5.2. Monitoring the plankton community

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5.2.1. Nutrients and chlorophyll *a*

Nutrients and chlorophyll *a* are sampled at all stations, using a CTD water bottle rosette sampler. Nutrients samples are collected from standard depths throughout the entire water column, while samples for chlorophyll *a* are collected at standard depths from 0 to 100 m. The sampling (handling of samples) is carried out in accordance with the existing manuals (Anonymous, 2012) and additionally written procedures are found on all research IMR vessels.

5.2.2 Phytoplankton

Phytoplankton water bottle sampling and phytoplankton vertical net hauls using an Algae net with a 0.1 m^2 opening and 10 µm mesh size, are carried out at selected stations (every 3rd to 4th station) during the ecosystem survey and at predetermined stations along the fixed transects. From each of the depths 5, 10, 20 og 30 m, a **quantitative** 25 ml water sample from the respective water bottles is obtained by a custom made measurement cylinder. Each sample is poured into the same glass bottle (brown with a screw cap), thus obtaining a joint integrated 100 ml water sample that is fixated using 2 ml lugol. For those stations where 5 m is not a standard depth, a water sample from the surface (0 m) obtained by a bucket over the ship side is used as a substitute for the 5m-sample.

The sample from the vertical net haul (0-30m) is regarded a **qualitative** sample, should be somewhat concentrated in the cod-end bucket, and then poured gently into a glass bottle (brown with a screw cap) and fixated using 2 ml of 20% formalin.

The SECCI depth should be registered at all stations during daylight hours, using a rope mounted white SECCI disk available on all research vessels, and operated from the side of the vessel at station.

5.2.3. Zooplankton

The aim of these investigations is to provide information on zooplankton (e.g. annual and regional variations in abundance, biomass and species composition) to different research groups at IMR and PINRO. The Barents Sea Ecosystem cruise provides an area coverage of the mesozooplankton biomass in the Barents Sea, including the region slightly west and north of Spitsbergen. In addition seasonal sampling is conducted along the standard sections Fugløya–Bear Island, Vardø–North, Kola, and Kanin (described above), including the period of the Barents Sea Ecosystem survey.

Zooplankton sampling on Norwegian vessels is carried out by WP2 plankton nets (Unesco, 1968), with a 0.25 m^2 opening and 180 µm mesh size, using vertical hauls from bottom-0 m, now omitting the 100-0m hauls that was originally part of the sampling program. In addition to WP2, mesozooplankton sampling on Norwegian vessels is carried out with the MOCNESS, a multiple opening/closing net and environmental sensing system for sampling zooplankton (Wiebe et al., 1976; 1985). Approximately 1 haul/station per day is undertaken during the area coverage in the Barents Sea in order to obtain information on the vertical stratification of mesozooplankton, in this case the somewhat larger zooplankton (i.e. smaller krill) is also better represented. The MOCNESS is towed obliquely from 300-200, 200-150, 150-100, 100-50, 50-25, and 25-0m. The number of depth strata and nets used vary from about 3 to 8 depending on the bottom depth at station. For all MOCNESS and WP2 conducted, the biomass (mg m^{-3} and g m^{-2}) is computed. Due restrictions with respect to laboratory resources, only a carefully selection of samples is worked up and analyzed for species abundances (nos. m^{-3} or nos. m^{-2}).

Samples are normally split in two, one part was fixated in 4% borax neutralized formalin for species analysis and the other one was size-fractioned as follows; >2000 µm, 2000-1000 µm and 1000-180 µm size categories. These size-fractionated samples are weighed after drying at 60°C for 24 hours. For large organisms like medusae and ctenophores their volume fraction are determined by displacement volume onboard the vessels. From the >2000 µm size fraction krill, shrimps, amphipods, fish and fish larvae are counted and their lengths measured separately before drying. *Chaetognatha*, *Pareuchaeta* sp. and *Calanus hyperboreus* from the >2000µm size fraction are counted and dried separately, but individual sizes are not measured. All dry weights are determined after additional drying at the IMR laboratory when the samples are returned to Bergen.

