FIRST NOISE MEASUREMENTS OF AN OSCILLATOR SYSTEM FOR DRILLED SHAFTS: Its Implications for the Endangered Cook Inlet Beluga Whale

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INTRODUCTION

• Oscillator systems are used to excavate and place piles for bridge construction projects since they are considered ‘quieter’ than impact and vibratory pile-driving.
• The Knik Arm Bridge and Toll Authority (KABATA) proposes to build a bridge in Cook Inlet, Alaska. The proposed construction site is in an area designated as critical habitat for the endangered Cook Inlet beluga whale (Delphinapterus leucas).
• Concern has been raised about potential impacts of marine construction projects on this beluga population.
• The goal was to obtain the first acoustic recordings of an operating oscillator system. These data are intended to assess if potential noise impacts to Cook Inlet beluga whales could be reduced if an oscillator is used to install large-diameter piles for the Knik Arm Crossing (KAC).

METHODS

• The study was conducted 9-25 January 2011 at the Gilmerton Bridge Replacement Project in Chesapeake Bay, Virginia. Noise measurements were made prior to and during operation of an oscillator (72-ton Leffer VRM 3800) installing 12-foot-diameter steel casings.
• Sampling locations were 30 m (Site 1) and 300 m (Site 2) from the pile installation site.
• Sampling equipment was a calibrated CR-3 hydrophone (Cetacean Research) at 96 kHz sampling rate with Microtrak II (M-Audio) with 49 dB gain. Data was extracted as 1 sec files using Adobe Audition 3.0.
• A custom MATLAB algorithm was used for analysis. All noise associated with the oscillator system (i.e., direct: the oscillator; indirect: hammering) were grouped to encompass the entire expected range of sound pressure levels (SPLs).

RESULTS

• Site 1 (30 m) - Acoustic recording included loud, broadband pulses and high-frequency construction noise (15, 30, and 45 kHz) separated by quieter periods (Table 1; Figs 1-3). Overall, 70% of the recorded oscillator SPLs were lower than 120 dB re 1 μPa.
• Site 2 (300 m) - Only the low-frequency component (<1 kHz) was recorded (Fig 1). Most of the noise dissipated rapidly.

DISCUSSION

• The majority of recordings measured from continuous oscillator noise (120 dB at 30 m) was below that of impact and vibratory pile drivers (150-205 dB within 10 m of source) and below measured ambient noise levels of Knik Arm (lowest =124 dB).
• The optimal hearing range for beluga whales is 11-90 kHz. Results suggest that animals swimming within 30 m of an operating oscillator would hear tones (with harmonics) generated at 15 kHz. All measured SPLs were below levels estimated to cause beluga hearing loss or behavioral disturbance.
• A test-pile program at the KAC project site would be necessary to validate these data due to variations between the study area and Knik Arm (e.g., sound propagation profiles, topographies, and pile-casing dimensions).

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Table 1. Underwater Monitoring Results for Oscillator Noise Measurements Made During January 2011 at the Gilmerton Bridge Replacement Project in Chesapeake Bay, Virginia.

<table>
<thead>
<tr>
<th>Location; type of noise measurement</th>
<th>Distance to pile (m)</th>
<th>Mean SPL (dB re 1 μPa rms)</th>
<th>Standard deviation (dB)</th>
<th>SPL range (dB re 1 μPa rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1: Ambient Noise</td>
<td>30</td>
<td>115.9</td>
<td>0.4</td>
<td>114.9-116.9</td>
</tr>
<tr>
<td>Site 1: Oscillator</td>
<td>30</td>
<td>121.6</td>
<td>6.1</td>
<td>115.6-141.5</td>
</tr>
<tr>
<td>Site 2: Oscillator</td>
<td>300</td>
<td>116.9</td>
<td>0.6</td>
<td>115.8-118.6</td>
</tr>
</tbody>
</table>

Figure 1. Underwater noise recorded at a distance of 30 m from the oscillator (Site 1).

Figure 2. Combined sound spectra for ambient noise. Ambient noise (blue) and oscillator noise at distances of 30 m (green; Site 1) and 300 m (red; Site 2).

Figure 3. Temporal variation in SPLs for oscillator noise at a distance of 30 m from the construction site (Site 1) compared to ambient noise.

Report can be downloaded from: http://www.knikarmbridge.com/research_reports.html