Differential vulnerability to ship strikes between day and night for blue, fin, and humpback Whales based on dive and movement data from medium duration archival tags

John Calambokidis1, James Fahlbusch1,2, Angela Szesciorka1,3, Brandon Southall4,5, David Cade2,5, Ari Friedlaender3,5, and Jeremy Goldbogen2

1Cascadia Research Collective, 2Stanford University, 3Scripps Institution of Oceanography, 4Southall Environmental Assoc., 5Univ. Calif. Santa Cruz

Abstract
We examine the dive and movement behavior of blue, fin, and humpback whales along the US West Coast in regions with high ship traffic where ship strikes have been identified as a major concern. All three species are known to feed in coastal waters near areas of high ship traffic:1) the Southern California utilized by ships using the ports of LA/Long Beach, 2) the Gulf of the Farallones west of the ports in San Francisco Bay, and 3) the Strait of Juan de Fuca, the main access for ports in Vancouver and Puget Sound. We analyzed data from 33 archival tag deployments representing over 3,000 of data that were attached with suction cups or short darts for periods >24 hours and recorded depth (≥1 Hz), fast-lock GPS positions and other deployment-specific sensors. There were clear differences among the three species but all showed a distinct diurnal difference in diving behavior. While dive depth varied among animals based on where prey was located, whales spent a high proportion of their time closer to the surface where they would be more vulnerable to ship strikes at night than in the day. This was most pronounced for blue whales where vulnerability was twice as high at night compared to the day.

All three species were more vulnerable to ship strikes at night than in the day including spending up to twice as long near the surface at night.

At night whales often did not feed, they engaged in different diving behavior, and also tended to take more directional movements than in the day.

Daytime positions were not very good predictors of locations of whales at night.

Key Findings
There were significant differences among species (blue, fin, and humpback whales) in their diving behavior and movements that alter their vulnerability to ship strikes.

Cumulative time at depth varies by species and time of day

Differences in depths by species and day versus night

Examples of positions and behavior near shipping lanes between day and night

Acknowledgments
Megan McKenna and Erin Oleson contributed to previous research exploring initial aspects of this question. Ana Širovic at Scripps Institution of Oceanography (now Texas A&M) and Steve Jeffries at WDFW were PIs on some of the funding sources mentioned above. We thank the Channel Island National Marine Sanctuary and the crew of their vessel Shearwater that assisted in some of the field effort. We also thank the field personnel in the latter years of the SOCAL Behavioral Response Study who assisted with some of the tag deployments and supporting elements of the field studies that included some of the tag deployments used in this study. Nathan Harrison helped to prepare some of the tag components used in this study.