Acoustic and Visual Detections of Odontocetes from Line Transect Surveys off Southern California

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Abstract

Detailed knowledge of cetacean population dynamics is needed to evaluate potential impacts from anthropogenic sound sources such as naval training operations. Ship-based acoustic and visual line-transect surveys were conducted in waters off Southern California to assess the distribution, density, and abundance of odontocetes, and to appraise the effectiveness of using passive acoustic survey methods to detect and classify species. On 12 California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises from 2006 to 2008, odontocetes were detected acoustically using a six-element hydrophone array with a bandwidth of 2-96kHz towed at 9 knots and a depth of 15 meters. The hydrophone array was lowered more than 180 days covering 13,800 kilometers yielding 302 acoustical detections including at least 8 Delphinid species (Feresa Attenuata) and Physeteridae (N=22). The most common acoustically detected species were Delphinus spp. (43%), Lagenorhynchus obliquidens (10%), Phocoena macrocephalus (7%) and Grampus griseus (4%). Of 249 on-effort (array under tow, 2 observers, sea state ≤ 5) acoustic and/or visual detections, 69% were documented with both methods, 22% were acoustic only, and 9% were visual only. Analysis of group size, sea state and distance from ship indicated two of these variables were significantly different between the detection methods (Kruskal-Wallis, p < 0.05). The proportion of visual sightings with associated acoustic detections varied as a function of species and ranged from 57% (L. obliquidens) to 100% (Tursiops truncatus). Species-specific click structures were used to classify 6 groups of C. obliquidens and 12 groups of P. macrocephalus that were not detected through visual methods. Of 76 unclassified acoustic only detections, 85% contained whistles. Currently, calls classification methods for whistling species have relatively high error rates; however, refinements in species discrimination algorithms as well as the incorporation of prior probabilities will increase the utility of acoustic methods, potentially expanding strip-width and precision for line-transect surveys.

CalCOFI Marine Mammal Project

The California Current Ecosystem is a highly productive and dynamic marine environment that sustains over 20 cetacean species and supports human activities including fishing, shipping, military and industrial operations. Cetacean distribution, density and abundance in southern California has traditionally been assessed on broad temporal and spatial scales. CalCOFI surveys provide comparatively high seasonal and annual coverage and a broad range of oceanographic indices.

Basis for the Current Research

- Detailed knowledge of odontocete distribution, density and abundance off Southern California is needed to assess potential impacts from natural/anthropogenic sources of disturbance
- Visual survey methods are limited by daylight/environmental conditions and may miss submerged or distant animals
- Passive acoustic surveys may enable to detect and classify cetaceans off Southern California

Objectives of the Research

- **Goal**
  - Develop passive acoustic survey methods to detect and classify odontocete calls to species.

- **Approach**
  - Identify species-specific call features; test, refine and apply the optimal call classification engines.

- **Future Application**
  - Perform ship-based acoustic censuses of odontocetes off Southern California.

Field Methodology

- Odontocetes were visually identified and acoustically recorded on ship-based passing mode surveys utilizing two marine mammal observers and a six-element towed hydrophone array.

CalCOFI Station Map

- Acoustic & Visual

Visual & Acoustic

Visual

Acoustic

Visual Search: 7X Binos

Sighting Data/Detection Method

- On-Effort Odontocete Acoustic and Visual Detections

<table>
<thead>
<tr>
<th>Year</th>
<th>Acoustic Only</th>
<th>Visual &amp; Acoustic</th>
<th>Visual Only</th>
<th>Total Detections</th>
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<tbody>
<tr>
<td>2006</td>
<td>23</td>
<td>10</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>2007</td>
<td>10</td>
<td>79</td>
<td>10</td>
<td>99</td>
</tr>
<tr>
<td>2008</td>
<td>28</td>
<td>79</td>
<td>8</td>
<td>111</td>
</tr>
<tr>
<td>Total</td>
<td>64 (223%)</td>
<td>203 (69%)</td>
<td>28 (9%)</td>
<td>294 (100%)</td>
</tr>
</tbody>
</table>

Detection Method by Species: Call ID Not Incorporated

- Species-specific click characteristics for two dolphin species off southern California.

Species-specific click characteristics for two dolphin species off southern California.

Species Call ID System

Acoustic ID of species-specific odontocete calls has several potentially important scientific applications:

- Expand range and distance of odontocete detections.
- Increase precision for line-transect density and abundance estimates and expand knowledge of habitat use.

Linear Discriminant Analysis: Whistles

<table>
<thead>
<tr>
<th>Predicted ID</th>
<th>Tl</th>
<th>Common</th>
<th>Sd</th>
<th>Pacific</th>
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</thead>
<tbody>
<tr>
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<td>90%</td>
<td>10%</td>
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<td>0%</td>
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<tr>
<td>Common</td>
<td>90%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Sd</td>
<td>90%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pacific</td>
<td>90%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Whistle classification matrix for bottlenose (Tl) and common dolphins (Dd) for the two optimal LDA models Percent correct classification scores were all significantly above chance alone (X² test, p < 0.05) and ranged from 88-90% for Tl and 68-70% for Ddd. Training/Testing Ratio = 1:1

Conclusions

- Echolocation clicks can be used to differentiate Pacific white-sided and Risso’s dolphins.
- Whistles can be used to differentiate between bottlenose and common dolphins.
- Acoustic call classification improves the ability to identify odontocete species during ship-based surveys.

Schematic of Anticipated Call ID System

Acknowledgements

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Species-specific click structures were used to classify 6 groups of Pacific white-sided dolphins and 12 groups of sperm whale that were not visually identified. Dolphin whistle classification tasks will be integrated into future analyses.