Session 2pABb

Animal Bioacoustics: Noise Impacts on Marine Life

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Contributed Papers

3:30

2pABb1. Passive acoustic monitoring for marine mammals during Navy explosives training events off the coast of Virginia Beach, Virginia. Cara F. Hotchkin, Mandy Shoemaker, Anurag Kumar (Naval Facilities Eng. Command, Atlantic, 6506 Hampton Blvd., Norfolk, VA 23508, cara.hotchkin@navy.mil), Carl Hager (U.S. Naval Acad., Annapolis, MD), David MacDuffee, Jene Nissen, and Ronald Filipowicz (U.S. Fleet Forces Command, Norfolk, VA)

Navy training events involving the use of explosives pose a potential threat to marine mammals. This study used passive acoustic and visual monitoring data to evaluate marine mammals' behavioral responses to noise from explosive events. Monitoring was conducted during five training events in the Virginia Capes (VACAPES) Range Complex during August/September of 2009–2012. Passive acoustic monitoring methods ranged from a single hydrophone to an array of sonobuoys monitored in real time. Visual monitoring effort over the five events totaled approximately 34 h (day before events: 10.1 h; days of events: 22.3 h; day after events: 1.5 h), yielding a total of 27 marine mammal sightings. Approximately 54 h of acoustic data were collected before, during, and after the five events. Behavioral changes were evaluated based on analysis of vocalizations detected before, during, and after explosions and concurrent data from visual sightings. For time periods with both visual and acoustic monitoring data, detection methods were compared to evaluate effectiveness. Continuing use and evaluation of both visual and passive acoustic methods for monitoring of explosive training events will improve our knowledge of potential impact resulting from explosive events and help improve management and conservation of marine mammals.

3:45

2pABb2. Use of Automated passive acoustic monitoring methods for monitoring for marine mammals in conjunction with US Navy Mid-frequency Active Sonar training events. Stephen W. Martin, Roanne A. Manzano-Roth, and Brian M. Matsuyama (SSC PAC, 53560 Hull St., Code 71510, San Diego, CA 92152, steve.w.martin@navy.mil)

Automated passive acoustic detection, classification, and localization (DCL) methods are employed to deal with large volumes of acoustic data to support estimating the sound pressure levels (SPLs) that marine mammals are exposed to from mid-frequency active sonar (MFAS) during US Naval training events. These methods are applied to a training event involving MFAS conducted February 2012 in Hawaiian waters with thirty one hydrophones of data collected continuously over an 11 day period. The automated methods detect and determine locations of marine mammals, specifically minke and beaked whales, and the times of the MFAS transmissions utilizing custom C++ algorithms. Streamlined manual validation methods are employed which utilize custom MATLAB display routines. Animal locations uncertainties are addressed for the two different species. Once the transmitting ship and animal locations are determined acoustic propagation modeling is utilized to estimate the sound pressure levels (in dB re 1 micro Pascal) that an animal, or group of animals, were exposed to. Surface ducted propagation conditions can result in species such as beaked whales being exposed to over 30 dB higher SPL's when they return to the surface to breathe compared to when at depth foraging.

4:00

2pABb3. Impact of underwater explosions on cetaceans. Simone Baumann-Pickering (Scripps Inst. of Oceanogr., Univ. of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093, sbaumann@ucsd.edu), Amanda J. Debich, Ana Širović (Scripps Inst. of Oceanogr., Univ. of California San Diego, San Diego, CA), James V. Carretta (Southwest Fisheries Sci. Ctr., National Oceanic and Atmospheric Administration, San Diego, CA), Jennifer S. Trickey, Rohen Gresalfi (Scripps Inst. of Oceanogr., Univ. of California San Diego, San Diego, CA), Marie A. Roch (Dept. of Comput. Sci., San Diego State Univ., San Diego, CA), Sean M. Wiggins, and John A. Hildebrand (Scripps Inst. of Oceanogr., Univ. of California San Diego, San Diego, CA)

Use of seal bombs to deter sea lions from being caught in nets and preying on catch is a common practice for a number of fisheries. Purse seine fisheries in Southern California target primarily squid, but also scombrids and baitfish such as sardine and anchovy, while set gillnet fisheries' primary catch are halibut and white seabass. All of these fisheries use seal bombs as deterrents. Continuous passive acoustic recordings at several sites in the Southern California Bight collected since 2007 revealed an extensive use of smaller explosives, most likely seal bombs, during nighttime hours with a seasonal occurrence matching fishery activities. During several months of the year they were used all night, every night. The median occurrence of explosions when detected was 8 per hour; however, during periods of high fishing effort they reached up to 480 explosions per hour. From behavioral response and opportunistic studies we know that beaked whales as well as endangered blue whales react negatively to anthropogenic sound sources. We are testing the hypothesis that these underwater explosions have a suppressive effect on the acoustic behavior and therefore the communication and foraging of cetaceans, possibly leading to impacts on the individual fitness and overall population health.

