Biological Oceanography Committee

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REPORT OF THE
WORKING GROUP ON ZOOPLANKTON ECOLOGY

Bergen, Norway

27–29 March 1996

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 BACKGROUND AND OPENING OF THE MEETING

The meeting was held at the Directorate of Fisheries (27 March) and at the Institute of Marine Research (28-29 March) in Bergen, and was opened at 0900 on Wednesday 27 March. The meeting was attended by 16 scientists from 8 countries. The list of participants is given as Annex 1.

The Working Group met with the following terms of reference (ICES C. Res. 1995/2:51):

a) review and develop detailed plans for a co-ordinated field programme on *Calanus finmarchicus* in 1997;

b) consider further co-ordination and cooperation of experimental studies of *C. finmarchicus;*

c) review evidence for interactions between zooplankton populations and fish stocks in marine ecosystems and consider the implication with regard to assessing trends in fish stocks;

d) consider methods and technologies for monitoring zooplankton populations in a cost-efficient manner, and consider means of expressing and exchanging such information in ways which are useful to fishery managers;

e) review evidence for the regulatory role of zooplankton grazing on population dynamics and blooms of harmful algae, and suggest research activities to fill gaps in knowledge;

f) examine feasibility of, and potential contributions to, and Environmental Status Report for the ICES Area on an annual basis, and report to the Advisory Committee on the Marine Environment by the end of 1995;

g) continue, by correspondence, the work on reviewing and completing the Zooplankton Methodology Manual.

A draft agenda, based on the points of the terms of reference, was presented at the start of the meeting. This was adopted as the meeting programme, and chairs and rapporteurs for the different agenda points were appointed. The meeting programme is given as Annex 2.

The Working Group met overlapping with the ICES Working Group on Cod and Climate Change. The morning session on the first day (27 March) was a joint session with the WGCCC, covering point c) on our terms of reference.

2 INTERACTIONS BETWEEN ZOOPLANKTON AND FISH STOCKS

This issue was discussed at a joint session with the ICES Cod and Climate Change Working Group. The session was chaired by Roald Sætre.

It was recognized that there was a connection between the climate, cod and zooplankton changes. There is a need to make the common connections between these phenomena with the aim to look for effects of climate change on zooplankton populations and in turn how these effects trends in fish stocks. The 1995 Woods Hole meeting of the Working group on Zooplankton Ecology suggested a need to look at the interactions between fish stocks (including recruitment and growth) and changes in zooplankton populations, including both population size and community structure. As a result of the 1995 recommendations a series of papers were presented at the 1996 meeting dealing with interactions between zooplankton and fish stocks.

Data were presented by Hein Rune Skjoldal and Padmini Dalpadado on the close interaction between phytoplankton, zooplankton, krill, amphipods and the fish stocks of capelin, herring and cod in the Norwegian and Barents Seas.

There was a close relationship between the ocean climate warming and cooling and the size of the *Calanus* populations. Poor *Calanus* stocks resulted in poor growth of capelin because of poor grazing conditions.

Capelin were shown to have a profound impact on zooplankton biomass in the upper layer by their feeding activity. A significant positive correlation was shown between the growth of capelin and the size and biomass of the zooplankton they fed on.

A strong relationship was shown to exist between euphausiids and capelin in the Barents Sea. During years of high capelin biomass the levels of euphausiids were low and vice versa. The age structure of the krill changed in years when the population of capelin was high, suggesting a high mortality of the krill due to predation. A similar result was seen between the amphipods and capelin.

Eilif Gaard presented data from the Faroe shelf area. Here zooplankton egg production was dependent on the level of phytoplankton, and the success of the cod spawning may depend on the abundance of *Calanus* eggs.

These papers showed there was a close relationship between the physical environment, zooplankton populations and fish populations. There was a strong impression that with larger data bases and a deeper and better understanding of the long term changes in zooplankton populations, that this information could have strong predictive potential for fish stock managers.

The problem of making environmental information such as levels of primary and secondary production, the physical conditions of the environment, and the timing of biological events usable to the fish stock assessment biologists was addressed. A plan to provide an environmental index that can be incorporated into the fisheries assessment process when quotas are set was described by Doug Sameoto. This environmental index will rate a variety of physical and biological parameters and their favourableness to the recruitment and growth of different types of fish. It will thus provide a means of allowing the assessment biologists a way of including a measure of the environment's health in their fish assessment models. The first step in this process is to hindcast the environments of previous years and look for factors that may have some predictive value for fish stocks trends. This exercise will be carried out in 1996, and the preliminary results will be presented at the next meeting of the Working Group on Zooplankton Ecology.

3 MONITORING OF ZOOPLANKTON

3.1 The need for long time series

Two principal reasons for conducting long time series observations of marine plankton communities which form the base of major fisheries, were discussed.

1) There is need to be able to assess long-term changes in the plankton because of the questions society poses about the health of the ecosystem when crises come.

2) Changes in the plankton are either a consequence of changes in the composition and dynamics of fish populations or promulgate such changes. In either case, zooplankton populations are an integral part of the process and therefore should be included in stock assessment and predicted changes in stock size.

H.R. Skjoldal raised a point for discussion centered on the variability in the characteristics of time series and the fact that often the changes in time series are more gradual than might be expected. If this is true, then it may be possible to see these changes and use them for predictive purposes.

D. Sameoto supported this statement and showed data which contrasted spatial versus temporal variability in CPR data in the line running from the US across Georges Bank, along the Scotian Shelf, and onto the western end of the Grand Banks. Seasonal abundance changes from year to year in the records from these three regions. For example, on the Grand Banks in the 1960's, *Calanus finmarchicus* maximum abundance was in the fall, but in the 1990's, the maximum abundance of this species was in the spring. In this data set, *Acartia* appears to show a 3 year cycle of abundance in the 1960's. (This data set is seriously compromised because the CPR data has a serious gap due to the cessation of observations between 1975 and 1991 when monitoring of the environment fell out of favour.)

There was discussion about the stability of zooplankton populations versus fish populations. There was an impression that for fish populations, there is a boom/bust cycle not usually seen in plankton populations. But when considered on a species by species basis, zooplankton are not likely different from fish. H.R. Skjoldal presented data from the Barents Sea in which gradual changes in biomass were observed. The conclusions from these data were that the variations in biomass had continuity from one year to the next and that there was a certain amount of stability. This is not to say that there are not significant changes in species composition. Mathews 3-year study of plankton in a Norwegian fjord (the Korsfjord near Bergen) with a LHPR was cited as showing that there were large changes in the dominant species present. In this case, there was stability in the herbivore, omnivore, carnivore, ratios over the study period. The point was made that on Georges Bank, while the abundance of individual fish species varied by orders of magnitude over the 30 to 40 years of the time series, total fish biomass on the Bank varied by a much smaller amount. A conclusion was that while individual species changes may be quite large, there are compensatory responses within the ecosystem so that the more integrative bulk measures of the standing stock of animals in a region show smaller variation.

