters apart, of four acoustic data loggers for each were stationed across the main channel of the Tian-e-zhou Oxbow of China's Yangtze River at intervals of 150 meters to record sonar signals of free-ranging finless porpoises (*Neophocaena phocaenoides*). Acoustic observations, concurrent with visual observations, were conducted on 17-19 October 2004. During a total of 24 hours of observation, 405 finless porpoises

were sighted and 10,445 sonar signals were recorded by loggers. The acoustic data loggers recorded ultrasonic signals of porpoises clearly. Each acoustic array detected the presence of porpoises with a correct detection level of ~77.6% and a false alarm level of ~5.8% within an effective distance of 150 meters. Time differences of recorded signals between both arrays were used to determine the movement directions of the porpoises. In total, 250 individuals were observed visually to pass both arrays upstream or downstream. Among them, 70% were detected by both arrays. Moving directions of the animals were decided by time differences of the detected signals from both arrays and confirmed by visual observations. Results indicated that the stationed passive acoustic monitoring method was effective in both detecting presence of the porpoises and determining movement directions of the porpoise groups.

Field Tests of Acoustic Alarms Designed to Reduce Bottlenose Dolphin (*Tursiops truncatus*) Depredation in a North Carolina Gillnet Fishery

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Dolphins frequently take Spanish mackerel (*Scomberomorus maculatus*) from coastal gillnets in North Carolina. We observed these interactions during the summers of 2003-2005 from commercial gillnet vessels and a small research vessel. Dolphins encountered 26% of all gillnets we monitored in 2003 and engaged in the following behaviors: patrolling along the length of the net, taking fish from the net (depredation) and begging for discarded fish. Sharks, rays, turtles, crabs and other fish species also engaged in depredation, which occurred in 71 (52%) of the 136 gillnet sets. Spanish mackerel catch declined by 38% when dolphins interacted with gillnets. In 2004 and 2005 we assessed the efficacy of Save Wave® acoustic alarms designed to reduce dolphin depredation. The Save Wave® devices have a double signal system with randomized transmission intervals and pulse lengths, meant to reduce the possibility of habituation which has been found to occur with other small cetaceans and single signal acoustic deterrents. We placed an observer aboard a commercial vessel to deploy either active or control devices on all gillnets each day. The observer monitored the catch of Spanish mackerel in each net and the number of interactions between dolphins and gillnets. In addition, we conducted focal follows of dolphins around gillnets from a small research vessel. There was no difference in Spanish mackerel catch per unit effort ($p=0.94$) between active and control sets (nets equipped with inactive alarms). We observed several dolphins interacting with nets with active alarms and their behavior and proximity to the nets were similar to that recorded during control sets. Our results suggest that Save Wave® acoustic deterrent devices did not deter dolphins from closely encountering nets and possibly engaging in depredation. Other approaches should be explored to reduce the extent of depredation by dolphins in this fishery.

Spatiotemporal Distributions of North Atlantic Right Whales and Characterization of Vessel Traffic Along the Southeastern U.S. Coast

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For more than a decade, NOAA Fisheries has supported winter (Dec-Mar) aerial surveys in the southeastern U.S. to gather data used in developing measures to protect North Atlantic right whales. Data from aerial surveys, conducted by the New England Aquarium, and the states of Florida (FWC) and Georgia (GDNR), were used to investigate spatiotemporal distributions of right whales and vessel traffic. Relative abundance estimates and distributions of right whales were examined using aerial survey observations stratified monthly and within cooler versus warmer winters.

Monthly compilations showed peaks in relative abundance of right whales in the months of January and February. Therefore, we used data from these months over the time series to compare inter-annual distributions. Generally, the earlier winters in the time series were cooler than the later winters based on averaged sea surface temperatures (SSTs) measured within the southeastern critical habitat (1992-2002). The mapped distributions illustrated areas where whales were consistently observed but also demonstrated elasticity in distribution that may be, in part, explained by water temperatures; fine-scale habitat shifts were noted between cooler versus warmer winters. There was evidence for a negative relationship between mean seasonal SST values and seasonal relative abundance estimates. Aerial observations of vessel traffic were also adjusted for survey effort and mapped. In addition, information reported to the federal Mandatory Ship Reporting System (MSRS) was used to characterize commercial ship traffic patterns within the critical habitat. In combination, the aerial survey observations of right whales and vessel traffic and MSRS data helped to identify areas where right whales and vessels tended to co-occur. A long time series was critical to investigating relative abundance estimates and distributions of right whales relative to environmental factors and human activities that change over time.

Marine Mammal Strandings in the Eastern Caribbean Region

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The Eastern Caribbean Cetacean Network (ECCN) is a regional, volunteer network that records sightings and strandings of marine mammals in the Eastern Caribbean. Twenty-two species have been recorded as stranded or involved in fishery interactions. Short-finned pilot whales (*Globicephala macrorhynchus*) are the most commonly reported species to single and mass strand by the number of individuals and by number of stranding events. Records of cetacean strandings provide unparalleled opportunities to collect information about elusive and potentially rare species, which are difficult to study in the wild. For example, the pygmy sperm whale (*Kogia breviceps*) strands in the region but are seldom observed in the wild. Information from directed hunts may demonstrate a species extending its range, such as the common Bryde's whale (*Balaenoptera cf. brydei*). An important component of ECCN is the necessity of inter-island cooperation, since marine mammals are wide-ranging and transboundary. This first collective compendium of historical and current records from the Eastern Caribbean provides critical information about marine mammal species diversity, distribution and occurrence, and local knowledge. Through research and education, ECCN's objective is to gain community support for the protection of resident and migratory whales and dolphins and their marine habitat, and provide information for the United Nations Environment Programme's (UNEP) newly developed Marine Mammal Action Plan (MMAP) for the Wider Caribbean Region (WCR).

Distribution and Density Estimates of Cetaceans Along the Mid-Atlantic Ridge During Summer 2004

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The Mid-Atlantic Ridge (MAR) is a tectonic spreading zone between the Eurasian and American plates, running from Iceland in the North to the Azores in the South. Rough bottom topography, hydrothermal activity, seamounts, and other topographical features characterize it. Historical whaling data and other anecdotal information implied that the MAR is an important cetacean habitat. During 4 June – 2 July 2004, the Norwegian R/V *G.O. Sars* conducted a single transect multi-disciplinary survey along the MAR from Reykjanes Ridge to north of the Azores. This provided the first systematic survey information on the MAR cetacean population. Observers located on top of the bridge (15.5 m above sea level) searched using naked-eye or hand-held binoculars in a 140° arc centered along the ship's heading. At least 17 cetacean species were sighted along 2,321 km of effort. The most commonly sighted species (number of groups) were

sei whales, *Balaenoptera borealis* (54); sperm whales, *Physeter macrocephalus* (50); fin whales *B. physalus* (15); common dolphins, *Delphinus delphis* (28); pilot whales, *Globicephala* sp. (15); and striped dolphins, *Stenella coeruleoalba* (12). Density estimates and coefficient of variation of individual animals were: pilot whales (0.459, 0.53), common dolphins (0.272, 0.58), striped dolphins (0.191, 0.53), sperm whales (0.013, 0.37), sei whales (0.009, 0.44), and fin whales (0.002, 0.63). Species distribution varied north to south; the highest aggregations of both baleen whales and sperm whales were sighted north of the Charlie Gibbs Fracture Zone (CGFZ). Pilot whales were mainly in the colder Labrador water masses along the Reykjanes Ridge. Conversely, both common dolphins and striped dolphins were observed south of the CGFZ in areas with warmer (14°C) surface water temperatures.

Global Sperm Whale (*Physeter macrocephalus*)

Depredation of Demersal Longlines

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Depredation is the removal or damage of hooked fish or bait from fishing gear by cetaceans. Depredation has been observed in a variety of fisheries, by different marine mammal species (e.g., killer whales, bottlenose dolphins, pilot whales, and false killer whales) in several ocean basins. Our goal was to compile an initial review of sperm whale depredation worldwide, with a focus on depredation of demersal longlines. We tallied 17 sources, some describing a single depredation event and others documenting years of interactions and multiple depredation events. We found documentation of depredation in four ocean basins: including the North Atlantic, North Pacific, South Pacific, and Sub-Antarctic. In general, depredation and interactions are most likely to occur: (1) in natural foraging areas of sperm whales, (2) during hauling periods, and (3) when fishers and sperm whales are utilizing the same fishing hotspots. Reported rates of depredation vary widely from less than 1% to 100% of catch removed. Commonly removed prey includes sablefish (*Anoplopoma fimbria*) and Patagonian toothfish (*Dissostichus eleginoides*). Typically, individuals or small groups, composed of 2-4 sperm whales, are observed in the vicinity of fishing vessels. Depredation by sperm whales is a complex issue that arises when there is temporal and spatial overlap for the same resources between whales and humans. The consequences of increased depredation include economic implications for fishermen and increased risks of marine mammal mortality due to entanglement. In order to design effective mitigation strategies, there is a critical need for understanding how depredation occurs (see abstracts by Straley *et al.*, Thode *et al.*, and Tiemann *et al.*), the etiology of interactions, for better documentation of the geographic extent and magnitude of depredation, and an appreciation for how changing fishing regulations may affect depredation.

Longevity of Hair Clip Marking on New Zealand Fur Seal Pups

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Since there is a high rate of tag loss in New Zealand fur seals (*Arctocephalus forsteri*) hair clipping is the preferred method of marking for mark-recapture studies solely interested in population abundance estimates. It has been assumed that hair clip marks on pups disappear at their first moult at approximately six months of age, but this assumption has not been previously tested. This study documented the longevity of hair clip marks on New Zealand fur seal pups of varying age and found that clip marks do not automatically disappear at the first moult, but factors such as age at clipping greatly affect the visibility and longevity of marks. Different types of marks also had different longevity which has applications for research in colonies with high tourist value. Pups marked during the moult were documented to retain their marks for as long as 153 days, and it is assumed until their next moult at 1.5 years of age. Thus, hair clipping may prove useful in preliminary studies on natal dispersal using batch marking.

Female Bottlenose Dolphin (*Tursiops* sp.) Behavior in Relation to Sexual Coercion in Shark Bay, Western Australia

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To understand the evolution of sexually selected traits it may be more appropriate to investigate the conflict over sex due to sexual coercion rather than focus only on traditional female choice or male-male competition. In Shark Bay, male alliances guard single females in consortships. We first used female behavior to further substantiate the hypothesis that these consortships constitute sexual coercion and, second, we measured the cost of these consortships to the female. Consortships were considered sexual coercion if they were maintained by force and decreased mating opportunities with non-consorting males or increased mating opportunities for consorting males. Previously, Connor and colleagues documented male aggression toward cycling females, but the female's perspective was not examined. Behavioral data on adult females were collected during follows of individuals during the breeding season (N=33 females, 52 consortships, 181 hours). Females experienced more aggression from males when they were in a consortship than when they were with adult males otherwise, indicating at least some consortships were used to sequester females by force and were not simply the result of being around aggressive males. The amount of affiliative behavior displayed toward males was positively correlated with, and occurred more often after, aggressive behavior toward females, consistent with intimidation. Females socialized primarily with consorting males, even though several other adult males were present; presumably resulting in decreased mating opportunity for non-consortship males. We also measured potential costs of consortships to females. We compared behavior of the same females in and out of consortships (N=20 females, 85 hours in/ 54 hours out). Females experienced more aggression, increased time in deep water, and increased time in contact with their calf compared to when they were not in consortships. During the subset of consortships containing aggression toward the female, females spent less time foraging compared to when not in consortships.

Respiratory Patterns as Indicators of Diving Ontogeny of the Gray Whale, *Eschrichtius robustus*, from Birth to Nine Months of Age

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The ability to perform effective dives is an essential skill for all cetaceans. The ontogeny of this behavior has not been adequately described for many species, and is particularly lacking for baleen whales. We analyzed respiratory data from focal observations of cow-calf pairs collected in different years from five locations: San Ignacio Lagoon, Mexico (1980, 1981, 1993, n=22), Piedras Blancas, California, USA (2005, n=20), Oregon coast, USA (1978, 1979, n=9), W Vancouver Island, Canada, (2003, n=2), and NE Sakhalin Island, Russia (2002, n=7). "Clumped" dive patterns (Harvey and Mate 1984) were subsampled from each focal observation and the long duration dives in these bimodal distributions were investigated across locations, in addition to total blow rates (TBR). With increased age and size of the calf, we expected to see greater dive durations with greater variance, and lesser TBRs. Dive duration and TBR varied significantly with location (dive $F_{4,64} = 16.383$, $P < 0.001$; TBR $F_{4,64} = 17.291$, $P < 0.001$). Piedras Blancas and Oregon calves had the greatest dive times and least values of TBR. Baja calves had the least dive times and greatest values of TBR. Canada and Russia calves grouped together, between the values of the other two groups. Additionally, Russia calves overlapped statistically with Oregon calves for values of TBR. Variance of long duration dives increased with increased dive times. These patterns indicate an increase in dive duration after the first few months of life (Baja), and imply that calves are able to accomplish long duration dives early in their development. They appear to be pushing their physiological limits during the migration, and then decrease their dive durations in the northern feeding areas. If calves were observed more intensely during the

several months post-weaning, longer dive times may be observed in association with the stress of nutritional independence.

Coda Production by Individual Sperm Whales

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The rhythmic coda vocalizations produced by sperm whales are thought to function in social communication. Previous work has focused on coda production by aggregated groups of sperm whales socializing during extended periods at the surface. We deployed digital recording tags in three regions to determine the depth and timing of coda production by individual whales. We examined three phases of behavior: foraging dives (dives to >300 m with median durations of 45 min, from fluke out to surfacing), inter-dive surface intervals (at < 10 m depth between two foraging dives for median durations of 9 min), and extended surface periods (periods of surface and shallow diving behavior with median durations of 56 min). The median depth of coda bouts across all contexts was 94 m in the Gulf of Mexico (18 whales), 49 m in the Atlantic Ocean (4 whales), and 501 m in the Ligurian Sea (5 whales). Tagged whales produced (median) 83%, 43% and 100% of their recorded codas during foraging dives in the three regions, respectively. When foraging dives were normalized by dive depth, codas were produced primarily in the top 20% of the dive depth in the Atlantic, the top 40% in the Gulf of Mexico, and from 40-80% of the dive depth in the Ligurian Sea. Median coda rates during dives were highest during descents and ascents. There were no differences between median coda rates comparing descent and ascent in all regions. Coda rates were higher during ascents than inter-dive surface intervals in the Gulf of Mexico and Ligurian Sea. Coda rates were lower during extended surface periods than during dive descents and ascents in the Gulf of Mexico. In addition to producing codas while socializing at the surface, sperm whales also produce a significant proportion of codas during their foraging dives, perhaps to coordinate movement before and after active foraging.

An Evaluation of a Trinational Gray Whale Photo ID Database

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This evaluation was performed to assess the usefulness of a Gray Whale Photo ID Database and software developed by Steven L. Swartz and Jorge Urbán-Ramírez as a resource for gray whale researchers in Canada, the United States, and Mexico, and to produce an edited version of the database. The database was created to provide a way to statistically analyze gray whale reproductive rates, mortality rates, habitat distribution and timing of migration, *etc.* to assess the possibility that the whales may be approaching carrying capacity. It was also intended to be used as a widely distributed archival resource and to assist other researchers in performing other population analyses. All the functions and commands of the database (about 35 were examined in detail) were tested to determine how it operates; the organization of the database was examined; and the quality of the information contained in the database was evaluated. This qualitative assessment included determining if each function performed properly, evaluating how useful each command is to a researcher, investigating any unclear aspects or instructions associated with a function, and giving a final assessment of how best to perform the operations associated with each function. Instructions were written to researchers about how to avoid the technical problems associated with the database. A modified version of the database was produced for this study (May 2005). In this edited database, the photos were reorganized, low quality

photos were eliminated, and records and photos alike were deleted if they lacked necessary information. The database will be a very useful resource for researchers, and will give them a standardized way to organize their data. Using the database will facilitate data exchange among gray whale researchers on the Pacific Coast of North America. Similarly, this expanded effort will be useful for management considerations and decisions.

