9:05

4aAA4. Low frequency sound problems found in mixed use buildings that house entertainment venues and residential developments and containment options. Scott W. Smith (Ballentine Walker Smith, Inc., Kennesaw, GA 30144, bwsacoustics@bellsouth.net) and Steven D. Pettyjohn (The Acoust. & Vib. Group, Inc., Sacramento, CA 95820-1852)

Many problems are to be expected when mixed use buildings include restaurants and residential spaces. When the residential spaces are condominiums and the restaurant becomes a nightclub, the sound problems multiply quickly. The low frequency sound produced in a nightclub featuring music catering to a young crowd is of particular concern. This is partially because of the difficulty of finding remedies once the building construction is complete. This is the situation that arose in a facility recently completed. The nightclub wanted to continue its operation while the condominium owners wanted a resolution of the problem. Sound tests were completed in the residential spaces during operation of the nightclub, but the low frequency content was not always the same, requiring multiple attempts to measure in the source and receiving spaces. Results of these measurements and the recommendations for correcting the problem are presented in this paper. The goal is to provide results of sound measurements made after the recommendations are implemented. Again, sound will be measured in the source and receiver spaces to understand how the noise reduction changed and compared with the predicted sound reduction.

Contributed Paper

9:25

4aAA5. An historic conversion: From a bank to a restaurant and residences. Ioana Pieleanu, Jeffrey Fullerton, and Benjamin Markham (Acentech Inc., 33 Moulton St., Cambridge, MA 02135)

A conversion of an old bank building in Boston's tony South End to a mixed-use building featuring retail on the ground floor and luxury condominiums above was completed in 2007. More recently, a new restaurant (garnering awards for its interior design and rave reviews for its food) has opened in one of the ground floor retail spaces directly below a particularly noise-sensitive resident. Consultants at Acentech worked on two aspects of the project: first, on the base building as consultants to the architect, and second, on the isolation between the restaurant and the second floor residences as consultants to the restaurant. Using this case study and extensive data measured on site, the authors will discuss best practices to achieve good sound isolation in mixed-use buildings, common pitfalls that result from working with existing historic structures, and some difficulties in achieving the high degree of sound isolation that some luxury condominium owners expect.

THURSDAY MORNING, 21 MAY 2009 GALLERIA NORTH, 8:25 TO 11:50 A.M.

Session 4aAB

Animal Bioacoustics: General Topics in Animal Bioacoustics I

Holger Klinck, Chair
CIMRS, Oregon State Univ., Newport, OR 97365

Chair's Introduction—8:25

Contributed Papers

8:30

4aAB1. Auditory temporal summation in pinnipeds. Asila Ghoul (Univ. of California Santa Cruz Long Marine Lab., 100 Shaffer Rd., Santa Cruz, CA 95060), Marla M. Holt (Natl. Marine Fisheries Service, Seattle, WA 98112), Colleen Reichmuth, and David Kastak (Univ. of California Santa Cruz Long Marine Lab., Santa Cruz, CA 95060)

In addition to improving the understanding of auditory processing in pinnipeds, direct measures of temporal summation are relevant to the selection of signal parameters when conducting audiometric research, assessing the effects of signal duration on communication ranges, and evaluating the potential auditory impacts of anthropogenic signals. In the present study, individuals from three pinniped species were tested to determine how signal duration influenced pure-tone hearing thresholds. The psychophysical method of constant stimuli was used to obtain aerial thresholds for each subject at nine different signal durations ranging from 25 to 500 ms. Parameter estimates derived for a California sea lion (*Zalophus californianus*) from an exponential model of temporal summation yielded time constants (τ) of 176, 98, and 141 ms at frequencies of 2.5, 5, and 10 kHz, respectively. Preliminary results with a northern elephant seal (*Mirounga angustirostris*) at 5 kHz (this study), and a harbor seal (*Phoca vitulina*) at 2.5 kHz [M. M. Holt et al., J. Soc. Am. **116**, 2531 (2004)] show similar values for (τ), 134 and 144 ms, respectively. These time constants are similar to those of other mammals tested and do not appear to vary with respect to frequency.

8:45

4aAB2. Annual temporal patterning in the vocalizations of captive seals: Two long-term case studies. Colleen Reichmuth and Ronald J. Schusterman (Inst. of Marine Sci., Univ. of California Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95060)

Seasonal changes in vocalizations occur in a variety of species. Factors such as the condition of conspecifics, physiological states that in turn may be related to environmental cues, and developmental and individual differences all potentially influence temporal changes in sound production. In the present study, the vocal behavior of two captive seals was monitored daily for over 10 yrs. Both seals were housed in the absence of conspecifics from the age of 1 yr extending past sexual maturity. The male harbor seal (*Phoca vitulina*) began characteristic underwater vocal displays at the age of 6. Intense periods of acoustic activity lasted weeks to months, overlapped with the breeding activity of local harbor seals, and comprised stereotypic sound emissions that were structurally similar to those reported for wild seals. The female northern elephant seal (*Mirounga angustirostris*) produced aberrant intense airborne vocalizations from the age of 4 that were annually synchronized to a period of approximately 5 weeks coinciding with estrous. Endogenous changes appear to trigger these behavioral cycles, presumably as a

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.