There was discussion about the development of indices of the health of the ecosystem that would enable order of magnitude changes to be determined. H.R. Skjoldal argued that more subtle changes were being sought, but D. Sameoto said that he thought that it was the very large increases or decreases in zooplankton that might be most important. The point was made that both long-term trends and order of magnitude sharp changes were both being sought. In this discussion, it was also emphasized that measurements on species, especially key or target species, as well as bulk properties were needed. H.R. Skjoldal made the point that small changes in mortality rates can cause large variability in numbers. Thus, a factor of 2 difference in prey density could give rise to a much larger difference in fish survival. In the CPR data that D. Sameoto has worked up, there are changes in some taxonomic categories of about 2 orders of magnitude. J. Runge cited a similar finding of about a factor of 4 change in biomass of plankton in late June in the southern Gulf of Saint Lawrence when mackerel recruitment takes place.

The point of much of this discussion was stimulated in thinking about the need for long time series to evaluate current changes in plankton populations and the effect such change has on the fish recruitment process.

3.2 What monitoring programs of zooplankton are currently in place or planned to take place

3.2.1 Canada

J. Runge and D. Sameoto summarized the zooplankton monitoring that was ongoing on both Canadian coastlines. In the Pacific, there are surveys being conducted on the shelf region west of Vancouver Island by D. Machas. These have been carried out for approximately the past 10-years.

In eastern Canada, there have been no long time series. There was a grid of stations on the Scotian Shelf occupied during the late 1970s and early 1980s where zooplankton and ichthyoplankton were collected. There is a short time series in the southern Gulf of Saint Lawrence (1982–1991). There are 10-years of data that have been collected along the "Halifax line" and this work is continuing in combination with sampling at two additional cross shelf lines across the Scotian Shelf. In addition, the research vessels of the Bedford Institute of Oceanography will sample Emerald Basin when leaving Halifax on a cruise, making CTD casts and plankton hauls.

In the Quebec region, a programme has been put in place with a long term commitment of support. This will involve sampling at two stations in the Gulf of Saint Lawrence on a weekly or bi-monthly basis. The data collection will be supplemented with current meter data and a comprehensive 3-D flow field and climate model. It was pointed out by J. Runge that there is now a fishery for zooplankton (both krill and *Calanus*) in the Gulf of Saint Lawrence, and that as long as this fishery persists there will be a need to survey the copepod and euphausiid populations in order to establish fishing quotas for the region. This survey takes place in September of each year, since 1994. Thirty stations in the Lower Estuary are sampled with the BIONESS, for zooplankton biomass and composition. There are plans to include an acoustic survey for euphausid biomass and distribution and to deploy an OPC at the survey stations.

In the Newfoundland area, there is a long-term station on the shelf just outside St. Johns where physical data (CTD's) have been collected. Plankton and ADCP acoustic sampling will be added to the sampling at this station. This is an outgrowth of pressure to develop long time series for the eastern Canada region.

Canada, through funding originating in Ottawa, will continue to support the CPR line from Iceland to St. Johns, the line from the Grand Banks to Georges Bank, and a new CPR route that may be established in the Gulf of Saint Lawrence.

3.2.2 United States

P. Wiebe described the ongoing US GLOBEC Georges Bank Program Sampling that has taken place since 1994 and plans for sampling in the 1997 to 1999 period. Broad-scale sampling has taken place at 30 or more stations on the Bank at monthly intervals from January through June/July. This is not monitoring in a strict sense since it is work in support of a basic research program. However, the sampling currently being done and that anticipated to take place is in part designed to provide a means of developing a more cost effective and efficient means of monitoring this ocean region.

A longer time-series of sample collection from the continental shelf region including the mid-Atlantic Bight, Georges Bank, and the Gulf of Maine, known as MARMAP, was begun in the 1970s and ended in the early 1990s. Subsequently, a smaller sampling effort has been conducted to keep the time series going.

3.2.3 Norway

B. Ellertsen described the past and current monitoring activities for the Norwegian and Barents Sea areas. In the period 1948 to 1976, there were zooplankton sampling at standard hydrographic sections done 2 to 6 times per year. These extended perpendicular from the coastline out into the deep offshore wasters of the respective basins. There was also monitoring at fixed stations (5–6) along the coast. Beginning in 1991, monitoring along two of the sections into the Norwegian Sea was started again with sampling as frequently as every two weeks in the winter/spring period in 1995. Measurements include nutrients, phytoplankton biomass and species, zooplankton biomass and species, as well as standard hydrography (temperature, salinity, depth).

Monitoring of zooplankton in the Barents Sea has been carried out each autumn since 1986. This is done as an additional programme on stock assessment fish surveys which involves 3 ships and takes 1.5 months. Samples for zooplankton are done with WP-2 net and MOCNESS, both with 180 µm mesh. This effort involves sampling with MOCNESS at 30+ stations and with other nets at an additional 70+ stations. The stations are not set in a fixed grid, but spacing between stations is usually about 60 nm. The zooplankton samples are split at sea with one-half going for species enumeration and the other for biomass determination. Prior to the split, larger gelatinous forms are removed. For the latter, the sample is wet sieved into three fractions (>2000 µm, 2000 to 1000 µm, and <1000 µm), and then dry weight determinations made. Usually more samples are collected for species enumeration than can be counted, but these are achieved. The archive is an important resource for addressing questions/problems that were not recognized when the collections were made.

There are two other monitoring activities in the Barents Sea. Limited monitoring of zooplankton takes place during a survey cruise for capelin larvae and juvenile herring in early summer. Two N-S sections, at the western entrance to and in the central Barents Sea, are sampled 6 times per year.

There was a CPR transect run from 1948 to 1978 between Ålesund and Ocean Station "Mike" (also known as "M"). The data, however, is not available in Norway because Norway is not a member of the CPR consortium. Plans for reopening this CPR route are now under consideration. Additional sampling has been occurring at Station "M". The longest time series is physical data only, but more recently sampling for phytoplankton was added, and in 1997, collecting for zooplankton will be started.

There are other sampling programs that are contributing to the monitoring data compilation. In the Norwegian Sea, beginning in 1993, Mare Cognitum has been sampling the summer distribution of plankton at stations distributed 30 to 60 miles apart throughout the 2 million km^2 area. In addition to the sampling above, trawling is done to capture the larger macro-zooplankton and micro-nektonic animals (e.g., krill, amphipods, and fish). The need for the trawl sampling was highlighted by the fact that 1-m^2 MOCNESS sampling provided a regional estimate of about 3 million tons of krill whereas the trawl sampling provided an estimate of 50 million tons. The latter is believed more accurate due to avoidance of the smaller gear by these animals. A comparison of the distribution and abundance of Norwegian Sea zooplankton biomass between 1994 and 1995 revealed that changes had occurred between the two years. In 1995, the biomass in the region was 30% higher than in 1994, and the highest concentrations of zooplankton were found further to the north.

