Marine Bird and Mammal Distribution in the California Current: Hotspots and Conservation Implications

A Report to the Packard Foundation on Results of a Survey Conducted by PRBO Conservation Science and the Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration in 2006

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Abstract

We collected at-sea survey data on marine bird and mammal distribution and abundance between the US-Canada and US-Mexico borders and out to 400 km offshore from 6 April to 7 May 2006. The survey was part of a broader effort coordinated by the National Oceanic and Atmospheric Administration’s (NOAA’s) Southwest Fisheries Science Center (SWFSC) to characterize sardine abundance and oceanographic conditions in the region. We covered 4,381 km during the marine bird survey and counted 9,625 individuals from 45 species. During the marine mammal survey, we covered 3,339 km and counted 2,275 individuals from 18 species. Many of the species seen during the survey showed affinities for areas of enhanced productivity along the coast. Important coastal features included the Columbia River mouth, coastal promontories, and Monterey Bay. These features are associated with upwelling plumes or frontal boundaries that likely concentrate prey and provide rich foraging areas for top predators. As such, these areas may warrant additional protection and could be managed through the use of seasonal closures to commercial fishing and flexible boundaries that would accommodate the dynamic nature of the marine system.
Introduction

Long-term studies of the distribution and abundance of marine birds and mammals in the California Current System (CCS) have revealed that certain features and habitats are more important than others to these apex predators. For example, topographic features such as coastal headlands, seamounts, and the continental shelf-break appear to be sites of elevated use (Yen et al. 2004). Mesoscale oceanographic features (fronts and eddies) also appear to attract top predators (Ainley et al. 2005, Yen et al. 2006). These features are often sites of enhanced primary and secondary productivity. For example, researchers found high rates of Pacific sardine (*Sardinops sagax*) production in eddies off of southern California and hypothesized that those rates are due to entrainment of both productive coastal waters and larval fish (Logerwell et al. 2001). These features may also attract and / or concentrate the larger prey that many marine birds and mammals depend on.

We collected data on marine bird and mammal distribution and abundance between the US-Canada and US-Mexico borders and out to 400 km offshore in order to expand our knowledge of these habitat associations and to assess overlap between top predator and sardine distribution and abundance. The survey was part of a broader effort coordinated by the National Oceanic and Atmospheric Administration’s (NOAA’s) Southwest Fisheries Science Center (SWFSC) to characterize sardine abundance and oceanographic conditions in the region. We conducted the survey over a short time period (~ one month) using two research vessels, resulting in a synoptic picture of sardine and apex predator communities without the effects of migration and movements that may occur when surveys are conducted over longer time periods (Briggs et al. 1987). Herein, we present basic results from the marine bird and mammal survey and discuss implications for ocean conservation.
Methods

We used two NOAA research vessels to conduct the survey between 6 April and 7 May 2006. The NOAA Ship Oscar Dyson started at Vancouver Island and moved south, while the NOAA Ship David Starr Jordan started in San Diego and moved north (Figure 1). NOAA scientists collected data on fish, zooplankton, and surface and water-column characteristics (e.g., temperature, salinity, mixed-layer depth) along pre-determined, cross-shelf transect lines. Transect lines ranged between 100 km and 400 km offshore in the northern and southern parts of the study area, respectively. PRBO Conservation Science and NOAA biologists collected data on distribution and abundance of marine birds and mammals. Seabird observers used standard strip transect methods, identifying and counting all birds within a 300-m strip transect from the bow to 90° on the side of the vessel with the best visibility while the ship was underway at greater than five knots (Tasker et al. 1984, Philbrick et al. 2003). Mammal observers used modified line transect methods (Buckland et al. 1993), with one observer recording observations from the bow to 90° at any given time. Observers recorded the locations of seabirds and mammals in real time using the ship’s Global Positioning System. We calculated seabird density (number / km²) for each “on-effort” transect. We did not correct for flight direction, as recommended by Spear et al. (1992). We used seabird density and marine mammal encounter rate (number / km) as indices of abundance and plotted distributions using ArcGIS, Version 9.1 (ESRI 2005). We pooled data from the two vessels to provide a California Current-wide perspective.
Results and Discussion

