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REPORT OF THE

WORKING GROUP ON ZOOPLANKTON ECOLOGY

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International Council for the Exploration of the Sea

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TABLE OF CONTENTS

Section		Page
1	BACKGROUND AND OPENING OF THE MEETING	1
2	TAXONOMIC CODING SYSTEMS	1
	2.1 Background	1
	2.2 Description of NODC and Other Existing Codes	1
	2.3 Logistic Considerations	2
	2.4 Recommendations	2
3	REPORT ON EUROPEAN GLOBEC DEVELOPMENTS AND OTHER MEETINGS	2
4	ZOOPLANKTON MONITORING ACTIVITIES AND THE CPR SURVEY	3
	4.1 Continuous Plankton Recorder	3
	4.2 New Technology	4
	4.3 Spain	4
	4.4 Availability of Monitoring Data	4
	4.5 Germany and the Baltic	4
	4.6 New CPR Routes	5
	4.7 Recommendations	5
5	APPLICATION OF ENVIRONMENTAL DATA IN STOCK ASSESSMENT	6
	5.1 Recommendations	7
6	ZOOPLANKTON METHODOLOGY MANUAL	7
	6.1 Recommendations	8
7	PLANS FOR FURTHER WORK OF THE WGZE	8
	7.1 Next Meeting	8
8	RECOMMENDATIONS	8
9	REFERENCES	9
ANNEX 1	List of Participants	10
ANNEX 2	Agenda and Programme	12
ANNEX 3	Zooplankton Methodology Manual	14
ANNEX 4	Zooplankton Monitoring Activities in the ICES Area	19
ANNEX 5	Distribution of Monitoring Programmes in the ICES Area	27

1 BACKGROUND AND OPENING OF THE MEETING

The meeting was held at the Institut für Meereskunde from 16–18 March 1997 at the kind invitation of Professor Jürgen Lenz. The WGZE preceded the ICES Symposium on *Temporal Variability of Plankton and their Physico-Chemical Environment*. The meeting of the Working Group was opened at 1415 on Sunday 16 March, and was attended by 15 scientists from 8 countries. This list of participants is given as Annex 1.

The Working Group met with the following terms of reference (ICES C. Res. 1996/2:53):

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

b) consider plans for the ICES/GLOBEC Workshop on the Application of Environmental Data in Stock Assessment;

c) review and assess contributions of zooplankton information from the CPR Survey and ongoing national monitoring activities;

d) continue, by correspondence, the work on reviewing and completing the Zooplankton Methodology Manual;

e) review the status of development of taxonomic coding systems with a view to recommending the adoption of a single coding system for use in ICES.

2 TAXONOMIC CODING SYSTEMS:

The session was chaired by K. Brander, who provided an introduction to the existing taxonomic codes and justified the interest of adopting a single coding system for use in ICES. Luis Valdez acted as rapporteur. The subsequent discussion is summarised under the following headings:

2.1 Background

The overall purpose of adopting a single taxonomic coding system in ICES is to facilitate the banking and interchange of data between the marine laboratories and ICES and within the different laboratories.

A standard procedure to store and interchange data between laboratories have also been encouraged from different institutions (ICES, IOC) and it forms part of the recommendations in the data management of MAST and FAIR EU projects, as well as in several national funding agencies. Thus, the WGZE has undertaken as a main TOR to "review the status of development of taxonomic coding systems with a view to recommending the adoption of a single coding system for use in ICES".

The WG agreed that the single code adopted should fulfil the following requirements: i) the taxonomic code must contain logical hierarchical taxonomic information, ii) it must not be limited to planktonic species, iii) it must be flexible, giving opportunity to incorporate new codes to new species, and iv) it must be well established.

Information on several numerical codes was presented, and it was recognised that most of them restrict the list of coded species to species under commercial exploitation, such as fishes, shellfish, seaweeds, etc. (e.g. FAO, NAFO). The NODC taxonomic code, which has been already adopted by some ICES countries, was presented as the one that fulfils the above requirements, being the most widely used and most complete of the numerical codes.

2.2 Description of NODC and Other Existing Codes

The NODC, developed by the National Oceanographic Data Centre NOAA/NESDIS (USA), is a numerical code based on a hierarchical structure. The NODC taxonomic codes contain a maximum of 12 digits, and each code number is partitioned into a series of 2 digit couplets. Each couplet represents one or more levels of the taxonomic hierarchy. Thus, taxonomic information is contained in the hierarchy of each code. For example, the

species 6118040101 (Paracalanus parvus) is part of the genus 61180401 (Paracalanus), family 611804 (Paracalanidae), order 6118 (Calanoida), etc.

In its current version (7.0), the NODC taxonomic code contains approximately 206,000 records (all levels), covering viruses, bacteria, fungi and both plant and animal kingdoms, which makes the NODC the largest and most flexible of the existing codes. (subsequent to the meeting information was received that version (8.0) has now been released, which differs significantly).

The SOAEFD Aberdeen Marine Laboratory has developed its own taxonomic code, which contains both taxonomic information and biological information such as sex, developmental stage, size etc. However, the codes are restricted to the local species. On the other hand, due to the additional information included it is more complex to use. Thus, because of both considerations, at present its implementation at other laboratories is more difficult than the NODC.

2.3 Logistic Considerations

The NODC coding system is currently used for most biological databases in ICES member countries and the experience of its use is that it works well. The code deals only with taxonomic classification and not with additional information, such as age, developmental stage, size, etc. Such additional information should be coded in separate fields and the issue of whether and how to standardise these fields may also have to be considered.

Obtaining new codes from NODC takes some time and it would be useful for ICES to act as a 'clearing house' for new codes, by providing an interim code for species which do not already have one and co-ordinating the requests for new codes from NODC, by means of an annual update. It may be useful to produce subsets of the full species list, for use in parts of the ICES area, since there are considerable differences in the taxonomic composition between regions.

Biological data need to have a system of quality control comparable to the physical sciences, in terms of both sampling methodology and taxonomic identifications. Thus, to benefit the interchange of data among different laboratories, it is essential to provide a list of meta data (meta data are information about the data). These meta data should include a description of the sampling methodology (e.g. ship speed, gear used, mesh size, etc.) and a description of the sources used in identification (e.g. developmental categories, synonyms, etc.). Describing minimum meta data requirements that make the data useful for future users of the data should be considered in future meetings.

2.4 Recommendations

- The WGZE support the proposal that ICES should adopt a single, standard taxonomic coding system and advise that the NODC system is the first choice for plankton studies.

- The WGZE recommend that a comprehensive list of species codes in use in the ICES area be prepared, with species names and synonyms. The list should be reviewed and updated each year by the WGZE and/or similar group. In cases where NODC codes do not exist, such additions should be notified to NODC by ICES, with a request to supply new codes.

(subsequent to the meeting, it was pointed out that ICES is already the IOC's RNODC for Formats, responsible for maintaining lists of codes used in the IODE data exchange system. The RNODC also organises the allocation of Taxonomic Codes into recognised coding systems, for example the NODC Taxonomic Code. Details and links with the appropriate parts of NODC are available on http://www.ices.dk/ocean/rnodc.htm)

3 REPORT ON EUROPEAN GLOBEC DEVELOPMENTS AND OTHER MEETINGS

Keith Brander gave a brief account of planning for a meeting later in 1997 to consider the development of a Science Plan for a European GLOBEC Programme. Roger Harris reported on international GLOBEC developments, the recent Scientific Steering Committee meeting, the GLOBEC Science Plan, and planning for the first GLOBEC Open Science Meeting to be held in Paris in March 1998. Keith Brander then reviewed the

calendar and work plan of the ICES/GLOBEC Regional Co-ordinator, and drew the attention of the WGZE to the GLOBEC Theme Session at the 1997 ICES Annual Science Conference, to be held in Baltimore in September.