H.R. Skjoldal emphasized that the Norwegian Sea sampling within the context of Mare Cognitum, was better characterized as a research time series, not monitoring, and that it would continue under this sponsorship for several years. Beyond this, he said sampling of this sea area would continue in some form, but the exact form remained to be determined. He also emphasized the need for sampling well below the sea surface. Often the biomass is distributed deeply with a substantial portion occurring between 200 and 600 m.

It was noted that the Russians have been sampling the Norwegian Sea for the past 30 years and included in their suite of measurements are zooplankton biomass and species composition. The time series of biomass shows rather small changes over the 30-year period. It was also noted that the herring investigations in the Norwegian Sea are now a collaborative effort between the Norwegians, Russians, Icelanders, and Faeroese. The region is covered in summer and includes sampling of zooplankton and ichthyoplankton in addition to herring observations.

The question arose about how the monitoring programme is organized in Norway. H.R. Skjoldal said that environmental monitoring is carried out by the Institute of Marine Research in Bergen as a national monitoring programme. It is done in relation to environmental management and stock assessment.

Further discussion centered on the monitoring activities that are associated with the Norwegian offshore oil platforms. It was stated that most of the sampling was concerned with the benthos, but that there was about to be a shift to more emphasis on the water column. Regional surveys and sampling from the platforms will take place. J. Runge made the point that a paper by Cowles and Remillard (1983) had documented that serious sub-lethal affects of oil on copepod recruitment can take place. He suggested that future sampling should take into consideration these findings and that appropriate measurements be made in the monitoring process to see what impact low levels of oil might be having on rate processes in copepod populations around the platforms. This discussion was amplified by H.R. Skjoldal who noted that marine geological studies have been made in the Skagerrak sediments to look at time-series changes in contaminants and the fossil record. Starting about 1850, lead and cadmium concentrations began to increase which were associated with the industrial revolution. Barium, associated with drilling mud, appears about 1970. Investigations at the University of Oslo have shown that coincidentally there were substantial changes in the benthic foraminiferal community structure. Further, pelagic foraminfera have disappeared from the sediments over the last 200 years. The point was made that there was a need for background environmental information around the platforms in order to evaluate the effects of an accident. There was a suggestion that a meeting be held to look at the monitoring data developed around platforms. As one topic, the meeting might address the sub-lethal impacts of low levels of oil and other contaminants on zooplankton.

3.2.4 Iceland

O. Astthorsson described the Icelandic monitoring program which involves a series of perpendicular transects out from the coastline into the open sea. Sampling at the section lines to the north and east of Iceland was started in the 1960s. Additional section lines to the south and west were added in the 1970s. There are now about 90 stations total. There are cruises at these stations each year, occurring in February, May/June, August, and November. Sampling at all four time periods involves physical measurements. Sampling for phytoplankton and zooplankton occurs primarily in the May/June period and sometimes in August. Sample processing procedures are similar to those carried out by the Norwegians.

The Icelandic contribution to the Mare Cognitum programme involves two transects in the northeast sector which overlap slightly with those described above. These transects have thus far been sampled over an annual cycle on 9 cruises in 1995 and 1 cruise in 1996. Sampling included hydrography, phytoplankton chlorophyll and species, zooplankton biomass and species sampled obliquely with Bongo nets (0–100 and 0–200 m) and depth stratified with BIONESS (200 µm mesh), and CO_2 at some stations.

O. Astthorsson briefly summarized some of the zooplankton findings from an article published recently (Astthorsson and Gislason, 1995). During the late 1960s, there was a decline in zooplankton biomass which co-occurred with the herring collapse in the mixed Atlantic/Arctic region. Associated with this was a decrease in input of Atlantic Water to the region, an increase in stratification and lower production. Citing earlier work, he said that as a transition region, the waters around Iceland were warmer during the 1920 to 1960 period and changed in the 1960s to the cooler more unsettled conditions that have prevailed since then. O. Astthorsson also presented data which showed that there was a very strong relationship between zooplankton biomass and the 0-group herring index. This suggested that zooplankton biomass might be a useful index in fish stock assessments.

3.2.5 Faroe Islands:

Eilif Gaard presented a similar description of four monitoring sections perpendicular to the islands, one that extends out into the Norwegian Sea to the North and three that extend into the Faroe- Shetland trough to the south. Sampling takes place four times per year in February, May, August and November. Data collections include hydrography (CTD), nutrients, fluorescence/chlorophyll, and zooplankton. The latter is collected with a WP2 net (with 200 µm mesh) towed vertically in the upper 50 m. Dry weight biomass measurements and species counts are done on the zooplankton samples. The data are reported in local Faroese reports and in the ICES meeting reports.

3.2.6 UK

R. Harris described several monitoring activities around the British Isles. The CPR transects throughout the North Sea and North Atlantic continue to be run by the Alister Hardy Foundation using ships of opportunity. The data from these transects constitute the longest running time-series for plankton in the Atlantic.

Three independently operated near shore stations were described, only two of which are currently active. Off Newcastle in the North Sea, the Dove Marine Laboratory, University of Newcastle, has been collecting plankton and benthos samples on a monthly basis for the past 20 years. The "E4" coastal station off Plymouth has been sampled by R. Harris and colleagues on a weekly schedule for the past ten years. Counts of plankton are done and process work looking at egg production of copepods is ongoing in relation to environmental factors, chlorophyll, phytoplankton species composition, and particulate biochemistry. Further offshore of Plymouth, at station "E1" (the Russell Cycle Station) a long time series of collections of macrozooplankton and larval fish in relation to environmental parameters was carried on a monthly basis over the period 1924–1972. This programme was halted when funding reductions forced it to be placed on the inactive list. There are plans to re-start the monitoring at this station.

A new five-year programme of observations has been started which is known as the Atlantic Meridional Transect (AMT). The observations will be made during the transit of a research vessel between the UK and the Antarctic Continent which occurs twice each year. The vessel stops for a two-hour sampling station once each day. Optical, phytoplankton, and OPC data are included in the suite of measurements. The AMT sampling has been done once at 30+ stations and is scheduled for autumn of 1996.

A proposal, not yet funded, for a pan-European effort (headed by S. Poulet) to seasonally sample copepod production was described by R. Harris. He indicated his support for the idea and said such an effort was needed.

3.2.7 France

F. Carlotti briefly stated that there was a station off Villefranche, France, that was quite similar to "E4", where observations had been made for about 20 years. He also said that P. Nival had a strong desire to see a CPR line in the Mediterranean Sea. This idea has met with some resistance in France, and F. Carlotti thought a review of comparisons between CPR and other sampling techniques would be quite helpful.