The following detailed steps describe treatment of zooplankton samples on board the Norwegian research vessels:

1. From the total sample, large medusa (jellyfishes=Scyphozoa) and ctenophores are removed. These are identified to genus or species if practical, and their displacement volume is measured.
2. The rest of the sample is divided, usually into two parts, using a Motoda splitter. If the sample is very large, it is split more than once (1/4, 1/8 etc.).
3. One part (usually 1/2) is preserved in formaldehyde. This part will later (if time permits) be analysed for species identification, etc at the IMR laboratory in Bergen.
4. The other part is used for dry weight measurements. The procedure for dry weight measurement is as follows:
5. The sample is divided into size categories: First the sample is filtered through a 2000 µm net, then 1000 µm net, then finally through a 180 µm net (mesh size identical to the WP-2 or MOCNESS nets). From the >2000 µm fraction, krill, fish, shrimps, chaetognaths, *Pareuchaeta* and *Calanus hyperboreus* are removed and treated separately. Of these krill, shrimps, amphipods (*Themisto* spp.) and fish are identified to species and their lengths measured (see "Lengdemålingsskjema for TOKT"). *Pareuchaeta* spp,, *Calanus hyperboreus* and *Chaetognatha* are counted. Each group of organisms is then put onto separate aluminium trays for dry weight measurements. The rest of the sample retained on the 2000 µm gauze is taken into a separate aluminium tray. The contents in the 1000-2000 µm and 180-1000 µm fractions are also in separate trays for weighing.
6. The trays are put into an oven onboard the research vessel for drying at about 60 ºC for ~18-24 hours. Thereafter, the trays are stored in a freezer at -20°C and brought back to the laboratory in Bergen after the cruise, where they are additionally dried for 6 hours at 60 ºC to obtain stable weight, and then weighed using a micro-balance weight. Since the weight of the original trays may differ somewhat, all empty trays are weighed and numbered at the laboratory before going to sea.
7. Weighing such small samples onboard the ship is not possible because of vibrations from the engine, waves, etc.

Details on the plankton procedures and forms to be filled in are found in the official Plankton Manual (Anonymous, 2012). that is always located in the plankton laboratory on board the research vessels.

The sampling on the Russian vessel is carried out by vertically stratified hauls using a Juday net with a 0.1 m^2 opening and 180 µm mesh size. Depth intervals for plankton sampling are the layers from bottom-0m, 100-0m and 50-0m.

The processing of Juday net samples from the Russian vessels included weighing of wet samples to within 0,0001 g, with removal of excessive moisture by a filtering paper for species identification and abundance determination. A more detailed processing of species and stage composition as well as numerical abundance will be undertaken in the laboratory at PINRO according to standard procedures. Dry weights will be derived using a conversion factor of 0.2. All zooplankton data are presented as biomass or numbers per 1 m^2 surface.

Macrozooplankton sampling

On the Russian vessels, macroplankton sampling is undertaken by the BR plankton net (with a 0.2 m^2 opening and 564 µm mesh size) attached to the bottom trawl.

On the Norwegian research vessels the new Macroplankton trawl (Melle et al, 2006; Krafft et al., 2010; Heino et al., 2011) has from 2010 been used on a regular basis to obtain quantitative samples of macrozooplankton, particularly krill, amphipods, mesopelagic fish and shrimps. This trawl will also give improved quantitative estimates of various types of jellyfish, overall the schyphozoan medusae but also siphonophores. It should also be used as an additional gear when ground-truthing acoustic scattering layers for the type of organisms they contain. Particularly this is the case, when the scattering structures are potentially of zooplankton origin.

For abundance estimation of macrozooplankton the Macroplankton trawl should as standard be lowered to approximately 20m above the bottom at low ship speed to reduce filtering when the trawl is on its way to maximum depth. After reaching maximum depth ship speed should be increased to approximately 3 knots while the trawl is obliquely hauled in. It is important to attach a Scanmar trawl-eye and speed sensor for monitoring trawl performance. Data from these sensors must also be logged on the computer at the ships bridge for later determining trawl profile and volume of water sampled.

The samples should be completely worked up on board according to traditional pelagic trawl sampling procedures. This includes species identification, length measurements and wet weights of krill, amphipods, mesopelagic fish and shrimps. A quantity of 200-300 krill and amphipods should be length measured for each trawl haul.

For each trawl haul an additional **quantitative** sub-sample of macrozooplankton (the krill and amphipod component) should be preserved on formalin preferably on a 250 ml plastic bottle for later analysis of their gonad maturation, external maturity and sexual characteristics. Qualitative samples of krill (N=100) and amphipods (N=100) are also requested to be individually frozen for later analysis of their stomach content. On G.O. Sars the -80 °C freezer can be used while freezing at -20°C on Johan Hjort is the only feasible option.

All data registered from the Macroplankton trawl should be input to the extended Plankton database version that also has the possibility of including pelagic trawl data.

Zooplankton acoustics

On all research vessels the scientific echosunders should be operative throughout the entire cruise, and data logged at all available frequencies.

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