

Session 5aAB

Animal Bioacoustics: Animal Hearing and Vocalization

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Contributed Papers

9:00

5aAB1. A comparison of acoustic and visual metrics of sperm whale longline depredation. Aaron Thode (SIO, UCSD, 9500 Gilman Dr., MC 0238, La Jolla, CA 92093-0238, athode@ucsd.edu), Lauren Wild (Sitka Sound Sci. Ctr., Sitka, AK), Delphine Mathias (GIPSA Lab., Grenoble INP, St. Martin d'Hères, France), Janice Straley (Univ. of Alaska Southeast, Sitka, AK), and Chris Lunsford (Auke Bay Labs., NOAA, Juneau, AK)

Annual federal stock assessment surveys for Alaskan sablefish also attempt to measure sperm whale depredation by quantifying visual evidence of depredation, including lip remains and damaged fish. An alternate passive acoustic method for quantifying depredation was investigated during the 2011 and 2012 survey hauls. A combination of machine-aided and human analysis counted the number of distinct "creak" sounds detected on autonomous recorders deployed during the survey, emphasizing sounds that are followed by a period of silence ("creak-pauses"), a possible indication of prey capture. These raw counts were then adjusted for variations in background noise levels between deployments. For most locations, the noise-adjusted counts of "creak-pauses" were highly correlated with survey counts of lip remains during both years (2012: $r(10) = 0.89$, $p = 1e-3$; 2011: $r(39) = 0.72$, $p = 4e-3$) and somewhat correlated with observed sablefish damage in 2011 [$r(39) = 0.37$, $p = 0.03$], but uncorrelated with other species depredation. The acoustic depredation count was anywhere from 3% to 80% higher than the visual counts, depending on the survey year and assumptions employed. The observed correlation breaks down when three or more whales are present. The results suggest that passive acoustics can provide upper bounds on the bias of survey depredation monitoring efforts for moderate depredation levels.

9:15

5aAB2. Equal loudness contours and possible weighting functions for pinnipeds. Colleen Reichmuth (Inst. of Marine Sci., Long Marine Lab., Univ. of California, 1, 100 Shaffer Rd., Santa Cruz, CA 95060, coll@ucsc.edu)

The idea of developing frequency weighting functions for marine mammals has received considerable attention recently because such functions can determine the relevant bandwidth for noise exposure assessments, and because they take differences in auditory sensitivity between species into account when identifying acoustic risks. However, such weighting functions are difficult to establish for nonhumans as they rely on equal loudness relationships that are subjective. Equal auditory reaction times may serve as a proxy for equal loudness judgments. For this experiment, we measured frequency-specific latency-intensity (L-I) functions for one California sea lion and one harbor seal with tones that were +0, +2, +4, +6, +10, +20, +30, and +40 dB re: sensation level (SL). The L-I plots were reliably fit with a power function to enable the determination of sound pressure levels corresponding to discrete latency values for each subject at each frequency. From these data, equal latency contours were drawn to describe differential auditory sensitivity as a function of frequency. The weighting functions derived from these contours are less conservative than the currently proposed "m"-weighting function for marine mammals, and may be more reliable than the alternative inverted audiogram approach. [Work supported by ONR.]

9:30

5aAB3. Psychophysical studies of hearing in sea otters (*Enhydra lutris*). Asila Ghoull and Colleen Reichmuth (Inst. of Marine Sci., Long Marine Lab., Univ. of California Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95060, asila@ucsc.edu)

The sensory biology of sea otters is of special interest, given their amphibious nature and their recent evolutionary transition from land to sea. However, little is known about the acoustic sense of sea otters, including sensitivity to airborne and underwater sound. In this study, we sought to obtain direct measures of auditory function. We trained an adult-male southern sea otter to participate in audiometric testing in an acoustic chamber and an acoustically mapped pool. We used a psychoacoustic method of limits to determine absolute auditory thresholds in air and under water across the hearing range. In addition to obtaining aerial and underwater audiograms, we also evaluated hearing in the presence of noise. The otter's aerial hearing closely resembled that of a sea lion, and showed reduced sensitivity to high-frequency (>22 kHz) and low-frequency (<2 kHz) sounds relative to terrestrial mustelids. Under water, hearing was less sensitive than sea lions and other pinnipeds, especially at frequencies below 1 kHz. Critical ratios were >10 dB above those measured in pinnipeds, indicating that sea otters are not especially well-adapted for extracting acoustic signals from noise. These data suggest that evolutionary changes in hearing are secondary to other adaptations for semi-aquatic living.

9:45

5aAB4. Explanation of the loudness and other features of cicada sounds. Derke R. Hughes (Sensors & Technol. Office, Naval Undersea Warfare Ctr., Newport, RI), Allan D. Pierce (P.O. Box 339, East Sandwich, MA 02537, adp@bu.edu), Richard A. Katz (Sensors & Technol. Office, Naval Undersea Warfare Ctr., Newport, RI), and Robert M. Koch (Chief Technol. Office, Naval Undersea Warfare Ctr., Newport, RI)

A quantitative explanation is given of features of noise emitted by cicadas (classed as the loudest of all insects). Microphone data shows sounds are emitted in a sequence of closely spaced tone bursts. Listeners do not perceive the individual pulses because of the finite integration time of the ear. The principal sound radiators are two platelets referred to as tymbals, which vibrate after being struck by ribs that have undergone buckling. The energy of each sound pulse is initially stored in tensed muscles and is initially released via buckling into the kinetic energy of ribs, which strike the tymbals in a manner similar to that of a drumstick striking a drum. The tymbals "ring" at a frequency controlled by the mass of the tymbals and the springiness of the air cavity within the abdomen of the cicada. The wavelengths of the radiated sound are much larger than the tymbal radii but comparable to the overall dimensions of the cicada. The detailed theory explains the radiation pattern of the sound radiation, the amplitude of the sound, the number of cycles in each pulse, the radiation damping of the tymbal vibrations, and why the cicada is such an efficient radiator of sound.