Reduced Genetic Variation and Nonrandom

Association of Alleles in the MHC of the Northern

Elephant Seal: Does this Reduce Disease Resistance?

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The northern elephant seal (*Mirounga angustirostris*) is a classic example of a species that has gone through extreme population bottlenecks. Despite continuous pre-20th century hunting and the resultant founder events, it has recovered from near extinction, such that it has a robust and still increasing population size of over 175,000. The major histocompatibility complex (MHC) has a crucial role in the immune system of mammals, and thus disease resistance. Reduced variation at MHC loci may compromise a species if challenged by novel pathogens, as being homozygous at certain alleles can be associated with susceptibility to diseases. To determine if genetic variation in MHC loci is as low as that found in other genes of the northern elephant seal, we surveyed 110 individuals from two populations at three different class II loci, *DQA*, *DQB*, and *DRB*. Our data revealed three important results: *i*) very few alleles at all three MHC loci; *ii*) a significant association with geographic location for the *DQA* locus — inferring a possible fitness difference between the islands; and *iii*) a nonrandom association of alleles at different loci, *i.e.*, linkage disequilibrium, between *DQB* and *DRB*. This complete association between alleles for *DQB* and *DRB* may be a direct consequence of past population bottlenecks or other factors. As of yet, there are no demonstrable adverse effects on fitness. These data suggest that the northern elephant seal is in fact a species that is inbred but may have overcome the effects of inbreeding depression.

High Site-Fidelity of a Deep-Water Dolphin: Rough-Toothed Dolphins in the Hawaiian Archipelago

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Animals should be expected to show fidelity to a particular area if resources are both greater and more reliable there than in surrounding areas. High levels of site fidelity have been previously documented for coastal dolphins living in structured environments but are rarely reported for oceanic species. Rough-toothed dolphins are distributed in tropical and warm temperate waters world-wide, generally in oceanic waters. We studied this species around the main Hawaiian Islands as part of a larger effort to assess odontocete population status and structure in Hawai'i. We hypothesized that rough-toothed dolphins seen around the main Hawaiian Islands were part of a larger oceanic population with little or no fidelity to the islands. In approximately 28,000 km of surveys between 2000 and 2005, we encountered this species on 44 occasions, 32 times off the island of Hawai'i, once off O'ahu, and 11 times off the islands of Kaua'i/Ni'ihau. Group size ranged from 2 to 50 individuals (mean = 10, SD = 9.8). We photo-identified 184 distinctive individuals, 79 off Kaua'i/Ni'ihau, 16 off O'ahu, and 89 off Hawai'i. Off Hawai'i there were 37 within-year re-sightings and 19 inter-year re-sightings, suggesting both a small population

size and high site fidelity. No inter-island matches were documented despite reasonable samples of identified individuals off Kaua'i/Ni'ihau and Hawai'i. While they were found in water ranging from 250 to 4,300 m (mean = 1,950 m, SD = 935 m), an analysis of sighting depths in relation to effort indicated sighting rates were highest in the deepest portions of the study area (2,000 to > 4,000 m). These results suggest that, despite their oceanic nature, the population size of rough-toothed dolphins around the main Hawaiian Islands is relatively small and they may show fidelity to specific islands, as has been documented for bottlenose dolphins in Hawai'i.

Inter and Intra-Annual Variations in the Encounter Rates of the Estuarine Dolphin (*Sotalia guianensis*) in the Eastern Coast of Brazil

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The estuarine dolphin (*Sotalia guianensis*) was studied through boat surveys in the Caravelas Estuary and coastal adjacent areas (17°54'S - 39°21'W), eastern coast of Brazil, 2002-2004. The study area was surveyed monthly (3-9 days/month), totaling 238 surveys and 241 groups sighted. Encounter rates (ER) were calculated for each day based on distance traveled by boat divided by total number of individuals sighted. ER variations were tested (through Kruskal-Wallis) both among the three different years and also within each year looking for any seasonal variation. There was no correlation between survey effort and ER. We found no significant differences in the ER within the three years ($p > 0.05$), indicating that dolphins are present year-round without any seasonal variation. Significant inter-annual difference in ER was detected ($p < 0.05$). There was a trend of decreasing ER from 2002 to 2004 (2002 - 0.12 ind/km; 2003 - 0.10 ind/km; 2004 - 0.06 ind/km). Using our research design and ER as an abundance index for this population, we found through a power analysis that negative population trends shall be detected after 10 years of monitoring (0.90 power to detect a 10% negative trend). The decrease in ER of the estuarine dolphins in the Caravelas Estuary may be related with the dredging activities and barge traffic in the area which started in the first semester of 2002. Though better assessment is required, dolphins may be responding either by chronic exposure to human sources of impact, or to alteration in water dynamics of the estuary. The habitat alteration (caused by the excavation of the main channel of communication of the estuary with coastal waters) may ultimately lead to local changes in prey abundance and distribution. Continuous monitoring and further analysis, including a detailed assessment of the influence of environment variables in the ER, are required to test this hypothesis.

Effect of Water Turbidity on the Visual Acuity of Harbor Seals (*Phoca vitulina*)

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The pinniped eye is well adapted to the under water environment. Therefore, the visual system of pinnipeds is often considered to be the major source of sensory information for under water orientation and navigation. However, many pinniped species like the harbour seals (*Phoca vitulina*) in the German Wadden Sea live in very turbid waters. The effect of turbidity on vision and how the animals might compensate for the loss of visual information under high levels of turbidity has not yet been considered. Using psychophysical techniques we determined the visual acuity of two male harbour seals (Bill and Sam) at different levels of turbidity. Turbidity was measured in formazin nephelometric units (FNU) that compare the turbidity of a water sample to the standard formazin conforming to DIN EN 27027 and ISO 7027. During our experiments the turbidity in our experimental pool varied from 0.2 to 7.8 FNU. Starting

with acuity angles of 5.5' and 12.8' in clear water we found acuity angles to decrease rapidly with increasing turbidity at rates of 7.4' and 6.0' per formazin nephelometric unit (FNU). Besides the individual differences in visual acuity of the harbor seals tested, our results reveal a dramatic loss of visual resolution even at moderate levels of turbidity. At sites in the German Wadden Sea, where harbor seals are known to roam and forage, we measured turbidity levels exceeding 40 FNU. These data suggest that turbidity has to be considered as an important factor in the sensory ecology of pinnipeds.

Is Herring Fishing Displacing Humpback Whales on Their New England Feeding Grounds?

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Jeffreys Ledge is an important feeding habitat for humpback whales (*Megaptera novaeangliae*) in the Gulf of Maine, where herring (*Clupea harengus*) is their primary prey. In 1998, the mid-water and pair trawl fishery for herring in Fishery Management Area 1A (including Jeffreys Ledge) was greatly expanded. Trawl catches of herring increased from a mean of 366.3 (± 166.5) metric tons per year from 1988-1997 to 43,004 ($\pm 9,412$) from 1998-2004. Concern has been expressed that the increase in herring catches has displaced humpback whales. We tested this hypothesis using photo-identification data from 1988-2004. Both the number of individual whales identified per year (mean = 114.2 \pm 12.8, peak = 172, from 1988-1997; mean = 55.1 \pm 5.2, peak = 80, from 1998-2004) and the number of sightings of identified whales per year (mean = 429.5 \pm 95.2, peak = 928, from 1988-97; mean = 152.1 \pm 21.4, peak = 255, from 1998-2004) showed a significant decrease during the period of increased trawl fishing (t-tests; $p = 0.001$, $p = 0.02$). The number of whales also significantly correlated with the 1A trawl catch per year during the entire study period ($r^2 = -0.357$, $p = 0.01$). Trawl fishing was closed from 15 September - 15 October for herring spawning each year. Significantly more whales than predicted by chance were seen during and immediately after these closures in 1999 and 2002 - 2004, four of the six years for which sufficient effort in October was available. We also documented eight cases from 1998-2004 where whales were consistently sighted until trawl fishing boats were seen, and, then within days, the whales vacated the area. This data is consistent with the hypothesis that herring fishing is displacing whales from a preferred feeding habitat. Further work is needed to assess the consequences of this displacement on the whale's annual energy budget, which is beyond the scope of the existing data.

Distribution and Behavior of Dusky Dolphin "Nursery" Groups off Kaikoura, NZ

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Off Kaikoura, New Zealand, large groups (150+) of dusky dolphins (*Lagenorhynchus obscurus*) occur throughout the year, and are targeted by swim-with-dolphin and other tourism. There are also smaller "nursery groups", defined as at least two calves per 6 non-calves. Calves are estimated <6 mo. old, based on small body size and poorly defined coloration pattern, "cork-like" surfacings, and consistent echelon position with an adult. A survey route was followed to determine locations of nursery groups. Sixty-eight nursery groups were encountered on 50 survey days, January-May, 2005, and 1,544 min of behavioral data were collected during focal group follows. For the survey area of 97.5 km², 34% was less than 20m deep and 66% was deeper than 20 m. Of all nursery groups encountered, 53 (78%) were in depths less than 20 m. In comparison, of 48 large (150+) mixed groups encountered, only 25 (52%) were in less than 20 m. 38 (n=51) of the nursery groups were within 3km of a large group. In all but 3 of these cases, the closest large group was the target of swim-with and other tourism for that day. Focal group follows of 30 min. each, with 5-min blocks of predominant behavior (resting, socializing, traveling, or foraging) and predominant structure (parallel, pack, extended, scattered) were conducted for 37 nursery groups. For 25 of these groups,

resting was the predominant group behavior for at least 50% of the time ($n=37$). Group structure was either pack or parallel in 25 of the 37 groups, demonstrating that individuals in these groups usually stay within one body length of one another. Clarifying the habitat requirements of these important sub-groups of the population has important implications for management of fisheries and tourism industries in the area.

The Influence of Inter-Annual Environmental Fluctuations on the Foraging Behavior of Male California Sea Lions

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Reduced prey availability resulting from stochastic environmental fluctuations results in changes in pinniped foraging behavior such as increased percentage time at sea, increased percentage time diving while at sea, and increased home range coupled with increased foraging effort. All previous studies have been on juvenile or adult female otariids while very little is known about the response of males to environmental perturbations, in particular adult males. Further, sexual differences in foraging strategies are evident among sexually dimorphic species. Absolute metabolic requirements increase with body mass requiring more energy per unit time than smaller body size. To attain and maintain larger size adult male otariids require a higher energy intake and likely forage differently and respond differently to fluctuations in prey availability. California sea lions are sexually dimorphic, with the males up to four times the mass of adult females. Foraging of adult male sea lions is not constrained by dependent young, and while we have some idea of post-breeding movements, individual dispersal routes and foraging behavior remain largely unknown. Using SMRU satellite relay data loggers we investigated the spatially explicit foraging behavior of male California sea lions and compared foraging effort (time at sea, time diving, and home range) between 'normal' oceanographic conditions in 2003/04 ($n=22$) and during anomalies in 2004/05 ($n=3$). During 2003/04 sea surface temperatures (SST) in the North-eastern Pacific were 'normal', whereas during 2004/05 persistent positive SST anomalies were recorded from January through April. During 2003/04 the at-sea movement patterns of sea lions were confined to the continental shelf region while in 2004/05 animals foraged well off the continental shelf making repeated loops up to 400 km offshore. Large body size and lack of dependent young likely enable observed responses to environmental fluctuations.

Foraging Ecology and Maternal Transmission of Foraging Specializations of Bottlenose Dolphins (*Tursiops truncatus*)

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Bottlenose dolphins (*Tursiops truncatus*) use a variety of foraging specializations to detect and pursue prey. Like other mammals, individual dolphins may use specialized foraging techniques that are shaped in response to habitat type or prey resources. The long duration of the mother-calf bond presents an opportunity for mothers to transmit such specializations to their calves. This study explored how the use of foraging specializations may influence selection of foraging habitats and how such specializations may spread within a dolphin community. Focal follows were used to document the foraging behavior of five resident females and their calves from June-August 2003 in Sarasota Bay, Florida. Sarasota Bay was classified into habitat types based upon bathymetry and bottom topography. Females significantly differed in their selection of foraging habitats ($\chi^2=462.64$, $p<0.001$). Three of the five females used foraging specializations, kerplunking and barrier feeding, and each female preferred only one type of behavior. Each behavior was associated with seagrass habitats, and females that specialized increased their use of these habitats while foraging. Findings suggest that the use of foraging specializations is associated with individual foraging habitat preferences in Sarasota Bay. Limited observations from this study and anecdotal evidence from past studies suggest that maternal transmission may play a role in the spread of foraging techniques and emphasize the significance of the mother-calf bond in the development of foraging specialization use. If the use of

foraging specializations is habitat-specific and transmitted from mother to calf, such behavioral and habitat preferences may persist through generations and serve as valuable adaptations to the environment. This is the first study to focus on the examination of the transmission of foraging specializations in Sarasota Bay. Evidence from this study contributes to the growing understanding of individual foraging specialization use and the role of foraging specializations in predator-prey interactions.

Humpback Whales (*Megaptera novaeangliae*) of the Cape Verde Islands

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The movements of individual humpback whales (*Megaptera novaeangliae*) can be tracked by matching photographs of the distinctive markings on the ventral sides of their flukes. During winter-spring research cruises between 1990 and 2005, a total of 64 individual humpback whales were identified from the waters of the Cape Verde Islands. These were compared with over 5,500 individual fluke photographs taken in the North Atlantic. One match was made with a whale previously photographed in the Denmark Strait off Iceland, a second match to Bear Island, Norway thus providing the first direct evidence of a link between the humpbacks in tropical waters of the eastern North Atlantic and a high latitude feeding grounds. Twelve inter-annual matches of humpback fluke photographs have demonstrated a high return rate to this region. The presence of cows with young calves, as well as singers during the humpback mating and calving season implies that waters surrounding the Cape Verde archipelago suggest the area is a breeding and calving ground for an Eastern North Atlantic population of humpback whales. These findings are consistent with the mitochondrial DNA evidence of at least two distinct breeding populations of humpback whales in the North Atlantic.

Milk Composition and Calf Growth in Free-Ranging Bottlenose Dolphins (*Tursiops truncatus*)

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Free-ranging bottlenose dolphin calves may consume milk as either a sole or combined energy source until up to as many as 7 years of age in some cases. Although calves require milk for survival during their first year of life, at least, basic information on wild dolphin milk is scarce. The objectives of this study were to determine the nutritional value of milk received by bottlenose dolphin calves including fat, protein, water, ash, lactose and caloric energy content. We also investigated the relationship between calf survivorship, age, size and body condition of both mothers and calves and the nutritional value of wild bottlenose dolphin milk. Forty-two milk samples were collected between 1988 and 2004 during the temporary capture and release of individually identified bottlenose dolphins in Sarasota, Florida. Wild bottlenose dolphin milk fat averaged 14.9% (range = 6.9% - 31.5%). Milk water averaged 68% (range = 56.0 - 75.6%). Milk protein averaged 12.7% (range = 9.7 - 15.0%). There was no significant relationship between calf survivorship and milk composition. Milk parameters were not correlated with the body condition, size or age of the mother. Linear regression analyses indicated that calf mass increased significantly with the percentage of milk fat and varied inversely with milk water content. Through the course of development, the water content of milk obtained by calves decreased significantly. In captive bottlenose dolphins, milk fat and milk protein increase over the course of lactation

and milk water decreases. Although milk fat and milk water values are similar between free-ranging and captive populations, milk protein is slightly higher in wild dolphins. Quality of milk in lactating bottlenose dolphins is highly variable but has important implications for calf mass.

