9:05

4aAB4. U.S. Navy application and interest in passive acoustics for estimation of marine mammal population density. Anu Kumar (Living Marine Resources, NAVFAC EXWC, 1000 23rd Ave., Code EV, Port Hueneme, CA 93043, anurag.kumar@navy.mil), Chip Johnson (Environ. Readiness, Command Pacific Fleet, Coronado, CA), Julie Rivers (Environ. Readiness, Command Pacific Fleet, Pearl Harbor, HI), Jene Nissen (Environ. Readiness, U.S. Fleet Forces, Norfolk, VA), and Joel Bell (Marine Resources, NAVFAC Atlantic, Norfolk, VA)

Marine species population density estimation from passive acoustic monitoring is an emergent topic of interest to the U.S. Navy. Density estimates are used by the Navy and other Federal partners in effects modeling for environmental compliance documentation. Current traditional methods of marine mammal density estimation via visual line transect surveys require expensive ship time and long days at-sea for an experienced crew to yield limited spatial and temporal coverage. While visual surveys remain an effective means of deriving density estimates, passive acoustic based density estimation methods have the unique ability to improve on visual density estimates for some key species by: (a) expanding spatial and temporal density coverage, (b) providing coverage in areas too remote or difficult for traditional visual surveys, (c) reduce the statistical uncertainty of a given density estimate, and (d) providing estimates for species that are difficult to survey visually (e.g., minke and beaked whales). The U.S. Navy has invested in research for the development, refinement, and scientific validation of passive acoustic methods for cost effective density estimates in the future. The value, importance, and current development in passive acoustic-based density estimation methods for Navy applications will be discussed.

9:25

4aAB5. Towing the line: Line-transect based density estimation of whales using towed hydrophone arrays. Thomas F. Norris and Tina M. Yack (Bio-Waves Inc., 364 2nd St., Ste. #3, Encinitas, CA 92024, thomas.f.norris@bio-waves.net)

Towed hydrophone arrays have been used to monitor marine mammals from research vessels since the 1980s. Although towed hydrophone arrays have now become a standard part of line-transect surveys of cetaceans, density estimation exclusively using passive acoustic has only been attempted for a few species. We use examples from four acoustic line-transect surveys that we conducted in the North Pacific Ocean to illustrate the steps involved, and issues inherent, in using data from towed hydrophone arrays to estimate densities of cetaceans. We will focus on two species of cetaceans, sperm whales and minke whales, with examples of beaked whales and other species as needed. Issues related to survey design, data-collection, and data analysis and interpretation will be discussed using examples from these studies. We provide recommendations to improve the survey design, data-collection methods, and analyses. We also suggest areas where additional research and methodological development are required in order to produce robust density estimates from acoustic based data.

Contributed Papers

9:45

4aAB6. From clicks to counts: Applying line-transect methods to passive acoustic monitoring of sperm whales in the Gulf of Alaska. Tina M. Yack, Thomas F. Norris, Elizabeth Ferguson (Bio-Waves Inc., 364 2nd St., Ste. #3, Encinitas, CA 92024, tina.yack@bio-waves.net), Brenda K. Rone (Cascadia Res. Collective, Seattle, WA), and Alexandre N. Zerbini (Alaska Fisheries Sci. Ctr., Seattle, WA)

A visual and acoustic line-transect survey of marine mammals was conducted in the central Gulf of Alaska (GoA) during the summer of 2013. The survey area was divided into four sub-strata to reflect four distinct habitats; "inshore," "slope," "offshore," and "seamount." Passive acoustic monitoring was conducted using a towed-hydrophone array system. One of the main objectives of the acoustic survey was to obtain an acoustic-based density estimate for sperm whales. A total of 241 acoustic encounters of sperm whales during 6,304 km of effort were obtained compared to 19 visual encounters during 4,155 km of effort. Line-transect analytical methods were used to estimate the abundance of sperm whales. To estimate the detection function, target motion analysis was used to obtain perpendicular distances to individual sperm whales. An acoustic-based density and abundance estimate was obtained for each stratum (N = 78; CV = 0.36 offshore; N = 16; CV = 0.55 seamount; N = 121; and CV = 0.18 slope) and for the entire survey area (N = 215; D = 0.0013; and CV = 0.18). These results will be compared to visual-based estimates. The advantages and disadvantages of acoustic-based density estimates as well as application of these methods to other species (e.g., beaked whales) and areas will be discussed.

10:00–10:15 Break

10:15

4aAB7. Studying the biosonar activities of deep diving odontocetes in Hawaii and other western Pacific locations. Whitlow W. Au (Hawaii Inst. of Marine Biology, Univ. of Hawaii, 46-007 Lilipuna Rd., Kaneohe, HI 96744, wau@hawaii.edu) and Giacomo Giorli (Oceanogr. Dept., Univ. of Hawaii, Honolulu, HI)

Ecological acoustic recorders (EARs) have been deployed at several locations in Hawaii and in other western Pacific locations to study the foraging behavior of deep-diving odontocetes. EARs have been deployed at depths greater than 400 m at five locations around the island of Kauai, one at Ni'ihau, two around the island of Okinawa, and four in the Marianas (two close to island of Guam, one close to the island of Saipan and another close to the island of Tinian). The four groups of deep-diving odontocetes were blackfish (mainly pilot whales and false killer whales), sperm whales, beaked whales (Cuvier and Bainsville beaked whales) and Risso's dolphin. In all locations, the biosonar signals of blackfish were detected the most followed by either by sperm and beaked whales depending on specific locations with Risso's dolphin being detected the least. There was a strong tendency for these animals to forage at night in all locations. The detection rate indicate much lower populations of these four groups of odontocetes around Okinawa and in the Marianas then off Kauai in the main Hawaiian island chain by a factor of about 4–5.

10:30

4aAB8. Fin whale vocalization classification and abundance estimation. Wei Huang, Delin Wang (Elec. and Comput. Eng., Northeastern Univ., 006 Hayden Hall, 370 Huntington Ave., Boston, MA 02115, huang.wei1@husky.neu.edu), Nicholas C. Makris (Mech. Eng., Massachusetts Inst. of Technol., Cambridge, MA), and Purnima Ratilal (Elec. and Comput. Eng., Northeastern Univ., Boston, MA)

Several thousand fin whale vocalizations from multiple fin individuals were passively recorded by a high-resolution coherent hydrophone array system in the Gulf of Maine in Fall 2006. The recorded fin whale vocalizations have relatively short durations roughly 0.4 s and frequencies ranging