exposure and hearing loss led to further investigation, ultimately resulting in the dismissal of all claims against the employer who then filed an action against the claimant's attorneys and physician under the Racketeering in Corrupt Organizations Act (RICO). The details of the legal complaint, which reads like a detective novel, can be found at the United States District Court for the Southern District of New York [93 Civ. 7222 (LAP)].

10:45

3aAA5. Legal versus technical evidence of warning signal effectiveness. Sanford Fidell (Fidell Assoc., Inc., 23139 Erwin St., Woodland Hills, CA 91367)

A vast gulf separates technically from legally compelling proof. Attorneys (if not juries) crave deterministic certainty, simplicity, and self-assurance in expression of technical opinions, while scientists are more accustomed to discussing bandwidth-adjusted signal to noise ratios, working hypotheses, confidence intervals, and full disclosure of the limitations of data collection and theoretical interpretation. Given the many constraints imposed by the adversarial nature of civil litigation, presenting a jury with technically meaningful evidence about the effectiveness (or ineffectiveness) of acoustic warnings can be a formidable challenge. Favorable factual information and genuine expertise in interpreting it are helpful, but there are no guarantees that a jury can be persuaded that a technical opinion is correct.

11:10

3aAA6. A method to prove violation of building code sound insulation standards in small condominiums. David Lubman (David Lubman & Assoc., 14301 Middletown Ln., Westminster, CA 92683)

Building code sound insulation standards are health measures intended to protect people from excessive noise. In the USA, minimum values for Field Sound Transmission Loss (FSTC), and Field Impact Insulation Class (FIIC) are widely used to rate noise insulation between adjacent condominiums. Current American Society for Testing and Materials (ASTM) field test standards specify minimum room volumes for each of 16 one-third octave band test frequencies. For field impact insulation class ratings (FIIC), ASTM E 1007 specifies a minimum room volume of 2100 ft^3 for valid measurement in the 100-Hz band. For air-borne sound transmission class ratings (FSTC), ASTM E 336 specifies minimum room volumes of 1400 ft^3 for valid measurement in the 125-Hz band. FIIC and FSTC cannot be determined for bedrooms and kitchens of smaller condominiums which fail the minimum size requirement for the lowest bands. However, upper bounds can be determined merely by excluding invalid lower bands from computations. It is shown that when the upper bound on FIIC or FSTC falls below the code requirement (field values of 45 under the Uniform Building Code and the International Building Code), one may logically conclude that the code requirement is violated under existing standards.

WEDNESDAY MORNING, 12 NOVEMBER 2003 PECOS ROOM, 8:30 A.M. TO 12:00 NOON

Session 3aAO

Acoustical Oceanography: Acoustic Remote Sensing

Aaron M. Thode, Chair
Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, California 92093-0238

Contributed Papers

8:30

3aAO1. Integrated acoustics systems for ocean observatories. Bruce M. Howe (Appl. Phys. Lab., Univ. of Washington, Seattle, WA 98105) and James H. Miller (Univ. of Rhode Island, Narragansett, RI 02882)

Integrated acoustics systems providing navigation and communications and conducting acoustic measurements in support of science applications is, in concept, analogous to the Global Positioning System, but relies on acoustics because the ocean is opaque to electromagnetic waves and transparent to sound. A series of nested systems is envisioned, from small- to regional- to basin-scale. A small number of acoustic sources sending coded, low power signals can service unlimited numbers of inexpensive receivers. Drifting floats with receivers can be tracked accurately while collecting ocean circulation and heat content data, as well as ambient sound data about wind, rain, marine mammals, and seismic activity. The sources can double as transmitters of control data from users to remote instruments; if enabled as receivers, two-way acoustic communications links in large-scale networks can be established. Acoustic-based instrumentation that shares the acoustic bandwidth with, and depends upon, the navigation and communications capabilities completes the concept of integrated acoustic systems.