Seasonal Differences in Heat Flux and Skin Temperature Across the Dorsal Fin of Free-Ranging Bottlenose Dolphins (*Tursiops truncatus*)

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Bottlenose dolphins in Sarasota Bay, Florida, USA experience large seasonal changes in water temperature, T_w , (11-33°C). We hypothesized that during periods of reduced T_w , dolphins would decrease their skin surface temperature, T_s , and rates of heat loss across their thermal windows, such as the dorsal fin. To test this hypothesis we deployed a thermal logger (suction cup attachment) on 17 free-ranging dolphins during January/February (winter) and June (summer) of 2004-05. This device recorded heat flux (HF ± 0.1 W/m²) and T_s (± 0.1 °C), from a site located near the middle of the dorsal fin, and T_w (± 0.1 °C) every 2 seconds. We recorded a total of 17 hours of thermal data from winter and 25 hours from summer. To reduce the variability in the data set we restricted our analysis to stable records longer than 30 minutes (n=5 winter dolphins, n=6 summer dolphins). Water temperatures for winter ranged between 17.1-18.1°C and in summer from 28.9-32.7°C. When the analysis was restricted to the first 30 min immediately following release, no seasonal differences were found, a result similar to our stationary dolphin HF measurements. When entire records were examined however, mean HF was significantly lower in winter than summer (Mann-Whitney test, $p=0.014$). Values from winter ranged between 40.7-97.2 W/m² and from summer between 86.2-164.3 W/m². T_s tracked T_w very closely and average differentials were 0.14 ± 0.09 and 0.17 ± 0.06 °C for winter and summer, respectively, despite the greater than 10°C difference in T_w in winter. During winter Sarasota dolphins increase the insulative properties of their blubber and maintain T_s at the dorsal fin close to ambient T_w , presumably through vascular control. This reduces the temperature differential between the body core and T_w and thus overall heat loss potential. Such thermal adaptations could afford these dolphins considerable metabolic benefits during periods of colder water temperatures.

Oceanographic Effects on Mid-Frequency Sound Propagation in Beaked Whale Environments

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Anthropogenic ocean noise is recognized as a potential threat to marine mammals by the interference it may pose on their ability to use underwater sound for survival. Recent mass strandings of beaked whales (Ziphiidae, Cetacea) coinciding with the use of mid-frequency range (1-10 kHz) active sonar have caused speculation about the potentially adverse effects of these sound sources. Particular questions of the research and regulatory communities concern whether beaked whale sensitivity to mid-frequency sound exposure is influenced by oceanographic characteristics present at the time of the mass stranding events. This study investigated the interaction between beaked whale habitat characteristics and the nature of a mid-frequency signal by analyzing the oceanographic factors affecting underwater acoustic propagation. Three types of model sites were selected from five specific geographical locations where beaked whales have been regularly recorded or where a mass stranding event has been reported. A

ray-trace acoustic propagation model was used to generate transmission loss for a 3 kHz signal over a representative 60 km transect at each locality. Model outputs visually demonstrated how the combination of site/event-specific oceanographic characteristics affects the sound propagation of a moving source. A parametric sensitivity comparison and statistical analysis were conducted to identify influential factors between environmental parameters, source depth, and the resulting transmission loss. Major findings suggest that the sound speed profile plays the largest role in the overall effect of sound propagation. Among the test cases analyzed, varying the bottom composition showed the largest change in attenuation. The combination of these oceanographic characteristics could potentially influence the distance at which beaked whales may be affected in the presence of mid-frequency sound. This research demonstrates the value of publicly accessible data resources and environmental risk assessment and suggests the need for further applied research toward improving current protective measures.

Initial Findings from a Dolphin Research and Conservation Project in the Dominican Republic

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On 8th August 2002 at least 8 bottlenose dolphins were illegally removed from the Parque Nacional del Este in the Dominican Republic to supply a captive dolphin facility (Manati Park), with additional removals suspected prior to this and with no regard to the impact of the removal. Prior to the current study no scientific investigations had occurred in this region. This program seeks to: 1) assess the number of dolphins inhabiting the coastal waters of the Parque Nacional del Este through photo-identification and line transect surveys; 2) investigate patterns of dolphin habitat use and identify areas of critical habitat; 3) determine and quantify anthropogenic and natural causes of disturbance, injury and mortality to the dolphins; and 4) assess the sustainability of dolphin-watching activities in the region. Surveys began in June 2004, since then 245hrs of survey effort have been undertaken over 39 days. Resulting in 19hrs 21mins of encounters with dolphins and 3hrs 45mins with humpback whales. During these surveys 68 bottlenose dolphins, (*Tursiops truncatus*) and 43 Atlantic spotted dolphins, (*Stenella frontalis*) were sighted. Bottlenose dolphins were had encounter rates of 0.032 individuals per km. Atlantic spotted dolphins were recorded less at 0.280 individuals per hour an 0.020 individuals per km. Photo-identification findings suggest a population of 50-60 bottlenose and 30-40 Atlantic spotted dolphins. The area is used year round with some individuals showing signs of residency. If these estimates are correct the removal of 8 bottlenose dolphins would severely impact this fragile population. Evoking the 'precautionary principle' due to the low numbers, it is therefore critical to introduce conservation measures as soon as possible, such as identifying and minimizing anthropogenic impacts to the population – including ensuring non-disturbing dolphin-watching practices and ensuring that there are no further live captures from this historic dolphin population.

Good Times, Bad Times, and the Allocation of Maternal Resources in Weddell Seals

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Environmental variation influences food abundance and availability, which can be reflected in the reproductive performance of top predators. We examined maternal expenditure, offspring mass and condition for Weddell seals in two years exhibiting marked differences in these traits. Overall, females were significantly heavier in 2002; but in 2003, bigger (longer) females were heavier and shorter females were lighter (with no age effect).

This suggests that effects of environmental variability on foraging success and condition may be more pronounced in smaller individuals. There was no relationship between maternal post-partum mass (MPPM) and pup birth mass, indicating there was no differential expenditure in pups during the gestation period among years. However, there was a positive relationship between MPPM and pup mass gain, and relative maternal expenditure (pup gain, female loss) was 10.9 % higher in 2002 than 2003. This may indicate that costs associated with a putatively poor-resource year were delayed until lactation. Females lost the same proportion of mass during lactation in both years, regardless of MPPM. Therefore, smaller females may not have been able to compensate for their small size. Regardless of mass, females had the same relative body composition. Females with male pups lost a higher percentage of lipid than those with female pups. Yet, by the end of lactation female pups had 7.6 % higher lipid content than males, suggesting that there was a difference in utilization of resources between the sexes during lactation. It appears that Weddell seals may respond to environmental variability with differences in maternal mass and expenditure during lactation. These differences translate to changes in pup mass and condition at weaning, with potential consequences for future survival and recruitment into the population.

Autonomous Detection of Bottlenose Dolphin Signature Whistles

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The classification of bottlenose dolphin signature whistles is a key area of study within the field of dolphin communication. While human classification of signature whistles can be subjective and very time intensive, it is currently the most successful and consistent approach. Computer classification of these whistles would facilitate consistency across studies and be far more efficient. Efforts are currently in progress to produce computer-based systems that detect, extract, and cluster vocalizations based on their source animal. The current study focuses on whistle detection, a crucial processing stage of the signature whistle classification problem. We compare the detection performance of a k-means clustering approach to that of a feedforward neural network trained using the backpropagation algorithm and a training set developed by an expert biologist. Dolphin whistles for training and testing the detection approaches were extracted from tapes recorded during brief capture-release events in Sarasota, Florida, USA. Spectrograms were generated using power spectral density estimates obtained using a fast Fourier transform with a Hamming window of size 512 and no overlap. The spectral values were processed through a band-pass filter so that only frequencies approximately in the range 5-16 kHz were utilized for detection. The variances of power estimates across individual spectra (columns in the spectrograms) were computed and then normalized by dividing by the largest variance estimate. The normalized variances were then used as inputs for both the k-means and the neural network detector algorithms. While both approaches successfully detected dolphin signature whistles among noise, the neural network was more robust in handling irregularities such as whistle tail-offs and recording dropouts. The results from this study provide a reliable method for autonomously detecting bottlenose dolphin signature whistles and lay the groundwork for automated extraction and classification of whistles.

Climate, Learning and the Evolution of Cultural Capacity on Land and Sea

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Behaviour may be determined directly by genes, or through individual learning or social learning. Patterns of environmental variation influence the utility of different learning strategies. Stochastic, individual-based evolutionary models were used to assess the relative advantages of 15 different learning strategies (genetic determination, individual learning, social learning, and contingent combinations of these), in variable environments described by "1/f" noise. When environmental variation had little effect on fitness, then no learning is required and genetic

determinism persists. When environmental variability is large and uncorrelated ("white noise"), then individual learning is adaptive and persists against alternatives even when there are substantial costs. Social learning is advantageous in "red noise" environments when variation over long time scales is large. However, for social learning to compete successfully against alternatives, social learning must not be very costly, and, under some conditions, the red environment must not be too variable. In the red environments characteristic of terrestrial and, especially, oceanic climates, variability increases with time scale. The ocean climate is particularly red at scales of less than one year, but "redness" in population biology generally increases with trophic level. Thus short-lived organisms may be able to rely largely on genetic determination, and track environmental change over longer scales through selection. Most longer-lived organisms, especially those that live in naturally variable environments, benefit greatly from individual learning. Social learning is predicted to have a more restricted role, particularly among long-lived organisms living in red habitats, such as the ocean, and when the population biology of other species constitute key environmental elements. This provides a potential explanation for the evolution of advanced social learning, and culture, in humans and cetaceans.

Striving Towards Responsible Viewing: An Evaluation of Dolphin-Watch Tour Operations in Clearwater, Florida

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Numerous studies have quantified the impacts of tour operations on marine mammals; however, few studies have investigated tour operators' procedures and their compliance with regulations and guidelines. To minimize potential harassment and promote responsible viewing, NOAA has developed guidelines for viewing marine mammals in the wild. NOAA guidelines include specific recommendations for appropriate approach distances, vessel maneuvers, viewing time, and responses to dolphin disturbance behaviors. This study quantifies operator compliance with NOAA guidelines, examines the structure of tour educational programs, and investigates dolphin behavior during encounters with tour vessels. Data were recorded onboard five commercial dolphin-watch vessels in Clearwater, Florida. During 45 encounters, operators adhered to the guidelines approximately 60% of the time. Operators complied with the viewing time limit but did not end encounters when dolphins exhibited possible disturbance behaviors, such as chuffing and tail slapping. Compliance per guideline varied within and among tour companies. Operators approached dolphins within the 50-yard distance limit and used inappropriate techniques to maneuver around dolphins. The percentages of appropriate vessel maneuvers per tour company ranged from 34% to 67%. Educational programs onboard the tour vessels were unstructured. Although many tour operators presented information about basic dolphin biology and behavior, few included other components of an effective education program, such as information about the MMPA, the NOAA viewing guidelines, or current conservation and research efforts in the area. Recommended efforts to increase operator compliance and promote education on tours in the Clearwater area include the development of a) a training workshop to incorporate responsible viewing practices and structured education programs into daily tours, b) a code of conduct to address cumulative impacts of tourism and promote self-enforcement among dolphin-watch operators, and c) a monitoring program to manage dolphin-watch operations and assess long-term effects of tourism on bottlenose dolphins.

Hydrodynamic Determination of the Swimming Direction of an Artificial Fin in a Harbor Seal (*Phoca vitulina*)

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When foraging in dark or muddy waters, marine mammals cannot rely exclusively on their visual system. Consequently, a high selection pressure can be expected on the development of sensory systems suitable to complement or even substitute vision. While odontocetes possess a sonar system, corresponding sensory abilities are not known in other marine

mammals. In this respect it has been shown for blindfolded harbor seals that they can use their vibrissal system to detect and follow hydrodynamic trails left by moving objects. As it is crucial for successful trail following that a seal is able to recognize the swimming direction of a fish at any given point of the trail, we determined the maximum time after which a harbor seal could indicate the swimming direction of an artificial fish tail and analyzed the hydrodynamic parameters allowing this discrimination. Hydrodynamic trails were generated using of a fin-like paddle moving from left to right vv (~0.2m/s) in the calm water of an experimental box (2.0x1.80x1.70m). During trail generation the blindfolded seal stationed in front of the box and was supplied with headphones for acoustical masking. After delays of 5-50s the animal was asked to enter the box for trail detection and decided about trail direction by a choosing a left or right response target at the front of the box. The seal was able to recognize the direction of the paddle movement when the trail was up to 35 s old. Particle Image Velocimetry revealed that the seal might have used two different hydrodynamic parameters to determine the swimming direction of the fin-like paddle. The arrangement of the vortices in the hydrodynamic trail and the net water velocity, maybe averaged over the upper range of velocities encountered, are characteristic of the movement direction and are within the sensory range of the seal.

Underwater Behavior of Humpback Whales in a Western North Atlantic Foraging Area

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In July of 2004 we used synchronous motion, digital acoustic recording tags (DTAGs) to investigate the underwater behavior of humpback whales in the Great South Channel. Tag attachments to four animals resulted in ~50 hours of data in water depths from 70 - 90m. We conducted a detailed analysis of dive patterns, including apparent bottom feeding and associated sounds. We partitioned dive records into 3 categories: descent, ascent, and at-depth. All four animals traversed a majority of the descent in free-glide (86%, 78%, 84%, and 70%), and fluke-strokes were confined to the upper portions of the water column [ending at: -11.2 m (0.22), -16.1 m (2.9), -12.0 m (2.9), -25.5 m (6.8)]. On ascent, fluke-strokes were in much more of the water column [ending at: -19.9 m (2.4), -39.6 m (11.0), -24.4 m (6.0), -28.6 m (5.6)], but animals still traversed a substantial portion in free-glide (24%, 54%, 33%, and 33%). Thus, descent and ascent demonstrated buoyancy related adaptations for locomotor efficiency. At-depth behavior consisted primarily of presumed foraging activity. In 95% of flat-bottomed dives whales exhibited a characteristic "side-roll" behavior. Side-rolls involved the animal rolling laterally more than 40° from dorsal and holding that position for a consistent duration, usually more than 10 seconds. Mean number of side-rolls per dive for each animal was 2.84, 6.7, 3.15, and 4.32. Two animals had a consistent mean side-roll duration (in seconds), while mean duration for the other two was more varied [17.7 s (4.0), 24.6 s (11.5), 13.1 s (2.6), 19.1 s (14.4)]. For each animal the angle of roll was consistent [96.7° (7.7), -73° (17.6), -80.5° (3.7), -84.2° (23)], and they maintained a head-down pitch angle [28.5° (3.2), 24.4° (9.3), 10.7° (4.8), 32.2° (2.6)]. Between side-rolls, animals returned to a dorsal-ventral orientation. Side-rolls occurred at or within a few meters of the sea floor and were often preceded by a stereotypic sound. We speculate that side-rolls indicate periods of consumatory feeding. Data have management implications with regards to whale entanglement and fishing gear modification.

