9:05

4aAB4. Pinniped hearing and anthropogenic noise. Brandon L. Southall, Ronald J. Schusterman, David Kastak, Colleen Reichmuth Kastak (Long Marine Lab., Univ. of California, Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95060, branlee@cats.ucsc.edu), and Marla M. Holt (Long Marine Lab.)

Our behavioral studies of pinniped auditory processing, including amphibious hearing, auditory masking, and temporary threshold shift (TTS), have provided comparative data on hearing and the potential effects of anthropogenic noise for three pinniped species. Differences for one harbor seal between aerial thresholds measured using headphones in a noisy environment and those measured without headphones in a hemi-anechoic chamber are quite large. While additional data are required, the preliminary data suggest that it will be necessary to re-evaluate pinniped aerial hearing capabilities and their susceptibility to aerial anthropogenic noise impacts. Assessments of simultaneous (masking) and residual (TTS) effects of controlled noise exposure have also provided insight into the potential effects of anthopogenic noise on free-ranging pinnipeds. Our underwater masking studies indicated relatively low critical ratios for low-frequency tonal sounds, while underwater TTS studies demonstrated that auditory fatigue occurs in pinnipeds, even following exposure to moderate levels of noise. The TTS studies have also provided some means of estimating the onset of TTS and supplied data on the relative importance of fatiguing noise exposure level and duration. Results suggest that equal-energy relationships and the octave effect previously shown in humans and some terrestrial mammals may not apply for some pinnipeds.

9:25

4aAB5. It is all about SOUND science: Manatees, masking and boats. Edmund R. Gerstein, Laura A. Gerstein (Leviathan Legacy, Inc., 1318 S.W. 14th St., Boca Raton, FL 33486), Steve E. Forsythe (Navy Undersea Warfare Ctr. Div. Newport, Newport, RI 02841), and Joseph E. Blue (Leviathan Legacy, Inc., Orlando, FL 32806)

A series of controlled underwater psychoacoustic tests with captive manatees, along with comprehensive acoustic surveys of manatee habitats and boat noise propagation measurements, were conducted to investigate manatee hearing and acoustical factors that render Florida manatees vulnerable to repetitive boat collisions. Masked thresholds, critical ratios, and directional hearing of various sounds, including species-specific calls and recorded boat noise were measured against white noise and natural ambient backgrounds. Significantly high acoustic levels were required for manatees to detect approaching vessels. Slow moving boats generate relatively low power and frequency spectra compared to the louder higher frequency cavitation noise produced by faster boats. Counterintuitive to convention, the sounds of slower moving boats are more difficult for manatees to detect and they are often masked by the noise of snapping shrimp and distant faster moving boats. Furthermore, physical boundary effects inherent in shallow water attenuate and limit the propagation of dominant low-frequency sounds produced by many recreational and commercial vessels. While not adapted for hearing or localizing these lower frequencies, manatees can hear and localize an array of narrow band higher FM sounds that could be incorporated into a low-intensity directional alarm to alert them of approaching boats.

9:45–10:00 Break

10:00

4aAB6. Shallow water acoustics and marine mammals. Peter H. Rogers (G. W. Woodruff School of Mech. Eng., Georgia Inst. of Technol., Atlanta, GA 30326, peter.rogers@me.gatech.edu)

Human activity is causing significant changes to the shallow water acoustic environment. A good understanding of the basics of shallow water acoustics is essential to a proper assessment of the impact of this activity on marine mammals. Misunderstanding of the relevant underwater acoustics can often lead to erroneous conclusions about the impact of such changes on marine mammal ecology. This paper will address some of the issues and misunderstandings. Shallow water regions present an acoustic environment which is typically much more demanding and complex than the deep water environment. Propagation is strongly influenced by the surface, water column, and sea bottom and will vary greatly from place to place, and time to time. Shallow water regions are highly reverberant and are often very noisy. Marine mammals rely on underwater sound for communication and detection of prey. Unlike fish, which evolved entirely in the sea, the marine mammals auditory system evolved from a terrestrial auditory system. This paper will also address the differences between shallow water acoustics and atmospheric and deep water acoustics, and how they effect the acoustic behavior of marine mammals. Specific adaptations of the dolphins echolocation system to the shallow water environment are highlighted.

10:20

4aAB7. Sound propagation in deep water. W. A. Kuperman and G. L. D'Spain (Marine Phys. Lab., Univ. of California, San Diego, La Jolla, CA 92093-0238)

The basics of deep water sound propagation as related to marine mammal issues are reviewed. The spatial distribution of sound for a variety of source situations is qualitatively and quantitatively presented. Special care will be given to the details of the units describing sound levels. Acoustic signals will also be discussed in the context of natural and manmade ambient noise.

10:40

4aAB8. A general-purpose acoustic recording tag for marine wildlife. William C. Burgess (Greeneridge Sci., Inc., 1411 Firestone Rd., Goleta, CA 93117)

Acoustic recording tags have demonstrated the potential to measure free-ranging marine animals' exposure and response to sound. To fully realize this potential, however, acoustic recording tags must be applied to a large sample of subjects. To enable the broad use of acoustic recording tag technology, a new general-purpose tag has been developed. Miniaturization to a cylinder 3 cm in diameter by 23 cm in length allows the application with a variety of species and attachment methods. Encapsulation in resin and the use of