

1:25

**2pAB2. Seals and sound in a changing Arctic: Ongoing psychoacoustic studies of spotted and ringed seals.** Jillian Vitacco (Ocean Sciences, University of California at Santa Cruz, 100 Shaffer Rd, Santa Cruz, CA 95050, jillian.vitacco@gmail.com), Colleen Reichmuth, Asila Ghoul (Long Marine Laboratory, Institute of Marine Sciences, University of California, Santa Cruz, CA), and Brandon Southall (Southall Environmental Associates, Aptos, CA)

Arctic environments are changing rapidly as a result of climate warming and industrialization, and as sea ice recedes, activity associated with transportation and oil and gas production increases. Among the many concerns for ice-living seals in the region is the potential for behavioral or auditory effects resulting from noise exposure. Currently there are limited data available concerning the hearing sensitivity of arctic seals - some data exist for harp and ringed seals, while the most comprehensive data are for harbor seals. As the phylogenetic relationships among northern seals are not well resolved, extrapolation across species for management purposes is difficult. To this end, we are working to describe the species-typical hearing of spotted (*Phoca largha*) and ringed seals (*Pusa hispida*). Thus far, measurements of the underwater hearing sensitivity of spotted seals show best sensitivity between 3.2–25.6 kHz and peak sensitivity of 51 dB re 1  $\mu$ Pa at 25.6 kHz. Absolute thresholds for airborne tonal signals indicate acute sensitivity of <10 dB re 20  $\mu$ Pa from 0.80–12.8 kHz. Audiometric testing for ringed seals is ongoing, as are critical ratio measurements for both species. These studies will provide valuable insight into how arctic seals perceive acoustic signals, as well as inform management practices for these vulnerable species.

1:45

**2pAB3. Simultaneous sound production in the bowhead whale *Balaena mysticetus*—Sexual selection and song complexity.** Outi M. Tervo (Arctic Station, University of Copenhagen, Post box 504, Qeqertarsuaq 3905, Greenland, outiter@gmail.com), Lee A. Miller (Institute of Biology, University of Southern Denmark, Odense, Denmark), and Mads F. Christoffersen (Arctic Station, University of Copenhagen, Qeqertarsuaq, Qaasuitsup, Greenland)

Different components of bowhead whale *Balaena mysticetus* song were localized using hydrophone arrays. In 2008 recordings were made using two hydrophones spaced 20–35 m apart. In 2009 a linear GPS synchronized array of four hydrophones with an aperture of ~1400 m was used. The localization results confirm the co-location of the sound sources. The analyses show amplitude modulation of one signal caused by the onset of the second signal, which provides additional evidence of simultaneous sound production. Sound, when used as an indicator of fitness forces the vocalizing animal to improve the quality of its signal to compete with other vocalizing conspecifics. Several methods can be used to improve signal quality and these include 1) large repertoire size, 2) annually/seasonally changing repertoire, 3) broad frequency band, and 4) simultaneous sound production. Bowhead whales show all these features in their acoustic behaviour and we suggest that these complex songs have evolved as the result of sexual selection. Song complexity has been shown to be of importance in the sexual selection of many song bird species implying that sound complexity may be a key factor in the sexual behaviour of bowhead whales.

2:05

**2pAB4. Bowhead whales and airgun pulses: Detecting a threshold of behavioral reaction.** Susanna B. Blackwell (Greeneridge Sciences, Inc., Santa Barbara, CA 93117, susanna@greeneridge.com), Trent L. McDonald, Christopher S. Nations (WEST, Inc., Cheyenne, WY), Aaron M. Thode (Marine Physical Laboratory, Scripps Institution of Oceanography, San Diego, CA), Katherine H. Kim, Charles R. Greene (Greeneridge Sciences, Inc., Santa Barbara, CA), and Michael A. Macrander (Shell Exploration and Production Co., Anchorage, AK)

Previous work has shown that bowhead whales cease calling when near (<40 km) seismic exploration activities involving airguns. The aim of this study is to estimate the received level threshold for the onset of this behavior (cessation of calling). The analysis relied on data collected during late summer of 2007-2010 by up to 40 Directional Autonomous Seafloor Acoustic Recorders (DASARs) in the Beaufort Sea. About 98,000 localized calls and hundreds of thousands of airgun pulses were included in the analysis. For each 10-min period of data collected at each recorder, each year, the cumulative sound exposure level (CSEL) from airgun pulses was calculated and paired with the number of calls concurrently localized within ~3.5 km of each DASAR. Poisson regression was then used to estimate the threshold of airgun sound exposure received at the whales when call cessation begins. The CSEL threshold was found to be near 124 dB re 1  $\mu$ Pa<sup>2</sup> s (95% confidence intervals = 119-129 dB). For an airgun array firing every 10 sec, this corresponds to a received single pulse SEL at the whale of ~106 dB re 1  $\mu$ Pa<sup>2</sup> s. [Work supported by Shell Exploration and Production Company.]

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**2pAB5. Arctic marine mammal passive monitoring and tracking with a single acoustic sensor.** Juan I. Arvelo (Applied Physics Laboratory, Johns Hopkins University, 11100 Johns Hopkins Rd., Laurel, MD 20723, juan.arvelo@jhuapl.edu)

The Arctic Ocean is a unique environment in the number of physical mechanisms that may be potentially exploited with much simpler acoustic systems than would be required in other oceans. The Arctic sound speed profile forms a surface duct with favorable cylindrical-spreading for near-continuous detection of marine mammal vocalizations. This ducted waveguide exhibit low seasonal variability, particularly under the ice cap, forcing under-ice sound to heavily interact with this rough elastic stratified boundary. The ice roughness introduces steeper slopes that enhance water-to-ice sound penetration [Arvelo, POMA 2012]. The ice elasticity is responsible for the excitation of a radially polarized longitudinal wave and a transverse-horizontal shear wave with group velocities around 2700-3000 m/s and 1550-1650 m/s, respectively. A third dispersive flexural vertical plate wave propagates at much slower speeds (<1200 m/s) at low frequencies [Stein, Euerle & Parinella, JGR 1998]. Vocalization distance may be estimated from the time delays between the three wave types via blind deconvolution, while an arctangent bearing-estimator may increase the azimuthal localization resolution for high SNR vocalizations [Maranda, Oceans 2003]. Therefore, the unique Arctic environment is well suited for passive marine mammal monitoring and tracking with just a single ice-embedded geophone or under-ice vector sensor.

2:45–3:00 Break

2p TUE. PM