4 ZOOPLANKTON MONITORING ACTIVITIES AND THE CPR SURVEY

The discussion was introduced and chaired by Chris Reid, and Steve Hay acted as rapporteur.

The session opened with a reminder by Roger Harris, the WG chairman, of this session's antecedents in discussions of previous WG meetings. He also pointed out that Hein-Rune Skjoldal intended to arrive soon and would bring a summary map illustrating monitoring endeavours recorded by previous WG meetings, which should be updated by the present WG (see Annex 5).

4.1 Continuous Plankton Recorder

Chris Reid then gave a presentation of the current routes (see Annex 5) and status of the SAHFOS CPR work in which he made a number of points. He considered that although necessary to the continuity of the long term series and constrained by economics and ships of opportunity, the current routes were not always commensurate with the need to monitor areas which modern hydrobiological research had highlighted as of particular importance or interest. He felt that future improvements in the relevance and quality of the CPR surveys would depend to some extent on taking account of the identifiable ecological subdivisions of the seas (Longhurst, 1995. *Progress in Oceanography*, 36, 77-176)) and indeed should consider the implications of work such as Colebrook's analysis (1984, *Marine Biology*, 83, 313-323) of seasonality and the temporal and spatial variability evident in CPR colour index data. Chris Reid also cited two examples of CPR data analysis to illustrate the particular relevance of the wide range and large scale of the phenomena that the CPR data illuminate. Firstly he showed a fascinating long term picture of increases in Echinoderm larval abundance over the Dogger Bank in the North Sea. Secondly he illustrated the variability and disparity in individual size between populations of *Calanus* in the North Sea and in the Irish Sea.

There followed some general discussion of these points and results, in particular the Echinoderm larvae increases excited Keith Brander to point out the importance and direct relevance of these data to the ICES WG on Effects of Fishing and as evidence of environmental change for the ICES Benthic Ecology WG and Fish Stock Assessment groups. Steve Hay noted that perhaps not enough work was being done on meroplankton and that despite difficulties with taxonomic identification, this was an area with great potential for plankton studies very relevant to fisheries and benthic research and management. The relevance of the biomass variability data was also discussed with regard to the importance of considering such variability in relation to comparison of regional differences in standing stocks and secondary production. It was generally felt that there is a great need for standardisation of biomass measurement methods and for wider studies of the causes and consequences of biomass variability in important species throughout the ICES regions. It was hoped that the forthcoming manual might help with such standardisation.

Chris Reid also pointed out that the perennial problems of underfunding resulted in too little available staff time at SAHFOS for exploratory analysis of the CPR data, which would certainly provide new insights into plankton ecology of surveyed areas and extend the active worth of the dataset.

Doug Sameoto remarked that the major criticisms of the restricted sampling and lack of calibration of the Hardy sampler against other more widely used gears in terms of sampling efficiency and selectivity had not been fully addressed. This he felt frequently inhibited recommendations for wider CPR use. Also the spatial limitations incurred in the use of ship of opportunity routes caused fears for the spatial representation quality of the CPR data. Doug Sameoto also suggested that perhaps ICES/SAHFOS could approach international agencies such as UNESCO to help with funding.

Chris Reid pointed out that the shipping trade is busy and that many options for extended or particular area coverage were feasible should demand and funding allow. Roger Harris emphasised that the interpretation and re-interpretation of CPR data is also informed and enhanced by reference to other sampling/monitoring studies where many methodologies are deployed. Steve Hay pointed out that modellers while frequently utilising CPR and other time series data are often critical of the quantitative accuracy of the data. Calibration and comparisons of CPR data with other sampling would go some way towards meeting such criticism, but also it would be useful

to call on the modelling community to produce positive suggestions and reinforce calls for future sampling and monitoring strategies. It was suggested too that since a number of countries had monitoring programs, perhaps CPR equipment could be deployed alongside or as part of such work and that SAHFOS could perhaps provide training in zooplankton taxonomic analysis or carry out such analysis.

4.2 New Technology

Chris Reid also indicated that new techniques such as deployment of CTD, fluorometer and other instruments in parallel with CPR sampling were in place on selected CPR runs. Also being developed were undulating and moored buoy systems, capable of microzooplankton (<200 microns) sampling, as recommended by ICES, but that such expensive refinements were generally outwith the scope of current funding. Chris also said that he would investigate the problems with criticisms of the representational quality and sampling capabilities of the CPR system relative to other gears. Keith Brander reminded the group that there were some good results from the ICES study group on zooplankton sampler design. Doug Sameoto pointed out that in his experience moored systems in offshore waters could prove a very expensive option when compared to the cost and more extensive sampling potential of repetitive ship cruises. He also stated that many developments were ongoing in the moored systems and described briefly the SEAMOSS profiling system by way of an example.

4.3 Spain

At this point Luis Valdez showed the group a presentation on the Spanish monitoring programme and explained that there were now 7 transect sites around the Spanish coast, 4 in the ICES area and 3 in the Mediterranean. These involved an extensive physical, chemical and biological, monthly sampling series at each site with additional primary production and grazing studies at two sites (see Annex). Sampling was carried out according to JGOFS and ICES WG protocols. These data and those from other work were input to a newly commissioned, comprehensive computer database linked through a network to all the sites. This sampling effort is currently funded with two days of sea time per month per station. This work and database were also related with Spanish sampling efforts based at Vigo concerned with sampling for pollution monitoring and harmful algal blooms. Luis Valdez pointed out that the rationale for the monitoring work involved the recognised need for seasonal and interannual information on the shelf seas around Spain. Also, information prior to this endeavour was confined largely to the results of spatially and temporally limited survey work mostly that resulting from studies of fish spawning areas.

4.4 Availability of Monitoring Data

There was then some discussion of the need to tabulate the sites and nature of monitoring studies in the ICES area in addition to updating the map. Keith Brander agreed to prepare a proforma to collate these data and stressed the need for brief descriptions and inclusion of contact persons for each dataset (see Annexes 4 + 5). He also proposed that such a table to compliment the map of monitoring sites would be an obvious candidate for inclusion in an ICES web page to disseminate the information and promote communication. It was further suggested that if possible some summary information from monitoring sites could be available on the web site and regularly updated to promote interest in these studies. It was considered that summary data and sampling information from monitoring could be included in the ICES Environmental Statement and perhaps the ICES Newsletter. Roger Harris pointed out that there was another source of time series data from long term sampling at a site off the UK Northumberland coast and certainly a French monitoring effort and that since there was no French voice present he would approach contacts, perhaps at IFREMER, to inform them of the WG proposals and seek their participation.

4.5 Germany and the Baltic

There followed a brief description by Gerda Behrends of the Baltic Monitoring Program set up as HELCOM after the Helsinki Convention of 1979. In this program some thirty stations throughout the various basin areas of the Baltic Sea have been allocated to the various nations surrounding the area and sampled more or less at monthly intervals with resulting data being archived into the Helsinki database. Sampling, data handling and quality assessment protocols were generally agreed and applied, each institute involved analysing their own samples and with successful training and intercalibration workshops being held. Other specific national monitoring and ancillary sampling programs have contributed much data to the main sampling effort. Also presented by Heino Fock was an outline of the long running monitoring work undertaken at a station in the Helgoland roads. A description of the sampling site and the nature and frequency of sampling was given. It was

pointed out that the temporal information was supported by a long series of spatially resolved surveys of the surrounding area.