Nocturnal Foraging Ecology and Activity Budget of the Sea Otter (*Enhydra lutris*) in Elkhorn Slough, California

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Sea otter (*Enhydra lutris*) foraging behavior has been well studied in a variety of habitats during the daytime. Improved night vision equipment has made observation of nocturnal behavior possible for the first time. In this study, I quantified the nocturnal foraging behavior of sea otters in Elkhorn Slough by direct observation using night vision goggles. Duration of successful nocturnal dives (those resulting in prey capture) were not different from diurnal dive durations (reported by Jolly, 1997; nocturnal $x = 44.64$ sec, diurnal $x = 45.46$ sec, $t = 0.628$, $p > 0.05$). Foraging success was greater at night, as fewer dives were required to obtain prey items (1.41 dives/prey item; diurnal success rate = 1.63 dives/prey item). Prey species composition differed, with significantly more crabs (*Cancer* sp.) consumed at night than during daytime. I also constructed a nocturnal energy budget using scan sampling methodology. Sea otters spent 22% of the time foraging, which was greater than the 16% estimated from diurnal scan samples. Night vision technology is an important new tool for studying sea otter biology and constructing unbiased 24-hour estimates of energy consumption and activity budgets.

Impact of *Klebsiella pneumoniae* Epidemics on New Zealand Sea Lion Recruitment

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Epidemics among New Zealand sea lion pups during 2002 and 2003 highlight the importance of examining the role of disease in the population dynamics of pinnipeds. The pathogen implicated in both events was the gram negative bacterium *Klebsiella pneumoniae*. Isolates from both seasons were genetically indistinguishable suggesting the events were caused by a single introduction of an epidemic strain of the pathogen. The events were characterised by a sharp rise in the mortality rate ± 3 weeks into the pupping season. Necropsies showed affected pups had one or more of the following lesions: acute suppurative arthritis or polyarthritis, cellulitis, peritonitis, pleuritis, or meningitis. Adults were not affected. Prior to the appearance of *Klebsiella*, mortality to mid-January (~six weeks of age) among pups was 6.2%, with mortality by mid-February (~10 weeks) 16.7%. Mean values for years in which *Klebsiella* affected pup mortality were estimated at 18.5% (6 weeks) and 26.8% (10 weeks). Marginal increase in mortality attributable to *Klebsiella* was 12.3% at 6 weeks and 10.1% at 10 weeks and the latter value was used in survivorship calculations. There was no evidence of increased mortality in 2004 given the comparability of mortality data, and temporal pattern with pre-*Klebsiella* seasons. Using survival data from tagged fully mature cohorts, reduction in number of females recruiting to the adult population from epidemic years (2002 and 2003) was estimated. Between 42 and 72 fewer females from the 2002 cohort would reach age five, while between 47 and 80 fewer females from the 2003 cohort would reach age five. In 2008 when both 2002 and 2003 cohorts will contribute significantly to the mature female population between 93 and 144 fewer females will be present in the population. These missing females potentially represent between 2.3% and 4.6% of the adult female population at a marginal increase in mortality attributable to *Klebsiella* of 10.1%.

Individual Distinctiveness and Stability of Florida Manatee Vocalizations

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In the 1980's, TJO recorded captive and wild Florida manatees (*Trichechus manatus latirostris*), and analyses of acoustic parameters indicated possible individual distinctiveness of calls. To further test if manatee calls are

individually distinctive and to test if various acoustic features are stable over short (1-3 year) and long (19+ year) periods, recordings of wild and captive manatees were made between 2002-2004. Vocalizations from these recordings and from six manatees recorded in the 1980's were analyzed ($n_{\text{manatees}} = 33$), including four manatees recorded both in the 1980's and 2000's. Cross-validated linear discriminant analyses using nine call parameters determined that 1) for 30 out of 33 animals, a greater percentage of vocalizations was correctly classified than expected by chance when using only the 2002-2004 recordings; 2) an overall higher percentage of calls was correctly assigned to only one of four animals recorded in the 1980's when recordings from the 1980's were combined with those from 2002-2004; 3) a greater percentage of calls was assigned correctly to both adults and calves than expected by chance; and 4) a greater percentage of calls was assigned correctly to both females and males than expected by chance. These results indicate that manatee vocalizations are individually distinctive and have age and sex differences, but are not stable over long time periods. Results from ANOVAs on all nine parameters for certain manatees suggest that 1) many parameters change from calf to adulthood, 2) some calves, subadults, and adults show variable changes in parameters over short time periods, and 3) some calves and adults show short-term stability in all parameters. These results could contribute to research and conservation efforts by providing a means to document the presence of specific individuals and different age classes and sexes using acoustic monitoring, without boat-based surveys.

Variability in Cetacean Energetics: Do Killer Whales Really Have "Killer Appetites"?

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The debate concerning marked declines of marine mammal populations in the North Pacific has focused in part on predation by transient killer whales. Central to the arguments is the energetic demands of the whales and how these demands are translated into food consumption rates. To assess whether odontocetes in general and killer whales in particular have unusually high energetic requirements, we examined seasonal energetic costs and food intake in bottlenose dolphins (*Tursiops truncatus*, body mass = 189 kg) and the killer whale (*Orcinus orca*, body mass = 1,800 kg). Metabolic rate was determined using open-flow respirometry for animals trained to rest on the water surface. Monthly values were correlated to average fish intake rates and compared to other marine mammals. We found that the resting metabolism of dolphins, 5.64 ± 0.15 SE $\text{mlO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, was 2.1 times that predicted for terrestrial mammals. Killer whales followed similar trends for sea otters, pinnipeds and other cetaceans with a resting metabolism that was 1.5 - 2.0 times predicted values. Metabolism did not change with season, and did not correlate with monthly food intake. Field metabolic rates (FMR) estimated from these values also showed similar trends for odontocetes and other marine mammals as described by, $\text{FMR}_{\text{marine mammal}} = 1443.8 * \text{mass}^{0.75}$ ($n = 10$ species, $r^2 = 0.948$, $p < 0.001$), where FMR is in $\text{kJ} \cdot \text{day}^{-1}$ and mass is in kg. The results indicate that killer whales do not have elevated metabolic demands compared to other marine mammals including smaller odontocetes. Rather the high potential impact of killer whales on prey populations is attributed to the exceptional size of the individual predator (where adult whales are 10 to 20 times the mass of the biggest land carnivore) and to the large number of whales comprising social hunting groups. (Supported by the Alaska SeaLife Center and Six Flags-Marine World.)

Steller Sea Lion Photographic Monitoring and Brand Resights of Local, Seasonal Haulouts in Prince William Sound, Alaska

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In 2004, the Alaska Sea Otter and Steller Sea Lion Commission (TASSC) developed protocols whereby Tribes can determine various ecological trends of Steller sea lion (*Eumetopias jubatus*) within their Tribal

jurisdiction. The protocols call for a Tribe to conduct a Local and Traditional Knowledge survey. From the survey effort, protocols to monitor those areas deemed important are developed. One such monitoring protocol is highlighted here. Past and present cultural/ecological knowledge (TEK) of Steller sea lions was collected by the Native Village of Eyak (NVE) and analyzed by TASSC. The TEK survey revealed that sea lions have slowly relocated to eastern PWS and/or slowly increased in numbers since the 1989 Exxon Valdez oil spill. Approximately 30 sites encompassing all of Prince William Sound were surveyed by NVE Researchers in early spring and fall for population estimates; adult male, adult female, juvenile and pup composition estimates; and brand resights, following marine mammal viewing guidelines. Researchers are equipped with a digital SLR camera with high power telephoto lenses to document any brands and/or behaviors. The surveys occur outside of the "rookery behavior season" and cover many areas not surveyed in the NMFS aerial survey of Steller sea lions. Preliminary results indicate specific juvenile/pup areas, adult male areas, and to date 130 brand resights documented. The findings from the photographic monitoring surveys are valuable to NVE and other jurisdictional Tribal governments in Prince William Sound, working for sound tribal management practices. The data collected is valuable to the greater body of knowledge on Steller sea lions and offers a perspective otherwise not available to the scientific community.

Ageing Live Ringed Seals: Which Tooth to Use?

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Ageing animals is the crucial step to life-history analysis, population dynamics and management. In mammals, ages have been estimated from different indices which provide relative ages that distinguish between juveniles and adults. However, the need for more precise and accurate estimates resulted in the development of ageing techniques that look at the layered structure of tooth tissues. Because of its large size, the canine tooth has been the tooth used almost exclusively when ageing carnivores. However, the canine tooth is essential for feeding and reproduction in carnivores and could not be removed from live animals. Ages estimated from post-canines and incisors have been tested against ages estimated from canines with varying success for some pinniped species. Due to the high variability in the visibility of layered structures between species, tooth tissues and tooth types, it is essential to test the validity of new methods for each species individually. Ringed seal (*Phoca hispida*) samples ($n = 100$) from 2004 subsistence hunts in Hudson Bay, Canada were collected for scientific purposes and incisor, canine, and post-canine teeth were retrieved from skulls for comparison of age estimation. We tested the precision and accuracy of using alternate teeth (incisor and post-canine) to the canine for age determination purpose in ringed seals.

Variation in Fatty Acid Composition of Sea Lion Blubber by Body Site and Tissue Depth: Consequences for Biopsy Sampling in the Wild

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Analysis of the fatty acid (FA) composition of blubber is a new technique for estimating the diet of marine mammals. To determine whether sample 'completeness' or body site location affect results, full depth blubber samples were consistently collected from nine beach strewn Steller sea lion carcasses (neck, shoulder, mid-point, lateral-hip, dorsal-hip, hind). Samples were cut into three depth layers prior to FA signature analysis. In three animals an additional thin blubber layer found beneath the Latissimus dorsi muscle was also sampled. Arc-sin transformation on eight of the most variable FAs followed by ANOVA suggested signal homogeneity across the body was sufficient for representative point sampling of full depth blubber samples. However, significant variation (at hind and neck sites in 33% of animals) was observed when data were standardized to C18:0, and log transformed (*sensu* Budge *et al.* 2002). Depth stratification was observed in many FA concentrations, with differences in concentrations between layers sometimes exceeding 100%. Consistent trends by depth layer were also frequently observed. We also

tested the effectiveness of a remote dart delivery system (similar to Barrett-Lennard *et al.* 2001) to obtain complete blubber samples with minimal disturbance. Nine slow approaches by small boat were made to within 3-10 m of a sea lion haul-out on Vancouver Island, BC. A total of 30 blubber samples were collected (mid-laterally and dorsally above the hips) using Pseudart 389 dart projector equipped with a laser sight. Biopsy tips (35 mm long, 6 mm diameter), had a central dental barb to assist tissue retention. Approximately 1/4 of biopsies were considered whole samples (based on muscle presence), while the remainder were considered 'partial' samples (mean length=2.5 cm, range 0.8-4 cm). Although this method caused little disturbance, our validation data suggests comparison of full and partial depth blubber biopsies requires caution unless depth dependent correction factors are applied.

Determining Appropriate Limits for Bycatch of Small Cetaceans in the European Atlantic and North Sea

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Bycatch of small cetaceans, especially harbour porpoise (*Phocoena phocoena*), in European Atlantic and North Sea fisheries is an international conservation issue. Scientific working groups have recommended the development of a management procedure for setting appropriate bycatch limits to achieve management objectives. These working groups further recommended that candidate procedures should be evaluated using simulation performance testing (similar to the development of the International Whaling Commission's Revised Management Procedure and the U.S. Government's Potential Biological Removal procedure). The objective of our study is to develop such a management procedure for setting limits for bycatch of small cetaceans in the European Atlantic and North Sea using simulation performance testing. We initially define management objectives using the conservation objective of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) to maintain populations at >80% of carrying capacity. We then develop a set of alternative candidate algorithms that will generate bycatch limits, given data on absolute abundance, relative abundance and bycatch. Then, we test the performance of the candidate bycatch limit algorithms by conducting simulations over time of populations from which bycatch is removed, monitoring data (relative and absolute abundance) are generated through a simulated observation process, and bycatch limits are set by the candidate algorithms. The simulations explore multiple hypotheses regarding population dynamics, environmental variability, and biases in observation and bycatch. Our population model includes age/stage-structure and spatial/stock dynamics and is parameterised using species-specific information on life history, genetics, and movement rates. The final management procedure will be implemented using absolute abundance data provided by the upcoming Small Cetaceans in the European Atlantic and North Sea (SCANS-II) survey (July 2005) to set appropriate limits for bycatch for use by European governments to achieve international conservation objectives.

The Effect of Environmental Contaminants; Chromium, Mercury and Tributyltin, on Bowhead and Northern Atlantic Right Whale Cells

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Contaminants in the marine environment pose significant health risks marine mammals. Little is known about the direct effects of marine contaminants on marine mammals. We have initiated investigations of how several classes of contaminants affect the Northern Atlantic right whale and the bowhead whale, a potential surrogate model for the highly endangered Northern Atlantic right whale. It is particularly important to understand the effects of contaminants on the right whale as their population has been reduced to a few hundred individuals and is not

increasing. A potential explanation for low abundance and poor reproductive performance is the presence of environmental contaminants. Right whales are exposed to a variety of contaminants including polycyclic aromatic hydrocarbons (PAHs), metals, anti-fouling agents, anticorrosives, and radionuclides in their environment and diet. We evaluated the cytotoxic effects of mercury (HgCl₂), tributyltin (TBT) and hexavalent chromium (Cr(VI)) in various cell lines from both right whales and bowhead whales including skin, lung and testes. In right whales, cells originating from lung were more resistant to Cr than skin and testes which had very similar cytotoxicity responses. Specifically, 24 h exposure to Cr(VI) induced 88, 74, 52, 28 and 0 percent relative survival in lung cells at concentrations of 1, 2.5, 5, 10 and 25 µM; testes had a relative survival of 84, 86, 22, 2, and 0 percent and skin had a relative survival of 77, 58, 38, 6, and 0 percent at the same concentrations. In bowhead whales, there was no significant difference between any of the cell lines (lung and testes). Mercury did not induce a toxic effect in any of the cell lines at the concentrations tested, (1, 2.5, 5, 10 and 25 µM). TBT was the most toxic chemical tested in both right whale and bowhead whale cells; at 2 µM there was no survival in any cell lines. Further work will include investigating the cytotoxic effect of PAHs and flame retardants and investigating the genetic effects of these chemicals on DNA at the DNA strand and chromosomal level. We will also begin to look at individual differences in response to genetic damage from these contaminants. *This work was supported by NOAA grant NA03NMF4720478. Tissues were obtained under NMFS Permit No. 1008-1637-00.*

Abundance and Stock Identity of Bryde's Whales in the Hauraki Gulf, New Zealand

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Twenty-one species of marine mammals have been recorded in the Hauraki Gulf; a large, shallow embayment off the north-eastern coastline of New Zealand, in the South Pacific Ocean. Bryde's whales are the most frequently sighted large whale and are found feeding year-round in the Gulf with an apparent peak in density during early austral winter. Residency and abundance of this population were investigated using photo-identification and stock identity was investigated using mtDNA. Photographs showing congenital and acquired scars on the dorsal fin and body have been collected for individual identification since 1996, with considerable effort from March 2003 to February 2005. A total of 3,140 photographs were taken, representing 300 encounters with, between one to eight whales. From these, 60 whales have been individually identified, of which 43 have been resighted across periods of one to eight years and 28 of these whales were sighted across more than one year. Repeated sightings of some individuals, up to 22 encounters across five years, suggest some individuals are semi-resident. A discovery curve of newly identified individuals shows little evidence of an asymptote, suggesting that the population is larger than the minimum census. Genetic samples have been collected from 40 individuals for comparison of mtDNA haplotypes with previously published sequences from other regions. Current genetic and morphological evidence suggests that the Bryde's whales in the Gulf correspond to the species described by Wada *et al.* (2003) as *Balaenoptera brydei*. Preliminary analysis shows that mtDNA control region haplotypes from the Gulf match those reported by Yoshida and Kato (1999) from Bryde's whales in the offshore waters of the western North Pacific. The sharing of identical haplotypes across the two oceans suggests potential for trans-equatorial stock boundaries.

