Session 2aAO

Acoustical Oceanography: Innovations in Fish and Plankton Acoustics I

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Invited Papers

8:00

2aAO1. A seven-octave-bandwidth echo sounding system for application to fish and zooplankton. Kenneth G. Foote, Tor Knutsen (Inst. of Marine Res., P.O. Box 1870 Nordnes, N-5024 Bergen, Norway, tor@imr.no), Philip R. Atkins, Claire Bongiovanni, David T. I. Francis (Univ. of Birmingham, Birmingham B15 2TT, UK), Peter K. Eriksen, and Tom Mortensen (RESON A/S, DK-3550 Slangerup, Denmark)

A new echo sounder has been designed and built for measuring broadband acoustic scattering signatures of fish and zooplankton (BASS), which is also the name of the underwriting EU MAST-III project. Development of the system is described in terms of four elements: (1) acoustics, consisting of seven nominally octave-bandwidth transducers spanning the frequency range 25 kHz to 3.2 MHz, depth rated to 300 m, (2) electronics, for control of the transmission and echo reception processes, (3) man–machine interface, allowing remote operation of the transducers and electronics by a menu-driven personal computer, and (4) housing, including mounting of transducers on a bracket and packaging of electronics in a proximate pressure vessel. The system is presently configured for use as a vertical sonde, with ship-derived power. Early *in situ* applications to euphausiids and Norwegian spring-spawning herring observed on cruises in October and December 1998 are described. The issue of calibration is addressed. Supporting work on modeling the backscattering cross section of marine organisms based on measurement of their morphology and physical properties, and on measuring the same cross section *ex situ* in a so-called mesocosm of approximate volume 100 cubic meters, is mentioned. [Work supported by the EU through RTD Contract No. MAS3-CT95-0031.]

8:20

2aAO2. A multiple-frequency method for potentially improving the accuracy and precision of *in situ* target strength measurements. David A. Demer (Southwest Fisheries Sci. Ctr., P.O. Box 271, La Jolla, CA 92038, ddemer@ucsd.edu), Michael A. Soule (Sea Fisheries Res. Inst., Cape Town, South Africa), and Roger P. Hewitt (Southwest Fisheries Sci. Ctr., La Jolla, CA 92038)

The effectiveness of a split-beam echosounder system to reject echoes from unresolvable scatterers, thereby improving the measurements of *in situ* target strengths (TS) of individuals, is dramatically enhanced by combining synchronized signals from two or more adjacent split-beam transducers of different frequencies. The accuracy and precision of the method was determined through simulations and controlled test tank experiments using multiple standard spheres and 38- and 120-kHz split-beam echosounders. By utilizing the angular positional information from one of the split-beam transducers, additional corresponding TS measurements were shown to be obtainable from a juxtaposed single-beam transducer. Both methods were utilized to extract *in situ* TS measurements of Antarctic scatterers simultaneously at 38, 120, and 200 kHz. The ultimate efficiency of the multiple-frequency technique is shown to be limited by phase measurement precision, which in turn is limited by the scattering complexity of targets and the receiver bandwidth. Imprecise phase measurements also result in significant beam-compensation uncertainty in split-beam measurements. Differences in multi-frequency TS measurements provided information about the identity of constituents in a mixed species assemblage. The taxa delineation method has potential, but is limited by compounding measurement uncertainties at the individual frequencies and sparse spectral sampling.

8:40

2aAO3. The investigation of physiologically controlled resonance scattering data from fish using a new acoustic approach. C. Feuillade (Naval Res. Lab., Stennis Space Center, MS 39529-5004, cf@nrlssc.navy.mil)

Low-frequency acoustic scattering from fish is typically dominated by the swimbladder resonance response. Swimbladders are physically similar to bubbles, and it has been traditionally assumed that, as with bubbles, resonance frequency measurements may be directly used to calculate the swimbladdeer volume. Typically, swimbladder models used to interpret fisheries scattering data, and thus determine fish size and abundance, have adopted this premise. Questions are raised, however, by one set of measurements on depth-adapted Atlantic cod by Sand and Hawkins [J. Exp. Biol. **58**, 797–820 (1973)], which indicates resonance frequencies much higher, and with more rapid depth variations, than can be realistically explained using such simple assumptions. They argued that the anomalous resonances they observed were actively controlled by the fish, and not just a passive property of the swimbladders. To investigate this phenomenon, a new model was recently developed which incorporates both viscous and elastic properties of fish flesh as variables influencing swimbladder scattering [J. Acoust. Soc. Am. **103**, 3245–3255 (1998)]. This presentation will demonstrate how this model provides a basis for understanding the physiological behavior of the fish, and a starting point for determining which species of fish may be reliably surveyed using the traditional approach.