Discussion then ensued on the two terms of reference for this session, the fact that they were closely related subjects and that improvements to existing monitoring required close consideration of the usefulness of such data and the requirements for information of the diverse range of customers for the data. Examples of customers include those involved in fisheries recruitment studies and modelling, requests for interpretative data to inform studies on climate change and both general and specific ecosystem modelling efforts, investigators and managers of anthropogenic influences on marine ecosystems and for other investigators and managers involved in a wide variety of environmental assessments and conservation issues. It was agreed that time and again the utility of monitoring work had been undervalued and the work curtailed or discontinued after the crisis that initiated the monitoring had passed. Often too, specific groups were not aware of, or ignored, both available information and the potential of monitoring . An obvious example was the discontinuance of zooplankton monitoring on the east coast of the US and Canada just prior to the collapse of the cod stock. It was pointed out that modern fish stock assessment methods can easily deal with multiple affective variables and that appropriate indices based on zooplankton trends should not be too difficult to derive or use. Again the Echinoderm larval CPR time series was considered as an example of important and relevant data.

Chris Reid referred the meeting to the IOC workshop report of a meeting in Hamburg in May 1996 on "Oceanographic Biological and Chemical Data Management", in which many issues relevant to the collection methods and data archiving of marine oceanographic studies were discussed. In particular the lack of data on zooplankton relative to the mass of physical/chemical and even phytoplankton biomass data available was pointed out, as was the need for meta-data descriptions of datasets which are essential to interpretation, comparison and quality control. A long list of areas which would benefit from consistent collection and archiving of oceanographic data is given in the report, along with calls for methods manual update, training programs in taxonomic and other methods and in data management.

4.6 New CPR Routes

Chris Reid spoke about the international participation in SAHFOS and the new CPR routes that were in progress, in the Western Mediterranean and hopefully in the Alaska to California east Pacific area, in the Gulf of Guinea and Australia. However, although the prospects for global spread of CPR routes through GOOS, LME and other initiatives were good, the North Atlantic coverage had declined to between two thirds and half of previous levels and was not well funded. He showed examples of work utilising the CPR data which showed interesting spatial and temporal correlations with fisheries data and climatic/oceanographic indices such as the North Atlantic Oscillation and the North Wall of the Gulf Stream. He also demonstrated the way CPR data was being utilised by major international projects such as the Trans Atlantic *Calanus* Study (TASC). Chris again stated that funds were needed for modernisation of the survey with U-tow development, CTD and other sensors. He quoted a figure of some £50K per annum as a usual level for data partnership funding and stressed that current funding derived from 10 countries with 40% from the UK. The undulating U-tow system was nearing completion of development and had worked in level tow deployments and Aquapack instrument packages had been used on a number of routes. There were questions raised as to the availability of electronic sensor data and the requirements of users of CPR data. Whether for example hydrographers could routinely use or propose CTD data collection. Chris replied that the hydrogrphers did not yet seem well enough aware of the possibilities of such data from CPR surveys and that SAHFOS had only three Aquapack systems. It was suggested that perhaps SAHFOS should be more involved in specific surveys made by marine institutes and that the utility of such CTD data needed to be demonstrated in the literature before it could be better appreciated and that the ICES Shelf Seas Hydrography WG should be made more aware of the possibilities. It was pointed out that the agreement was good between, for example, CPR data on timing of the spring bloom in the North Sea and the results of the 1988 NERC North Sea Survey data.

4.7 Recommendations

The session concluded with discussion of the WG recommendations which should come out of the group's deliberations during this session. These recommendations were agreed as follows:

- Results of monitoring activities should be made more widely available, and reviewed annually by the WGZE; the summary map(s) and information in tabular form is a first step.

- It is recommended that the potential and existing relevance of physico-chemical measurements that could be made on CPR routes should be brought to the attention of the WG on Shelf-Sea hydrography.

- The next meeting should compare CPR results with other data-sets, lead by Chris Reid, and should also review the CPR "intercalibaration" made during the sea-going workshop.

- The next meeting should consider technologies for the remote acquisition of zooplankton information on data-buoys.

- It is recommended that the CPR observation on meroplanktonic larvae be brought to the attention of the relevant working groups.

5 APPLICATION OF ENVIRONMENTAL DATA IN STOCK ASSESSMENT

The discussion was introduced and chaired by Doug Sameoto; Assthor Gislason acted as rapporteur.

Doug Sameoto gave an overview of the scenario when the cod stock collapsed off Newfoundland. The collapse was probably caused by environmental changes but the mechanisms behind this are uncertain. As a consequence of the collapse of the cod stock there was demand from both the public and the fisheries scientists for specific explanations for why the cod stock had collapsed. The environmental scientists couldn't provide many answers. Following this the Canadians have developed indices of environmental conditions, which are an attempt to "parameterize" both phyto- and zooplankton in an attempt to incorporate information about the plankton and the environment into the fisheries assessment process. A document describing these indices was distributed at the meeting. Work on these indices is in progress. It is hoped that after some years one may find a relationship between one or more of the indices and the recruitment. There are indications that at least in some areas temperature conditions and the annual development of the phytoplankton may have changed at a similar time as the collapse of the cod stock.

Doug Sameoto also distributed a report on zooplankton changes along the Newfoundland-Georges Bank and Halifax CPR lines. The plankton greenness index decreased in 1994 while still above the long term mean. Further, the abundances of most copepod species measured by the CPR were lower in 1994 than in 1993, and many were lower than the long-term mean. To conclude the zooplankton populations, including krill, appear to be declining from high levels seen during the last few years.

During the discussion it was noted that in addition to zooplankton the CPR-data also contain information about the phytoplankton (the CPR-greenness index). This the Canadians have incorporated in their "phytoplankton indices". In the North Sea the Greenness Index has changed greatly from 1950-1990, but nobody seems to have tried to relate this to the recruitment of fish.

Luis Valdez briefly described an EU-funded research project which aims at an understanding of how the environment affects the recruitment of mackerel. Similar to the Canadian practice this program employs environmental indices to estimate if the environment is "good" or "bad". It was noted that in order to understand the impact of environmental factors on the recruitment it may be beneficial to work with pelagic fish because they feed on zooplankton during the whole lifetime. This was one of the reasons for that the above mentioned project deals with mackerel.

The members of the Working Group consider it likely that the environment is influencing the fish stocks through factors which are operating on a large scale, such as atmospheric forcing, because the changes are occurring at similar times over the whole North Atlantic. In this respect it was mentioned that the cod stocks were collapsing off Newfoundland (1986-87) at similar times as the Norwegian cod was increasing in the Barents Sea.

Keith Brander discussed ways of incorporating environmental data into the stock assessment process. This could for instance be done by ...

a) identifying promising examples for future study (i.e. the relationship between zooplankton (CPR data) and herring spawning biomass in the North Sea, the upwelling index and the recruitment indices of Bay of Biscay anchovy).

b) providing appropriate data sets, e.g. temperature, wind.
c) developing environmental indices, (Norway, Canada, Spain have made a start at this)
d) evaluating sensitivity of stock assessment to environmental data
e) considering strategic management and long-term changes.

Eilif Gaard spoke on variability in the recruitment of the Faroese cod stock, which has been highly variable. Before 1993 the biological production over the shelf was very poor, but after this the production was much higher, and then there was also a relation between the timing of the spring bloom and the recruitment of cod. After 1993 the zooplankton has played a pivotal role in controlling phytoplankton growth.