3.2.8 Germany

J. Lentz provided an overview of the long time-series work in the southern North Sea conducted by W. Greve. The Helgoland time series is described in a recent paper by Greve (1989). It consists of regular cruises and intensive sampling at a fixed station at Helgoland beginning in 1974. Quantitative meso- and macrozooplankton samples are taken every second work day (that means two to three times per week!) in the Helgoland Roads positioned about 50 km off the coast between the two islands of Helgoland at 54° 11' N; 7° 54' E. Passing between the islands from a depth of up to 50 m to the south, or 30 m to the north, the tidal currents mix the water in the shallow 6-m deep passage between the islands. The mean residual current passes along the German bight in a counter-clockwise direction. The river plumes of the Weser and Elbe reach as far as Helgoland. Thus, the samples taken may represent waters of coastal, estuarine, or stratified central North Sea water origin.

Since 1980, a quasi-synoptic research cruise is carried out every second week in July with a sampling grid of 75 stations in the German Bight. This sampling programme is designed to monitor the 'annual ecosystem performance' at the time of year when primary carnivores (mainly *Pleurobrachia pileus*) is being succeeded by secondary carnivores (mainly *Beroe gracilis*). The methods employed in both sampling programs are oblique hauls with a 150 µm Hydro-Bios net for mesozooplankton and with a 500 µm Calcofi net for macrozooplankton. The volume filtered is measured with a flow meter and totals about 0.6 m^3 and 100 m^3 respectively.

These data sets have provided evidence for structural changes in the North Sea ecosystem and highlighted a particularly large invasion of sub-tropical species. J. Lentz said that Greeve had also sought to have a new CPR route instituted through his area of interest, but that this had not yet been funded.

The Baltic International Monitoring Programme (HELCOM Program) was also discussed. This programme has been ongoing for 15 years and involves sampling of zooplankton (WP2 net with 100 µm mesh) for species composition, nutrients, chlorophyll, and phytoplankton species, and chemical contaminants. Data and samples are stored in Helsinki. Five year assessments are made and publication of results is usually made in local reports.

3.3 Existing technology

The interpretation of the CPR (Continuous Plankton Recorder) data was discussed. Based on comparisons Sameoto has made between the CPR and the OPC (Optical Particle Counter), he is now convinced that the CPR data provide a good indicator of plankton composition and change with time. A comparison of the data from the CPR at 6 m with an OPC operated between 0 and 40 m, resulted in a 0.9 correlation (r) between the two data sets. A further comparison between 6 m CPR data and 0-240 m OPC data, resulted in a 0.6 correlation. Thus, the CPR data provide a measure of abundance changes in zooplankton that is representative of more than just the surface layer sampled.

The value of the CPR data also was supported by O. Astthorsson and A. Gislason who described their work comparing the CPR time-series data with the time-series of zooplankton data collected annually in spring (May) survey along transects around Iceland (Astthorsson and Gislason, 1995). The fluctuations in zooplankton biomass in Icelandic waters corresponded very well with the fluctuations of zooplankton abundance in the north-east Atlantic as revealed by the CPR-survey. This is remarkable when the different sampling methods are borne in mind and also the limited time during which the Icelandic sampling takes place. This led them to believe that the material from the Icelandic spring surveys in fact reflects true variations in the zooplankton biomass. The CPR data collection and sample processing was considered by the members of the committee to be very cost-effective and worthwhile. It was noted that there continues to be a problem with Alister Hardy Foundation funding and that support from this group was very important.

3.4 Analyses of long time series and exchange of information

The question of whether or not the level of effort being put into long time series data acquisition is adequate to actually portray the events that are taking place was discussed. There was concern that some data sets might not stand up to rigorous statistical scrutiny and that this issue should be explored in future meetings of this Working Group. It was noted that an ICES symposium on time-series in plankton will occur in March 1997 in Kiel and it is likely that this issue will be addressed at that meeting.

It was concluded that better access to data is needed and that a web site on the Internet could provide a solution to this problem. H.R. Skjoldal said that IMR data are now becoming available on the IMR internal net, and that a means of providing access to them via the Internet while still maintaining internal security is being sought. It is envisioned that ICES will have the role as a regional data centre where data from different national programmes are compiled, assessed and used for e.g. an annual environmental status report.

It was concluded that the CPR data set is probably the best that exists in both the time and space coverage in the North Atlantic Ocean. Better access is needed to this and other national monitoring time-series if environmental status reports are to be made on a year by year basis (as discussed in another section below). It is recommended that ways be found to provide increased funding for the CPR program while at the same time acknowledging that increased support requires additional evidence that the CPR data actually provide a realistic picture of the status of plankton populations. Thus, it was also recommended that this Working Group encourage several of its members to provide working papers of their work which validates the CPR methodology.

3.5 New technology for monitoring

It was concluded that there is a need for new technology to enable monitoring of zooplankton populations in a more cost-effective, efficient, and comprehensive manner. The discussion focused on improvements to the CPR and on several tools which are under development or are being used now by the research community, that may provide enhanced monitoring capability. The latter are based on optical or acoustic sensors.

An undulating CPR has been under development for several years, and tests are underway with a new prototype (V-tow) to see if it can be phased in as a replacement for the CPR. This system has solid state data loggers and will acquire more physical data. A significant problem to be addressed concerns the intercalibration of old data sets with the new ones. Another is sample analysis. The CPR, regardless of form, is designed to collect samples that require humans to count them with aid of a microscope. The costs associated with this activity are perceived to be a limiting factor.

Several optically based systems might be used in place of a CPR. The Optical Plankton Counter (OPC) is now a commercially available product that counts and sizes individual organisms as they pass through an orifice. This device has been used in a towed mode, a pump mode (on deck), and more recently in a vertical mode as a vertical profiling system combined with a CTD. In this latter mode, there is need for a constant vertical velocity of about 1 m/sec. D. Sameoto described a computer-based winch controller system that enabled this to be achieved in spite of vessel motion (pitch, roll, and heave-see; Mitchell and Dessureault, 1992). A new digital version of the OPC, which has a direct measure of flow, has been developed by A. Herman and has been in use for the past year and a half. D. Sameoto indicated that problems with the existing commercial system associated with coincidence counting and the need to change orifice size when particle concentrations change significantly, will largely go away with the new system. A commercial version of the digital OPC will probably cost about $25,000. D. Sameoto suggested that under some circumstances (i.e., in regions where the species composition is simple), there is hope that the OPC could be used to replace net tows. But as H.R. Skjoldal pointed out the conflict revolves around resolving the spatial and temporal variability versus to know the species composition.

D. Sameoto also described a new underway CTD profiler that can be deployed off ships of opportunity steaming at 12-20 kts. Mounted on the stern of the vessel, the package, a small but powerful winching system, cable, and dead weight sensor package, is automatically deployed and recovered repeatedly while the ship transits to its destination. A plan to deploy the OPC and other biological sensors is now being developed.