4:15

2pABb4. Monitoring of marine mammal occurrence and acoustic behaviors in relation to mid-frequency active sonar using autonomous recorders deployed off the undersea warfare training range, Florida. Thomas F. Norris, Julie Oswald, Tina M. Yack, Elizabeth Ferguson (Bio-Waves, Inc., 144 W. D St., Ste. #205, Encinitas, CA 92024, thomas.f.norris@bio-waves.net), Anurag Kumar (Naval Facilities Eng. Command Atlantic, U.S. Navy, Norfolk, VA), Jene Nissen (U.S. Fleet Forces Command, U.S. Navy, Norfolk, VA), and Joel Bell (Naval Facilities Eng. Command Atlantic, U.S. Navy, Norfolk, VA)

Passive acoustic data were collected from nine Marine Autonomous Recording Units (MARUs) deployed 60–150 km in an area that coincides with the U.S. Navy's planned Undersea Warfare Training Range (USWTR) off Jacksonville FL. MARUs were deployed for 26 days during fall 2009, and 37 days in winter 2009–2010. Data were manually reviewed for marine mammal vocalization events, man-made noise, and mid-frequency active sonar events, which were logged using TRITON software. Seasonal and diel patterns were characterized qualitatively. Patterns and probabilities of vocalization events by species, or species groups, were related to sonar events. Vocalizations were detected for minke whales, North Atlantic right

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whales, sei whales, humpback whales, sperm whales, the blackfish group, and delphinids. Minke whale pulse-trains occurred almost continuously during the winter deployment but were absent in fall. Right whale events occurred mostly during winter at shallow-water sites, but unexpectedly were also detected at deep-water sites. Sperm whale events occurred exclusively near the continental shelf break and exhibited a strong diel pattern. Minke whale events had a strong negative relationship with sonar events. These results provide an initial assessment of marine mammal occurrence within the Navy's planned USWTR, and provide new information on vocalization events in relation to sonar.

4:30

2pABb5. Vocalization behaviors of minke whales in relation to sonar in the planned Undersea Warfare Training Range off Jacksonville, Florida. Talia Dominello, Thomas Norris, Tina Yack, Elizabeth Ferguson, Cory Hom-Weaver (Bio-Waves Inc., 364 2nd St. #3, Encinitas, CA 92024, talia.dominello@bio-waves.net), Anurag Kumar (Naval Facilities Eng. Command Atlantic, Norfolk, VA), Jene Nissen (U.S. Fleet Forces Command, Norfolk, VA), and Joel Bell (Naval Facilities Eng. Command Atlantic, Norfolk, VA)

Nine Marine Autonomous Recording Units (MARU's) were deployed in a rectangular array at a site coinciding with the United States (U.S.) Navy's planned Undersea Warfare Training Range (USWTR) approximately 60–150 km offshore Jacksonville, FL (13 September to 8 October and 3 December to 8 January, 2009–2010) at shallow, mid-depth, and deep sites (45, 183, 305 m). Data were reviewed in detail using TRITON (Wiggins, 2007). Event logs were created for each day at every site. Custom-written MATLAB scripts were used to calculate the probability of minke whale vocalization events occurring in the presence and in the absence of mid-frequency sonar. Minke whale vocalization events were completely absent in the fall deployment period, but occurred almost continuously during the winter deployment, indicating a strong seasonal pattern of occurrence. Minke whale vocalizations were detected most frequently at deep-water sites, and only at low levels (<0.03% of time) at shallow-water sites. Results of the probability analysis indicated a strong negative correlation to sonar. Minke whale vocalization events were greatly reduced, or completely ceased, during most days with nearly continuous sonar events during an approximate 3-day period. To our knowledge, such changes in acoustic behaviors of minke whales in relation to sonar have not been reported before.