Population Genetic Structure in Inshore Bottlenose Dolphins (*Tursiops aduncus*) in Southeastern Australia

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Inshore bottlenose dolphins (genus *Tursiops*) live in fission-fusion societies, where individuals join and leave schools on a fluid basis yet

maintain long-term associations with specific individuals. For these animals, it has been hypothesized that factors such as disjunct distributions and philopatry influence genetic structure by promoting isolation between groups. Alternatively, extensive ranging patterns, dispersal and occasional movements by individuals may enhance genetic exchange between adjacent groups. This study investigates genetic structure and dispersal patterns between seven putative dolphin populations in NSW using sequences of the mitochondrial DNA control region and seven polymorphic cetacean microsatellite loci. Preliminary results based on microsatellites indicate a complex pattern of population structure. Putative populations distributed across 730km of coastline follow a pattern of isolation by distance with moderate to high gene flow. On the other hand, despite smaller geographic distances, lower levels of gene flow were observed between dolphins inhabiting an enclosed embayment and those on the adjacent open coast.

When the Ice is Gone, Where Will All the Seals Go?

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There are over 100,000 glaciers in Alaska covering 5% of the total land mass; most, however, are in rapid retreat. In 1983, there were 52 recorded tidewater glaciers (terminating in the ocean) in Alaska; in 2004 we documented 31 remaining and all but about 5 were receding. Harbor seals use the floating ice calved from at least 17 of these glaciers, which seem to provide relatively safe locations to pup and molt, free from most predators and disturbance. Haul-out space on the floating ice is nearly always available, and is independent of tide height. Our research has shown that seals migrate from terrestrial haul-out sites during late May and early June to tidewater glaciers to bear and nurse their young. Recent concerns for seals have arisen from increased vessel traffic and disturbance by sightseeing and cruise ships in several tidewater glacial regions. We are conducting research, in collaboration with Alaska Native groups and the cruise ship industry, to understand and mitigate the impact of this traffic on harbor seals. Each spring from 1998 to the present, we censused three of the main glacial pupping areas in SE Alaska: Tracy Arm (Sawyer Glacier), Endicott Arm (Dawes Glacier), and LeConte Glacier. The seals at these sites were composed almost entirely of mother-pup pairs. In June of 2005, the Sawyer Glacier, which had been steadily decreasing by only tens of meters each year, was found to have receded by more than 2 kilometers. The width of the glacier (at sea level) was reduced approximately 66%. If this retreat continues at its current rate, the Tracy Arm will no longer have a tidewater glacier within a year or two. This reduction of prime pupping habitat could have a significant impact on harbor seal populations in Alaska.

Is Teflon (PFOS) Another Significant Global Toxic Threat to Marine Mammals?

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Teflon (active ingredient perfluorooctanesulfonate; PFOS) has seen increased industrial and consumer applications in ways that increase potential contamination of our oceans, putting marine mammals at risk. PFOS is well absorbed, yet poorly metabolized with a reported half life of over 8 years. Its long term toxic effects in marine mammals are unclear but reported effects with experimental exposure in land mammals include reduced perinatal survival, hepatotoxicity, thyroid and neurologic impairment. This work reviews levels of PFOS reported in various marine mammal species around the world from liver (ng/g) or blood (ng/ml) samples garnered from 1990 onward. PFOS levels above 10 for liver or 6 for blood are considered significant. Despite varying geographic locations and species studied, such levels were consistently achieved or even exceeded with liver levels of 1100 found in *Phoca hispida* in the Baltic

Sea. In this region species variations were also seen – e.g., blood levels of *Halichoerus grypus* (14-76) versus *Phoca hispida* (86-180). Similarly, in the southern North Sea region, *Stenella coeruleoalba* and *Lagenorhynchus acutus* showed markedly lower liver levels (10-26) compared to *Lagenorhynchus albirostris* (14-443). Differing geographic locations also affected values even within a species. Mediterranean *Tursiops truncatus* had liver levels 170-430 versus those in the Gulf of Mexico at 824. Baltic Sea *Halichoerus grypus* had liver levels 140-360 versus those in the southern North Sea 11-233. *Ursus maritimus* in the Canadian arctic had liver levels as high as 678. Finally there is evidence that levels are increasing over time. A dramatic example of this is in the Baltic Sea, where even within one species, *Phoca hispida*, blood levels in 1996 were at 86-180 and two years later, reached 100-384. Teflon is clearly another significant contaminant to be considered as a contributor to population declines in marine species, which will worsen with its escalating use.

Differences in Foraging Areas of Harbor Seals from Glacial Ice and Terrestrial Habitats in Glacier Bay National Park, Alaska

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Harbor seals have been hypothesized to select glacial ice habitats for hauling out to minimize the risk of predation. However, these benefits may be offset if seals must travel greater distances to forage which may increase their risk of predation. Our objectives were (1) to determine foraging areas of seals captured in glacial ice and terrestrial habitats and (2) to determine prey availability in seal foraging areas in Glacier Bay National Park, Alaska. 46 seals were captured in 2004 and 2005 at glacial ice (n = 18) and terrestrial (n = 28) habitats and fitted with VHF transmitters. Foraging areas were determined by conducting real-time tracking of seals from a boat with concurrent acoustic prey surveys. Foraging areas were determined for 36 seals on 74 occasions. Seals captured at glacial ice sites traveled significantly greater distances to foraging areas than seals captured at terrestrial sites (on ice= 32.58 ± 7.26 km; terrestrial= 4.64 ± 0.73 km). These patterns were similar for males (ice= 24.61 ± 7.43 km; terrestrial= 4.25 ± 0.53 km) and females (ice= 33.84 ± 8.35 km; terrestrial= 4.86 ± 1.11 km). Some seals from glacial ice traveled to an adjacent fiord 20 km away where there are high densities of capelin and myctophids. Other seals from ice habitat traveled up to 102 km to the mouth of Glacier Bay, an area of high productivity associated with intense tidal currents and mixing. Increased travel distance to foraging areas may increase energetic cost and predation risk for seals; however, these costs may be offset by a combination of factors including: (1) the predation refuge that is offered by drifting glacial ice which is not tidally influenced as are terrestrial haulouts (2) and/or by increased energetic benefits associated with prey density and quality at foraging areas.

The Genetics of Recolonization: an Analysis of Gray Seal (*Halichoerus grypus*) Stock Structure in the Northwest Atlantic

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Gray seals (*Halichoerus grypus*) were historically distributed along the northeast coast of the United States (U.S.), through the 17th century. They were considered locally extinct until the 1980s, when naturally re-established breeding colonies were observed on islands off the coast of Massachusetts and Maine. Two large populations in Canada (Gulf of St. Lawrence and Sable Island) are both possible sources of immigrants for

the recovering U.S. population; some of the early and current breeders in the U.S. have brands and tags indicating they were born on Sable Island. To assess the stock structure of gray seals in the northwest Atlantic, a total of 262 tissue samples have been collected from both Canadian and the U.S. populations for genetic analyses. The combined use of nine highly variable microsatellite loci as well as the mitochondrial control region as molecular markers, has allowed for a detailed assessment of the relationship between these three populations and the pattern of re-establishment of gray seals in the U.S.

Apparent Lateralized Behavior in Gray Whales Feeding off the Central British Columbia Coast

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A digital acoustic recording tag was used to examine the 3-D orientation of gray whales feeding along the central British Columbia coast. A total of 96 feeding dives were recorded from 6 different whales. More than half (53.1%) of the whales' bottom time was spent rolled at an angle greater than 45°. Whales rolled an average of 2.9 times per feeding dive, and rolling behavior was often accompanied by a negative pitch angle. Out of 282 recorded rolls, 274 (97.2%) were to the right. Likewise, 98.5% of the total time spent rolled at an angle greater than 45° was spent rolled to the right. The gray whales in this study showed a significant right side bias on both an individual ($P < 0.009$) and group level ($P < 0.001$). Based on the findings of this study and previous reports of uneven baleen wear (Kasuya and Rice 1970), it is proposed that gray whales exhibit a population wide right side rolling bias similar in character to the 90/10 split of right handedness in humans.

Coupling Stable Isotope (C and N) Analyses of Stomach Contents and Tooth Collagen to Elucidate Patterns in a Transient Killer Whale's (*Orcinus orca*) Diet Composition

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It has been hypothesized that killer whales in the Bering Sea and North Pacific have shifted their diets over the recent past in response to prey availability, driving top-down food web changes. Analysis of the stable isotope ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) composition of marine mammals and their preys provides a means of examining the trophic level and diet of individuals. Changes in the diet of individuals over time can be detected by analyses of layer groups in teeth. By including analyses of known or hypothetical diet items it is possible to construct mass balance mixing models to evaluate the relative contribution of different food items to the diet. Often the isotope signatures for potential food items come from sampling in the geographic area of feeding. We analyzed the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of actual prey items found in the stomach of a transient killer whale from the AT1 population found dead in Prince William Sound, in Alaska. The whale contained the remains of harbor seals, sea otters, a river otter, and birds and represents the first time sea otter remains have been found in the stomach of a transient killer whale in Alaska. We compared the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of these prey items with the stable isotope composition of 7 samples (analyzed in triplicate) taken from a tooth of the killer whale. The prey items had relatively distinctive mean $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures (sea otter $\delta^{13}\text{C}$ $-13.69\text{‰} \pm 0.23\text{‰}$, $\delta^{15}\text{N}$ $18.27\text{‰} \pm 0.19\text{‰}$; harbor seals $\delta^{13}\text{C}$ $-16.24\text{‰} \pm 0.86$, $\delta^{15}\text{N}$ $16.41\text{‰} \pm 0.53\text{‰}$ and river otter $\delta^{13}\text{C}$ $-15.22\text{‰} \pm 0.36\text{‰}$, $\delta^{15}\text{N}$ $14.01\text{‰} \pm 1.03$). The mean $\delta^{13}\text{C}$ (-12.57‰) and $\delta^{15}\text{N}$ (20.18‰) values of the killer whale tooth samples showed very little variation between layer groups ($\pm 0.10\text{‰}$ and $\pm 0.23\text{‰}$ respectively) suggesting that the diet of this whale had not changed significantly over the ~40 years of its life.

Is the Vaquita Viable?

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The true impacts of bycatch upon the vaquita are largely unknown due to the extremely limited information regarding the size and demographics of the species' single population, as well as the actual level of take to which they are subject. A population viability analysis (PVA) was undertaken for the vaquita in order to assess the effects of some of the unknowns upon their survival prospects. The PVA model was constructed using data for the vaquita where possible, and extrapolations from other species when required (mainly the harbor porpoise). The current level of bycatch was found to be unsustainable in the majority of combinations of possible population sizes and bycatch take levels (*i.e.*, all but the largest populations with the smallest bycatch levels). The impacts of various management actions, such as enforcement of the totoaba ban or the banning of other fisheries within the reserve, were assessed for the various abundance/bycatch combinations, and it was found that reducing bycatch to 2% or less of the population was necessary to allow the population to grow. Alternatives to the various fishing industries in the region would almost certainly be needed to achieve this, as even high levels of ban compliance (assumed in the model not to be 100% at any level of enforcement) may not be able to reduce bycatch to that level. In order to assess the strength of the life history data incorporated into the model, some modified demographic parameters were also investigated. An increase in survivorship (to nearly 100% for some ages) provided only a small benefit to the population, while a 3% reduction in survivorship made the population unsustainable even with zero bycatch. Consequently, the results are thought to be quite reliable.

Scaling of Tissue Mass and Metabolic Rate: A Partial Explanation of the Development of Diving Ability in the Weddell Seal

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A model was constructed to examine the scaling of the aerobic dive limit with body mass of a Weddell seal. Allometric scaling was used to estimate individual tissue mass and total body composition for body mass from 50 to 500 kg. Allometrically estimated individual tissue mass and metabolic rates were combined to estimate whole animal resting metabolism. Metabolism was adjusted as needed to incorporate the increased metabolic costs of diving in the muscle tissue, and feeding on the digestive system. ADLs of the Weddell seal were estimated under conditions of resting submerged, postabsorptive diving, and postprandial diving. Minimal metabolic costs were similar to published data on resting metabolic rates for Weddell seals of similar size. The estimated ADL increased with increasing body mass under all conditions tested. Previously published ADLs were within the range estimated by this model under varying metabolic conditions. Variation in ADL with body mass was largely explained by the decrease in mass specific metabolic rate with increasing mass. The remainder of the increase in ADL with increasing body mass is possibly explained by variation in relative size of oxygen stores and learned diving behavior for more efficient oxygen use.

Distribution and Population of Cetaceans in the Central Coast of Peru

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In Peru, distribution and population of cetacean species are not well documented. This research was directed to identify coastal cetacean populations within the inshore waters at the southern and northern coast of Lima City, Peru (S 77°03' 12°03' – W 76°03' 11°03' / S 78°25' 12°18' – W 77°03' 12°03') as part of the long term Inshore Cetacean Population Research Program developed in the country from December 2000 to December 2004. This research follows a descriptive, observational, exploratory, and longitudinal methodology. Species are identified through external physical features: dorsal fins, beaks, flukes, color and behavior. Sightings are registered next to environmental conditions and biological observations, including dates, initial and final time and location provided

by GPS (global positional system). Surveys were conducted both in coastal stations located on cliffs, points and islands, and aboard boats surveying from the shore to 1 Km offshore. Stranding incidence per species in the area was also monitored. All year round identified resident species include: bottle-nose dolphins (*Tursiops truncatus*) and Burmeister's porpoise (*Phocoena spinipinnis*). Seasonal resident species include: striped dolphins (*Stenella coeruleoalba*) and spinner dolphins (*Stenella longirostris*). Identified transient species: common dolphins (*Delphinus delphis*), false killer whales (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*) and Bryde's whale (*Balaenoptera brydei*). A total of 5,036 hours in the field revealed that cetaceans are more abundant in southern inlets, coves and bays than those in the north of Lima City, with concentration peaks during summer. Despite many pods are transient travelers mainly foraging in the area, there is consistent evidence of resident pods related to the research area all year long or a season per year displaying reproductive, feeding and social behavior. Research also revealed a direct effect on the presence and behavior of these species when exposed to fisheries and recreational human interaction in certain areas.

Individual Variance in Song of Humpback Whales, *Megaptera novaeangliae*

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While in their winter breeding areas, humpbacks sing lengthy complex songs. Until now, it was generally assumed that all males within a region sing very similar songs. However, there should be individual variances, if the song is a sexual display that is selected by females. Then, we analyzed paying attention to the individual variances. We recorded 39 (>45 min.) songs at the breeding site of Ogasawara (27°06'2' N, 142°11'2' E), Japan, from 2002 to 2005. Individual singers were identified by photographs of the pigmentation patterns on the underside of their flukes. We compared to sequential organizations of the songs and the number of the units produced in a definite period of times between individuals of each seasons. There was a tendency that all individual songs shared common classes of unit patterns in each seasons. However the number of the units produced in a definite period of time was different between individuals. Also we found consistent syntactical variations in 2002. Overall, we suggest that these variations may be related to female choice.

