Title: Healy_0701_EK60_acoustic_backscatter_readme.pdf

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Data set version: 1.0 Preliminary 9/21/07

Data Set Overview:
Underway acoustic backscatter strength separated into backscatter consistent with scattering from swimbladdered fish and euphausiids.

Data:
Healy_0701_ek60_acoustic_backscatter_euphausiid_class.csv
Healy_0701_ek60_acoustic_backscatter_fish_class.csv

Figures:
Healy_0701_EK60_acoustic_backscatter_euphausiid.pdf
Healy_0701_EK60_acoustic_backscatter_fish.pdf

Instrument Description:

We mounted Simrad 120-7C and 38-12 transducers 10 cm apart in a transducer well on Healy's hull which is at a depth of 8.4 m. The transducers were mounted 5 cm from the face of a composite urethane acoustic window which is bolted to the hull. The wells were filled with a 1.3 % freshwater and propylene glycol solution to prevent freezing of the water in the wells. The transducers were connected to Simrad EK60 120 and 38 kHz general purpose transceivers. The time on the logging computer was synchronized every 5 minutes to a timeserver aboard the ship to ensure that the echosounder time stamp matched that of other data streams. A standard sphere calibration of the system and transducer cabling was conducted prior to the installation. In order to adjust for signal loss due to transmission and reception through the acoustic window, the echosounder gains were adjusted by the transmission loss measured on this material at an incidence angle of 90 degrees (1.2 dB at 38 and 3.2 dB at 120 kHz (Bockstege, 1991).

A sequential instrument triggering system was used avoid interference from other instruments. The trigger was based on the transmit pulse of a Seabeam 2112 system delayed by 0.5 seconds in order for the EK60 to receive after energy from the Seabeam transmission had attenuated. The EK60 ran at ~0.7 pings per second when not limited by travel time to the bottom (i.e. < ~750m depth). The Sperry SRD500 doppler speed log, which cannot be triggered, was turned off to avoid interference at 120 kHz. Acoustic data were logged continuously along the vessel track line during the period of 11 April - 11 May 2007.

Table 1: Echosounder parameters used during data collection.

	38 kHz	120 kHz
Gain	20.61	22.31
Sa Correction	-0.49	-.085
3dB beamwidth alongship	12.09	6.59
3 dB beamwidth athwart ship	12.03	6.58
Equivalent Beam Angle	12.5	-21.0
Power	1000 Watts	500 Watts
Pulse Length	1 ms	1 ms

Data processing:

The acoustic data exhibited evidence of reverberation at close ranges, which dropped off substantially with range. As this does not occur when the transducers are not mounted in the well, it is attributed to reverberation inside the transducer well. In order to eliminate this reverberation from the data analysis, data at short ranges 35m at 38 kHz were ignored. Backscatter from 16m from the surface (120 kHz) or 24m from the surface (38 kHz) extending to 0.5m from the sounder detected bottom were analyzed. Backscatter measurements are made to a maximum of 250m in to keep the background noise levels well below the integration threshold.

When Healy traveled through heavy ice, the breaking of ice and ice under the hull often resulted in blocking of the acoustic signal, which was evident as a weak bottom echo. In order to minimize the impact of interference, which occurred when breaking heavy ice, only pings with a minimum bottom return of –30 Sv in the bottom echo were used in the analysis. Applying this filter removed obvious acoustic noise caused by impacts with the ice as well.

Two acoustic categories, one attributed to swimbladdered fish and one to euphausiids were developed based on the observed frequency response at 120 and 38 kHz (e.g. Figure 1). Experience on NOAA surveys, where organisms are sampled to verify the acoustic backscatter in the Bering Sea as well as other studies suggest that this is a reasonable generalization (Korneliussen and Ona, 2002, Miyashita et al., 1997, De Robertis, unpublished data). Acoustic records were averaged into 5 ping by 5m cells, and the frequency difference was in each cell was computed. Cells with a S_{v120}-S_{v38} (Sv is a log10 unit of backscatter strength) in the range of –9.3 to 9.3 dB were assigned to the fish category and those in the range of 9.3 to 30 dB were assigned to the euphausiid category. Acoustic backscatter in these categories were averaged in 0.5 nmi elementary sampling distance units (EDSU's) in 5m depth cells along the vessel trackline. Backscatter passing the "fish" category was integrated at 38 kHz and fish passing the "euphausiid" category was integrated at 120 kHz using a -80 Sv integration threshold. Acoustic backscatter strength is given in s_A with units of m^2 nmi^{-2} averaged over the water column. s_A is a linear measure of backscatter strength (see MacLennan et al, 2002 for a good discussion of acoustic units).

Data Format:
two files one for 38 kHz backscatter strength consistent with fish and one for 120 kHz backscatter strength consistent with euphausiids.