4:45

2pABb6. Behavioral responses of California sea lions (*Zalophus californianus*) to controlled exposures of mid-frequency sonar signals. Dorian S. Houser (Dept. of Conservation and Biological Res., National Marine Mammal Foundation, 2240 Shelter Island Dr., San Diego, CA 92106, dorian.houser@nmmfoundation.org), Stephen W. Martin, and James J. Finneran (US Navy Marine Mammal Program, SSC Pacific, San Diego, CA)

Acoustic dose-response functions can be used to explore the relationship between anthropogenic noise exposure and changes in marine mammal behavior. Fifteen sea lions participated in a controlled exposure study to determine the relationship between the received sound pressure level (SPL) of a mid-frequency sonar signal (1-s duration, 3250-3450 Hz) and behavioral deviations from a trained behavior. Sea lions performed 10 control trials followed by 10 exposure trials within an open-water enclosure. Acoustic playbacks occurred once during each exposure trial when the sea lion crossed the middle of the enclosure. Received levels, ranging from 125 to 185 dB re 1 μPa (rms) SPL, were randomly assigned but were consistent across all trials for each individual. Blind scoring of behavioral responses was performed for all trials. A canonical correlation analysis indicated that cessation of the trained behavior, haul-out, a change in respiration rate, and prolonged submergence were reliable response indicators. Sea lions showed both an increased responsiveness and severity of response with increasing received SPL. No habituation to repeated exposures was observed, but age was a significant factor affecting the dose-response relationship. Response patterns and factors affecting behavioral responses were different from those observed in bottlenose dolphins and are indicative of species-specific sensitivities.

5:00

2pABb7. The characteristics of boat noise in marine mammal habitats. Christine Erbe (Ctr. for Marine Sci. & Technol., Curtin Univ., Kent St., Bentley, WA 6102, Australia, c.erbe@curtin.edu.au)

Environmental management of underwater noise tends to focus on sources related to offshore oil and gas exploration and navy operations. However, in many, specifically near-shore habitats, boat noise prevails, yet remains largely unregulated. Underwater noise of personal watercraft (jet skis) was recorded in Queensland, and consisted of broadband energy between 100 Hz and 10 kHz attributed to the vibrating bubble cloud generated by the jet stream, overlain with frequency-modulated tonals corresponding to impeller blade rates and harmonics. Broadband monopole source levels were 149, 137, and 122dB re 1 μPa @ 1m (5th, 50th, and 95th percentiles). Underwater noise of zodiacs (inflatable boats with outboard motors) operated by whale-watching companies was recorded in southern British Columbia. At slow cruising speeds (10 km/h), underwater noise peaked between 50 and 300 Hz; at fast traveling speeds (55 km/h), underwater noise peaked between 100 and 3000 Hz, exhibiting strong propeller blade rate tonals at all speeds. Broadband source levels increased with speed from 126 to 170dB re 1 μPa @ 1m according to SL = 107 + 32 log10(speed/km/h). Even though noise levels from jetskis are lower than those of propeller-driven boats, it is not necessarily the broadband source level that correlates with the bioacoustic impact on marine fauna.

5:15

2pABb8. Complex masking scenarios in Arctic environments. Jillian Sills (Ocean Sci., Univ. of California at Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95050, jmsills@ucsc.edu), Colleen Reichmuth (Inst. of Marine Sci., Univ. of California at Santa Cruz, Santa Cruz, CA), and Brandon L. Southall (Southall Environmental Associates, Aptos, CA)

Critical ratios obtained using octave-band noise and narrowband signals provide a useful first approximation for understanding the effects of noise on hearing. When considering realistic listening scenarios, it may be necessary to examine the effects of spectrally complex, time-varying noise sources on an animal's ability to detect relevant signals. In the case of Arctic seals, the increasing prevalence of seismic exploration makes an examination of masking by impulsive sounds particularly relevant. However, the characteristics of received sounds from airgun operations vary dramatically depending on the seismic source, environmental parameters, and distance. In order to determine the potential for auditory masking by airguns, we developed a paradigm to quantify the influence of spectral and temporal variations in typical seismic noise on signal detectability. This method calls for calculation of detection probabilities for seals listening for the same signal embedded at different time windows within a background of distant airgun noise. We believe this approach will enable an experimental assessment of masking potential by impulsive noise as distance between the receiver and source is increased. Such an assessment will aid in determining the extent to which standard critical ratio data can be reasonably applied in complex masking scenarios. [Work supported by OGP-JIP.]