The Video Plankton Recorder (VPR) is another optical system that has the potential to become an advanced technology monitoring tool. An inexpensive video camera coupled with a magnifying lens and a strobe light positioned to provide back-lighting of a small, undisturbed water volume can be used to make images of the plankton at 60 frames per second. The towed system, described by Davis *et al.* (1992), has been used extensively in the western north Atlantic. It is also being used as a vertical profiler on a CTD system. It has become commercially available. Like the CPR, identifying, counting, and sizing individuals in the images is time consuming when done by humans, but image analysis techniques are being used to automate the process. Although all images are stored on video tapes, real-time processing at sea can sort out and store only those images containing in-focus individuals. Work is ongoing to use shape, size, density contrast, and other characteristics of the individuals to make identification to the taxa level (or better) automatically. Under development is a moored bottom mounted VPR system which can periodically profile the water column in shallow coastal waters. This system will be put into operation on Georges Bank as part of the US GLOBEC Program.

High frequency acoustic systems also hold promise as a tool to enable more efficient mapping of vertical and horizontal spatial distributions of animal populations. A variety of active acoustic devices are now available, and new systems are under development that are intended to take advantage of recent advances in our understanding of how sound is backscattered from plankton (see Stanton *et al*, 1994). The fundamental problem with current acoustic systems is that identification of the targets creating the echoes remains elusive.

D. Sameoto described the four frequency system that they now use for mapping relative changes in animal distributions in combination with the OPC and net tows. The typical configuration includes 12 kHz (which particularly highlights fish with swim bladders), 50 kHz (which seems to best highlight siphonophore with gas inclusions), 105 kHz (which best highlights euphausiids) and 200 kHz. Other frequencies are sometimes used in place of these four. The RDI ADCP (153 kHz) is also used to estimate relative changes in animals distributions. The calibration of this equipment is an issue, and D. Sameoto said that they rely solely upon the factory calibration.

K. Foote presented a description of a new design for a broad-band echo sounder which would operate over a continuous frequency range of 25 kHz to 3 MHz. This three-year EU MAST project involves K. Foote (IMR), a Danish transducer manufacturer (Razon), and modelers at the University of Birmingham. Seven devices are planned to synchronously control the operation of the system over the two decade frequency range. In addition to calibration of the system which is a major issue, K. Foote emphasized the need for much better information about the material properties of zooplankton species (*Meganyctiphanes norvegica, Thysanoessa* spp., and *Calanus finmarchicus*) which are the focus of intense study in the Norwegian Sea and elsewhere in the North Atlantic. The two principal animal body properties are the speed of sound contrast with the surrounding water and the density contrast with surrounding water.

4 ENVIRONMENTAL STATUS REPORT FOR THE ICES AREA

4.1 Background

Roald Saetre from IMR attended the meeting at this agenda point to provide information about the background for the Environmental Status Report proposal. The Norwegian delegation had proposed at an ACME-meeting in May 1995 for ICES to publish such a report annually. A section on ocean climate and biological conditions was previously published in the Annales Biologiques, but these ceased several years ago. After that there has been limited opportunity for reporting the state of environmental conditions within the ICES. The implementation of an Environmental Status Report for the ICES Area would be a way to improve the interdisciplinary work within ICES. The proposal was included in the terms of reference of relevant ICES Working Groups, and some have already responded.

The Working Group discussed how zooplankton data could be incorporated in an Environmental Status Report for the ICES Area. At the beginning there was discussion as to the extent and limits of the ICES Area, and the group concluded that the ICES Area could be defined by the geographic position of the participating nations and therefore included all of the North Atlantic starting at the ICES members coastlines. Thus the region of the North Atlantic that would be subject to the environmental status report would be bounded southerly by the Gulf Stream after it leaves the US coastline at Cape Hatteras to the west and by the Iberian Peninsula to the east, and northerly by the northern edge of the Norwegian Sea, Barents Sea, and Labrador Sea.

It was felt that while the Biological Oceanography Committee would have a role in compiling the biological data, the Advisory Committee on the Marine Environment (ACME) would be responsible for writing the report. Further, the ICES Secretariat would play a key role in producing the report.

4.2 Description of existing status reports

The group noted that already there are several national status reports on ocean climate and biological conditions. These could possibly be integrated and used as a basis for a report for the whole ICES area. The group reviewed some existing national status reports.

The Working Group noted that it could be useful to prepare a map showing the national standard sections together with the CPR-routes across the North Atlantic and the North Sea.

4.2.1 Norway

Hein Rune Skjoldal presented the Norwegian Report on Environmental Conditions 1996 which is prepared by IMR and had just come out from the printer. The report, which is published annually in March, describes environmental conditions and plankton development in 1995 along the Norwegian coast, and in the North Sea, the Norwegian Sea, and the Barents Sea. Further, the main results for the Norwegian fish larvae surveys are presented. Information on long-term changes in hydrographic conditions and zooplankton biomass is also presented. In the report, there are sections on pollution and harmful algal blooms, and a chapter on special topics which may be relevant in a particular year. Finally, there is a prognosis for the coming year (1996) with respect to both ocean climate, ocean production, and fish distribution. The report is not used directly by the fishery biologists in the stock assessment process. However, it may be said that the fisheries biologists have its contents in the back of their heads when estimating the productivity of the fish stocks. This report has been produced for about ten years and the prognosis part has been included in the report for the last three years.

4.2.2 Iceland

Astthor Gislason provided an overview of the Report on Environmental Conditions in Icelandic waters in 1995. The Icelandic report, which is published annually in October-November, summarizes information on hydrographic conditions and plankton communities in 1995 mainly based on observations carried out along standard sections around Iceland in February (hydrography), May/June (hydrography, chemistry, plankton), August (hydrography, O-group fish) and November (hydrography). Information on long-term changes in hydrographic conditions and zooplankton biomass is also presented, and further there is a chapter dealing with the distribution and density of O-group fish. In the report, there is also room for the reporting of special issues, such as the seasonal cycle of plankton in a particular area and harmful algal blooms. The report does not include a prognosis for the coming year. Similar to the results of the Norwegian report, the results of the Icelandic report are not used directly as inputs in the stock assessment calculations. However, it has been a part of the stock assessment process in recent years to investigate if the various environmental variables are significant as explanatory variables in the stock assessment models. For the Icelandic groundfish stock assessment models, this has, however, never been the case.

4.2.3 Canada

Doug Sameoto described the process by which environmental status reports are now being prepared in Canada. The first step in the report development involves a meeting of physical and biological oceanographers, fisheries biologists, and fish assessment personnel from three regions: Newfoundland, Nova Scotia, and Quebec. Individuals present data on the conditions of the environment from each perspective especially with regard to how it might affect fish assessment. A series of reports or research documents are then prepared for the assessment biologist for each fish stock. Using this information, the assessment biologist prepares a report on each fish stock and includes a prognosis of the future of the stock.