Olafur S. Astthorsson demonstrated some relationships from Icelandic waters between zooplankton and/or environmental variable on one hand and fish on the other. There is for instance a significant relationship between zooplankton biomass on the drift route of cod larvae south and west of Iceland and O-group indices of cod. The O-group indices are in return significantly related to cod recruitment three years later. The biomass of zooplankton north of Iceland is significantly greater in warm years, when the inflow of warm Atlantic water North of Iceland is high, compared to cold years. Similarly the biomass of the most important planktivorous fish stocks in Icelandic waters, the capelin, is significantly greater in warm years than cold years.

To summarise the Working Group considers the relationships outlined above to be of relevance to the fisheries management process and would like to see them employed in the stock assessment models.

5.1 Recommendations

- The Workshop on Application of Environmental Data to Stock Assessment should recognise the importance of supporting and exploiting ongoing zooplankton monitoring activities.

- The Workshop should also be aware of the summary of monitoring activities prepared by the WGZE and be invited to pose specific questions based on these data sources.

- In addition the WGZE recommends that the Workshop should take note of discussions held at previous the previous IOC meeting.

- The WGZE is concerned that data acquired in zooplankton monitoring activities is not being used to it's full potential in stock and other assessment activities.

6 ZOOPLANKTON METHODOLOGY MANUAL

The session was chaired by Hein-Rune Skjoldal and Jürgen Lenz acted as rapporteur.

Work on the completion of the Zooplankton Methodology Manual (ZMM) has been carried on for a number of years. A milestone in progress was the Working Group Meeting in Woods Hole, USA, in June 1995. The Letter of Information to Authors by H. R. Skjoldal, dating from December 1994, contains a general overview on the scope and format of the ZMM and a preview of the contents of the 13 chapters planned (an updated version is given in Annex), while the Working Group Report for the Woods Hole Meeting gives a detailed outline of the greater number of chapters with their present draft status. During the last two years, however, further progress has been rather slow, mainly due to work pressure on the first authors responsible for the single chapters, even to the extent of withdrawal from authorship in some cases.

Recognising the need for a new impetus, it was thus decided to reinforce the editorship. Roger Harris was asked and Peter Wiebe will be asked to join the Editorial Board to assist in speeding up the process of drafting and reviewing the single chapters as well as harmonising the final manuscripts. Keith Brander and Chris Reid offered their help, too, for informing the oceanographic community on the preparation of the ZMM and assisting in the process of publication.

Following a proposal of Chris Reid, it was decided to prepare an update of the outline, based on the document from Dec. 1994, and of the present status of the ZMM for presentation at the next IOC Meeting in May this year (see Annex).

It was further suggested to explore the possibility for publication of single chapters after the review process with the IOC, following the JGOFS Protocols as an example for rapid publication. This would give a wide audience the opportunity to comment on the methods and latest developments. The final form of publication could then be a book printed at the Academic Press, the official ICES publisher.

In order to speed up the completion of the ZMM, it was agreed to take the following steps first:

Hein Rune Skjoldal, as main editor, will undertake the task of finding lead authors for the three missing chapters on Optical Methods, Behaviour and Modelling within the next three months and to bind them to deliver a first draft within nine months. If this is not possible, the missing chapters will be dropped.

The authors, who have not yet finished their chapter will be given a final period of six months to complete their draft.

The chapters already drafted will be first put in a closed box on the World Wide Web for internal review among them the WG members and later on an open Web site for external review. K. Brander and H. R. Skjoldal will provide technical assistance in putting up the Website.

The supervision of the external review of the chapters will be shared among the members of the Editorial Board.

6.1 Recommendations

- An updated overview be prepared as an Annex to this report.
- ICES should be approached regarding placing the draft Chapters on it's Web-site
- Chapters should then be made openly available on the WWW.
- The Manual project should be more widely advertised and a document on it should be submitted to the 1997 IOC Annual Meeting.
- It is recommended to ICES that they consider the possibility of publishing the chapters separately as Reports.
- The initial ICES contacts with Academic Press, regarding publication, should be followed up.
- Lead authors for the Optics, Behaviour and Modelling Chapters must be recruited in the next three months, or those Chapters will be dropped. The Chapters to be completed by the next meeting of the WGZE.
- The other ongoing chapters to be finished in 6 months.
- External review to start. Peter Wiebe to be approached to join for the CD-ROM, Roger Harris to assist. Clear editorial plan to be agreed.

7 PLANS FOR FURTHER WORK OF THE WGZE

7.1 Next Meeting

The meeting concluded with discussion of the future work of the WGZE. Two offers were made to host the next meeting; in Reykjavik, by Drs Astthorson and Gislason, and in Santander, by Dr Valdez. It was decided to recommend acceptance of the invitation from Spain for the 1998 meeting, with the hope that a subsequent meeting of the WGZE might be held in Iceland in the following year.

8 RECOMMENDATIONS

The Working Group on Zooplankton Ecology make the following recommendation:

The Working Group on Zooplankton Ecology will meet for 3 days at the Instituto Espanol de Oceanographica, Santander, Spain, in March/April 1998 to:

1) complete a final review of the Zooplankton Methodology Manual and to agree plans for it's publication.

2) carry out the first annual review of the results of zooplankton monitoring activities in the ICES area using the summary map(s) and information in tabular form in this report as a basis.

3) carry out a comparison of CPR results with other data-sets, lead by Chris Reid, and to also review the CPR "intercalibaration" made during the sea-going workshop.

4) consider technologies for the remote acquisition of zooplankton information on data-buoys and other remote platforms.

5) consider recommendations for maintaining and preserving zooplankton taxonomic skills within the ICES scientifc community.

9 REFERENCES

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ANNEX 1

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ANNEX 2

ICES Working Group on Zooplankton Ecology

Kiel, 16-18 March 1997

AGENDA AND PROGRAMME

Sunday 16 March

14:15 - 18:00 **OPENING, AGENDA, MEETING PROGRAMME**

TAXONOMIC CODING SYSTEMS
(Chair: Keith Brander, Rapporteur: Luis Valdez)

TOR e): *"review the status of development of taxonomic coding systems with a view to recommending the adoption of a single coding system for use in ICES".*

REPORT ON EUROPEAN GLOBEC DEVELOPMENTS
(Keith Brander)

OTHER INFORMATION ITEMS
Other relevant meetings, Working Groups, Baltimore ICES ASC, etc

Monday 17 March

09:00 - 13:00 **ZOOPLANKTON MONITORING ACTIVITIES AND THE CPR**
(Chair: Chris Reid , Rapporteur: Steve Hay)

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

TOR c): *"review and assess contributions of zooplankton information from the CPR Survey and ongoing national monitoring activities;"*

13:00 - 14:00 Lunch

14:00 - 18:00 **APPLICATION OF ENVIRONMENTAL DATA IN STOCK ASSESSMENT**
(Chair: Doug Sameoto, Rapporteur: Astthor Gislason)

TOR b): *"consider plans for the ICES/GLOBEC Workshop on the Application of Environmental Data in StockAssessment;"*

(cont)

Tuesday 18 March

09:00 - 13:00	**ZOOPLANKTON METHODOLOGY MANUAL** (Chair: Hein-Rune Skjoldal , Rapporteur: Jürgen Lenz) TOR d): *"continue, by correspondence, the work on reviewing and completing the Zooplankton Methodology Manual;"*
14:00 -	**SUMMARY DISCUSSION, COMPLETION OF REPORT, FUTURE PLANS**

ANNEX 3

ZOOPLANKTON METHODOLOGY MANUAL

Background

ICES established in 1992 a Study Group on Zooplankton Production chaired by Hein Rune Skjoldal. The SG were given as terms of reference to: a) review existing methods for measuring biomass and production processes; b) make proposals for improvement and standardization of methods, and prepare a methodological manual; c) consider the need for laboratory and seagoing workshops to intercalibrate experimental methods and evaluate new technology.

