9:00

2aAO4. Fisheries and plankton acoustics: State of the art and beyond. David N. MacLennan (Marine Lab., P.O. Box 101, Victoria Rd., Aberdeen AB11 8DB, Scotland, MacLennan@marlab.ac.uk)

Acoustical methods are well established as a means of remotely observing aquatic organisms. The range of applications reported in the literature is wide, from studies of isolated animals to populations extending over large areas. The geometric scale of target organisms is similarly huge, from microscopic plankton to the largest of marine mammals. The information required from acoustical investigations may be simple quantities like abundance estimates, or more descriptive output like species identification. In each case, there are different problems to be considered. The multi-disciplinary nature of acoustical techniques is important. Success depends on a combined appreciation of scattering physics, animal physiology, statistics, and sonar technology to mention just some of the contributing fields. The historical context is explained, leading to a critical review of recent developments. To a large extent, the driving force has been new technology, especially the rapid growth of computing power. It is important to ensure that appropriate scientific research is done to achieve the benefits of new technology, in acoustics as in other fields, for a better understanding of the living resources in the sea and fresh waters.

Contributed Papers

9:20

2aAO5. Acoustic observations of the annual cycle of fish and plankton populations in the Beaufort Sea. Robert Pinkel (Scripps Inst. of Oceanogr., 9500 Gilman Dr., La Jolla, CA 92093-0213)

During the period November 1997 through September 1998, a 160-kHz Doppler sonar was operated at the SHEBA ice camp. During this period, the camp drifted clockwise around the Beaufort Sea. The sonar, constructed at the Marine Physical Laboratory of the Scripps Institution of Oceanography, transmitted coded pulses with an 8-kHz bandwidth and recorded echo intensity, spectral bandwidth, and mean Doppler shift. The fall 1997 data featured very weak return echoes. Distinct hard targets were observed over ~5% of the profile. These have been tentatively identified as Arctic Cod. With changing season and camp location, both plankton and fish populations have evolved significantly. Algorithms have been implemented to track the discrete hard targets and the underlying continuum planktonic population through the course of the year.

9:40

2aAO6. Acoustic abundance estimation of midwater animals. Kenneth G. Foote and Ingolf Roettingen (Inst. of Marine Res., P.O. Box 1870 Nordnes, N-5024 Bergen, Norway, ingolf.rottingen@imr.no)

The echo integration method of estimating the abundance of midwater animals, specifically pelagic fish and zooplankton, is reviewed. The roles of the modern scientific echo sounder and complementary postprocessing system are emphasized, but requirements imposed by availability of the target animals to surveying by vertical transducer beam, environment including weather and possible presence of other significant scatterers, and the animal itself, are mentioned. The process of converting acoustic measurements of animal density to abundance over the survey region is illustrated in detail for the case of Norwegian spring-spawning herring (Clupea harengus) when wintering in a fjord system. A simple explanation is given for continued interest in the scattering properties of midwater animals, specifically their backscattering and extinction cross sections. The constant need for positive scatterer identification, as through physical capture or optical registration, or, failing these, acoustic classification, is described. The usefulness of geostatistics in estimating abundance and the variance of the abundance estimate, as well as in quantifying the observed spatial distributional properties of the animal, is mentioned. [Partial support of the EU through RTD Contract Nos. AIR2-CT94-1007 and MAS3-CT95-0031 is acknowledged.]

10:00–10:20 Break

10:20

2aAO7. Use of acoustics in large tuna trophic-habitat characterization in French Polynesia. Arnaud Bertrand (ORSTOM, BP 70, 29280 Plouzane, France, arnaud.bertrand@orstom.fr)

Tuna have a high metabolic rate, yet they often live in regions characterized by low primary productivity rates. Improving knowledge on tuna-habitat trophic relationship is of main importance for understanding tuna distribution and catchability. Distribution of large tuna food webs, i.e., micronekton, was described in French Polynesia at depths up to 500 m using acoustics and pelagic trawls. At large scale, acoustics profile response, morphological characterization of acoustic structures, and quantitative descriptors of sound scattering variability were used. Due to water masses advection and oxygen limitation main micronektonic production was localized 8 degrees south of the equatorial upwelling. At a smaller scale, micronekton was classified into seven scattering type: gas-filled swimbladder fish, absent swimbladder fish, gas-bearing invertebrates, cephalopods, fluidlike crustacean, fluidlike jelly-fish, and elastic-shelled invertebrates. Qualitative and quantitative aspects of the scattering structures were also described. Then scattering structure composition and the tuna trophic interest of aggregations was determined.

10:40

2aAO8. Multi-frequency measures and models of Lake whitefish (*Coregonus clupeaformis*) backscatter from Lake Michigan. J. Michael Jech, John K. Horne (CILER, Univ. of Michigan, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, jech@glerl.noaa.gov), Lee A. Powell, and James H. Grandt (Univ. of Wisconsin, Madison, WI 53706)

To improve chances for discriminating and identifying fish and zooplankton species, more acoustic information is better. Multifrequency, digital echosounders increase information bandwidth by increasing the number discrete frequencies transmitted and received through multiple transducers. Multifrequency data provide a range of aural perspectives just as colored spotlights accent different components of a painting. Lake whitefish (*Coregonus clupeaformis*) represent an increasing biomass in Lake Michigan and have a disproportionately large, single-chambered swimbladder relative to the body volume. Frequency-dependent, echo amplitude predictions from a Kirchhoff-ray mode model were compared to *in situ* backscatter measurements of constrained and free ranging lake whitefish at five discrete frequencies (38, 50, 120, 200, and 420 kHz). In addition to geometric scattering, backscattering characteristics of whitefish in the resonance region were also modeled. This combination of theoretical model prediction and multifrequency measures allows the quantification of the importance of intraspecies backscatter variability due to fish sizes and behavior. [Work supported by ONR.]

11:00

2aAO9. Status and distribution of the dolphins in the Black Sea—By the acoustically improved line transect sampling technique. Ali C. Gucu (Inst. of Marine Sci., Middle East Tech. Univ., P.O. Box 28, Erdemli, 33731, Icel, Turkey, gucu@ims.metu.edu.tr)

Although dolphins are an endangered species, until 1983 they had been harvested in the Black Sea. Due to severe ecological changes taking place in this sea, the fish stocks experienced a decline within the last decade. The dolphins preying upon fish stocks were adversely affected and their population size was shrunk due to food shortage. But there is an ever growing lobbying on the government for legalizing dolphin fishery, because fishermen believe that the dolphin population has increased since the ban of dolphin fishery, resulting in an increased predation over the fishes