8:45

3aAO2. Acoustic detectability of squid egg beds. Kenneth G. Foote (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543), Roger T. Hanlon (Marine Biological Lab., Woods Hole, MA 02543), Annette E. Henry (California Dept. of Fish and Game, La Jolla, CA 92037), Alfred Hochstaedter (Monterey Peninsula College, Monterey, CA 93940), Rikk Kvitek (California State Univ., Monterey, CA), Deidre Sullivan and Yuko Yogozawa (Monterey Peninsula College, Monterey, CA 93940)

Egg beds of the market squid (*Loligo opalescens*) on the bottom of Monterey Bay seem to have been detected by means of sidescan sonar at 420 kHz. Evidence for this is presented in the form of sidescan sonar

images and egg-bed distribution maps from the same area, as prepared from camera surveys by scuba divers. The general detectability issue is also considered, with specific reference made to preliminary physical measurements performed on two egg capsules. [Work supported by Sea Grant.]

9:00

3aAO3. Fish schooling behavior inferred from differences between backscatter levels in Doppler sonar beams. Len Zedel (Phys. Dept., Memorial Univ., St. John's, NF A1B 3X7, Canada)

The general availability of Doppler profilers on survey ships provides a convenient source of acoustic backscatter data. Aside from calibration issues, caution must be exercised when analyzing this data because each of the diverging beams has a different interaction angle with the scatterers. In particular, for targets with directional scattering characteristics a different backscatter strength will be seen in each beam. The availability of data from multiple beam directions can however provide information on scatterer orientation when groups of such scatterers undertake coherent motion. This effect is demonstrated in observations of Norwegian spring spawning herring (*Clupea harengus*). In data collected while these fish are actively migrating with mean swimming speeds of 20 cm s^{-1}, a difference of 5 dB is seen in volume backscatter strength depending on the direction of fish movement with respect to the acoustic beams. In contrast, in data collected when these fish schools have less well defined movements with a mean swimming speed of less than 10 cm s^{-1}, a difference of less than 1 dB is seen.

9:15

3aAO4. Field trial of a Doppler sonar system for fisheries applications. Cristina D. S. Tollefsen and Len Zedel (Dept. of Phys. and Physical Oceanogr., Memorial Univ. of New Foundland, St. John's, NF A1B 3X7, Canada, cristina@physics.mun.ca)

Various deployments of commercial Doppler current profiling systems have demonstrated that these instruments can detect fish and measure their swimming speeds. However, research into the possible application of Doppler sonar to fisheries problems is limited and has not taken advantage of coherent signal processing schemes. A field trial was undertaken in August 2002 to explore the capabilities of a coherent Doppler sonar when applied to detecting discrete targets. The passage of migrating salmon on the Fraser River in British Columbia provided an ideal test opportunity with fish of well-defined swimming behavior and allowed for comparisons with conventional fisheries acoustics techniques. The instrument tested was a 250-kHz sonar which provided for phase coding of transmit pulses and coherent sampling of successive acoustic returns. The field trial resulted in 11 consecutive days of Doppler sonar data acquired during the peak of the sockeye salmon (*Oncorhynchus nerka*) migration. A total of 7425 individual fish were identified and their swimming speed was measured with an accuracy of between 10 cm s^{-1} and 20 cm s^{-1}, which depended on pulse length, pulse spacing, and target range. By comparison, water velocity measurements made with the same instrument can only achieve a theoretical accuracy of 60 cm s^{-1}.