Time_UTC	Latitude	Longitude	s_A (m^2 nmi^{-2})
2.01E+13	54.2456	193.4301	33.7609
2.01E+13	54.2538	193.4308	27.1382
2.01E+13	54.2621	193.433	7.2133

Data remarks:
Bad s_A data flagged as -99.
Assessment of data: Generally of good quality with no interference from other acoustic devices. There are several gaps (not flagged as missing) due to failures of the network and triggering system.
Much of the "fish" backscatter (especially that near the shelf break) is consistent in appearance and location with that of walleye pollock. The "euphausiid" backscatter performs clear vertical migrations and a substantial portion of the population migrates above the transducer during the night.

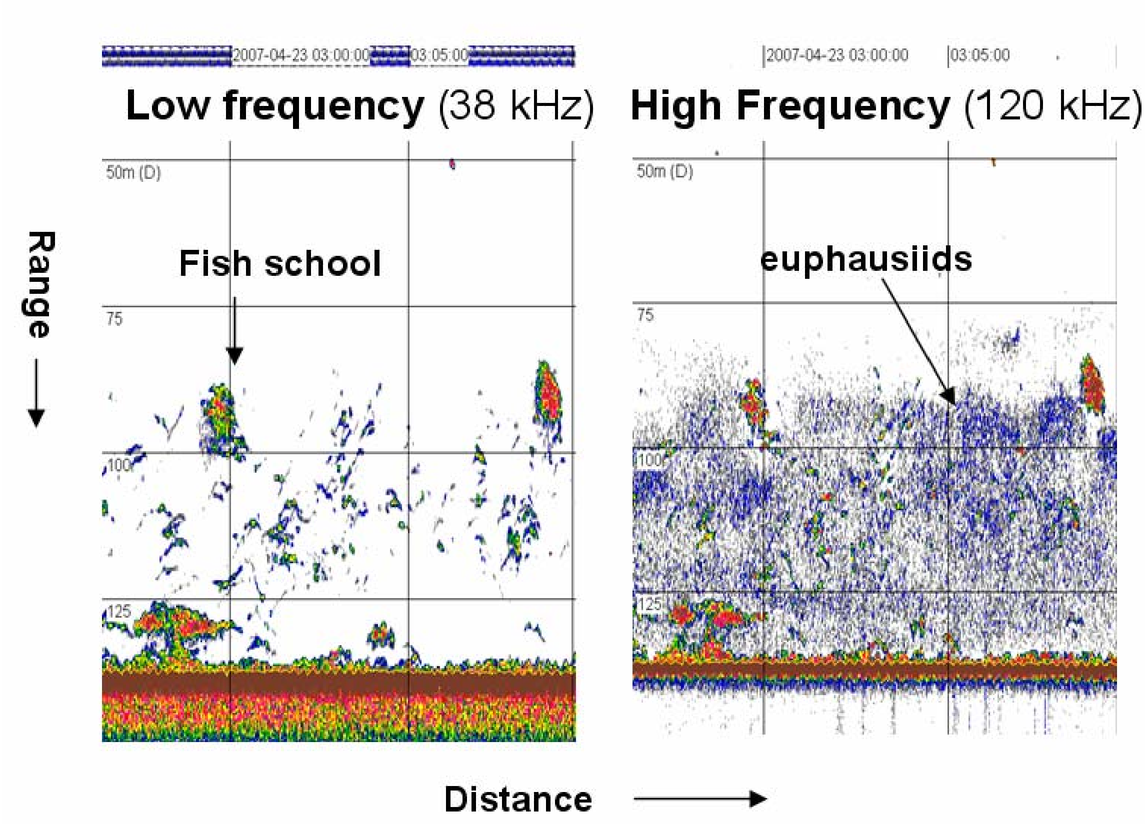

Figure 1: 38 and 120 kHz echograms from Healy showing backscatter from fish schools that are evident at 38 kHz. The fish are also visible at 120 kHz and also the light blue backscatter from macrozooplankton which is much weaker at 38 kHz. This frequency dependence is the basis for the classification used in this data set.

Acknowledgements: This work involved a complex instrument installation and integration with the ship's systems, and could not have been performed without the assistance of Healy's staff, particularly Dale Chayes and Master Chief Peter Perron.

References:

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MacLennan, D. N., Fernandes, P. G., and Dalen, J. 2002. A consistent approach to definitions and symbols in fisheries acoustics. ICES J. Mar Sci 59: 365-369.

Miyashita, K., Aoki, I., Seno, K., Taki, K., and Ogishima, T. 1997. Acoustic identification of isada krill, *Euphausia pacifica* Hansen, off the Sanriku coast, north-eastern Japan. Fisheries Oceanography 6: 266-271.