Status of humpback, blue, and gray whales along the US West Coast and relevance to entanglements

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Research Biologist
Cascadia Research
Goals of talk

- Updated status of humpback, blue and gray whales as it relates to entanglement threat
  - Relevant aspects of population structure
  - Current trends and how that relates to risk
  - Focus on humpback whales but also relevant issues for blue and gray whales
  - Some of the new tools available to examine whale behavior and interaction with human activities.

- Research and results from some specific research efforts on entanglements
Activities related to entanglements

- Long term photo-ID of humpback, blue and PCFG gray whales
  - Abundance and trends
  - Dedicated surveys, other research and collaboration with whale watch industry
  - Matching identification photographs of entangled whales
- NOAA Scientific Review group, Pacific Offshore Take Reduction Team
- Disentanglement Level 4 responder
- Sect 6 grant from NOAA to WDFW, ODFW, CDFW
- Study on entanglement scaring rates in humpback whales along the US West Coast
- Working groups on impact/mitigation of ship strike and ship noise off N and S California
Long-term studies by Cascadia Research

**Humpback whale**
- Abundance
- Long-term trends
- Movements & migrations
- N Pacific wide studies (SPLASH)

**Blue whale**
- Abundance
- Movements
- Tagging work
- Feeding behavior
- Vocal behavior

**Gray whale**
- Existence of seasonal residents
- Movements
- Abundance
- Site fidelity
- Strandings
Cascadia Photo-ID catalogs and encounters for E N Pacific

<table>
<thead>
<tr>
<th>Species</th>
<th>Start of primary effort</th>
<th>Photo-ID catalog (unique IDs)</th>
<th>Sightings/IDs</th>
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<td>Humpback whales</td>
<td>1986</td>
<td>3,564</td>
<td>25,715</td>
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<tr>
<td>Gray whales</td>
<td>1998</td>
<td>1,732</td>
<td>26,265</td>
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<tr>
<td>Blue whales</td>
<td>1986</td>
<td>2,257</td>
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</table>
Resightings of identified whales

Based on results from SPLASH
SPLASH multi-strata estimates (Wade et al.)
E N Pacific humpback whaling and SPLASH ID locations with regions
Humpback whale
Biologically Important Feeding Areas

4. Biologically Important Areas for Selected Cetaceans Within U.S. Waters – West Coast Region

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\( ^5 \) Passive Acoustic Research Group, Northeast Fisheries Science Center, Woods Hole, MA 02543, USA

New ESA status of humpback whales
## Match rate to US West Coast

<table>
<thead>
<tr>
<th>Region, Sub-area</th>
<th>Matches</th>
<th>Breeding Collection</th>
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<tr>
<td>Mexico, Mainland</td>
<td>254</td>
<td>30%</td>
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<tr>
<td>Mexico, Baja California</td>
<td>84</td>
<td>12%</td>
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<tr>
<td>Mexico, Revillagigedo</td>
<td>18</td>
<td>1.7%</td>
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<td>S Mexico</td>
<td>42</td>
<td>60%</td>
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<tr>
<td>Central America</td>
<td>69</td>
<td>90%</td>
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Proportion of humpback whales matching breeding areas
Humpback whale trends – California and Oregon

- Chao 4-Yr
- Darrock 4-yr
- Peterson 2-yr
Likely implications of increased whale abundance reaching carrying capacity

• Increased number of whales
• Expansion into peripheral habitats and fully utilizing habitat / prey
• Increased time on feeding grounds including more animals over-wintering on feeding grounds and arriving earlier on feeding grounds
Areas of recent expansion of humpback whale occurrence

- Salish Sea
- Columbia River
- SF Bay
- S California Bight
Increased sighting reports of humpback whales in Salish Sea

Sighting reports of humpback whales in the Salish Sea

4-year Running Estimates
Sighting reports of humpback whales to Cascadia and Orca Network through 2015
Humpback switch prey but blue whales switch locations

Flemming et al. 2015
Use of scarring in live animals to examine trends in entanglements

• Has incidence of entanglement scarring increased in last 10-15 years?
• Is higher incidence of entanglement reports in Monterey Bay reflective of the higher effort there or is incidence also high in other areas?
Photo-identifications of entangled whales along US West Coast 2006-16

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<td>Blue whale</td>
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Entangled humpback whales with known sighting histories

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<tr>
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<th>CaseID</th>
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<th>Year</th>
<th>County</th>
<th># Resight</th>
<th>Central America</th>
<th>Mexico</th>
<th>US West Coast</th>
<th>US West Coast</th>
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<th>Max Loc Code</th>
<th>Min Dec Lat</th>
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<td>12315</td>
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<td>9</td>
<td>2007</td>
<td>2014</td>
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<td>63</td>
<td>37.4846</td>
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<td>2009</td>
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<td>2013</td>
<td>51</td>
<td>53</td>
<td>36.7639</td>
<td>38.1686</td>
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Interaction with gear: why do whales get entangled
Track of two humpback whales off the Bay area in 2016 from dart-attached TDR-10 tags.
Recent research on whales around crab gear in 2016 and 2017