**Marine Birds**

We covered 4,381 km during the marine bird survey and counted 9,625 individuals from 45 species (Appendix A shows distribution maps for selected species). Seven of the species seen on the survey are known to breed on islands within the study area, and the at-sea distribution for most reflected the locations of these breeding colonies. Glaucous-winged Gulls (*Larus glaucescens*) arrive at breeding colonies in the northern part of the study area between February and April (Verbeek 1993) and were concentrated near the coast of Vancouver Island at the time of the survey. Rhinoceros Auklets (*Cerorhinca monocerata*), Common Murres (*Uria aalge*), and Fork-tailed Storm-Petrels (*Oceanodroma furcata*) breed north of Point Conception, California, and Western Gulls (*Larus occidentalis*), Cassin’s Auklets (*Ptychoramphus aleuticus*), and Leach’s Storm-Petrels (*Oceanodroma leucorhoa*) breed throughout the region (Manuwal and Thoresen 1993, Pierotti and Annett 1995, Gaston and Dechesne 1996, Huntington et al. 1996, Boersma and Silva 2001, Ainley et al. 2002). Common Murres, Rhinoceros Auklets, and Western Gulls were concentrated near Vancouver Island, the Columbia River mouth, coastal promontories (e.g., Point Conception, Point Reyes, Cape Blanco), and Monterey Bay. Cassin’s Auklets were widely distributed and did not show these concentrations, though this species experienced early breeding failures in 2005 and 2006 (Sydeman et al. 2006, PRBO unpublished) and may have been more widely distributed than usual for April and May. Storm-Petrels were found over the shelf throughout the study area, with Leach’s Storm-Petrels generally occurring farther offshore than Fork-tailed Storm-Petrels.

Species that migrate through the area to northern breeding grounds include Pacific Loons (*Gavia pacifica*) and Red (*Phalaropus fulicaria*) and Red-necked phalaropes (*Phalaropus
lobatus; Rubega et al. 2000, Russell 2002, Tracy et al. 2002). Pacific Loons migrate through the area in April and May and were concentrated near coastal promontories, Monterey Bay, and the Columbia River mouth (Appendix A). Red and Red-necked Phalaropes were primarily seen in the southern portion of the study area; these species begin their migrations to northerly breeding areas later in the season and were likely on their way north at the time of the survey. Red-necked Phalaropes were generally seen close to shore and were especially concentrated near the Channel Islands and Point Reyes. Red Phalaropes occurred closer to the shelf-break than Red-necked Phalaropes, including a large concentration near the Farallon Islands. Northern Fulmars (Fulmarus glacialis) do not show a strong directional (south to north) spring migration, but disperse throughout the northeastern Pacific Ocean during the winter months (Hatch and Nettleship 1998) and were widely dispersed throughout the region at the time of the survey. Bonaparte’s Gulls (Larus philadelphia) can be found along the coast in the winter and during their migration to inland breeding areas (Burger and Gochfeld 2002) and were seen sporadically along the coast.

Several species seen during the survey breed south of the study area and generally visit the CCS during long-distance foraging trips or post breeding. Black-footed Albatrosses (Phoebastria nigripes) were widely distributed and may have included both non-breeding birds and breeding birds on long-distance foraging trips from breeding colonies in the Hawaiian Islands (Appendix A; Whittow 1993, Hyrenbach et al. 2002). Sooty Shearwaters (Puffinus griseus), Pink-footed Shearwaters (Puffinus creatopus), and Cook’s Petrels (Pterodroma cookii) breed in the southern hemisphere and move north into the study area post breeding (Briggs et al. 1987, Bartle et al. 1993, Imber et al. 2003, Shaffer et al. 2006). Sooty Shearwaters were widespread at the time of the survey. Pink-footed Shearwaters and Cook’s Petrels were seen only offshore of central and
southern California, with Cook’s Petrels showing a more offshore distribution than Pink-footed Shearwaters.

