Box 6.3 BIOMAPER-II

Sampling of plankton communities historically has been a costly, labour-intensive activity, due in large part to the effort needed for sorting and identifying organisms collected by nets, pumping systems, or water bottles. Thus, in the planning phases of the Global Ocean Ecosystem Dynamics (GLOBEC) programme, more efficient, higher-resolution samplers were designed, tested, and deployed in the field sampling at many of the study sites. Video and acoustic technologies employed have demonstrated the capability for cost-efficient plankton sampling and identification. One such system is the Bio-Optical Multifrequency Acoustical and Physical Environmental Recorder, or BIOMAPER-II. This is a towed system capable of conducting quantitative surveys of the spatial distribution of coastal and oceanic plankton/nekton (Wiebe *et al.* 2002).

BIOMAPER-II consists of a multi-frequency sonar, a Video Plankton Recorder (VPR-Davis *et al.* 1992) system (Davis *et al.* 2005) and an environmental sensor package (CTD, fluorometer, transmissometer). The latter sensor set is used to describe the hydrographic and environmental characteristics of the water column that then can be related to plankton distributions and abundances.

The acoustic system collects backscatter data from a total of 10 echo sounders (5 pairs of transducers with center frequencies of 43 kHz, 120 kHz, 200 kHz, 420 kHz, and 1 MHz), half of which are mounted on the top of the towbody looking upward, while the other half look downward. This arrangement enables acoustic scattering data to be collected for much of the water column.

These acoustic frequencies were chosen to bracket the transition from the Rayleigh to geometric scattering regions for zooplankton and micronekton in the range of 1 to 200 mm. The software enables data aquisition on five frequencies with each pair of transducers. The range of the 0.5 m depth strata allocated for each transducer is dependent on frequency with the lowest frequencies given the longest range and highest frequency the shortest range (i.e. 43 kHz = 200 m, 120 kHz = 200 m, 200 kHz = 149 m, 420 kHz = 100 m, 1,000 kHz = 35 m). Echo integration is normally conducted at 12 s intervals to provide volume backscattering data at all five frequencies. Split-beam data are normally collected at the four lower frequencies, which enables individual targets to be identified and target strength (TS) determined.

Acoustic data from the up- and down-looking transducers are processed in real time and combined to provide a vertically continuous acoustic record extending from the surface to at least 200 m, and at most 350 m, depending on the position of the BIOMAPER-II along its undulating towyo path.

The VPR is an underwater video microscope that images and identifies and counts plankton and seston in the size range 0.5–25 mm, often in real time. The VPR video data augments the high-resolution acoustical backscatter data. The two systems together allow high-resolution data to be obtained on zooplankton in the water column. The range-gated acoustical data provides distributional data at a higher horizontal resolution than is possible with an independent VPR, while the video data provides high-resolution taxa-specific abundance patterns along the towpath and allows for direct identification, enumeration, and sizing of objects in acoustic scattering layers, so that the VPR data can be used to calibrate the acoustical data.

BIOMAPER-II in combination with a Multiple Opening/Closing Net and Environmental Sampling System (MOCNESS) was used on a series of five US GLOBEC cruises in the Gulf of Maine in a project to examine the overwintering stock of *Calanus finmarchicus*. The high-frequency volume backscattering data provided the most complete coverage of the Gulf of Maine basins on the cruises. Although the backscattering data did not reflect the distribution of the zooplankton and micronekton biomass directly, patterns in the

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