High Resolution Multi-frequency Acoustics for study of Zooplankton

Use of a high resolution multi-frequency acoustic instrument, the Acoustic Zooplankton Fish Profiler, for studies of zooplankton biomass and characterization of vertical ecosystem structure in the North Bering and Chukchi seas.

There is a need to develop new techniques for the monitoring and study of zooplankton. One promising approach is the use of high resolution multi-frequency acoustics to understand vertical structure, abundance, and species composition.

In the summer of 2013, Drs. John Nelson of Seastar Biotech and Svein Vagle of Fisheries and Oceans Canada in collaboration with David Lemon and Jan Buermans of ASL Environmental Sciences, deployed an instrument package consisting of an Acoustic Zooplankton and Fish Profiler (AZFP), along with an Acoustic Doppler Current Profiler (ADCP), to characterize zooplankton communities and ecosystem structure in the N. Bering and Chukchi Seas (Figure 1).

The AZFP-ADCP package was put over the side of the Canadian Coast Guard Ship Sir Wilfrid Laurier at stations that are part of an initiative known as the Distributed Biological Observatory (DBO), which is a multi-disciplinary collaborative project supported by the US National Science Foundation and Fisheries and Oceans-Canada, and led by Drs. Jackie Grebmeier and Lee Cooper from the University of Maryland.

The goal of the DBO is to monitor and assess status and trends in the physical and biological oceanography of an area that is undergoing rapid environmental change; because of the pivotal role of zooplankton, it is critical to understand how they are responding to this change. The aim of the work described here is to develop and apply acoustic methods that will improve and refine the standard net-based zooplankton estimates which are subject to bias due to “catchability” of particular species and high variability of estimates due to patchy zooplankton distribution.

The instrument package consisted of a battery powered AZFP pinging at 125, 200, 455, and 769 kHz fastened to a cabled 150 kHz ADCP (see Figure 2.). The channels are pinged sequentially, starting with the highest frequency and transmitting at the end of the receiving period for the preceding channel. The transmission sequence was repeated once a second. The goal is to combine differential volume backscattering profiles of the biotic layers from the AZFP with current estimates from the ADCP to produce taxon specific plankton abundance estimates; this approach holds great promise for improving on the standard and widely applied net-based techniques. A secondary goal is to examine correspondence of water column properties with layering patterns to get an idea of how the water properties influence the horizontal distribution of zooplankton and phytoplankton.

Preliminary results demonstrate the utility of this approach. Shown are 125 kHz echograms from four stations in the N. Bering Sea that are superimposed with temperature, salinity and fluorescence profiles from the ship-board CTD (Figure 3). Comparison of the backscattering layers to the fluorescence profiles reveals station-to-station variation in community composition and ecosystem configuration. Follow on work will combine multi-frequency AZFP data, and information regarding species composition and abundance from net tows and water samples, with the ADCP derived current data to develop methods for taxon specific abundance estimates. The low power requirements and small size of the AZFP allowed us to conveniently deploy the instrument in “casting” mode. It is apparent that the instrument holds significant potential for cost effective collection of multi-frequency acoustic data which can be deployed in a range of formats.

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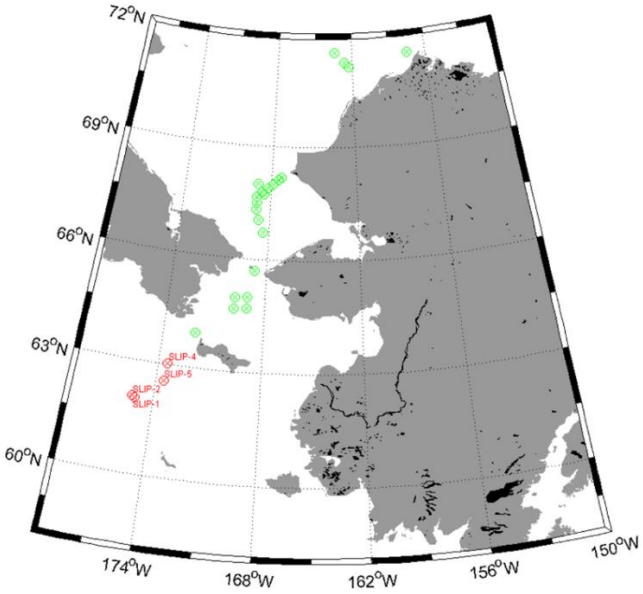

Figure 1. Location of Areas studied - North Bering and Chukchi Seas. Data from the stations in red is shown here.

Figure 2. AZFP - ADCP instrument package.

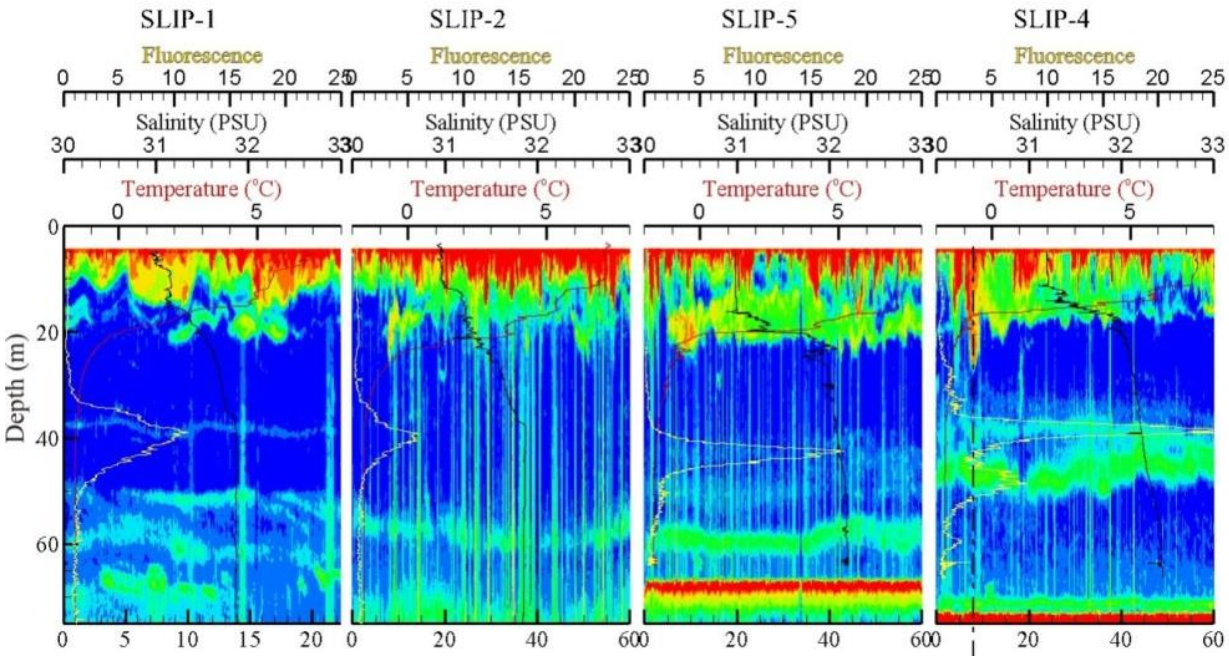

Figure 3. Water column properties superimposed on 125 kHz echograms from four stations in the North Bering Sea. Shown are profiles of fluorescence in yellow, salinity in black, and temperature in red.