The second step involves a FOC (Fisheries Oceanography Committee) and RAP (Regional Assessment Process) meeting with members of the fishing industry present. Based on their evaluation of the environmental status reports, this group decides on the direction research effort should be expended. At this meeting, papers (2–4 pages in length) are presented. These papers are written in a style readable by the lay public and include statements concerning the outlook for the next year. These are assembled into a document which is published.

During the discussion, a question was raised concerning the indices (more detail given below) that are being developed, and where they fit into this review process. D. Sameoto said that they have not been used yet because they are still being formulated, but he indicated that they will be needed for assessment of fish stocks. The indices will be discussed at the FOC and RAP meeting next year, and they will be presented in the context of backward/retrospective analysis of earlier data which involved Labrador and Scotian shelf physical oceanography and fish and zooplankton populations. The zooplankton assessments rely now on the CPR data described in an earlier session, and the Halifax line.

4.2.4 CPR

Roger Harris spoke on the CPR-data and draw attention to the Annual Report of the Sir Alister Hardy Foundation for Ocean Science. It was felt that the CPR-data should be included in a future Environmental Status Report for the ICES Area.

4.2.5 The Faroe Islands

Eilif Gaard gave a brief presentation of the Faroese Report on Environmental Conditions around the Faroe Islands. The report is included in the Faroese Status Report on the Fish Stocks and is published annually in spring. It summarizes data on hydrography and plankton mainly along three standard sections. In the report, there is also a section on O-group abundance in Faroese waters. There is no prognosis for the next year and similar to the other national status reports, the data do not go into the fish stock assessment calculations.

4.3 Indices of environmental health

Doug Sameoto gave a brief summary of the indices of environmental conditions which are being developed for the Grand Bank and the Scotian Shelf. These indices categorise various environmental and biological variables and may help us to put the environment into the stock assessment process. Sameoto was given the task to provide all members of the group with the indices schemes. The members of the Working Group will then develop and define the indices further by correspondence and adapt them to local conditions in their respective areas. A central question that came out of this discussion was whether this approach of using indices could be adopted by this group as the method for providing input to an environmental status report? R. Harris commented that adopting such an approach would be useful in making people focus on what measurements are required and whether a particular country is collecting the required data.

4.4 Biological inputs

There was brief discussion as to what kinds of biological variables were needed and which simultaneously could be provided on a timely basis. It was felt that information on meso-zooplankton biomass and species composition should form a natural part of any future Environmental Status Report for the ICES Area. There was further broad consensus that this Working Group should develop further the indices based approach for characterising the environment.

4.5 Recommendations

The Working Group made the following recommendations:

1. The Working Group considers the Environmental Status Report for the ICES Area to be a useful enterprise and would like to contribute to it. We recommend that as a first step the report should be based on ongoing national activities and status reports. In the future the Working Group is willing to take part in the assessment of such data.

2. The Working Group recommends adopting an indices based approach for characterising the environment. In the future these should be developed further and adapted to local conditions in the different ICES regions. This Working Group should consider specific criteria for index inclusion into the group of indices used in the environmental status evaluation at a future meeting.

3. The Working Group recommends that ICES should set up a means of data exchange for data collected as part of the monitoring activities.

5 COORDINATED FIELD PROGRAMME ON *CALANUS FINMARCHICUS* IN 1997

The session was chaired by R. Harris. He provided an overview of the European programme for Transatlantic Studies of *Calanus finmarchicus* (EU TASC). The three major goals of EU TASC are:

1) To determine the role of cross shelf exchange processes in controlling seasonal population dynamics.

2) To determine the mechanisms controlling the large scale demography, life history and productivity of *Calanus* in the Nordic Seas.

3) To establish the basic biological and physiological characteristics, notably growth and reproduction, that are responsible for the observed demography and productivity of *Calanus*.

The 1997 field studies will focus on the Norwegian Sea and the region between Iceland, the Faroe Islands and Scotland. In addition to European TASC, proposals to study *Calanus finmarchicus* in the Georges Bank region and in eastern Canadian waters on the western side of the Atlantic have been submitted as part of the US GLOBEC and GLOBEC-Canada programs. The goal of the session was to inform representatives, many of whom are directly involved in either the TASC or GLOBEC programs, of the various research initiatives and to provide a forum for discussion of common themes and coordination of research activities on both sides of the Atlantic. A fax was sent by C. Miller, coordinator of the TASC newsletter, in which common themes were identified and the need for research on both sides of the Atlantic was stressed.

The regional plans for field study within TASC were reviewed. MRI, Iceland (A. Gislasson) plans four cruises (Nov/Dec 96, Feb. 97, Apr. 97 and Jun/Jul 97) in the region to the south and southwest of Iceland as part of the EU TASC subtask 1.2 (overwintering, advection and spring spawning), in particular the question of the role of advection of *Calanus* through the Faroe Channel into the northern North Sea. Iceland will participate in the collection of samples every two weeks from 6 time series stations located in the same region (subtask 2.2: latitudinal variations in the annual life history cycle). Iceland will also participate in the analysis of long time series derived from the CPR, Icelandic spring surveys, Russian surveys and Faroe Island surveys.

IMR, Norway (B.Ellertsen) is involved heavily in activities related to Task 2. A large scale field survey will be conducted in the Norwegian Sea in the summers of 1996 and 97, coordinated with herring surveys (EU Subtask 2.1). The samples will provide data on life history, cohort structure and other demographic characteristics in a region where planktivorous fish also occur. Samples will be taken routinely at Weather Station M for the comparative time series program (Subtask 2.2). Phytoplankton dynamics at Weather Station M will be studied at the same time, in order to relate *Calanus* life cycle to the primary production cycle. A modelling study of the interaction between the large scale circulation and *Calanus* life cycles in the Norwegian Sea will be conducted.

The Universities of Oslo and Bergen (S. Kaartvedt; D. Aksnes) are focusing on the study of *Calanus* in different light and predation regimes (EU subtask 2.3). The vertical distribution and mortality rates of *Calanus* are observed in four Norwegian fjords of varying depth and predator assemblages, in order to test the hypothesis that the vertical distribution of Calanus life stages is controlled by the distribution, abundance and composition of its predators. The relationship between predation, seasonal variations in light cycle and the life history of *Calanus*, in particular the "decision" to overwinter will also be investigated.

On the western side of the Atlantic, proposals have been submitted to conduct the second phase of the US GLOBEC Georges Bank study (coordination: P. Wiebe). An intensive field study of the Georges Bank and surrounding area, involving physical and biological oceanographers from a number of US and Canadian institutions, is planned for 1997. Focus in the second phase is sources of input and loss of zooplankton (particularly *Calanus* and *Pseudocalanus*) on Georges Bank. Broadscale surveys, comprising an array of stations visited approximately monthly between January and June, will be conducted, as well as several process cruises, to study zooplankton recruitment, mortality losses and predation, during the same period. Approximately 400 days of ship time have been requested in 1997. Potential advective sources of *Calanus* on Georges Bank include the Gulf of Maine, Scotian Shelf and the slope water flowing into the Gulf of Maine at depth in the Channel to the north of Georges Bank.