Biological Information on Killer Whales Entrapped by Ice in the Shiretoko Peninsula, Hokkaido, Japan

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On 7 February 2005 a pod of 11 or 12 killer whales (*Orcinus orca*) were entrapped in broken pack ice near Aidomari port in the Shiretoko Peninsula, Hokkaido, Japan and 9 of them were found dead on the next day. We examined all of the carcasses (AKW1 to AKW9) during the week after the stranding. The composition of the pod was one male, five females, and three calves. Findings on these individuals are as follows: AKW1 male, 765 cm, sexually mature with large testes tall dorsal fin; AKW2 female, 563 cm, sexually mature with corpora on both ovaries, lactating; AKW3 male, 271 cm, calf with fetal folds, fringed tongue, yellowish white infant pigmentation; AKW4 female, 658 cm, sexually mature with corpora on left ovary; AKW5 female, 686 cm, sexually mature

with corpora on both ovaries; AKW6 female, 600 cm, sexually mature with corpora on left ovary, lactating; AKW7 female, 298 cm, calf with fetal folds, fringed tongue, yellowish white infant pigmentation; AKW8 female, 274 cm, calf with fetal folds, fringed tongue, yellowish white infant pigmentation; and AKW9 female, 654 cm, sexually mature with corpora on left ovary, lactating. Although the postmortem changes were severe especially in larger individuals, we found no evident lethal pathological condition in any of the carcasses. Among five larger females, all had evidence of ovulation and three were lactating. Most of the larger individuals had parasites in the stomach. No parasites were found in the pterygoid sinuses of 7 individuals investigated. According to our findings these whale died as a result of ice-entrapment and not by any gross pathological cause. Rapid ice movement and strong social bonds between pod members probably was the major factor of this mass mortality.

The Increasing Trend in Sighting Numbers of Humpback Whales (*Megaptera novaeangliae*) off the West Coastal Waters of Chichi-jima, Ogasawara (Bonin) Islands, Japan

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The Ogasawara Islands have been known as a breeding ground for humpback whales (*Megaptera novaeangliae*) in the western North Pacific. From 1988 to 2002 there has been an increase of sightings along the west coast of Chichi-jima the largest inhabited island among the region where dense whale watching activity on this species and a possible disturbance occurs. Data collected from these years (1988-2002) in this region (west coast of Chichi-jima) were analyzed by using two different methods: 1) whales observed from land based survey (n=9,864)(1989-2002) and 2) individually photo identified whales from vessel surveys (n=1,535)(1988-2002). The increase rate of sightings per unit of effort (SPUE) for each year for the land surveys was 13.6% and of the identified whales per unit of effort (IWPUE) for the vessel surveys was 5.8%. Nevertheless, it is important to consider that SPUE and IWPUE values provide mostly crude numbers, our long term study with the same study method gives the valuable results to indicate an increasing trend in the population of the humpback in the west coast of Chichi-jima and possibly of the entire region of the Ogasawara Islands. Also, while some of the abundance estimate studies in the world previously demonstrated an increase in numbers of this species, this study may also indicate that the species is returning to areas previously occupied before historical whaling depleted the stocks.

Trace Elements and Butyltins in a Dall's Porpoise (*Phocoenoides dalli*) from the Sanriku Coast of Japan

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Concentrations and body burdens of 13 trace elements (Hg, Cr, Mn, Co, Cu, Zn, Sr, Ag, Cd, V, Se, Mo, and Fe) and butyltins (BTs) (tributyltin TBT, dibutyltin DBT and monobutyltin MBT) were determined in various tissues of a mature male Dall's porpoise (*Phocoenoides dalli*) collected off the Sanriku coast of Japan. Selective accumulation in this porpoise was observed for Hg, Mn, Cu, Ag, Mo, Fe, and total BTs (TBT, DBT and MBT) in the liver, Cd in the kidney, Zn, Sr, V and Co in the bone and Se in the skin. In contrast, Cr concentrations in all tissues were similar. This

distribution pattern in this mature porpoise was in general agreement with the accumulation characteristics of trace elements and butyltins reported for other marine mammals. The whole body of the porpoise contained approximately 62 g Fe, 13 g Zn, 4.0 g Sr, 2.9 g Se, 1.9 g Cu, 0.19 g Hg, 0.17 g Cd, 0.16 g Mn, 0.05 g Cr, 0.009 g Mo, 0.009 g Ag, 0.004 g Co, and 0.7 g of BTs (0.4 g TBT, 0.2 g DBT and 0.1 g MBT). Metabolism of TBT to its breakdown products of this porpoise seems to be limited, since TBT still accounted for about half of the total burden of BTs. As in the cases of Hg, Mn, Cu, Se and Fe, the muscle was the most important reservoir (43%) for the whole body burden of total BTs, 80% of which was TBT, and thus muscle played a crucial role in the higher body composition of TBT in this Dall's porpoise. To our knowledge, this work might be the first direct comparative study between trace element and butyltin accumulations in a cetacean individual.

Initial Assessment of the Conservation Status of the Indo-Pacific Humpback Dolphins (*Sousa chinensis*) from the Saters off Western Taiwan

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A small group of Indo-Pacific humpback dolphins were discovered in 2002 during the first dedicated cetacean surveys of the waters off western Taiwan. More extensive surveys in 2003, 2004 and 2005 led to great concern for these dolphins because the coastal waters in which they inhabit were severely degraded, the dolphins appeared to be few in number and highly restricted in distribution. To better understand the conservation status of this population, an initial assessment was performed by applying the IUCN Red List criteria to the available information. Differences in pigmentation between dolphins of the waters off western Taiwan and Hong Kong suggest that dolphins of the former region belonged to a different populations so assessing them as such was supported. Further population-level structuring within this group is not expected (the distributional area is small and recognizable individuals have been observed throughout the distribution). This population was found to be restricted to a limited, narrow strip of coastal waters (about 80 km long and <3 km wide). A preliminary abundance estimate for this population was 507 dolphins (CV=51.4%; 95% CI = 190 to 1,349) of which 304 (95% CI = 114 to 809) were mature (assuming 60% of the population is mature based on studies of the Hong Kong population). A continuing decline in dolphin abundance and habitat is inferred from the poor condition of western Taiwanese waters and continuing large-scale coastal development projects, alterations in river flow (thus affecting the estuaries used by these dolphins), large amount of gillnet fishing effort and other harmful human activities and with almost no conservation attention given to these dolphins. At the minimum, this population qualifies as *Endangered* B1ab, B2ab, C2ii but if the lower limit of the estimate is used (a precautionary approach), then the population qualifies as *Critically endangered* C2aai.

Molecular Characterization of Expressed *DQB* and *DRB* Genes in the Bottlenose Dolphins

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Bottlenose dolphins (genus: *Tursiops*), with their wide distribution and top feeding position of food web, could be a good sentinel for disturbance on marine environment. This is the first approach to the molecular characterization of MHC class II genes of bottlenose dolphins and also of all dolphins in Delphinidae. In this study, full-length expressed MHC class II *DQB* and *DRB* gene products from the blood cells of two *T. truncatus*

and two *T. aduncus* were determined by RACE using degenerate primers. Three unique *Ta-DQB*, three unique *Tt-DQB*, six unique *Ta-DRB* and eight unique *Tt-DRB* sequences all show completed open reading frames, were identified, indicating the presence of at least one *DQB* locus and two *DRB* loci in these two species. The high proportion of non-synonymous nucleotide substitutions in exon 2 of *Tt-DQB*, *Ta-DRB*, and *Tt-DRB* was noticed. This phenomenon is speculated to be related with some positive selection pressure on these loci. However, several features did not support a traditional role for the *Ta-DQB* molecules in peptide binding, including the extremely low number (n=1) non-synonymous residue substitutions in the antigen recognition site, the relatively high number of nonsynonymous substitutions in non-peptide binding regions (n=3), and the overall lack of sequence variation. A phylogeny based on the *DQB* exon 2 alleles from *Tursiops* and other 17 cetacean species showed a clear monophyletic distinction between *T. aduncus* and *T. truncatus*. Moreover, the "coastal-freshwater" cluster, containing *T. aduncus*, *Orcaella brevirostris*, *Neophocaena phocaenoides*, *Phocoena phocaena*, *Phocoena sinus*, and *Lipotes vexillifer*, was observed. A phylogeny based on the full-length coding region of *DRB* sequence from *T. aduncus*, *T. truncatus*, domestic cow, human, and California sea lion indicated that there may be two *DRB* loci and clear monophyletic distinction between *T. aduncus* and *T. truncatus* exists in each *DRB* locus.

Phylogeography of Pantropical Spotted Dolphin, *Stenella attenuata*, in Western and Eastern Tropical Pacific

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Phylogeography and demographical history of pantropical spotted dolphin, *Stenella attenuata*, were estimated for specimens from western and eastern tropical Pacific Ocean. Osteological variation of specimens from the western and eastern tropical Pacific (ETP) was investigated morphometrically. Geographic variation was estimated among specimens from the ETP, Japan, and Taiwan. Multivariate analyses of covariance demonstrated significant geographical variation. Skull size for the ETP was the smallest of the three localities. Pair-wise comparisons between localities showed fewest differences in female specimens between Japan and Taiwan. The percentages of correct classification to the three regions by canonical discriminant function were 77% for males and 81% for females. Population assignment was also examined for a few specimens from the western tropical Pacific; all specimens from the Solomon Islands and one from the eastern Carolina Basin were assigned to the ETP, with probabilities of 0.87 to 1.00. The close relationship of tropical offshore samples implies that oceanographic similarities may be more important than geographical distance in skull variation of the pantropical spotted dolphin. In addition, 30 mtDNA haplotypes were obtained from 64 samples in waters of the ETP, Japan, Taiwan, South China Sea and the western tropical Pacific. Haplotype diversity ranged from 1.00 to 0.7885, nucleotide diversity from 0.0161 to 0.0066 were estimated from the populations. Analysis of molecular variance indicated genetic subdivision among the regions (6000 Markov step, Exact P value < 0.0001). Nested clade analysis revealed 6 of 15 clades were with significant geography-haplotype association. The inference of demographic history suggested that long-distance colonization, range expansion, fragmentation, or isolation by distance could be the explanation of phylogeography of pantropical spotted dolphin in waters of the western and eastern tropical Pacific.

Stomach Contents of Orcinus Orca Mass-Stranded in Rausu-cho, Hokkaido, Japan

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On February 7, 2005, eleven or twelve killer whales became stranded on the coast of Rausu-cho, Hokkaido. Of these, nine carcasses were recovered, consisted of one sexually mature male (AKW-1), five sexually mature females (AKW-2, 4, 5, 6, and 9), one newborn male (AKW-3), and two newborn females (AKW-7 and 8). We report here the analysis of their stomach contents. All stomach samples of mature individuals contained an assortment of bones, claws, vibrissae, and the furred skin of phocids. In particular, the stomach contents of AKW-5, and AKW-6 contained the hind limbs of phocids, the tibia and fibula of which were still covered with soft tissue. In the AKW-2 stomach, there were partially digested fore limbs. In the AKW-1 and AKW-9 stomachs were found various types of bones; including whole skulls and numerous vertebrae, which sometimes contained soft tissue of phocids. Also found were the beaks and cartilage of cephalopods, as well as various parasites, now in the process of identification. Fringed tongue, erupting teeth and fetal folds indicated that AKW-3, 7 and 8 were sucklings and we confirmed milk in two of the newborns AKW-3 and 8, whereas in AKW-7 the stomach was virtually empty. On the feeding habits of killer whales off Japan, there is only a single report of roughly categorized stomach contents from whales killed during 1948-57. The study found fishes, cephalopods, cetaceans, and phocids in this order of proportion. In contrast to the study, the stomach contents of these stranded killer whales did not include any fishes.

Individual Differences in Object Play Behaviors in a Group of Bottlenose Dolphins (*Tursiops truncatus*)

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Although dolphins are known to play with objects both in the wild and in captivity, little is known about individual differences in these play behaviors. In this study we investigated individual differences in the frequency and type of spontaneous object play behaviors. Observations of a group of seven captive female dolphins (four adults, two juveniles, and one calf) were analyzed to determine the object play activities of each dolphin. Ball play was the most common object play behavior and was the only object play behavior frequently produced by each dolphin. One individual difference concerned the types of objects with which the dolphins played. The calf was most likely to play with a wide variety of objects. The other dolphins had a smaller subset of preferred play objects. For example, two of the adult females played with water more than the other dolphins, and one of these females was also most likely to play with bubbles. Another individual difference concerned interest in other beings. Younger animals were more likely than older animals to use one another as play objects by mouthing and playing with one another. In addition, the calf was most likely to orient towards other dolphins and observe their behaviors. Each of the dolphins oriented towards humans, but the calf was the most likely to choose to play with people (e.g., by tossing them a ball). She was also most likely to play with other dolphins. These findings from a small group of dolphins demonstrate that there are individual differences in dolphin play behavior. Determining the extent to which these differences reflect age, social status, and/or stable individual differences in behavior will require a longitudinal study of additional animals.

Energy and Thermal Balance in Male California Sea Otters (*Enhydra lutris nereis*): The Effect of Territoriality on Daily Energy Expenditure

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Sea otters are the smallest marine mammals, the only without a sub-dermal blubber layer, and are found exclusively in cold water habitats.

Consequently, thermoregulation and energy balance represent important physiological challenges. To evaluate this, we measured core body temperature (T_b) via temperature sensitive VHF radio transmitters in free-ranging California sea otters. In addition, we assessed field energetic cost by determining activity budgets of wild otters and measuring energy expenditure in captive adult male California sea otters resting, diving, foraging and grooming in a 9.1m deep tank. Study animals exhibited a highly variable T_b that was strongly correlated with behavior. Resting periods ended when the heat increment associated with food digestion diminished to baseline when and T_b had fallen approximately 1.5°C. As a result, changes in T_b influenced daily activity budgets and therefore energetic costs. Grooming and surface swimming incurred the highest energetic cost and was 2.2 times resting values (14.9 mL $O_2 \cdot \text{min}^{-1} \cdot \text{kg}^{-1} \pm 2.0 \text{ SD}$). Daily energetic requirements for individual male otters based on these values and activity budgets for non-territorial male otters along the central California coast averaged 2,900 kcal day⁻¹. In comparison, territorial males had exceptionally high daily energetic requirements that were 1.8 times the value for non-territorial animals. This was attributed both to greater body size and to the higher proportion of time spent patrolling territories. Together these results demonstrate that the activity patterns and daily energetic demands of sea otters are determined by the unique thermoregulatory challenges of this small marine mammal. Because territorial males incur higher energetic demands they may be disproportionately impacted by decreases in food availability.