The SG has met six times, in March 1992 in Bergen Norway; in March 1993 in Las Palmas, Spain; in March 1994 in Plymouth, UK; in June 1995 in Woods Hole; in March 1996 in Bergen; and in March 1997 in Kiel.

The SG decided on the first meeting to aim at producing a Zooplankton Methodology Manual as the main product from the work of the SG. To assist in the review of methods and to provide input to the issue of standardization and improvement of methods, 3 special workshops have been convened. The first was a seagoing workshop onboard RV 'Johan Hjort' and RV 'A. V. Humboldt' on zooplankton sampling methods (June 1993) The two others were laboratory workshops at the University of Bergen on production methods using the copepods *Acartia tonsa* (October 1993) and *Calanus finmarchicus* (April 1994).A fourth workshop was arranged by the US GLOBEC at Hawaii using marine copepods (April 1994). Results from these workshops havve been developed for use in the work for the SG in producing the Manual.

ICES changed the status of the SG to a Working Group on zooplankton Ecology (WGZE) at the 1994 Annual Science Meeting. The WG has taken over the task of completing work with the Manual.

Scope

Zooplankton Methodology Manual (ZMM) is a working title for the book which is being planned. The Scope of the ZMM is to provide an *updated review* of basic methodology used in studies of zooplankton including recommendations on improvements, harmonization and *standardization* of methods. The reviews should keep a balance between being introductory and comprehensive. They should provide an overview of methods that are useful for e.g. graduate students who are orienting themselves into a new field. They should emphasize the sources of error and the strengths and weaknesses of methods for various purposes and tasks. It may not be possible, however, to go into great detail for all methods, and reference to recent reviews and detailed descriptions of methods should be used where possible and/or appropriate.

The review of methods should be accompanied by recommendations regarding choice and conduct of methods. Where possible detailed descriptions of standard protocols should be included. In many cases it may prove difficult to propose an agreed standard protocol. It should be possible, however, to provide guidelines that will reduce the variability in methods

and contribute towards harmonization and standardization. The standard protocol or guidelines need to have a clear reference to investigative purpose and biological conditions, e.g. a standard protocol may be suggested for a given purpose but need not be generally applicable for all purposes. The ICES WGZE will take the main responsibility for the issue of standardization based on contributions from chapter authors and other selected experts.

Format

The ZMM is planned with a format in two or three parts:

I. A review of methodology related to sampling and determination of zooplankton biomass and production. This part will be organised in 13 chapters with named authors.

II. Recommended standard protocols or guidelines towards harmonization and standardization.

Parts I and II will form the published manual. The aim is to have this as a book limited to about 300 pages. It is envisioned that part I will consist of about 20 pages for each of the 13 chapters, excluding references. Part II will be included with the manual, but it is envisioned that it also can be made available as a separate handbook and leaflets.

A part III has been considered as a CD ROM version of the manual that could also include information or data which otherwise would be too large or in a form precluding their publication. For example, output from simulation models and videos of gear in operation or laboratory techniques could he made available in this format.

Editors

The Manual is being edited by Hein Rune Skjoldal (chief editor), assited by Jürgen Lenz, Peter Wiebe and Roger Harris.

The various parts of the manual will be reviewed by the ICES WGZE. in addition it is envisioned to use peer reviewers for outside this group in the final stage of editing the manual.

Authors

The various chapters are being authored by a group of experts selected from both members and non-members of the ICES SGZP. The drafting is being organised and co-ordinated the a main author assisted by co-authors. Their names will appear on the authorlist for each chapter of the manual. The Table below gives an overview of the main authors of the 13 chapters of part I of the ZMM.

Chapters

The contents of the 13 chapters of the Manual part I, have been discussed and agreed by the ICES SGZP; the staus of the chapters at April 1997 is sumarised in the Table below.

Chapter 1 will give a short and general introduction to zooplankton and their production and

ecology. The chapter should highlight the role of zooplankton in marine ecosystems and their central position in relation to current research topics (aspects related to GLOBEC, JGOFS, LME, etc.). This chapter should also highlight the need to put more emphasis on species and populations, and on the role of behaviour in relation to physical processes.

Chapter 2 will give an introduction to the strategy and design of studies of zooplankton. The chapter should highlight the need for integration of various approaches, such as net sampling with acoustical and optical methods, field studies with experimental and modelling studies, and studies of zooplankton with studies of physics, phytoplankton and fish within a system ecological framework.

Chapter 3 will deal with of zooplankton by nets and other means of physically retrieving the animals from the water. The chapter should give an overview of sampling methods with emphasis on method improvements and standardization. The major sources or error such as avoidance and clogging, and the issue of scale and representativeness should be reviewed. Sampling of live animals for experimental purposes should also be treated.

Chapter 4 will deal with the methods of determining biomass and abundance of zooplankton in samples taken with nets or pumps. Determination of biomass and abundance by indirect means such as acoustics or *in situ* video and other optical techniques will be dealt with in the following two chapters (5 and 6). This chapter should deal with issues such as units of biomass, determination of biomass and bulk biochemical composition (C, N, P, protein, lipids, etc), species identification and enumeration, determination of size, and indirect determination of biomass from size frequency data.

Chapter 5 will give an introduction and overview of methods and systems for determining distribution and abundance of zooplankton by use of acoustics. The chapter should review the present state of plankton acoustics, the main avenues for further development, and the need to integrate plankton acoustics with other methods such as net sampling and optics, and with fishery acoustics.

Chapter 6 will deal with optical methods for determination of zooplankton abundance, biomass and distribution patterns This chapter should give an introduction and overview of optical instrumentation and methods. Use of optics for determination of feeding rates, growth and behaviour should not be dealt with here (except for possible inclusion in a general overview and introductory remarks), but treated in subsequent chapters (7, 8 and 10). This chapter should deal with optical techniques for use both in the laboratory and *in situ.* This would include optical plankton counters, video-based systems and photography including silhouette photography. Optical methods for providing supporting information in zooplankton research (e.g. light conditions, phytoplankton pigments) could be treated in a brief and summarily manner.

Chapter 7 will describe the different approaches and methods for determining feeding and feeding rates of zooplankton. The chapter should include an introduction and overview of methods as well as a more detailed review of or determination of ingestion, assimilation, food selection and predation. The chapter should describe different measurements based on incubations and/or gut analyses and indirect methods such as biochemical techniques. Methods for determination of *in situ* feeding rates could also be included.

Chapter 8 will describe different approaches and methods for determination of growth and of production of zooplankton. The chapter should give a general introduction to growth and production and give a review of methods based on direct determination of growth in incubation experiments, egg production methods, methods based on moulting rates and stage duration, and biochemical methods. Methods based on size-frequency analysis of mixed plankton samples and general relationships between P/B ratio and size should be included in this chapter, whereas methods based on cohort analysis are to be treated in chapter 12.

Chapter 9 will describe methods for determination of metabolism and metabolic rates of zooplankton. The chapter should give a short review of factors and sources of error influencing metabolic rates and describe direct methods based on incubation and indirect methods such as biochemical techniques.

