for suppressing range sidelobes and pulse designs with both range and Doppler sensitivity will be reviewed. The constraints imposed by the transducer will be considered, particularly in relationship to ultrahigh range resolution capabilities. Finally, a comparison between an early 1960s sonar and a modern equivalent will be made in terms of performance, power consumption and size.

10:05–10:25 Break

Contributed Papers

10:25

1aAO3. Acoustic classification of individual zooplankton using artificial neural network. Andone C. Lavery and Timothy K. Stanton (Woods Hole Oceanogr. Inst., Dept. of Appl. Ocean Phys. and Eng., Woods Hole, MA 02543)

The acoustic scattering characteristics of zooplankton generally fall into one of three categories: gas-bearing, fluidlike, or elastic shell. Acoustic scattering models are available for zooplankton that fall into each of these categories. A multilayered feedforward artificial neural network, based on a backpropagation algorithm, has been used to discriminate between the model-based acoustic scattering responses of individual zooplankton from these different zooplankton classes. Realistic animal size distributions, taken from net tows, have been used as input to the models to create (simulated) acoustic data for use as input into the classification network. Two different approaches have been taken to selecting input features from the model-based zooplankton scattering responses, and the results of the neural network classification for these two features sets are compared. The feasibility of applying this neural-network-based classification technique to both multifrequency and broadband target strength data from field surveys is discussed.

10:40

1aAO4. Simple, nonoptimal, real-time classifiers for euphausiid and copepod numerical density estimation. Philip R. Atkins, Claire Bongiovanni, David T. I. Francis (School of Electron., Univ. of Birmingham, Edgbaston, Birmingham B15 2TT, UK), Kenneth G. Foote (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543), Tor Knutsen (Inst. of Marine Res., N-5817 Bergen, Norway), Peter K. Eriksen, Mette Torp Larsen, and Tom Mortensen (RESON A/S, DK-3550 Slangerup, Denmark)

An active sonar covering the frequency range 1.6–3.2 MHz was used to observe zooplankton at two sites along the Norwegian coast during the period 28 April–9 May 1999. The sonar transmitted LFM signals with an approximate bandwidth-time product of 100. The matched-filter envelope was computed within the receiver at a sampling rate of 10 M samples/s. Freshly caught, swimming specimens were insonified *ex situ* in a tank mounted on the stern of R/V JOHAN HJORT, and the envelope signal was classified by eye as belonging to the euphausiid *Meganyctiphanes norvegica*, or copepod *Calanus finmarchicus*. The separated signals were then averaged to produce templates corresponding to the two classes. All orientation information associated with the specimens was thus removed. A sliding-window-normalized covariance was calculated between the templates and the receiver output for a large number of *ex situ* and *in situ* pings, a technique capable of being implemented at the sampling rate of the receiver. Although simple, this multiple-hypothesis-testing procedure outperformed a conventional split-window (CFAR) normalizer and produced a rapid and apparently reliable method of distinguishing the two classes and estimating their numerical density. [Work supported by EU RTD Contract No. MAS3-CT95-0031.]

10:55

1aAO5. Observation of fish length and behavior of an individual fish using echo trace analysis. Kouichi Sawada, Yoichi Miyanohana, Hideyuki Takahashi, and Yoshimi Takao (Natl. Res. Inst. Fisheries Eng., Fisheries Res. Agency, Hasaki, Kashima, Ibaraki 314-0421, Japan, ksawada@nrife.affrc.go.jp)

A compact sized split-beam echo sounding system was developed and used in Sagami Bay, Japan, to validate echo trace analysis (ETA) that can observe the length and the behavior of an individual fish. Fishing by hook and line was conducted to confirm the fish species and its length distribution. The echo sounding system was tethered from an anchored ship. Electric power was provided through a cable. This system consists of a split-beam transducer (70 kHz, 118 mm), a transmitting and receiving unit, a data-recording unit, and a control unit and the total weight of the echo sounding system is about 30 kg. Recorded data are up linked to the computer on the ship through a LAN cable. The fish length and fish swimming speed were estimated using ETA. From the fishing results, 79l (*Scomber japonicus*) or horse mackerel (*Trachurus japonicus*) had an average fork length (FL) of 27.9 cm. The estimated fish length distribution coincides with that obtained from a fishing well. The estimated swimming speed was 0–1.2 m/s and corresponds to 0–4.3 (FL). These results show the validity of ETA.

11:10

1aAO6. Use of multiple-beam echo-sounders for estimation of target strength *in situ*. Ian Hampton (BENEFIT, P.O. Box 912, Swakopmund, Namibia) and Michael A. Soule (Marine and Coastal Management, Dept. of Environ. Affairs and Tourism, Roggebaai, 8012, Cape Town, South Africa)

In principle, the average target strength of fish in a defined volume can be estimated *in situ* from the ratio between the volume backscattering strength and a count of the number of fish in the volume. The chief problems, which have precluded use of the method in practice, are the difficulty in obtaining reliable counts at common fish densities and in defining beam volume. It is suggested that both problems could be solved to a large extent by using a relatively modest high-frequency, multi-beam echo-sounder as a counter. This presentation outlines the underlying principle of the method, considers the design criteria, and describes a 48-element 420 kHz system, (code named ABACUS) which is being built to test the method. The system, which has been designed to operate to approximately 70 m, for target strengths in the range 40 to 55 dB, generates a single transmit beam and 32 receiving beams orthogonal to it, which intersect to give up to ten 1 deg $\times$ 1 deg resolution cells. Preliminary test-tank results are presented, and plans for further experimental work discussed. It is believed that the method should be capable of delivering *in situ* target strength estimates at densities well beyond the limit of current methods.

11:25–11:55

Panel Discussion