9:30

3aAO5. Fish schools are the dominant cause of long-range active sonar clutter in the New Jersey Continental Shelf: Quantitative correlations. Deanelle T. Symonds, Purnima Ratilal (MIT, 77 Massachusetts Ave., Cambridge, MA 02139), Redwood W. Nero (Naval Res. Lab., Stennis Space Center, MS 39529), and Nicholas C. Makris (MIT, Cambridge, MA 02139)

Long-range underwater acoustic remote sensing data, acquired using a low- to mid-frequency bistatic sonar system, is compared with data from a downward-directed, fisheries-standard high-frequency fish-finding sonar. These data were simultaneously measured in the New Jersey Continental Shelf environment during the Main Acoustic Clutter Experiment 2003. The long-range sonar is capable of imaging extensive areas, spanning tens of kilometers in range, in near real-time. This makes it possible to continuously observe the spatial and temporal variability of environmental returns over wide areas. In contrast, the fish-finding sonar's single, downward-directed beam typically provides a swath of only 10 m width along the ship track. Dense populations of fish, indicated by prominent returns from the fish-finding sonar, are overlain onto long-range acoustic images. The outputs of the two systems are also directly correlated along the track of the fish-finding sonar. High correlation was found between locations of prominent environmental clutter in the long-range sonar system and locations of densely clustered fish schools measured with the fish-finding sonar. Additionally, regions absent of clutter were also found to be absent of significant fish populations. These correlations were observed repeatedly over a period of roughly 3 weeks.

9:45

3aAO6. Long-range acoustic imaging of the Continental Shelf Environment reveals massive fish schools: 2003 Main Acoustic Clutter Experiment. Nicholas C. Makris, Purnima Ratilal, Yisan Lai, Sunwoong Lee, Deanelle T. Symonds, Lilimar A. Ruhlmann (MIT, 77 Massachusetts Ave., Cambridge, MA 02139), Redwood W. Nero (Naval Res. Lab, Stennis Space Center, MS 39529), John R. Preston (Appl. Res. Lab, Penn State Univ., State College, PA 16804), Edward K. Scheer (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543), and Michael T. Sundvik (Naval Undersea Warfare Ctr., Newport, RI 02841)

Results from the three-ship, April–May 2003 Main Acoustics Experiment of the ONR Acoustics Clutter Program are presented. A long-range bistatic sonar system was used to image extensive clutter over wide areas of the New Jersey Continental Shelf in the low- to mid-frequency range in near real-time. A downward-directed high-frequency fish-finding sonar was also simultaneously operated from one of the ships to determine whether fish schools occur in the location of the clutter events. Tracks of the long-range sonar were repeated over days throughout the experiment. Most of the clutter features were observed to evolve both in time and in space moving throughout the survey area and therefore do not consistently correlate with static geologic features. The clutter features were observed to cluster, disperse, and gradually disappear and then re-emerge in the general vicinity at later times. The long-range active sonar data show that the primary source of clutter corresponds to objects moving in the waveguide. This was made certain by our ability to accurately register a number of fixed point targets deployed as controls throughout the experiment. The preliminary finding of this experiment is that the dominant source of clutter in this Continental Shelf environment is marine life, particularly fish schools.

10:00–10:15 Break

10:15

3aAO7. Long-term, large-scale acoustic fluctuations in the Ulleung Basin. Donald R. DelBalzo, LauriAne Winsett, and Erik R. Rike (Neptune Sci., Inc., 40201 Hwy. 190 E., Slidell, LA 70461)

An analysis of long-term, large-scale oceanographic conditions in the Southern Japan/East Sea has identified several interesting phenomena, including a previously undiscovered stable eddy. That analysis was based on temperature profile data observed daily with 23 PIES (pressure inverted echo sounder) instruments spaced at about 40 km throughout the Ulleung Basin during a 2-year period. In the present work, a gridded version of the PIES data was used to study the relation between oceanographic structure and acoustic transmission loss structure from 50 to 500 Hz throughout the area in terms of long-term fluctuations on the order of days to weeks. Significant correlations between oceanographic and acoustic variability were observed with different characteristics during summer and winter. The results indicate predictably stable acoustic paths that correlate with benign ocean conditions and predictably unstable acoustic paths that correlate with dynamic ocean features. The implication is that there are frequencies and sensor geometries that favor long-term acoustic monitoring with controlled uncertainty and that certain stable scenarios preclude the need for daily temperature sampling. [Work sponsored by ONR.]