Chapter 10 will describe methods for studying the behaviour of zooplankton. The chapter should give a brief introduction to the need for integrating behaviour in ecological studies of zooplankton distribution, trophodynamics and production. The chapter should review methodology for observing and quantifying behaviour both in the laboratory and *in situ*.

Chapter 11 will present methods for describing population genetics and genetic variability of zooplankton. The chapter should give a short general introduction to traditional and new approaches to studies of zooplankton genetics, and how genetics may be applied in studies of zooplankton population structure, dynamics and distribution patterns. It should review the strengths and limitations of current and new methods and point the direction for future developments.

Chapter 12 will describe methods for studies of zooplankton population dynamics. The chapter should give a brief introduction and overview of methods, and review methods for quantitative estimation of population dynamics based on results from analysis of zooplankton samples. Description of zooplankton population dynamics by use of numerical simulation models with no or limited use of data should not be treated in this but in the following chapter (13).

Chapter 13 will describe use of numerical models in studies of zooplankton ecology. The chapter should give an overview of modelling approaches and present a brief review of models for zooplankton feeding, growth, population dynamics and production, zooplankton life history and distribution, including coupled physical-biological models and models of zooplankton-fish interactions. Use of data assimilation in numerical models should be included.

Original Timetable

A timetable for the production of the manual was made at the meeting of the ICES SGZP in March 1994. According to this the author list and detailed plans for the various chapters should be completed by August 1994. Drafting should start in autumn 1994 with first drafts produced by January 1995. Further drafting and review of chapters should continue in spring 1995 with the aim to have completed drafts for review at the meeting of the ICES WGZE in June 1995 at Woods Hole. Independent external peer review of the chapters was planned to be done in autumn 1995 with the aim of having the Manual ready to go to the printer in November 1995.

NEW REVISED TIMETABLE

We are somewhat behind the planned timetable in our progress. Three main authors still remain to be identified. Otherwise all main authors and most of the associate authors have either completed their assignments, or are actively writing. The co-ordinating editors will work with the main authors for the chapters of their responsibility to facilitate the process and ensure progress:

Jürgen Lenz has agreed to be responsible for review of Chapters 2, 3 & 4.
Roger Harris will review Chapters 4B, 7, 8, & 9
Peter Wiebe will review Chapters 6 & 10
Hein-Rune Skjoldal will be responsible for the review of Chapters 5, 11, 12 & 13

The March 1998 meeting of the WGZE, proposed for Santander, is the endpoint for the ZMM. In the meantime existing drafts will go to external peeer review, will be mounted on the ICES web-site, and may be published individually in ICES Report format.

Publication

ICES has offered to provide help with the technical editing of the Manual. Discussions have begun with Academic Press regarding technical aspects of publication.

Zooplankton Methodology Manual : Status of manuscripts at 15 April 1997

	Chapter	Main author	Status	Responsible editor
1.	Introduction	Lenz	1st draft (March 97)	
2.	Sampling / exp. design	Skjoldal	In drafting	JL
3.	Collecting zooplankton	Sameoto	1st draft (Oct 96)	JL
4.	Biomass and abundance	Postel	In drafting	JL
4-B	Microzooplankton	Gifford	1st draft ()	RPH
5.	Acoustical methods	Wiebe	In drafting	HRS
6.	Optical methods	Foote	Being organised	PW
7.	Feeding	Båmstedt	In drafting	RPH
8.	Growth	Runge	1st draft ()	RPH
9.	Metabolism	Ikeda	1st draft (revised April 97)	RPH
10.	Behaviour		Being organised	PW
11.	Genetics	Bucklin	In drafting	HRS
12.	Population dynamics	Aksnes	1st draft ()	HRS
13.	Modelling		Being organised	HRS

ANNEX 4

ZOOPLANKTON MONITORING ACTIVITIES IN THE ICES AREA

Zooplankton monitoring activity record

Country: CANADA

Monitoring location:	Halifax line 44°24N 63°28Wto 42°33N 61°4W	Louisbourg line 45°49N 59°51W to 43°46N 57°49W
Frequency	2x / year	2x / yr
Duration	12 yrs	3 yrs
Contact address/location of data	doug.sameoto@maritimes.dfo.ca	same
Items sampled/measured		
zooplankton	✔	✔
chlorophyll	✔	✔
T and S	✔	✔

Contact: Dr Doug Sameoto
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Fax: +1 902 426 9388
e-mail: doug.sameoto@maritimes.dfo.ca

Zooplankton monitoring activity record
Country: FAROE ISLANDS

Monitoring location:	Section N, E &W	Section S	Faroe Shelf	Faroe Bank
Frequency	4 yr^{-1}	4 yr^{-1}	Annual (June)	Annual (June)
Duration	1990 - pr	1995 - pr	1989 - pr	1990 - pr
Contact address/location of data	*	*	*	*
Items sampled/measured				
Zooplankton	✔	✔	✔	✔
Fluorescence / Chlorophyll	✔	✔	✔	✔
Nutrients	spring - summer	spring - summer	✔	✔
Gear	WP2 200µm	WP2 200µm	WP2 200µm	WP2 200µm

Contact: Eilif Gaard
Fisheries Lab of the Faroes
P.O.Box 3051, Noatun
FR-110 Torhavn
Faroe Islands
Tel +298 15092
Fax +298 18264

Zooplankton monitoring activity record

Country: GERMANY

Monitoring location:	Baltic Sea	Island of Helgoland (54° 11'3"N 7°54'0"E)
Frequency	3 monthly (March, May, Aug, Oct)	3 times a week (Mon-Wed-Fri)
Duration	1979 - present	1974 - present
Contact address/location of data	see below EDC, HELCOM	see below
Items sampled/measured		
Mesozooplankton	✔	✔
Chlorophyll	✔	✔
Primary production	✔	✔
Hydrography	✔	✔
Phytoplankton	✔	
Gear	WP-2 100µm vertical haul	mesozooplankton with 150 µm net macrozooplankton with a CalCoFi 500 µm net.

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Tel: + 381 51970
Fax: + 381 5197 440