Using Compass and Reticle Binoculars to Measure Animal Position: An Evaluation and Comparison to Theodolite Data

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Shore-based theodolite tracking of coastal cetaceans is a useful and widespread technique that is not always feasible due to expense, geography, experience-level of observers or other issues. We tested the feasibility of using reticle binoculars to replace or supplement theodolite tracking for determining whale and vessel locations from a shore based observation site with known elevation above sea level. We compared the accuracy and precision of binocular ($n=278$) versus theodolite fixes of humpback whales off the island of Hawai'i, collected during scan sampling sessions in 2003 and 2004. Theodolite positions are recorded in azimuth and declination and then are converted into x/y coordinates. Reticle binoculars allow users to report azimuth and declination from the horizon. Both methodologies allow calculation of distance, dependent on a known elevation above sea level. We found close agreement between distances to whales obtained from binocular and theodolite fixes when measured reticles >1 . A linear regression of binocular reticle distance on theodolite distance was significant ($F_{(1,276)} = 5120$, $p < 0.00001$, $r^2 = 0.948$). A similar regression of binocular bearing on theodolite bearing was even more predictive ($F_{(1,275)} = 26619$, $p < 0.0001$, $r^2 = 0.989$). Binocular measurement distance error increased greatly when measurements with reticles <1 were used (i.e. closer to the horizon). Marine binoculars with compass bearings and reticles cost less than a theodolite, are very portable and have a wider field of view than theodolites. Tracking animals with binoculars also requires less training and can be used by several observers at the same shore station. Locations derived from marine binoculars may be less precise, and may not be suitable for distant or detailed tracking, but this technique opens the possibility of measuring animal locations to a greater range of observers (e.g., schools and citizen science groups).

Thyroid Function Testing in Elephant Seals in Health and Disease

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Changes in levels of circulating thyroid hormones are associated with

physiologic (e.g., molt) and pathologic (e.g., infection) skin conditions in mammals. Whether the hormone changes are a cause or a consequence of changes in the skin has been long debated. Abnormalities of the thyroid gland that result in decreased hormone levels (hypothyroidism) can result in hair loss, scaling and secondary skin infections. However, concurrent illness (including skin ailments) can suppress basal levels of thyroid hormones and mimic hypothyroidism (a condition known as “sick euthyroid syndrome”); these two conditions can be distinguished in dogs by testing the response of the thyroid gland to exogenous thyrotropin (Thyroid Stimulating Hormone, TSH). Hypothyroid animals do not respond to TSH stimulation, but “sick euthyroid” animals will respond with increased levels of circulating thyroxine (T_4) (and sometimes triiodothyronine [T_3], although this is less reliable). Northern Elephant Seal Skin Disease (NESSD) is a severe, ulcerative, skin condition of unknown cause affecting primarily yearling northern elephant seals (*Mirounga angustirostris*); it has been associated with decreased T_4 and T_3 . To determine whether hypothyroidism is involved in the etiology of this disease, we tested thyroid function of stranded, rehabilitating, yearlings in the following categories: healthy seals (rehabilitated and ready for release; N=9), seals suffering from NESSD (N=16) and seals with other illnesses (e.g., lungworm pneumonia; N=10). Levels of T_4 increased significantly for all three categories of elephant seals following TSH stimulation, suggesting that seals with NESSD are “sick euthyroid” and that the disease is not associated with abnormal thyroid gland function.

Partitioning of Contaminants Between Blubber, Blood and Milk in Free-Ranging Bottlenose Dolphins: Implications for Bio-Monitoring

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Concerns regarding the accumulation of organohalogen contaminants in marine mammals and the potential link to unusual mortality events, emerging diseases, survival and reproductive success have prompted increases in bio-monitoring efforts. Exposure to organohalogen compounds, including polychlorinated biphenyls (PCBs) and organochlorine pesticides has been associated with adverse health effects such as immunotoxicity, carcinogenicity and endocrine disruption in other mammals. Research investigating the health effects of these compounds in live, free ranging marine mammal populations requires the collection of non-lethal tissue samples for contaminant analysis that are indicative of whole body burdens. Blubber contains >90% of total body burden concentrations of organic contaminants, hence it is currently the most common tissue used for bio-monitoring efforts. However, due to the invasive nature of the biopsy procedure, short-term repeated blubber collections are not feasible for wild or captive populations. Blood and milk can be collected less invasively; however the use of these tissues as predictors of blubber concentrations or body burden and risk has not been adequately demonstrated. To establish the utility of blood or milk as potential matrices for organohalogen determination, the Sarasota Dolphin Research Program collected full depth blubber biopsies, plasma and milk samples, when available, from free-ranging bottlenose dolphins in Sarasota Bay, Florida. All samples were analyzed for organochlorine pesticides and PCBs by gas-chromatography-mass spectrometry (GC-MS). Analyses of blubber (n=21) and plasma samples (n=12) collected during February 2004 show a strong positive correlation between total PCB concentrations and 4,4'-DDE on a wet weight basis ($r^2=0.90$; $r^2=0.97$, respectively), indicating plasma may serve as a predictor of organohalogen concentrations in blubber. However, PCB and 4,4'-DDE milk concentrations were not strongly correlated with concentrations in blubber ($r^2=0.35$) or in plasma ($r^2=0.58$), suggesting milk should not be used to estimate body burden concentrations. Analysis of additional samples spanning several years and seasons is currently underway.

Stable Isotopes in the Teeth of Steller's Sea Lions: Do They Tell Us the Age at Weaning?

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Stable-carbon and nitrogen isotope analyses provide biologists a means of investigating diets from samples of bone and teeth collected in the past, since isotopic signatures remain unchanged in dentine. We describe changes in the patterns of $\delta^{13}C$ and $\delta^{15}N$ in teeth of Steller's sea lions and relate them to age-specific patterns of weaning and a 1977-76 North Pacific climate shift. We collected dentine from the teeth of 113 adult female Steller's sea lions born during 1960-1983, and measured levels of $\delta^{13}C$ and $\delta^{15}N$ in the first four growth layer groups (GLGs). As sea lions aged, $\delta^{15}N$ decreased as $\delta^{13}C$ increased. We conjecture that this pattern is caused by a reliance on mothers' milk by nursing 1st year animals and lack of such by (probably weaned) 4th year animals. A linear discriminant function (LDF) of $\delta^{15}N$ and $\delta^{13}C$ correctly discriminated GLG-1 and GLG-4 in 97% of samples. We applied the LDF to the stable isotope values in GLGs 2-3 to determine which were more similar to GLG-1 (“nursing”) or GLG-4 (“weaned”). The LDF classified 60% of animals as “weaned” by the end of their first year, another 30% in their 2nd year, and another 10% in their 3rd year. The proportion of 2-year old animals, classified as “nursing”, increased during 1960-1980 (except for 1975-76 regime shift) from about 35% to 50%; however, the observed proportion of nursing animals for the time of the regime shift was only 23%, less than predicted value of 45% based on the increasing trend. We conjecture that at the beginning of the regime shift, it was more difficult for females to nurse their pups into the second year and that a greater proportion of pups that survived (to have their teeth sampled for this study) were weaned by the end of their first year.

New Analyses for Capture-Recapture Data Based on Non-Invasive Tagging Methods

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Non-invasive tagging methods (e.g., use of DNA samples and natural markings) have become more common as individual identification tools in capture-recapture studies. Currently, the data collected based on non-invasive tags are typically analyzed by conventional capture-recapture models which assumes 1) all captured individuals can be tagged; the tag 2) is unique to each individual; 3) remains permanent during the study; and 4) there are no errors in individual identifications. However, those assumptions may not be reasonable for non-invasive tags, and analysis using conventional capture-recapture models may lead to biased estimates. For DNA samples, errors in individual identifications are probably the most notable issue, and there has been models developed for such data. Although there hasn't been much attention paid to the differences between DNA sample and natural mark tags, natural mark tags can lead to other complex issues such as presence of unmarkable individuals and ‘evolution’ of tags over time (e.g., change in marks due to acquisition of new scars). We discuss these issues and their possible effects on the estimates when the data are analyzed by conventional capture-recapture models. We also present possible solutions in terms of study design and new capture-recapture models that may be more appropriate for the data based on non-invasive tags.

The Effect of Salinity on the Distribution of Bottlenose Dolphins (*Tursiops truncatus*) and Potential Prey Species in North Inlet, South Carolina (USA)

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We examined concurrent changes in the distribution of bottlenose dolphins and their potential prey in wet and dry summers in the North Inlet salt marsh estuary, South Carolina. The 2002 year was characterized by a severe drought and high salinities throughout the system. The 2003 year had above average precipitation with an unusually wide range of salinities,

from 4 to 35 psi depending upon location. The distribution of resident bottlenose dolphins in North Inlet was determined from 129 focal animal follows (204.9 total hours on dolphins) during June through August of 2002 and 2003. Mean group size was 4.3 dolphins (range 1-15) with no significant difference between years (two-tailed t-test, $p=0.08$). Fish distribution was determined from monthly trammel net surveys during the same period. Seventy sets (approximately 12 per month randomly selected from 33 sites) were made with a 122 m long, 2.5 m deep net, yielding 1,461 fish from 37 species. During the wet (low salinity) year, both dolphins and fish shifted their distribution in favor of high salinity areas. Dolphins were displaced from specific areas that had been identified from five years of previous surveys as favored summer habitat for mother/calf pairs. Of the eight most common fish species, five demonstrated a change in distribution between years with a significant preference for high salinity sites. These included Atlantic croaker (*Micropogonias undulatus*), pinfish (*Lagodon rhomboides*), striped mullet (*Mugil cephalus*), spot (*Leiostomus xanthurus*), and ladyfish (*Elops saurus*). Since dolphins in North Inlet have been observed to routinely move in and out of low salinity waters in the past, the similar shift in distribution by both dolphins and fish in 2003 suggests that one or more of these prey species comprise a significant proportion of the dolphins' diet.

Photo-Identification of Risso's Dolphins in Eastern Waters of Taiwan

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Risso's dolphin (*Grampus griseus*) is the most common species and has been one of the most main targets for whale watching in the eastern waters of Taiwan. The sighting rate of this species was reported as 22.4% from transect-line surveys, and was 35.6% from whale watching records. We executed photo-identification works by relay of different researchers near 3 whale-watching harbors located at eastern Taiwan: Hualien, Shirti and Chengong, during the periods from 1998 to 2005. At least 1069 individuals were identified and 115 animals were resighted at Shirti, and more than 21 individuals were resighted at other two nearby areas. Photo-identified individuals usually stayed the same area for 1-3 days, and disappeared. The longest interval between two sighting of the same individual was up to 4 years. The resighting rate is quite low as 10.8%, which could result from 3 causes. First, data could be biased: including low quality photos, variation of the scars or notches along the years, and insufficient coverage of photos. Second, the population size of resident Risso's dolphins could be too large, and we encountered only a very small proportion. The last, the sighted members could include many vagrant individuals. In addition, the pod size varies significantly among seasons, with largest pod size during summer time. With combined with behavior observations, we suggest Risso's dolphins form summer mating aggregation in the near shore waters of eastern Taiwan.

The Auditory Perception of Complex, Harmonic Tones by a False Killer Whale (*Pseudorca crassidens*)

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A complex tone is a combination of two or more pure tones, of which the lowest frequency is the fundamental frequency and the whole-number multiples of the fundamental frequency are harmonics, each separated by amounts equal to the fundamental frequency. Some vertebrate species are able to discriminate the individual harmonics of a complex tone. However, no experimental evidence exists regarding the detection of complex tones or the discrimination of harmonic frequencies by a marine mammal. Therefore, the objectives of this investigation were to examine whether a false killer whale can discriminate pure tones from complex

tones, and if this ability exists, to determine the minimum intensity level of a harmonic tone required for the whale to make the discrimination. From December 2004 to March 2005, the study was conducted at the Hawaii Institute of Marine Biology with a go/no-go modified staircase procedure. An adult, female false killer whale was trained to respond only to a pure 5 kHz tone, and to reject all other combinations of tones. Created with a custom LabView program, the different stimuli were complex tones with a fundamental frequency of 5 kHz with one to five harmonic frequencies. The results from this complex tone discrimination task demonstrated: (1) that the false killer whale was able to discriminate a 5 kHz pure tone from a complex tone with up to five harmonics, and (2) that discrimination thresholds or minimum intensity levels exist for each harmonic combination measured. These results indicated that both frequency level and harmonic content may have contributed to the false killer whale's discrimination of complex tones. Although complex tones have been identified and characterized from odontocete vocalizations for decades, this was the first attempt to experimentally determine the ability of a cetacean to perceive and distinguish harmonic combinations of sound.

Culturally Selected Call Structures May Affect Social Structure and Mate Choice in Resident Killer Whales

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Vocal culture affects social structure in a number of bird species and possibly humans. Vocal culture is generally involved in the social segregation of groups, which then leads to non-random or assortative mating among groups. Gene flow is associated with the social transmission of behaviours in these populations through a process called gene-culture co-evolution. Previous studies have suggested that vocal culture affects the social structure of resident killer whales and possibly influences the gene flow in that population. Here, we show that cultural selection is responsible for vocal divergence among interbreeding groups and possibly leads to social separation among resident communities. Earlier studies showed that whales of the same matrilineal groups (matrilines) use structurally identical calls. Matrilines that share parts of their call repertoires form vocal clans and clans that socialize and interbreed form communities. Call repertoires of clans and neighbouring communities are discrete. However, we found that calls have complex syllabic structures and that syllables can be sorted into types. All identified 17 syllable types were shared among resident killer whale clans and communities and some types were shared between different populations. While the syntactical order of syllables differed greatly among clans within communities, the use of some syllable types was community specific. Hence, vocal culture is a stable characteristic marking both clan and community membership. Previous studies suggested that call similarity and divergence is the result of cultural drift. While this may be true for the vocal divergence within clans, we found that selection on syllable syntax was responsible for call type divergence among clans. Furthermore, selection on syllable use appeared to be responsible for vocal divergence among communities. Because syllable syntax is socially learned within matrilines, selection on these cultural markers may designate a process for choosing mates among whales within communities, while also constraining social contact outside of the community.

Normal Gastrointestinal Anatomy and Perforating Ulcerative Gastroduodenitis in California Sea Lions (*Zalophus californianus*)

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May - July 2003, 20 emaciated yearling California sea lions (CSLs) (60% female, 40% male) stranded along the California coast, were admitted to TMMC, and died within 1 - 28 days (mean 5.8d) from acute duodenal perforation. Of 1773 CSLs that died at TMMC between 1992-1999, 88 (79.5% yearling, 58% female, 42% male) had duodenal perforation. All

were emaciated and succumbed within 0 - 46d (mean 4.2d), and 31% presented May - July 1998. At necropsy of the 2003 cohort, stomach and/or peritoneal samples were submitted for aerobic culture (n=3), gastrointestinal tract (GIT) parasites were submitted for identification (n=3), and representative formalin-fixed tissues (n=15) were submitted to UCD for histology using routine and special stains. The entire GIT from 2 additional CSLs were submitted to detail gross and microscopic anatomy to facilitate accurate histological localization. Of the 2003 cohort, all had chronic gastroenteritis and (per)acute perforating ulceration within 2 cm of the pyloric-duodenal junction. In the proximal GIT, the presence of mixed bacteria (n=10), spiral bacteria (n=6), Anisakidae nematodes (n=5), and sharp foreign bodies (n=1) was inconsistent, and predisposing extra-GIT disease or neoplasia was absent. Pyloric-duodenal ulcers result from an imbalance between mucosal defense mechanisms and aggressive factors. In humans, idiopathic ulcers are recognized increasingly, more frequently perforate, occur at a younger age without sex predisposition, and probably result from the interplay of rapid gastric emptying with concurrent acid hypersecretion, reduced mucosal defense, genetic predisposition, and stress. In these CSLs, the common presentation and lack of a common etiology may suggest a similar pathogenesis. This study provides an increased understanding of GIT anatomy, more consistent sampling technique for systematic review of GIT, and increased recognition of this syndrome. All of these eventually may help elucidate the pathogenesis of what is proposed to be idiopathic perforating ulcerative gastroduodenitis in yearling CSLs.