**Marine Mammals**

During the marine mammal surveys, we covered 3,339 km and counted 2,275 individuals from 18 species, including 1 mustelid (sea otter), 4 pinnipeds, and 13 cetaceans (Appendices B and C show distribution maps for pinnipeds and cetaceans, respectively). California sea lions (*Zalophus californianus*) breed between May and July in California and Mexico (Antonelis and Fiscus 1980) and were seen near rookeries in the Channel Islands (Appendix B). Northern fur seals (*Callorhinus ursinus*) were seen sporadically throughout the study area, with a large concentration southeast of the Channel Islands. Northern fur seals do not start breeding until late summer, and the animals seen during the survey may have been wintering animals from farther north or members of the local breeding population (Antonelis and Fiscus 1980). Elephant seals (*Mirounga angustirostris*) were seen only four times. Elephant seals leave their breeding grounds in central and southern California in February and March for foraging areas offshore and to the north and are not known to be widespread in the study area in April and May (i.e., at the time of the survey; Antonelis and Fiscus 1980, Stewart and DeLong 1994). In addition, elephant seals spend considerable time at depth during this time and may be less likely to be seen than other pinnipeds. Harbor seals (*Phoca vitulina*) were only seen near islands off of southern California, though the species’ range extends north to Alaska (Antonelis and Fiscus 1980).

The dolphins and porpoises were generally widely distributed. Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), northern right whale dolphins (*Lissodelphis borealis*), and Dall’s porpoises (*Phocoenoides dalli*) were seen throughout the study area (Appendix C). These species
are generally associated with the cool waters in the northern part of the study area and extend into California during the winter months (February – April) and in cool-water years (Forney and Barlow 1998). Harbor porpoise (*Phocoena phocoena*) distribution was similar to that found in previous studies (Forney and Barlow 1998, Carretta et al. 2001), with sightings in nearshore waters throughout the study area. Risso’s dolphins (*Grampus griseus*), common dolphins (*Delphinus delphis*), and bottlenose dolphins (*Tursiops truncatus*) were concentrated in southern California. Forney and Barlow (1998) also found Risso’s dolphins concentrated off of southern California during the winter months (February – April) and speculated that they were part of a population that occupies waters in the northern part of the study area at other times of the year. Common dolphins and bottlenose dolphins are generally associated with warm waters and have been found in the same general areas on previous surveys (Leatherwood and Reeves 1983, Forney and Barlow 1998). Killer whales (*Orcinus orca*) appear to range widely throughout the year (Forney and Barlow 1998) and were seen four times throughout the study area.

Five species of whales were seen sporadically throughout the study area. Humpback whales (*Megaptera novaeangliae*) arrive in the area to feed during the summer months (Leatherwood and Reeves 1983; Forney and Barlow 1998) and were concentrated near Point Conception (Appendix C). Minke whales (*Balaenoptera acutorostrata*) and Cuvier’s beaked whales (*Ziphius cavirostris*) were only seen off of southern California, though their ranges extend from subtropical to polar waters (Orr 1972, Leatherwood and Reeves 1983). Dwarf sperm whales (*Kogia sima*) are generally associated with warm waters (Leatherwood and Reeves 1983) and were seen off of southern California. Sperm whales (*Physeter macrocephalus*) were seen throughout the region. Gray whales (*Eschrichtius robustus*) were not seen during the survey. Abundance may have been low because the survey was conducted after the peak of their February to May
migration from southern breeding grounds to northern feeding areas (Leatherwood and Reeves 1983). Also, gray whales generally occur within a few kilometers of the coast in much of the study area (Leatherwood and Reeves 1983), and little effort was associated with their habitat.

**Hotspots and Conservation Implications**

There were several areas throughout the region that were characterized by relatively high densities of multiple species. These areas included the Columbia River mouth, coastal promontories, and Monterey Bay (Table 1). Our observations are consistent with other surveys that have documented use of these areas (Croll et al. 1998, Yen et al. 2004, Ainley et al. 2005, Tynan et al. 2005, Yen et al. 2006). All of these features are associated with enhanced productivity and/or concentrated prey. For example, the Columbia River mouth is an area of extensive freshwater input. The freshwater plume can extend several hundred kilometers offshore and may provide enhanced productivity near plume boundaries or nearshore retention areas for prey species (U.S. GLOBEC 1992, Hickey and Banas 2003). Coastal jets, filaments, and meanders in the California Current are associated with coastal promontories from Cape Blanco to Point Conception (U.S. GLOBEC 1992). Coastal jets are characterized by high chlorophyll concentration (i.e., high primary productivity) and can also extend several hundred kilometers offshore and downstream (U.S. GLOBEC 1992, Rosenfeld et al. 1994). In addition, zooplankton species composition can shift abruptly at the frontal boundaries associated with these jets and may provide good foraging areas for top predators (U.S. GLOBEC 1992). Monterey Bay and the coastal region of the Southern California Bight are productive areas due, in part, to influences from upwelling associated with Point Año Nuevo and Point Conception, respectively (Dugdale and Wilkerson 1989, Rosenfeld et al. 1994).
For many species, these areas of enhanced productivity and concentrated prey are important areas on which to focus marine conservation efforts. Hooker and Gerber (2004) emphasized the need to protect both breeding grounds and foraging areas used by top predators. Marine bird and mammal breeding colonies and rookeries are fairly well protected along the west coast of the United States. Foraging areas are more difficult to identify and have received less protection thus far. However, top predators may be especially vulnerable in these areas due to a high degree of competition and overlap with commercial fisheries (Hyrenbach et al. 2000, Hooker and Gerber 2004). Hyrenbach et al. (2000) describe different types of marine protected areas, from static areas that are defined by bathymetric features to both persistent and ephemeral hydrographic features. They point out that even fronts associated with upwelling events are somewhat predictable in time and space, and it may be possible to enhance protection of those areas through highly adaptable management that would include the use of seasonal closures to commercial fishing and flexible boundaries.