Dr. Wulf Greve,
Biologische Anstalt Helgoland,
Notkestraße 31,
D-22607 Hamburg
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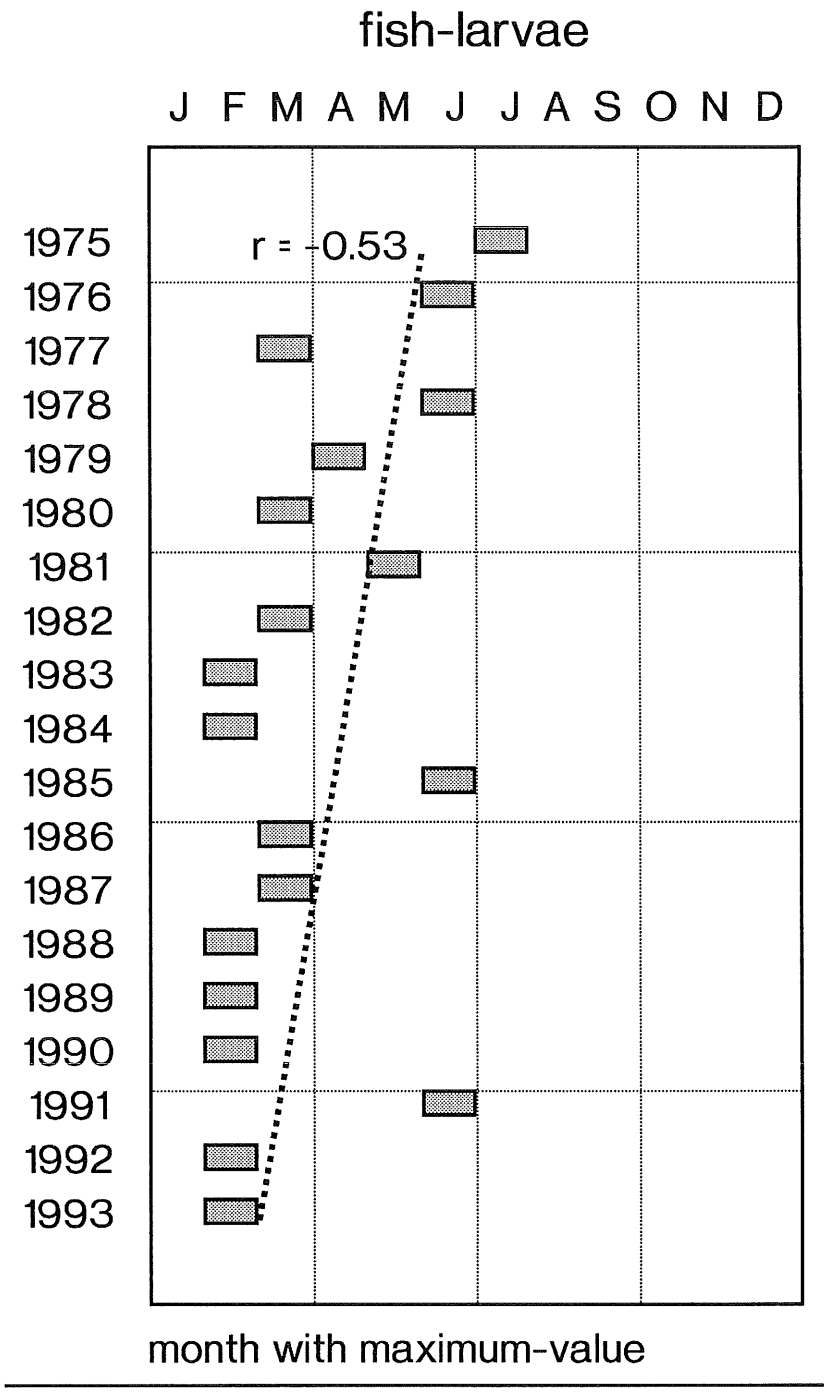

Figure The time of maximum abundance of fish larvae in the Helgoland Roads zooplankton samples shifted forward in the 80's and 90's. This indicates a shift in plankton community structure, characterized by an increasing contribution of the early spawned sandeel larvae (Ammodytes sp.) to the plankton.

Zooplankton monitoring activity record

Country: ICELAND

Monitoring location:	9 standard transects around Iceland (see fig) 80 stns
Frequency	Annually (May-June)
Duration	1961 - pr
Contact address/location of data	*
Items sampled/measured	✔
Zooplankton	✔
Phytoplankton	✔
Primary production	✔
Chlorophyll	✔
Nutrients	✔
Salinity	✔
Temperature	✔

Olafur Astthorsson / Astthor Gislason
Marine Research Institute
101 Reykjavik

ICELAND

Zooplankton monitoring activity record

Country: NORWAY

Monitoring location:	Transect A	Transect B	Transect C	Transect D
Frequency	monthly 2*month^{-1} in spring	monthly	5-6 yr^{-1}	3-4 yr^{-1}
Duration	1990-pres	1990-pres	1993-pres	1993-pres
Contact address/location of data	IMR	IMR	IMR	IMR
Items sampled/measured				
Mesozooplankton	✔	✔	✔	✔
Chlorophyll a	✔	✔	some	some
T/S	✔	✔	✔	✔
Nutrients	✔	✔	✔	✔

Data supplied by

Dr B. Ellertsen
IMR
PO Box 1870
N-5024 Bergen
Norway

Transect A Svinøy transect. 17 stations. Zooplankton sampling with WP-2 net at all locations and with MOCNESS at 3 locations. Chl a, CTD, nutrients at all locations.
Innermost location 62°22'N 005°12'E
Outermost location 64°40'N 000°00'E

Transect B Gimsøy transect. 15 stations. Zooplankton sampling with WP-2 net at all locations and with MOCNESS at 3 locations. Chl a, CTD, nutrients at all locations.
Innermost location 68°25.8'N 014°00.8'E
Outermost location 70°24'N 008°12'E

Transect C Fugløya-Bjørnøya transect. 18 stations. Zooplankton sampling with WP-2 net, Chl a, nutrients at 7 locations. CTD, at all locations.
Southern (innermost) location 70°30'N 020°00'E
Outermost location 74°15'N 019°10'E

Transect D Vardø-N transect. 18 stations. Zooplankton sampling with WP-2 net, Chl a, nutrients at 7 locations. CTD, at all locations
Innermost location 70°24'N 031°13'E
Outermost location 74°30'N 031°13'E

Zooplankton monitoring activity record

Country: SPAIN (North and West coasts)

Monitoring location:	Santander	Cudillero	La Coruna	Vigo
Frequency	Monthly	Monthly	Monthly	Monthly
Duration	1991- pr	1993- pr	1989- pr	1987- pr
Contact address/location of data	*	*	*	*
Items sampled/measured				
Zooplankton	✔	✔	✔	✔
Ichthyoplankton	✔	✔	✔	✔
Phytoplankton	✔	✔	✔	✔
Chlorophyll	✔	✔	✔	✔
Nutrients	✔	✔	✔	✔
Gear	Jud-Bog 50ø 250µm	WP-2 200µm	Jud-Bog 250µm	Jud-Bog 250µm

Country: SPAIN (Mediterranean)

Monitoring location:	Fuengirola	Cabo Palos	Palma	
Frequency	3-Monthly	3-Monthly	Monthly	
Duration	1992- pr	1996- pr	1993- pr	
Contact address/location of data	*	*	*	
Items sampled/measured				
Zooplankton	✔	✔	✔	
Ichthyoplankton	✔	✔	✔	
Phytoplankton	✔	✔	✔	
Chlorophyll	✔	✔	✔	
Nutrients	✔	✔	✔	
Gear	Bongo-40 250µm	Bongo-40 250µm	Bongo-40 250µm	

* Contact address: Luis Valdes
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Centro Oceanogr. Santander, P.O.BOX 240
39080 Santander
Tlf 34 42 27 50 62
Fax 34 42 27 50 72

Zooplankton monitoring activity record

Country: UK

Monitoring location:	L4	Wide coverage
Frequency	weekly	continuous
Duration	1988 - pr	1931 - pr
Contact address/location of data	R. Harris, PML	SAHFOS
Items sampled/measured		
CTD	✔	some years
Zooplankton	✔	✔
Phytoplankton	✔	✔
POC	✔	
PON	✔	
Nutrients	some years	
Lipids	some years	
Egg production	some years	
Gut fluorescence	some years	
Bacteria	some years	
Microzooplankton	some years	
Viruses	some years	

Contact:

