away from the perpendicular aspect. The echo structures were easily distinguishable between species and were generally consistent within species. The highlight structure of the echoes resulted in the spectrum being rippled, with local maxima and minima at different frequencies. However, differences in species were more obvious with the broadband dolphin signal than the narrow-band porpoise signal which had a much lower spatial resolution.

10:50

2aAB9. Hey Ron manatees do not echolocate either; the underwater hearing and acoustical behavior of West Indian manatees. Edmund Gerstein, Laura Gerstein (Leviathan Legacy Inc., 1318 SW 14th St., Boca Raton, FL 33486), Steve Forsythe (Naval Undersea Warfare Ctr., Newport, RI 02841), and Joseph Blue (Leviathan Legacy Inc., Boca Raton, FL 33486)

A comprehensive series of underwater psychoacoustic tests were conducted with captive manatees to measure their hearing abilities under varying acoustic conditions. Forced-choice paradigms with either a staircase, or method of constants, psychometric were used to define their audiogram, critical ratios, temporal integration, and directional hearing abilities. Pure tones, complex, broad and narrow-band noise were presented with a masker, at different intensities, to measure simultaneous masking effects at ambient levels recorded in manatee habitats. Masked thresholds across frequencies increased linearly with masker intensity. Critical ratios for pulsed signals were lower than nonpulsed, suggesting an inhibitory process affecting perception of nonpulsed tones. Comparisons with other mammals indicate manatees have acute filtering abilities for detecting pulsed sounds. While manatees do not exhibit a vocal repertoire to account for acute filtering, they are passive listeners, well adapted to selectively filter out continuous noise in favor of biologically significant sounds like their own 200-ms calls. Playbacks of band-limited calls suggest loudness summation across multiple critical bands may enable manatees to detect and locate their calls near or below ambient levels. This may explain why calibrated calls recorded in the wild exhibit no Lombard shifts. Low source levels and pulse rates negate their utility for active echolocation.

11:10

2aAB10. Underwater hearing thresholds in pinnipeds measured over a 6-year period. Brandon L. Southall (Long Marine Lab., Univ. of California, Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95060 and NOAA Fisheries Acoust. Program), Ronald J. Schusterman, David Kastak, and Colleen Reichmuth Kastak (Univ. of California, Santa Cruz, CA)

While absolute hearing thresholds have been obtained for some marine mammals, few published data are available on how measurements of individual auditory sensitivity may change over relatively long periods of time. Studies that have investigated temporal changes in sensitivity have typically focused on animals in which differences in hearing are anticipated (age-related hearing loss). This study investigated the replicability of underwater hearing thresholds in prime-aged individuals of three pinniped species over a 6-year period. Aside from their age and experience with behavioral signal detection tasks, test subjects were of similar physical condition throughout this experiment. They were tested in the same enclosure at similar test frequencies (0.1–6.4 kHz) using identical methodology and criteria. Underwater hearing thresholds obtained throughout this testing period were not significantly different. These data indicate that underwater hearing sensitivity may remain relatively stable over long periods in nonsenescent marine mammals, including those regularly exposed to noise. Further, our results suggest that variability in testing equipment and experimental personnel may have little impact on behavioral hearing data, as long as similar testing methodologies and subject response bias are carefully maintained.

Contributed Papers

11:30

2aAB11. Testing the acoustic prey debilitation hypothesis: No stunning results. Kelly Benoit-Bird (College of Oceanic and Atmospheric Sci., Oregon State Univ., 104 Ocean Admin. Bldg., Corvallis, OR 97331), Whitlow Au (Hawaii Inst. of Marine Biol., Kailua, HI 96734), Ronald Kastelein, and Sander van de Huel (SeaMarco, 3843 CC Harderwijk, The Netherlands)

We examined the hypothesis that sounds produced by odontocetes can debilitate fish by testing the effects of three odontocete-like pulsed signals on three individuals of each of three fish species: sea bass, cod, and herring. We used a high-frequency click with a center frequency of 120 kHz exposing the fish to approximately 112 dB, a mid-frequency click with a center frequency of 70 kHz and 208 dB exposure level, and a low-frequency click with a center frequency of 40 kHz and 193 dB exposure level. Individual fish were placed in a 0.3-m-diam net enclosure immediately in front of a transducer. Each fish was allowed to remain in the experimental set up for at least 3 min prior to exposure to the clicks which were presented at a rate of 100 pulses/s grading to 700 pulses/s in 1.1, 2.2, and 3.3 s. Sea bass were also exposed to a constant pulse rate of 700 pulses/s for exposures of up to 30 s. No effect was observed in any of the fish for any signal type or pulse modulation rate. Based on our results, the hypothesis that acoustic signals of odontocetes alone can disorient or stun prey cannot be supported.

11:45

2aAB12. Auditory brainstem response hearing measurements in free-ranging bottlenose dolphins (*Tursiops truncatus*). Mandy L. H. Cook (USF College of Marine Sci., 140 Seventh Ave. S., St. Petersburg, FL 33701-5016), Randall S. Wells (Mote Marine Lab., Sarasota, FL 34236), and David A. Mann (USF College of Marine Sci., St. Petersburg, FL 33701-5016)

Bottlenose dolphins (*Tursiops truncatus*) rely on sound for communication, navigation, and foraging. Both natural and anthropogenic noise in the marine environment could mask the ability of wild dolphins to detect sounds, and chronic noise exposure could cause permanent hearing loss. The hearing abilities of a wild population of bottlenose dolphins in Sarasota Bay, FL are being investigated to determine whether they suffer hearing losses in comparison to animals living in quieter environments. This study is the first to measure the hearing sensitivity of a large population of wild dolphins that are exposed to significant levels of noise. Data on hearing sensitivities at frequencies used for acoustic communication (5–20 kHz) and echolocation (20–100 kHz) are reported. Hearing sensitivity was measured in the field using the non-invasive auditory brainstem response (ABR) procedure. ABR responses were evoked by the presentation of amplitude-modulated (AM) tones (carrier frequencies of 5, 10, 20, 30, 60, and 80 kHz) through a jawphone. The tones were modulated at 600 Hz, which elicited a robust envelope following response. A rapid ABR procedure was employed so that an entire audiogram could be obtained in approximately 30 min. This study also provides baseline data for longitudinal hearing studies in known individuals.