2 s. Many of the recorded songs contained units that had high-frequency harmonics that extended beyond 22 kHz. These harmonic results suggest that humpback whale songs have a broadband quality not previously reported and may provide some insights on the high-frequency limit of hearing in these whales. The source levels of the songs were also estimated by considering the root-mean-square sound-pressure level referenced to 1 m for the unit with the largest level for different phrase within a song. Source levels varied between 171 to 189 dB *re*: 1 $\mu$Pa. Singing escorts have been regularly observed within two whale lengths of females and these observations and knowledge of source levels provide estimates of sound-pressure levels that male humpback whales expose female whales to.

**10:00–10:15 Break**

**10:15**

**4aAO5. Van Holliday—A role model for leadership in fisheries acoustics.** William A. Karp (NOAA Fisheries, Alaska Fisheries Sci. Ctr., 7600 Sand Point Way NE, Seattle, WA 98115)

Van Holliday completed his Ph.D. dissertation, entitled ''Resonance and Doppler Structure from Pelagic Fish Schools,'' in 1972. He soon published two journal articles based on this research, marking the first steps in a long, distinguished and ongoing contribution to fisheries science. He has published extensively to document his acoustic research on marine life, covering the size spectrum from plankton to marine mammals. This entire body of work is of interest to fisheries biologists who strive to understand the dynamics of populations at all trophic levels to help them better understand the fish populations they study. From this perspective, his advances in acoustic methods, technologies, and instrumentation, and his extensive biological and ecological research should all be considered important contributions to fisheries science. Trained as a physicist, his unique ability to transcend the barriers between physical and biological scientists has been elemental to his success. We recognize Van Holliday for his groundbreaking acoustic research on fish and other forms of marine life, and his scientific and technical excellence. We also recognize Van for his leadership, encouragement, mentoring, and support of colleagues and young scientists, and the vision and focus that he continues to bring to the field of fisheries acoustics worldwide.

**10:35**

**4aAO6. Light and lunar cycle as cues to diel migration of a sound-scattering layer.** Kelly J. Benoit-Bird and Whitlow W. L. Au (Hawaii Inst. of Marine Biol., P.O. Box 1106, Kailua, HI 96734, benoit@hawaii.edu)

The Hawaiian mesopelagic boundary community is an island-associated midwater scattering layer comprised of small fishes, shrimps, and squids that undergoes diel vertical as well as horizontal migrations. It has been hypothesized that light levels are an important cue or trigger for vertical migration and presumably, horizontal migration. The migration pattern of the scattering layer was measured over complete lunar cycles while the incident light levels were recorded. Due to differences in the rise and set times of the moon and cloud cover, light and lunar cycle were not completely coupled, allowing separation of the light effects of moon phase and other cues associated with lunar cycle. Four calibrated echosounder moorings were deployed with approximately even spacing, perpendicular to the leeward coast of Oahu. Moorings were deployed for one complete lunar cycle at each of three locations, recording 10 echoes every 15 min. Light sensors measured the nocturnal light intensity at 30-s intervals. Statistical analysis revealed significant effects of both light and other lunar cycle cues. Overall, the effect size was very low considering the light transmission characteristics of the subtropical Pacific, making measurement from stationary acoustic platforms critical.

## *Contributed Papers*

**10:55**

**4aAO7. Classification of bioabsorption lines at low frequencies: The Van Holliday connection.** Orest Diachok, Stephen Wales (Naval Res. Lab., Washington, DC 20375, OrestDia@aol.com), and Paul Smith (Southwest Fisheries Sci. Ctr., La Jolla, CA 92038-0271)

We will describe preliminary results of the second Bioacoustic Absorption Spectroscopy experiment in the Santa Barbara Channel (SBC), BAS II, which was designed to measure the effects of bioabsorptivity on transmission loss (TL) at frequencies between 0.25 and 6 kHz between an ultrabroadband source and a 16-element vertical receiving array. A fisheries echo sounder and trawls provided bioacoustic parameters. Colocated cores and chirp sonar provided geoacoustic parameters (Turgut, unpublished). Temporal changes in temperature structure were measured with three orthogonal thermistor strings. Highest losses were observed at night when fish were dispersed, and at the average depth of the absorption layer, 13 m, in accord with echo-sounder data and simulations. Absorption lines were evident at the resonance frequencies of 15-cm sardines (1.1 kHz) and 11-cm anchovies (1.8 kHz), in accord with trawls, and 20-cm jack mackerel (0.7 kHz), a species known to inhabit the SBC. This classification is consistent with Holliday's (1972) backscattering measurements of the resonance frequency of jack mackerel (samples collected by Purse Seiner corroborated his classification). Frequencies of absorption lines changed in accord with depth changes at twilight. [Work supported by the ONR and the Southwest Fisheries Science Center.]

**11:10**

**4aAO8. Bioacoustics and D. V. Holliday: A scientific tribute.** Kenneth G. Foote (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543)

A number of Holliday's seminal contributions to the acoustics of observing aquatic organisms are noted. Schooling pelagic fish have been sized from their echo resonance structure; fish swimming speeds have been measured through the Doppler effect; and snappers/groupers have been enumerated by high-resolution sidescan sonar. Zooplankton have been sized through multiple-frequency measurements of backscatter, and related to the underlying oceanography. Bowhead whales have been localized and tracked by means of a passive sonobuoy array. Certain themes have recurred, emphasizing the importance of both frequency diversity and spatial resolution in quantitative applications. Devices have been designed and built to solve specific problems, advancing the state of the art in these areas. For the student, the respective published work exemplifies the scientific method, introducing an important observational problem, describing its systematic approach, and interpreting results by means of simple but sound physical models. [Work supported by ONR.]