Histological Examination of the Mandibular Fat Bodies in the Bottlenose Dolphin (*Tursiops truncatus*) and Common Dolphin (*Delphinus delphis*)

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Specialized acoustic fat bodies located in and around the mandibular fossae of odontocetes have the proposed role of focusing received sound towards the ear. Previous studies have suggested that the heterogeneous distribution of lipids in these fat bodies may form a waveguide for incoming sound. To date no study has explored the anatomical and histological components of these tissues. We examined the inner mandibular jaw fat from two delphinids, the bottlenose dolphin (*Tursiops truncatus*) and common dolphin (*Delphinus delphis*). Formalin fixed, one-centimeter thick cross-sections were cleared with methyl salicylate. These show the fat bodies to be a heterogeneous structure consisting primarily of adipocytes interspersed with vascular tissue and other connective tissue. Polarized light microscopy of cleared tissue revealed that the birefringent collagen fibres of the connective tissue form highly organized and oriented arrays that may be species-specific. Few large blood vessels were seen in the thick tissue slices and these vessels were not uniformly distributed, being more abundant dorsally and becoming sparse ventrally. Some regions in the center of the inner mandibular fat appeared to be virtually devoid of blood vessels. Representative regions were examined histologically and confirmed that the inner jaw fat body itself is composed mainly of adipocytes within a connective tissue capsule that is contiguous with the periosteum of the mandible. Within the jaw fat, aggregations of adipocytes are subdivided by distinct layers of collagen. Given that different tissue types exhibit different acoustic properties, it is likely that the structural organization of the fat body will have an influence on sound conduction through the organ, thus, indicating that the composition and distribution of lipids may not be the only component influencing sound transmission through the mandibular jaw fat.

Observation of a Birth of a North Atlantic Right Whale (*Eubalaena glacialis*)

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The coastal waters of the southeast U.S. between Brunswick, GA and Cape Canaveral, FL is the only known calving ground for the North Atlantic right whale (*Eubalaena glacialis*). Limited survey effort began there in

1984 and systematic surveys began in 1994 to monitor reproduction and to reduce the potential of ship strikes on the calving ground. Since then aerial surveys by the New England Aquarium have covered over 326,000 nautical mile (nm) of track line and have resulted in the photo documentation of 473 adult right whales and 141 calves. Despite this extensive effort, no birthing events have previously been witnessed. On 1 January 2005, during the New England Aquarium research team's standard aerial survey, a single right whale was observed at the surface 17 nautical miles (nm) east of the northern tip of Talbot Island, FL. While circling over the whale to obtain photographs for individual identification, observers noticed a red coloration visible in the water around the whale that looked like blood. The water around the whale's belly, side and flukes was clearly red, but the color was dispersing quickly due to the thrashing behavior of the whale. After 3min and 37 seconds of observation a calf appeared to the side of the adult. The calf had no visible cyamid coverage on the head, body or flukes. The flukes appeared to be slightly limp and curled under at both tips. The mother lifted the calf to the surface on her back. As the mother rose to the surface, the calf was draped limply over her body. The calf rolled off the mother's back into the water and began to swim next to the mother. The event described here is the first known observation of behaviors that have been interpreted as a birth of a right whale calf.

Differences in Acoustic Signals from Marine Mammals in the Western North Atlantic and Northern Gulf of Mexico

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Differences in whistle types between species and populations of dolphins may arise from differences in body size, environmental conditions, geographic separation, and vocal learning between animals. Assessing vocalization differences between populations of delphinids, as well as the mechanism of divergence, has become a subject of interest since acoustic differences may help to distinguish between populations at sea. In this study, bottlenose dolphin (*Tursiops truncatus*), Atlantic spotted dolphin (*Stenella frontalis*), and pilot whale (*Globicephala* sp.) populations in U.S. waters were quantitatively compared to determine if differences in whistle structure exist between both neighboring and geographically separated populations. Comparisons were made for nine whistle characteristics between northern Gulf of Mexico and western North Atlantic populations of bottlenose dolphins and pilot whales and between continental shelf and offshore populations of Atlantic spotted dolphins in the western North Atlantic. Whistle characteristics were measured for 3,836 pilot whale whistles, 1,703 Atlantic spotted dolphin whistles, and 2,715 bottlenose dolphin whistles recorded between 2002 and 2004. Differences between groups were evaluated using principal components analysis and discriminant analysis. Bottlenose dolphin whistles in the Atlantic were significantly different (Hotelling's T-squared, $p < 0.0001$) from those in the Gulf of Mexico, differing chiefly in the whistle characteristics of end frequency, duration, and the number of inflection points. Offshore Atlantic spotted dolphin whistles were significantly different (Hotelling's T-squared, $p < 0.0003$) from those of the continental shelf population, differing principally in high frequency, central frequency, and bandwidth. No significant difference was found between pilot whale whistles in the two ocean basins. The whistle differences demonstrated in this study indicate that acoustic divergence exists between distinct populations and may arise from geographic isolation or due to habitat separation between neighboring but genetically distinct groups. This study suggests that acoustic studies are an excellent and cost-efficient method to assess population structure.

Identification of a Summering Ground of Humpback Whales (*Megaptera novaeangliae*) in the Southwest Atlantic Ocean

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Southern Hemisphere humpback whales (*Megaptera novaeangliae*) migrate from wintering grounds in tropical latitudes to feeding areas in the Antarctic Ocean. It has been hypothesized that the population wintering off eastern South America migrates to feeding grounds near the Antarctic Peninsula (ca. 65°S, 60°W) and/or South Georgia (54°20'S, 36°40'W), but direct evidence of support has never been presented. On 19-28 October 2003, 11 humpback whales (7 females and 4 males) were instrumented with satellite transmitters off Brazil (ca. 18°30'S, 39°30'W) to investigate their movements and migratory destinations. Tags were deployed using a fibreglass pole from a small skiff. Two tag configurations were used. Average daily positions were calculated with all location quality positions and minimum distance travelled was obtained between daily average positions. Mean tracking time for the 11 whales was 40 days (range = 5-204 days) and mean distance travelled was 1,726 km/whale (range = 89-7,568 km). Departure dates from the Brazilian coast ranged from late October to late December indicating that some whales are still in the wintering grounds in the beginning of the austral summer. Arrival in the feeding grounds happened from December to February. Migration lasted 40-60 days. Whales migrated south at an average heading of 170° and travelled a relatively direct, linear path from wintering to feeding grounds. Two whales were tracked all the way to feeding grounds near South Georgia and the South Sandwich Islands (58°S, 26°W), where humpback whales were heavily exploited in the early 20th Century. Migratory routes and destinations match catch positions of humpback whales illegally taken in the South Atlantic in the 1960's. This study is the first to describe migration and summering grounds of humpback whales in the western South Atlantic Ocean. Support for this study was provided by EP Division of Shell Brasil Ltd. and CNPq, Brazil.

Estimating Reproductive Success and Maternal-Calf Associations from Photo-identification Data

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This study examined the reproductive success of female bottlenose dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida, and factors influencing maternal fecundity and calf survivorship. Boat-based photo-identification records were used to identify mother-calf pairs between 1995 and 2004. We estimated the birth dates of 133 of 166 identified calves. We were unable to determine the ages of 33 calves because they were first seen after their young-of-the-year status had passed. Ninety seven (73%) of the calves were born between July and September, with 87 dolphins (65%) born in September alone. Seventeen percent of the mothers had two calves during this period; 3% gave birth to three calves. An inter-birth interval of 2 to 5 years was calculated for 7 mothers that had more than one calf during the study period. We were able to estimate the length of time the calf stays with its mother for fifty-three mother-calf pairs, based on the availability of the calf's estimated birth date and the last time that calf was sighted with its mother. Sixty-eight calves (51%) were seen with their mothers for 4-5 years, with five dolphins staying for as long as 6 years. Seven mothers lost all of their calves before the age of 1 year, and these animals occupied the same home ranges within the lagoon. We are currently exploring factors that may contribute to calves remaining with their mothers for longer periods of time than reported for other dolphin populations. This longer maternal investment could lead to fewer calves being born to each mother, decreasing reproductive capacity for the population. We are also exploring factors influencing calf loss, along with apparent infertility (including abortion, failure to conceive, etc.).

On the Multi-Pulse Structure of Sperm Whale Usual Clicks

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Sperm whales (*Physeter macrocephalus*) produce multi-pulsed clicks with their hypertrophied nasal complex. Using orientation measurements of a tagged whale and remote recordings the inter-pulse structure of the sperm whale regular clicks is described. The existence of a narrow, forward-directed P1 beam exiting the junk, is confirmed and may be described with source levels up to 229 dB_{peak} re 1 µPa at 1 m and a directivity index of 27 dB. The P0 pulse, generated by the phonic lips, is a backward directed beam with source levels near 200 dB_{peak} re 1 µPa at 1 m and a directivity index of 7 dB. A low-frequency component with source levels near 190 dB_{peak} re 1 µPa at 1 m is generated at the onset of the P0 pulse by air resonance. In addition to the currently accepted view of the sound generation process that predicts the presence of P0, P1, P2 and higher pulses with regular interpulse intervals, we demonstrate that the interval between P0 and P1 is aspect dependent, and that some of the sound energy is reflected on the frontal sac directly into the water creating an intermediate pulse P1/2, which is typically seen as confusing component in off-axis recordings.

Spring Observation of White Whale (*Delphinapterus leucas*) in the White Sea in 2005

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Air surveys were carried out in the period from 14 to 22 of March and from 20 to 24 April of 2005 by the multispectral technology developed in PINRO and approved by the WGHARP; the air surveyed area was the White Sea and the Cheshskaya Inlet of the Barents Sea; the airport of deployment is Arkhangelsk. The main task of the given flights was obtaining of materials on the distribution and abundance of the White Sea population of harp seal. Simultaneously with these works the visual observations of the other sea mammals species, white whale (*Delphinapterus leucas*), were performed. Specially trained observers, 2 persons from each side, monitored visually the sea surface. Observations were carried out through the convex windows (blister) without optics. A vertical viewing angle constituted on average 45 degrees and could somewhat change in dependence on the conditions of observations (visibility, altitude of the sun above the horizon, etc.). A width of a zone of accounting was from 200 to 400 m at the working altitude of a flight 150-200 m often depending on the lower border of the nebulosity. Air surveys were carried out by the parallel tracks oriented in the longitudinal directions with a step of 10°-20°. Duration of tracks depended mainly on the ice conditions, i.e., the tracks were laid above the ice surface to the edge, and the turn of the aircraft was carried out on the open water. A flight speed constituted 300 km/hr, on average, and the survey altitude was 190-210 m. In sites of the open pack ice, where ice-hole formed, and in the open water the white whales were observed both single and in small groups (to 26 individuals in a group). Totally 327 animals were met 71 times.

Can You Hear Me Now? Social Sounds and Underwater Behaviors of Hawaiian Humpback Whale (*Megaptera novaeangliae*) Calves

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Vocalizations from humpback whale (*Megaptera novaeangliae*) calves were recorded using underwater videography off the Hawaiian islands of Kaua'i and Maui in 2004 and 2005. The relationship between behavioral state, study location, and calf behavior (e.g., close approach, linger, swim

away) was examined for underwater encounters of pods with calves ($n = 51$). We present the first documentation of calf vocalizations with their associated behaviors. Previous published literature has suggested that humpback calves do not produce vocalizations. However, we found calf sounds occurred in 25% of the mother/calf groups ($n = 34$) we encountered. In all encounters with occurrences of audible calf sounds, the mother was resting, separated from the calf by greater than ~ 10 m, and the calf approached the diver alone, to within ~ 6 m. We called this type of calf behavior "curious". In two occurrences, repeated calf vocalizations resulted in the mother surfacing rapidly with directed movement toward the calf, indicating a possible alarm function to these calf calls. Our data indicate that calves exhibit "curious" behavior towards diver(s) most frequently when the mother is resting or out of diver sight. We also found a greater proportion of close calf approaches in Maui vs. Kaua'i. Underwater study of humpback whales allows for more detailed observations than surface observations and is more effective for recording calf social sounds. This ongoing study provides a baseline for future work on social acoustic communication and parent-offspring interaction studies in humpback whales. Results of this study show that apparent characteristics of mother/calf humpback sounds are typical of other "non-colonial" species. Future goals include quantitative acoustic analyses of calf sounds and refining acoustic recording equipment to localize sound sources. Further examination of the behavioral context of calf sounds and other humpback whale social sounds produced during breeding/calving season in Hawaiian waters is planned.

Depredation by Bottlenose Dolphins on the King Mackerel Troll Fishery in Florida

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We documented depredation by bottlenose dolphins (*Tursiops truncatus*) in the Florida king mackerel (*Scomberomorus cavalla*) troll fishery. Between March and June 2003, we conducted 26 interviews of charter and commercial fishermen in Islamorada, Florida and 23 along Florida's east coast from Fort Pierce south to Lake Worth Inlet. All fishermen indicated they had observed bottlenose dolphins depredating bait or catch, with king mackerel the species most often taken by dolphins. During on-board observations of depredation between March and June 2003, we found that dolphins took 6% of king mackerel caught by charter fishermen and 20% of fish caught by commercial fishermen. We conclude that depredation by bottlenose dolphins occurs commonly in this fishery and has the potential to incur a significant economic cost to king mackerel fishermen. To address this concern, we conducted preliminary tests of a gear modification designed to reduce depredation in the king mackerel fishery between December 2003 and January 2004. These tests demonstrated that a modification to the outrigger planar will successfully deter bottlenose dolphins from engaging in depredation, without causing a reduction in catch.

Spatial Aspects of Bottlenose Dolphin Occurrence Near Charleston, SC

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Charleston Harbor and its adjacent waterways is a 1,200 mi² estuarine environment with a high density of port and industrial facilities surrounded by considerable urban development. This urban-industrial marine environment is home to one or more populations of Atlantic bottlenose dolphins (*Tursiops truncatus*) that are currently the subject of a long-term health and risk assessment study. Information about the sub-areas near Charleston used by these dolphins is of interest in the estimation of area-specific environmental exposures. Sightings in areas where dolphins were photographically identified during 354 boat-based photo-identification ($n = 248$) and biopsy ($n = 106$) surveys carried out near Charleston, SC, between 1994–2003, were examined. Survey effort varied

between the five different sub-areas: Stono River Estuary ($n = 180$), North Edisto River ($n = 55$), Harbor ($n = 57$), Coast ($n = 37$), Intracoastal Waterway-East ($n = 25$). Survey effort also varied across survey years. We calculated Adjusted Sighting Proportions (ASP), which reflect an individual's sighting frequency in a sub-area relative to other areas, after adjusting for survey effort. For this analysis, we included only frequently sighted dolphins (freq. = 5 or >, $n = 248$). A dolphin with an ASP of 0.80 or greater, indicating that after adjusting for survey effort, more than 80% of its sightings were in a single sub-area ($n = 124$, 50%), was judged to have a strong area affiliation. Sixty-one percent ($n = 75$) of the dolphins exhibiting a strong area affiliation were sighted in only a single area. However, 50% of all frequently-sighted dolphins showed no strong area affiliation. In the aggregate, these data show that some Charleston dolphins show strong area affiliation, and may possibly reflect area-specific environmental exposure, while others, with diverse area affiliations, probably reflect a composite of their multi-area exposures.

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