Autonomous Zooplankton Sampling for Ocean Observing Systems

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INTRODUCTION

Continuous operation of autonomous instrumentation is essential for implementation of the U.S. Integrated Ocean Observing System in Alaska (AOOS). A multi-frequency acoustic sensor, appropriate for the site-abundance estimation of zooplankton from ca. 0.25 mm to > 25 mm total length, was successfully deployed and recovered during three sequential summers from a Gulf of Alaska biological shelf mooring. The instrument package autonomously sampled a single depth in the upper water column every 24 minutes in 2002 for 139 days, every 28 minutes in 2003 for 113 days, and every 28 minutes in 2004 for > 142 days. Volume backscattering strengths (0) revealed significant, incremental differences in the sound scattering. In the spring of 2002 we observed the highest biomass of all three years: total biomass was similar in the spring of 2003 and 2004, but was distributed differently among copepod-like and ephippin-like scatterers. Within a year, 2004, we observed an increase in biomass and the presence of a wider range of sizes when comparing April and August data. The same instrument was deployed on the Bering Sea shelf in the spring of 2006 with the capability to transmit data in near real-time. The data was successful with transmission of 5.9 GB of acoustic data. Successful autonomous operation of acoustic instruments for estimation of zooplankton site and abundance and spatial scale and behavior for planktonic crustaceans will be crucial for observing these often undersampled elements in remote locations such as the Bering Sea and Gulf of Alaska.

METHODS

Mooring

The biological mooring was located on the continental shelf of the northern Gulf of Alaska, west of Prince William Sound (Figure 1). The biological mooring consists of a large, surface moored buoy with a meteorological suite of sensors mounted on a tripod (Figure 2 - left panel). Below the moored buoy is a string of instruments that includes a single acoustic instrument (TAPS-B) at ca. 20 m depth, plus SeaCat CTDs, Miniature Temperature Recorders (MTRs), fluorometers, nitrite, and current meters.

Acoustics

There are several different acoustical methods to determine zooplankton biomass and distribution (Greene and Weise, 1998). We choose the multifrequency method because of our familiarity with this technique. A sensor sampling technology (U.S. GLOBEC, 1991, 1993, Smith et al., 1997) it builds upon the earlier success of a 21-frequency acoustic profiler (MAPS), and uses multi-scattering model (reverse solutions to enable acoustic volume backscatter by zooplankton into bins) (Holliday, 1977, 1996, Napp et al., 1993; Holliday and Papir, 1995; Holliday et al., 2003). The TAPS-B is an 8-frequency acoustic device (104, 165, 265, 420, 720, 1100, 1850, 3000 kHz) suitable for site-abundance estimation of zooplankton from ca. 0.25 mm to > 25 mm total length. The device consists of an electronics case with 8 wide-beam transducers and 2 battery cases (Figure 2 - right panel). Data from the TAPS-B consists of mean integrated echo intensities and echo variance ratios at each of the 8 frequencies, computed over 32 individual pings. Time between ensemble averages is user-defined. In the Gulf of Alaska and Bering Sea deployments measurements were made every 24 (2002) or 20 (2003, 2004 and 2006) minutes. Echo intensities for all 8 frequencies were measured from 2 (2-3 cup) upward casts at a range of ca. 3.5 m from the transducers. In addition, intensities were measured for the lowest 4 receivers plus the fastest transmitting pings that entered the sample range to ca. 16 m from the instrument (50 m sample volume). This latter mode is useful for estimating the abundance of larger, less numerous scatterers such as euphausiids, amphipods, and prawns.

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CONCLUSIONS

- The TAPS-B was successfully operated as a self-contained instrument for three seasonal summers in the northern Gulf of Alaska.
- The resultant zooplankton biomass data are rich in detail, showing many of the expected modes of diet, season, and interannual variability.
- Temporal resolution of the data from the mooring was far superior to what was collected from ships during NPE GLOBEC.
- The TAPS-B was successfully operated for a single summer in near real-time mode on the eastern Bering Sea shelf. Biocoustic and echo mooring data were transmitted from subsurface instruments to a surface transmitter via acoustic modems. The data were then transmitted to our laboratory computer via an Iridium satellite telecommunication link.
- Initial inspection of the Bering Sea data show many of the same modes of variability as the Gulf of Alaska data.
- Our next step is to create data products from the near real-time TAPS that can be posted on the world wide web.

BERING SEA PILOT STUDY

- A towed buoy and transect were acoustically sampled on the shelf of the Bering Sea during spring deployment. The transect and buoy were cast in on the shelf for the 8 receiver TAPS-B. See the details at the http://nsf.org/generic.topp/BS/BS_new/ for additional information.

REFERENCES