The Canadian contribution to 1997 field studies includes participation in the US GLOBEC Georges Bank Study and sample collection in the Gulf of St. Lawrence and Scotian Shelf system as part of the GLOBEC-Canada program. The US GLOBEC participation involves deployment during process cruises of multiple drifters for 7-10 d tracking of a water mass, for study of recruitment and mortality of *Calanus* (Durbin, Runge, Ohman). It is planned to study the predator field during the same cruises (Madin *et al.*) for identification of mortality sources. For the *Calanus* studies within GLOBEC-Canada (presently under review for funding within the Department of Fisheries and Oceans and the Natural Sciences and Engineering Research Council), it was decided to focus limited resources initially on the modelling component, particularly the influence of circulation, temperature and seasonal evolution of the mixed layer on the distribution and dynamics of *Calanus* populations (Runge, Loder, deYoung). The field component includes two cruises in spring and fall along the Scotian Shelf and into Cabot Strait, to study horizontal and vertical distribution patterns and *Calanus* recruitment rates (Herman, Sameoto, Head). In addition, there will be two time series stations, one on the Scotian Shelf (McLaren) and one in the St. Lawrence Estuary (Runge) that would contribute to the latitudinal comparison of Calanus life cycle.

The importance of the US and Canadian research to the overall objectives of the TASC was discussed. There is evidence that the Calanus "population" on the western side of the Atlantic is genetically distinct from its Northeast Atlantic counterpart. Common issues include: a) regional variation of life history timing, b) variation in development rate and its causes, c) variation in fecundity and its causes, c) mortality rates and source of mortality, and d) genetic coherence in stocks. Clearly, the overall objective of a TransAtlantic study of Calanus demographic and physiological characteristics would be compromised without the North American contribution. It was decided therefore that the Working Group should emphasize to ICES the importance of financial support from the US and Canadian funding agencies for the North American GLOBEC programs.

Ideas for coordinating and developing closer ties among the TASC activities on both sides of the Atlantic addressed four issues:

1) **Exchange of people and samples** While it was agreed that exchange of EU TASC and NA GLOBEC personnel would be welcome on research cruises, it was recognised that it may be difficult to accommodate additional research projects on multidisciplinary cruises where wire time and berths were already at a premium. In addition, the intensity of the field sampling effort on Georges Bank would probably not leave much opportunity for NA personnel to participate on European missions. There should be no problem in arranging to exchange samples, however, which is particularly important for the comparative genetic studies.

2) **Standardization of methods**. To facilitate standardization, it was agreed that publication and exchange of methodologies and protocols should be conducted this year. This could take place by one or more of the following means: a) Use the TASC newsletter edited by C. Miller (Oregon State Univ.) as a vehicle to communicate protocols and methodological issues. It was anticipated that the frequency and content of the newsletter would increase as the 1997 field season approaches. b) Pre-publish, by electronic means if possible, chapters of the ICES Zooplankton Methodology Manual that are ready for distribution. Preparation of the Manual is proceeding, but it will most likely be published after the 1997 field season. Certain chapters, however, are anticipated to have undergone the review process and be ready for distribution by late summer. c) Include a session on methodology at a joint planning session that would be held later this year.

3) **Possibilities for a joint planning meeting prior to the start of the 1997 season**. There are several options for a joint planning session later in 1996, including the EU-TASC planning meeting (time and date still to be determined), the ICES annual meeting in Reykjavik in September, and the US GLOBEC Science meeting, probably to be held in early autumn in Rhode Island. At the latter meeting, principal investigators in the first phase of the US GLOBEC Georges Bank program will present their results. This would be an opportunity for EU-TASC principal investigators to learn and profit from the US GLOBEC observations prior to the 1997 field season. In addition to joint sessions to discuss coordination of planning and methodology, there is a need for those involved in the modelling of *Calanus* population dynamics and its interaction with physical processes to discuss common approaches and problems.

4) **Possibilities for data exchange and management**. The possibility of a web site for TASC data management and exchange was discussed. A model for a data management center is the US GLOBEC site. The US GLOBEC program encourages their P.I's to submit their data to the web site within a year of sampling, so that it can be accessible to others in the program.

The WGZE recommends that ICES formally endorse (or sanction) a North American (US GLOBEC and GLOBEC Canada) and European (EU-TASC) coordinated field programme in 1997 to study *Calanus finmarchicus* and its role in the pelgagic ecosystem in waters and coastal seas of the North Atlantic Ocean.

6 EXPERIMENTAL STUDIES OF *CALANUS*

The discussion was chaired by R. Harris and centered on plans for co-ordinating experimental work under the framework of the TASC project. Much of what was reviewed is covered in the consideration of plans for the co-ordinated field programme (see above); the field and experimental activities are intimately interconnected. The main points to emerge were:

1) It was agreed that opportunities provided by the planned TASC *Calanus* Culture Facility (PML) and the TASC Mesocosm studies (Espegrend) should be publicised in the TASC Newsletter. In this way, these important experimental activities would be brought to the attention of the wider community, and possibilities for exploiting collaborative opportunities could then be explored. Specific experimental activities which could be added to the culture or mesocosm studies, without interfering with their primary objectives, would be very cost-effective.

2) It was recognised that many of the TASC cruises discussed under the 1997 field programme would provide potential opportunities for process related experimental work at sea.

3) The value of establishing a standard set of variables to be measured in relation to experimental studies was discussed. This also relates to the standardisation of methods protocols for the field studies, and intercalibration.

4) The value of archiving *Calanus* samples from experimental studies, for potential retrospective genetic analysis, was recognised. It was suggested that a short article on the best preservation technique for subsequent molecular work would be published in the TASC Newsletter.

It was recommended that a further meeting of TASC participants be considered to advance co-ordination of TASC activities, both field and experimental, before the 1997 campaign. Such a meeting might be held jointly with the EU-TASC Project Annual meeting, or with the US GLOBEC George Bank meeting. It should be held in the fall of 1996 if planning for 1997 is to be effective.