Research in Monterey Bay in collaboration with Stanford Univ. 9-11 April 2017

1. Fewer whales nearshore'
2. More whales offshore
3. Lower density of crab gear
4. Two multi-sensor video tags deployed

Tags deployed in Monterey Bay and off HMB in May 2016
Depth distribution of humpback whales from longer term tag data
Santa Barbara Channel is a key Biologically Important Area for blue whales.

Figure 4.1. Nine blue whale (*Balaenoptera musculus*) Biologically Important Areas (BIAs), overlaid with all sightings and predicted mean densities of blue whales from habitat-based density (HD) models generated from Southwest Fisheries Science Center ship surveys (see Becker et al., 2012a). Panels a and b show more detail for the areas where the BIAs are located. The BIAs are (from north to south) (1) Point Arena to Fort Bragg, August-November; (2) Gulf of the Farallones, July-November; (3) Monterey Bay to Pescadero, July-October; (4) Point Conception/Arguello, June-October; (5) Santa Barbara Channel and San Miguel, June-October; (6) Santa Monica Bay to Long Beach, June-October; (7) San Nicholas Island, June-October; (8) Tanner-Cortez Bank, June-October; and (9) San Diego, June-October (see Table 4.1 for details).
Matches between feeding areas not represented
Return of blue whales to the B.C. coast and Gulf of Alaska included whales from California and likely related to the PDO shift to cold regime.

Calambokidis et al. (Submitted 2008)
Blue whale behavior and Group types

Prey patches found at depth
Active lunge feeding from tag

Biologically Important Areas

4. Biologically Important Areas for Selected Cetaceans Within U.S. Waters - West Coast Region

John Calambokidis,1 Gretchen H. Stetger,2 Carrie Carrick,3 Jolie Harrison,4 Megan C. Ferguson,5 Elizabeth Heickel,6 Monica Doolittle1 and Sarita M. Van Parij1

Abstract

In this review, we outline existing published and unpublished information along with expert judgment to identify and support the designation of 20 biologically important areas (BIAs) in U.S. coastal waters. These areas are defined by unique, biologically significant features and serve as foraging habitat for cetaceans, such as blue whales and humpback whales. The BIAs are described based on key attributes, including geographic boundaries, species composition, and population dynamics. They are critical for the survival and recovery of these cetacean populations.

Keywords: foraging area, estuarine corridor, resident populations, biologically important areas, species, distribution, U.S. West Coast, South Pacific Ocean

Introduction

This review document outlines existing published and unpublished information used to defineBiologically Important Areas (BIAs) in U.S. waters of the West Coast region. BIAs are significant for the survival and recovery of the species found within them. The purpose of this review is to identify and describe the biologically important areas for cetaceans in U.S. coastal waters, focusing on the West Coast region.

The study was conducted using a comprehensive approach that involved reviewing existing literature, consulting with experts, and synthesizing data from various sources. The resulting BIAs are critical for the conservation and management of cetaceans in U.S. coastal waters.
Mud plume

Head of whale

Variety of prey and habitats

Aerial photograph of feeding whale in Strait of Juan de Fuca

Feeding in shallow water off Camano Island

Feeding pits made by gray whales off Whidbey Island, Puget Sound
Movement of gray whales

Frequent interchange within and between years among coastal sites

Movements in 1998

- N of Vancouver Island, BC
- Central Vancouver Island
- S. Vancouver Island
- U.S. Strait of Juan de Fuca
- N. Washington coast
- Oregon coast
- Northern California

Month
- June
- July
- August
- September
- October

Arrows indicate the movement of gray whales.
PCFG Gray Whale Abundance
Significant differences in mtDNA between feeding areas

Assessment of genetic structure among eastern North Pacific gray whales on their feeding grounds

**Table 4.** Results of pairwise comparisons across strata using (a) mtDNA and (b) 12 microsatellites. Comparisons that are statistically significant are shown in bold.

