result of hormonal changes associated with photoperiod. Vocalizations may be a noninvasive indicator of reproductive state and therefore may provide a useful management and conservation tool in captive settings.

9:00

4aAB3. A comparison of behavioral and electrophysiological measures of aerial hearing sensitivity in a Steller sea lion (*Eumetopias jubatus*). Jason Mulsow (Dept. of Ocean Sci., Univ. of California Santa Cruz, Earth and Marine Sci. Bldg., Santa Cruz, CA 95064) and Colleen Reichmuth (Univ. of California Santa Cruz, Santa Cruz, CA 95060)

A number of studies with odontocete cetaceans have demonstrated that hearing sensitivity measurements using electrophysiological auditory steady-state responses (ASSRs) can provide an efficient means of estimating a subject's behavioral audiogram. Expansion of ASSR methods to another marine mammal group, the otariid pinnipeds (sea lions and fur seals), holds the potential to increase the number of otariid individuals and species for which hearing sensitivity data are available. A within-subject comparison of ASSR and behavioral measures of aerial hearing sensitivity was conducted with an individual of the largest otariid species, the Steller sea lion. Psychophysical methods were used to obtain an unmasked aerial audiogram at 13 frequencies spanning a range of 0.125 to 34 kHz. Corresponding ASSR thresholds measured at frequencies of 1, 2, 5, 10, 20, and 32 kHz had differences (relative to behavioral thresholds) ranging from 1 dB at 20 kHz to 30 dB at 1 kHz. Overall, the ASSR audiogram was a fairly accurate predictor of the behavioral audiogram at frequencies of 2 kHz and above. Our results suggest that ASSR methods can be appropriately applied to otariid pinnipeds in estimating aerial sensitivity at frequencies of approximately 2 kHz and above.

9:15

4aAB4. Vibration characteristics of the tympanoperiotic complex in the bottlenose dolphin, *Tursiops truncatus*. Petr Krysl (Univ. of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0085), Ted W. Cranford (San Diego State Univ., San Diego, CA 92182), and John A. Hildebrand (Univ. of California, San Diego, La Jolla, CA 92093-0205)

Modal finite + boundary element analysis of a bottlenose dolphin's bony tympanoperiotic complex, including the ossicles, was performed to determine the mode shapes and natural frequencies. The goal was to gain insight into the transmission of sound pressure waves arriving through the soft tissues and transmitted across the bony components into the oval window of the inner ear. The finite element model of the bones was derived from CT scans with a 360 μm voxel resolution. In the first approximation the soft tissue was considered to be acoustically equivalent to an incompressible inviscid liquid, taken as infinite in extent. The added mass terms were computed with a boundary element model. The computed frequencies cover the range up to 160 kHz. The capacity of the natural vibration modes to excite motion of the stapes footplate was assessed by measuring the relative motion of the incudostapedial joint normalized by the normal displacement of the wet-surface of the ear bones. In addition to a quantitative assessment a number of qualitative observations may be made that could explain the function of the dolphin's ear complex. For example, the vibrational patterns are nontrivial and frequency dependent. [Work supported by the U.S. Navy CNO45.]

9:30

4aAB5. "Rivers" of sound in Cuvier's beaked whale (*Ziphius cavirostris*): Implications for the evolution of sound reception in odontocetes. Ted W. Cranford (Biology Dept., San Diego State Univ., 2674 Russmar, San Diego, CA 92182), Petr Krysl, and John A. Hildebrand (Univ. of California at San Diego, La Jolla, CA 92093)

Industrial CT scanning technology was used to collect the first x-ray tomograms from the head of an adult male Cuvier's beaked whale. These scans and tissue property measurements were used to construct a finite element model. Simulations revealed pathways for sound propagation into and out of the head. One intriguing result concerns a newly described gular pathway by which sound reaches the hearing apparatus. Propagated sound waves enter the ventral aspect of the head and form an acoustic "river" that flows toward the bony ear complexes through the internal mandibular fat bodies. The precise pathway and dimensions of the sound river vary with frequency, but it converges on the bony tympanoperiotic complex. A combination of tissue structures and air spaces act like an internal acoustic pinna that filters and concentrates the incoming sound. The river of sound apparently functions in concert with the absence of the medial bony lamina of the posterior portion of the mandible, a condition that exists in all toothed whales and their ancestral archaeocetes. The gular pathway and river of sound suggests that this is the primordial pathway for underwater hearing in whales and that Norris' jaw hearing mechanism was a more recent development.

9:45

4aAB6. Dall's porpoise (*Phocoenoides dalli*) echolocation click spectral structure. Hannah R. Bassett, Simone Baumann, Gregory S. Campbell, Sean M. Wiggins, and John A. Hildebrand (Marine Physical Lab, Scripps Inst. of Oceanogr., Univ. of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093, hbassett@ucsd.edu)

Dall's porpoise (*Phocoenoides dalli*) echolocation clicks have not been widely recorded. Concurrent with visual observations, acoustic recordings of free-ranging Dall's porpoise were made offshore of southern California using a towed hydrophone array with two elements of 250 kHz bandwidth. We examined 6035 clicks from 12 sessions totaling more than two hours over the course of seven days. The Dall's porpoise echolocations recorded were short (48–804 μs), narrow band (2–10 kHz [−3dB]) clicks with most peak frequencies between 117 and 141 kHz, but some as high as 198 kHz. Many clicks contained a multipulse temporal structure, resulting in stereotyped spectral peaks and notches. Two distinctive click types with different spectral banding patterns and peak frequencies (122.8 and 135.8 kHz) were observed. Spectral banding patterns have been used as a species identifier for Risso's dolphins and Pacific white-sided dolphins. These two dolphins and Dall's porpoise have similar head morphologies, which may play a role in producing clicks with spectral peaks and notches. This study shows that Dall's porpoise produce multiple click types, which may provide a tool for population classification, and that their clicks contain spectral banding patterns, which may provide insight into the mechanism by which such clicks are produced.

10:00—10:20 Break

10:20

4aAB7. Analysis of most prominent signal features of humpback whale (*Megaptera Novaeangliae*) vocalizations towards the goal of autonomous acoustic classification. Ted Abbot, Owen Mayer, Vince Premus, Philip Abbot, and Ira Dyer (OASIS, Inc., 5 Militia Dr. Lexington, MA 02421)

Humpback whale vocalizations were recorded using hydrophones on glider systems off Alaska in January 2000, in Hawaii in February 2008, and in the Stellwagen Bank National Marine Sanctuary in October 2007 and July 2008. The vocalizations have been grouped into five call types based on the most prominent signal features. Only five call types are used because autonomous species classification relies on the most consistent and repeatable signal features rather than the full diverse range of humpback vocalizations. The five call types are upsweep (increasing frequency over time), downsweep (decreasing frequency over time), flute (increasing and decreasing frequency over time), tone (little or no change in frequency over time), and groan (commonly a social or feeding-related vocalization, frequently characterized by unstructured broadband sound). We present detailed statistical analyses of these call types including bandwidth, minimum and maximum frequency, duration, and slope. A comparative analysis across data sets shows the relative frequency of occurrence of each vocalization type and indicates the degree of temporal and geographic variation of Humpback vocalizations.