7 REGULATORY ROLE OF ZOOPLANKTON GRAZING ON POPULATION DYNAMICS OF HARMFUL ALGAE

The session was chaired by J. Lenz, who provided an introduction under the following headings. This structure then formed the basis for the subsequent discussion, concentrating on topic 2), which is summarised below:

1) Introduction - Species spectrum, Environmental impact, Exceptional blooms, Algal watch, Origins, Blooming condition, - International activities

2) Role of grazers (micro- and meso-zooplankton) - Palatability of algae, Indirect promotion of blooms, Prevention of blooms

3) Recommendations - Experimental studies, Field studies

Harmful algae cover a wide spectrum of species in various systematic groups, being characterised by their toxicity or other impacts on the environment such as the foam production by *Phaeocystis* blooms. They range from brackish-water cyanophytes, dinoflagellates, prymnesiophytes, to less common systematic groups. Even some diatoms may be considered to be harmful algae, for example the recent appearance of the toxic *Pseudonitzchia pungens* in East Canadian waters. Most of these harmful algae bloom in the warm season after the phytoplankton spring bloom formed by diatoms in higher latitudes. Another characteristic feature is their irregular occurrence; their blooms are usually not predictable, and therefore they are termed "exceptional blooms".

The seed populations originate either from the hatching of benthic cysts or from offshore waters which have been transported inshore. A pre-requisite for build up of a "red tide" bloom in a short period of time of one to two weeks, as often observed, is that a seed population hits a so-called "ecological window" providing the species with a set of favourable growth conditions. Such conditions may include a high nutrient supply, high irradiance, little turbulence and also the absence of grazers. The latter factor, however, has rarely been checked and a lack of grazing pressure might not be identical with the absence of potential grazers. These may be composed of microzooplankton species, such as heterotrophic dinoflagellates and ciliates, mesozooplankton species, typically filter-feeding copepods, or sometimes meroplanktonic larvae such as mussel veligers.

The grazing pressure exercised on individual phytoplankton species depends on an number of factors such as cell size and shape, the presence of spines or the ability to form colonies. A decisive factor, often neglected but probably of special importance in harmful algae, is the biochemical composition of the cell and its palatability. There is evidence, for instance, that a number of cyanophytes are very little grazed by zooplankton and that their nutritive value is very low. Very little knowledge exists, however, on possible effects of toxin producing algae on invertebrate grazers. It could be that such toxins act as an effective defence mechanism against their grazers, and that they are thus able to lower the mortality rate in favour of a high growth rate. This would help to explain the apparent success of slow-growing dinoflagellate species in building up high cell concentrations in short periods.

8 ZOOPLANKTON METHODOLOGY MANUAL

The Working Group were to continue, by correspondence, the work on reviewing and completing the Zooplankton Methodology Manual. A brief discussion on the progress in this work was added to the agenda for this meeting.

H. R. Skjoldal gave a brief account of the status of the preparation of the Manual. He had received three of the chapters and was expecting to receive more in the near future. For three of the chapters (optics, behaviour, modelling) there were delays in their preparations due to difficulties in getting the author lists finished. Skjoldal expressed that he would push this issue in the hope that the preparation and editing of the outstanding chapters could be accelerated and accommodated in the process without causing undue delay of publication of the other near-finished chapters.

It was agreed that Skjoldal should contact the main authors to get further information on the status of chapters not yet submitted to the editors. He would then prepare a letter describing the status and progress in preparing the Manual that would be sent to all authors. The outstanding chapters needed to be pushed by follow-up correspondence between Skjoldal as the main editor, and the authors.

The uneven status in preparation between the different chapters and the consequence for the publication of the Manual was discussed. It was pointed out that it would be unfortunate if finished chapters had to wait in the publication process for a long time before they were made available to the scientific community. Means of avoiding such delay was considered. On the other hand it was felt necessary to maintain the goal to have the manual published as one book that would serve the intended purpose of a handbook. It was suggested that a two-stage publication would be a solution to this problem.

The Working Group agreed that chapters that had been through the review and editorial processing should be made available via electronic mail from home pages at e.g. ICES, GLOBEC and/or editors institutions. Hard copies of the single chapters could also be made available as citable, printed reports.

9 PLANS FOR FURTHER WORK OF THE WGZE

9.1 New chairman

Hein Rune Skjoldal had asked to be relieved as chairman of the Working Group. The group thanked him for the work he had done as chairman.

The Working Group propose that Roger Harris be the new chairman and look forward to working under his leadership.

9.2 Next meeting

There was discussion of the further work programme of the Working Group. It was considered important to continue work with the aim to link observations of zooplankton to the needs of fishery management. This would include the issues of monitoring of zooplankton, use of zooplankton information from monitoring and other sources in stock assessment work, and assessment of zooplankton data for use in the ICES Environmental Status Report.

Another task will be to contribute to the coordination of the ongoing and planned studies of *Calanus finmarchicus* in the framework of TASC. Related to this is the use of models to provide linkages between *Calanus* population dynamics and basin-scale and shelf circulation features.

A final issue is to oversee the completion of the Zooplankton Methodology Manual.

We make the following recommendation:

The Working Group on Zooplankton Ecology will meet for 3 days in Kiel, Germany, in March/April 1997 to:

a) review ongoing zooplankton monitoring activities in the ICES Area and consider ways of improving them;

b) consider means of incorporating environmental information (zooplankton) into stock assessments, including use of indices of zooplankton abundance based on Continuous Plankton Recorder (CPR) surveys and other monitoring activities in the ICES Area;

c) review and assess contributions of zooplankton information from the CPR Survey and ongoing national monitoring activities, for the use in an ICES Environmental Status Report;

d) review progress in the coordinated 1997 field programme and experimental studies on *Calanus finmarchicus* in the TASC project;

e) review progress in modelling activities within GLOBEC and TASC and consider ways of improving coordination and cooperation;

f) continue, by correspondence, the work on reviewing and completing the Zooplankton Methodology Manual.

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ANNEX 1

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ANNEX 2

AGENDA AND PROGRAMME

Wednesday 27 March

09^{00}	Opening, agenda, meeting programme
09^{30}	Joint session with Cod and Climate Change Working Group Interaction between zooplankton and fish stocks (ToR pt. c) (Chair: R. Sætre; Rapp: D. Sameoto)
12^{15}	Lunch
13^{15}	Monitoring of zooplankton (ToR pt. d) (Chair: J. Runge, Rapp.: P. Wiebe) * National monitoring activities, incl. research monitoring * Methods and technologies
18^{30}	Reception and film - Bergen Aquarium

Thursday 28 March

09^{00}	Environmental Status Report for the ICES Area (ToR pt. f) (Chair: P. Wiebe; Rapp.: A. Gislason)
12^{15}	Lunch
13^{15}	Coordinated field programme on *Calanus finmarchicus* in 1997 (ToR pt. a) (Chair: R. Harris; Rapp.: J. Runge) Experimental studies of *C. finmarchicus* (ToR pt. b) (Chair: R. Harris, Rapp.: S. Kaartvedt) Zooplankton Methodology Manual (Chair and rapp.: H. R. Skjoldal)

Friday 29 March

09^{00}	Zooplankton grazing and blooms of harmful algae (ToR pt. e) (Chair: J. Lenz; Rapp.: R. Harris)
12^{15}	Lunch
13^{15}	Summary discussion Completion of report Future plans New chairman