

for the backscattering cross section that agree to within 1 part in 10 000 to better than one part in 1 000 000 for  $k_a$  of the order of 100. [Partial support of the EU through RTD Contract No. MAS3-CT95-0031 is acknowledged.]

**3aAOa11. Shark and salmon movement measured by tracking radar-type acoustic transducers.** John Hedgepeth, David Fuhrman (BioSonics, Inc., Seattle, WA), Robert Johnson, David Geist (Battelle Memorial Inst., Richland, WA), Norm Bartoo, David Holts (Natl. Marine Fisheries Service, La Jolla, CA), Tim Mulligan, and George Cronkite (Dept. of Fisheries and Oceans, Nanaimo, BC, Canada)

Studies of fish behavior have used a methodology called the tracking transducer. The principle of tracking radar, aligning the antenna beam with a target, was applied with an acoustic split-beam transducer and dual-axis rotators for tracking individual fish over long periods of time. Deviation of the target from the beam axis produces a correction to point the axis toward the target. Initial studies with active acoustics have evolved an acoustic tag tracking method that is proposed for tracking both juvenile salmon and pelagic sharks. The major advance is that active and passive radar-type tracking can be combined in the same instrument. The tracking transducer was first used at Ice Harbor Dam, Snake River, 1995, and in 1996, at The Dalles Dam, Columbia River. Two tracking systems were used to triangulate a small acoustic transmitter in salmonid fish at Lower Granite Dam on the Snake River, Washington. Recently, adult salmon, returning to the Fraser River, were tracked to measure avoidance to surveying vessels. The feasibility for tracking sharks was shown at the Tacoma, Washington Point Defiance Aquarium. A proposed method of simultaneously tracking sharks with echoes and using acoustic tags will allow behavior, abundance, and associated pelagic assemblages to be determined.

**3aAOa12. Mechanoreception for food fall detection in deep sea scavengers.** Michael Klages (Alfred-Wegener-Inst. for Polar- and Marineresearch Postfach 12 01 61, 27515 Bremerhaven, Germany) and Sergey I. Muyakshin (Inst. of Appl. Phys., Nizhny Novgorod, 603600, Russia)

Although knowledge about functional principles of deep-sea ecosystems is rather scarce, it is assumed that the energy supply for scavengers is restricted to large food falls of dead vertebrates. It is generally accepted that chemoreception is one of the major tools for marine organisms to detect food sources. However, another major source of information may come from hydroacoustical feeding noises produced by scavengers appearing on a cadaver reached the seafloor. The aim of the present study was to investigate whether scavenging crustaceans—pandalid shrimps *Pandalus borealis*—are able to detect such rare food fall events via mechanoreception or not. These results are based on 228 single experiments indicating that these animals possess the sensitivity to the particle dis-

placement of 0.1–10 mkm in frequency range 30–250 Hz. Therefore, acoustic feeding noises offer a possibility for animals to detect such rare events but only at distances of a few meters. At such small distances chemoreception is presumably more important. However, based on theoretical calculations on the relevance of various types of waves, originating on the water-sediment interface from any object falling on the seafloor, it is proposed that such “micro seismic events” may allow resting scavengers even some hundred meters away the detection of this event, most likely followed by chemoreceptive tracking.

**3aAOa13. Echogram noise quantification with application to herring observations.** Rolf J. Korneliussen (Inst. of Marine Res., P.O. Box 1070, Nordnes, N-5024 Bergen, Norway, rolf@imr.no)

Pushing the limits of scientific echo sounders involves considerations of noise, which is inherently frequency dependent. Surprisingly, perhaps, there is also a dependence on bottom depth. In this work, noise is quantified by measurement for a standard echo sounder, the EK500, at 18, 38, 120, and 200 kHz. Use of empirical relations of noise as a function of range to reduce echogram noise is described in general, and illustrated in particular for data collected on Norwegian spring-spawning herring (*Clupea harengus*) when wintering in the Vestfjord system. [Work supported by the Norwegian Research Council through Grant No. 113517/120.]

**3aAOa14. Preliminary description of swimming activity and estimation of swimming speed of saithe (*Pollachius virens*) at one location in the North Sea.** Jens Pedersen (Danish Inst. for Fisheries Res., North Sea Ctr., P.O. Box 101, DK-9850 Hirtshals, Denmark, jp@dfu.min.dk)

Individual saithe were tracked with a split-beam echosounder, while the vessel was drifting, in the area around Eigersundbank in the North Sea and their swimming speed estimated. The average swimming speed was approximately 4 and 1 body lengths per second for small saithe (20–30 cm) and saithe >70 cm, respectively, and a significant inverse relationship between length of the saithe and swimming speed was found. There was clear evidence of diurnal variation in swimming speed of small saithe, as the swimming speed was significantly higher during night (18–06 h) than during day (06–18 h). The number of observations on saithe >70 cm was too small to compare day and night swimming speeds. Although the results indicate higher swimming speeds of saithe in the demersal layer compared to pelagic saithe, significant differences were not found. The duration of acoustic observation time was 36–56 min per 4-h sampling interval during the 24-h cycle. A total of 278 series of saithe were selected, which, according to selection criteria, were accepted as representing tracking of single fish over two pings or more. The species identify of the targets tracked acoustically was verified by trawling in the layers investigated.