<table>
<thead>
<tr>
<th>Pairwise comparison</th>
<th>( \Phi_{ST} )</th>
<th>( P )-value</th>
<th>( F_{ST} )</th>
<th>( P )-value</th>
<th>Fisher exact test ( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North(^a) (103) vs. PCFG (71)</td>
<td>0.012</td>
<td>0.0740</td>
<td>0.012</td>
<td>0.0045</td>
<td>0.0067</td>
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<tr>
<td>Chukotka (69) vs. PCFG (71)</td>
<td>0.020</td>
<td>0.0386</td>
<td>0.010</td>
<td>0.0349</td>
<td>0.0254</td>
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<tr>
<td>(b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North(^a) (105) vs. PCFG (70)</td>
<td>0.000</td>
<td>0.5269</td>
<td>0.000</td>
<td>0.5271</td>
<td>0.3491</td>
</tr>
<tr>
<td>Chukotka (70) vs. PCFG (70)</td>
<td>0.001</td>
<td>0.2539</td>
<td>0.003</td>
<td>0.2539</td>
<td>0.3503</td>
</tr>
</tbody>
</table>

\(^a\)Samples from Chukotka are included as part of the North stratum.
Variety of tag types

- Short term suction-cup archival
- Medium duration dart-attached archival
- Medium duration LIMPET satellite tags
- Deep implant position-only implant tags
Initial tag types deployed

- National Geographic Crittercam
  - video, sound, depth, temperature
- Acoustic tags
  - digital sound, temperature, pitch and roll angle, VHF, & satellite
- WHOI dTag
  - digital sound, temperature, accelerometers and magnetometers
- Multi-sensor video tags
Deploying tags on whales
Publications on underwater behavior of blue, fin, and humpback whales

Behavioral context of call production by eastern North Pacific blue whales
Erm M. Oleson\textsuperscript{1,4}, John Calambokidis\textsuperscript{2}, William C. Burgess\textsuperscript{3}, Mark A. McDonald\textsuperscript{4}, Carrie A. LeDuc\textsuperscript{5}, John A. Hildebrand\textsuperscript{1}

Insights into the Underwater Diving, Feeding, and Calling Behavior of Blue Whales from a Suction-Cup-Attached Video-Imaging Tag (CRITTERCAM)

Kinematics of foraging dives and lunge-feeding in fin whales
Jeremy A. Goldbogen\textsuperscript{1,2,6}, John Calambokidis\textsuperscript{3}, Robert E. Shadwick\textsuperscript{1}, Erin M. Oleson\textsuperscript{2}, Mark A. McDonald\textsuperscript{4} and John A. Hildebrand\textsuperscript{1}

\textsuperscript{1}Department of Zoology, University of British Columbia, 6270 University Boulevard, Vancouver, British Columbia, V6T 1Z4, Canada, \textsuperscript{2}Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093-0205, USA, \textsuperscript{3}Cascadia Research Collective, Olympia, WA 98501, USA and \textsuperscript{4}Whale Acoustics, Bellevue, CO 80512, USA

*Author for correspondence (e-mail: jergold@zoology.abc.ca)
Accepted 31 January 2006
2015-16 whale tag deployments
Medium duration dart-attached tags & new acoustic tag

Surgical stainless darts designed after LIMPET titanium darts

Dart attached Acousonde with GPS and satellite SPOT6. Acoustic and GPS data for up to 3 weeks. With high resolution accelerometry up to 4 days of multi-sensor data in current configuration.

Blue whale ship strikes Sept-Oct 2007

Min. 5 blue whales off S Calif. and Baja found dead

Heaviest ship traffic in and out of Los Angeles and Long Beach goes through Santa Barbara Channel
Interactions between ships and whales off California
Near miss of ship to a blue tagged blue whale 13 Sept 2014

History of whale
- First identified in 1987 in Gulf of Farallones
- 1 of 2 whales involved in overturning boat off San Diego on 2 July 2014
Acousonde deployment – B020

- Deployed 23 May 2016 in near W shipping lane off SF Bay
- >10 close ship approaches documented acoustically
- 2 June tag detaches from whale N of Bodega Bay and recovered same day
Two TDR10 tags on blue whales June-July 2017
Planned and continuing work with humpback whales

- Continued stock structure and abundance data from photo-ID and genetics under Sect 6 grant
- Deployments of suction cup tags on humpback and other species in collaboration with Stanford and OSU
- Pending proposal to use entanglement scaring to look at temporal and spatial trends in entanglements
- Pending proposal for continued development of medium duration archival tags and deployments
- Expanded work on overall N Pacific humpback whale status (IWC and post-listing monitoring)
Conclusions

- Changes in humpback whale status and management more accurately represent true status but present major challenges. Importance of management that emphasizes the feeding areas because:
  - Most time spent there
  - Most impacts occur on feeding grounds
  - Humpback whales most loyal to feeding areas

- Humpback whale distribution influenced by
  - Wider distribution and longer periods on feeding areas as population hits carrying capacity
  - Prey choice with krill near shelf edge and fish closer to shore

- Whale interaction with gear likely partly a result of their tendency to interact with kelp and other objects