A decadal geographic shift in humpback whale (*Megaptera novaeangliae*) distribution in the Northern Gulf of Maine

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**Abstract**

Many North Atlantic humpback whales (*Megaptera novaeangliae*) migrate annually to feed in the nutrient rich waters of the Gulf of Maine. In 2000, we instituted a research program in the northern gulf that uses whale watch vessels as opportunistic observation platforms. Here, on the basis of data collected from that program, we document a clear distributional shift in humpback whale sightings in the Northern Gulf of Maine over the past decade. Sightings from 2000–2010 (*n* = 2,941) were mapped in ArcMap and entered in a multivariate analysis of variance delineated by year (MANOVA; *λ* = 0.68; *F* = 62.3; *df* = 20, 5,585; *p* < 0.0001). Statistical analysis demonstrated that average longitude (*p* < 0.0001) and latitude (*p* < 0.0001) varied significantly across years. Scheffé post hoc analyses on pairwise yearly average latitude and longitude positions revealed a shift in humpback whale distribution in a generally consistent direction. Early in the decade humpback whales were regularly sighted in the most southwestern area of coverage, within the waters surrounding Mount Desert Rock. Since then, they have moved northeast paralleling the coastline and can now be found more than 16.6 miles away from habitat typical at the beginning of the decade, although in similar depths. These opportunistic data are supported by periodic standardized effort-corrected transects. On the basis of our findings we propose that humpback whales have undergone a small-scale distribution shift in the past decade, most likely related to changes in prey distribution.

**Introduction**

The Gulf of Maine is one of several feeding areas for northern hemisphere humpback whales (*Megaptera novaeangliae*). While distribution at ocean basin scale is reasonably well understood (Smith et al. 1999; Katona and Beard 1990), small-scale changes in distribution in the Gulf of Maine are less well documented. In the southern Gulf of Maine, such shifts appear to be strongly associated with changes in prey distribution (Payne et al. 1986; Kenney et al. 1996). In 2000, Allied Whale established an opportunistic whale sightings program aboard local whale watch vessels to examine distribution of balaenopterids in the Northern Gulf of Maine (Figure 1). This program has collected over 5000 sightings of multiple cetacean species. Here, we examine spatio-temporal patterns in distribution of humpback whales from 2000–2010.

**Methods**

Allied Whale researchers working aboard Bar Harbor Whale Watch Company vessels gather whale sightings data, including location, behavioral state, and dorsal and fluke photographs for individual identification. These data are opportunistic as whale watch trips tend to provide information that is neither corrected for effort nor randomly sampled. Our sightings data also include multiple observations of individuals. Whale watch trips typically run from May though late October, with 2-3 trips/day offshore to areas including Mount Desert Rock, the Inner Schoodic Ridges, and the East Bumps. Using latitude and longitude from each humpback sighting from 2000 to 2010, we performed a multivariate analysis of variance (MANOVA; DataDescription’s DataDesk) on coordinates to test for statistical variation in geographic distribution among years. We compared yearly spatial means using post hoc analyses (Scheffé) on both latitude and longitude. We used ArcGIS to map the coordinates of each sighting and to determine both the mean location and standard deviation ellipse (ArcGIS Geostatistical Analyst Extension).

**Results**

From 2000–2010 Allied Whale recorded 2,941 humpback whale sightings. Many of these sightings were concentrated in the Mount Desert Rock and Inner Schoodic Ridge areas. However, yearly mean positions (decimal degrees of latitude and longitude) are significantly different (MANOVA; *λ* = 0.68; *F* = 62.3; *p* < 0.0001). Scheffé post hoc analysis results for differences between specific years in both latitude and longitude are reported in Table 1.

![Figure 1. Gulf of Maine](image)

**Discussion & Conclusion**

Although our results reveal a small-scale distributional shift in humpback whale presence in the Northern Gulf of Maine to the northeast—approximately 17 m—neither the distance from shore nor the depth of water in which animals are located has changed (Figure 3). Our data suggest that humpback whale remains in waters averaging 90 to 140 m in depth (Figure 4). This correlates well with local traditional reserves, and are typically philopatric (Katona and Beard 1990; Smith et al. 1999). Within-season movements between feeding grounds such as the Gulf of Maine, Newfoundland, and the Gulf of St. Lawrence are rare. Therefore, once at a feeding ground an animal is generally committed to foraging at that site. Many individuals sighted by the Bar Harbor Whale Watch are frequently re-sighted within and among seasons (e.g., Kearnery et al. 2005; Allied Whale, unpublished data). This, we can expect small-scale shifts in distribution and residency depending on local, mostly oceanographically driven changes in prey distribution (Weinrich et al. 1997; Kearnery et al. 2005). Annual productivity in the Gulf of Maine is variable to a degree that it may significantly affect feeding success in other large whale species (Payne et al. 1986; Kenney et al. 1996; Greene et al. 2003).

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![Figure 2. Selected yearly sightings in the Northern Gulf of Maine](image)

![Figure 3. Geographic mean and standard deviation of all years](image)

![Figure 4. Bathymetry of the area surrounding Mount Desert Rock, the Inner Schoodic Ridges, and the East Bumps](image)

**Literature Cited**