Acknowledgments

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Literature Cited


Department of Commerce. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-349.


Table 1. Coastal areas with relatively high densities of marine birds and mammals in the California Current System.

<table>
<thead>
<tr>
<th>Coastal Feature</th>
<th>Description</th>
<th>Common Species</th>
<th>Protection Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River Mouth</td>
<td>Area of extensive freshwater input</td>
<td>Common Murre, Pacific Loon, Sooty Shearwater, Western Gull, Northern Right Whale Dolphin, Pacific White-sided Dolphin</td>
<td>No specific protection</td>
</tr>
<tr>
<td>Cape Blanco</td>
<td>Coastal promontory / upwelling center</td>
<td>Common Murre, Pacific Loon, Sooty Shearwater, Western Gull</td>
<td>No specific protection</td>
</tr>
<tr>
<td>Point Reyes</td>
<td>Coastal promontory / upwelling center</td>
<td>Common Murre, Pacific Loon, Red-necked Phalarope, Sooty Shearwater, Western Gull, Northern Right Whale Dolphin, Pacific White-sided Dolphin</td>
<td>Gulf of the Farallones National Marine Sanctuary</td>
</tr>
<tr>
<td>Monterey Bay</td>
<td>Coastal bay south of Point Año Nuevo</td>
<td>Black-footed Albatross, Common Murre, Northern Fulmar, Pacific Loon, Pink-footed Shearwater, Rhinoceros Auklet, Red-necked Phalarope, Sooty Shearwater</td>
<td>Monterey Bay National Marine Sanctuary</td>
</tr>
</tbody>
</table>
Table 1 (cont.). Coastal areas with relatively high densities of marine birds and mammals in the California Current System.

<table>
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<th>Protection Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Conception</td>
<td>Coastal promontory / upwelling center</td>
<td>Common Murre, Pacific Loon, Pink-footed Shearwater, Rhinoceros Auklet, Sooty Shearwater, Western Gull, California Sea Lion, Humpback Whale</td>
<td>No specific protection</td>
</tr>
</tbody>
</table>
Figure 1. Map showing the area surveyed in April and May of 2006. The transect extended from Vancouver Island, British Columbia to San Diego, California.
Appendix A

Seabird Distribution Maps
Sardine Cruise 2006
birds per km²

- 0
- 0.1
- 1
- 1.1 - 10
- > 10

Black-footed Albatross
Sardine Cruise 2006
birds per km²
- 0
- 0 - 0.1
- 0.1 - 1
- 1.1 - 10
- > 10

Common Murre
Red Phalarope
Red-necked Phalarope
Sooty Shearwater
Appendix B

Pinniped Distribution Maps
Appendix C

Cetacean Distribution Maps
Sardine Cruise 2006
Number of Individuals Observed
- 0
- 1
- 2 - 10
- 11 - 50
- > 50

Cuvier's Beaked Whale
Dwarf sperm Whale
Sardine Cruise 2006
Number of Individuals Observed
- 0
- 1
- 2 - 10
- 11 - 50
- > 50

Gray Whale
Sardine Cruise 2006
Number of Individuals Observed

- 0
- 1
- 2 - 10
- 11 - 50
- > 50

Pacific White-sided Dolphin
Risso's Dolphin

Sardine Cruise 2006
Number of Individuals Observed
- 0
- 1
- 2 - 10
- 11 - 50
- > 50