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Fax +44 (0) 1752 633101
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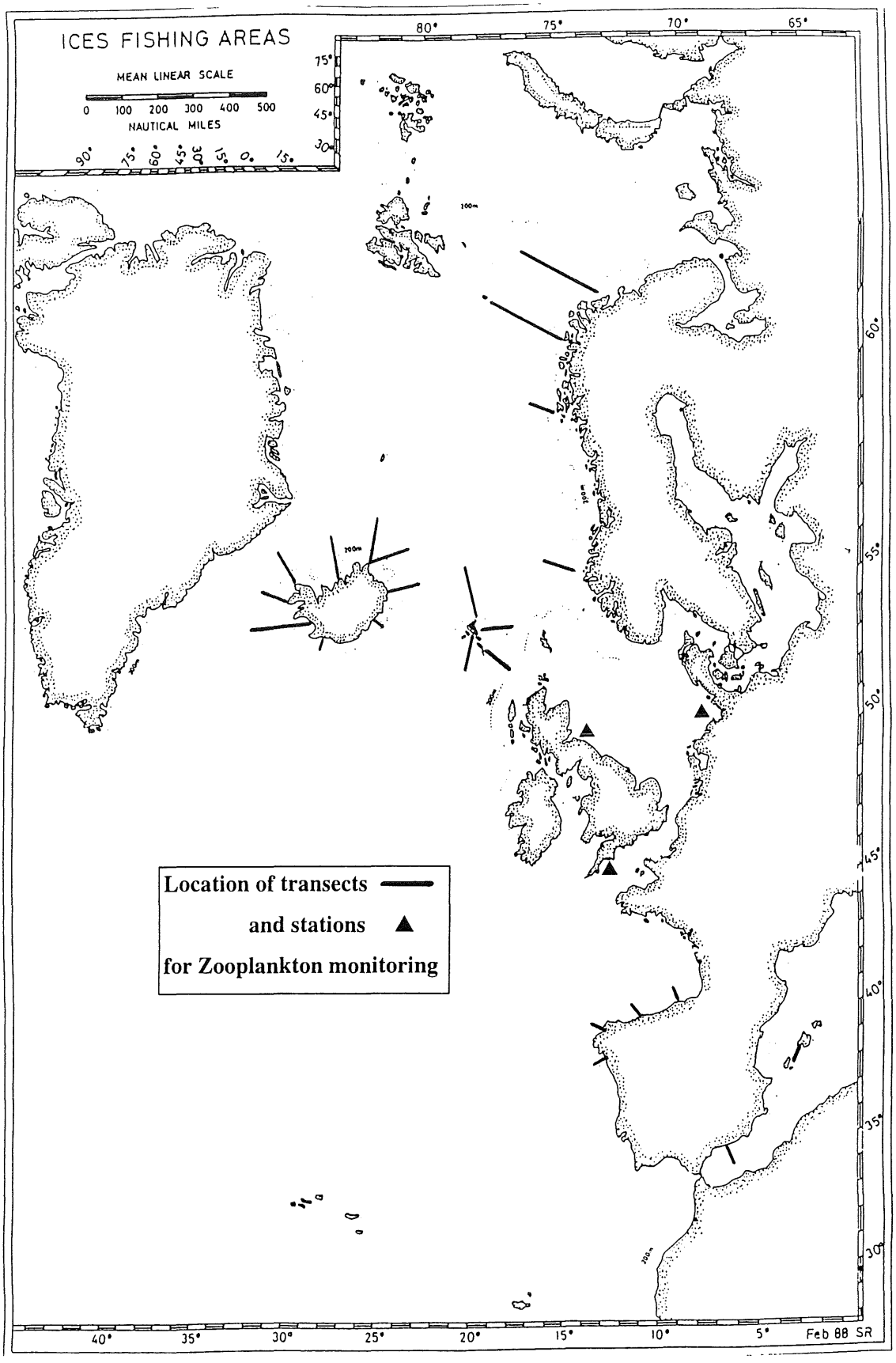
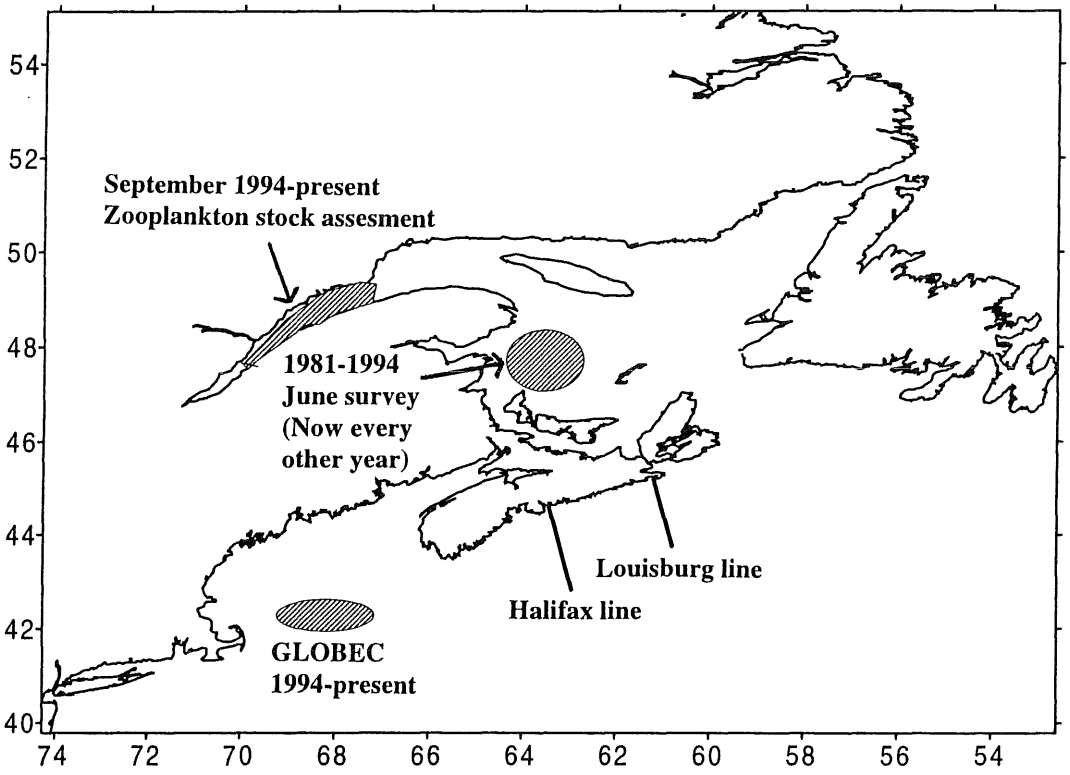
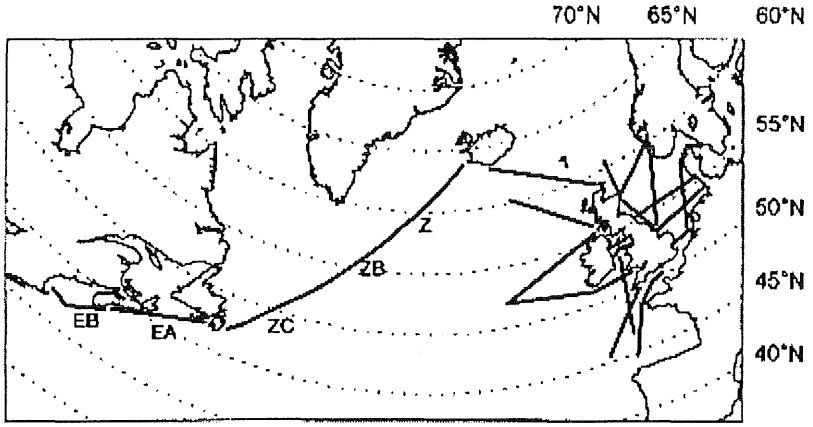
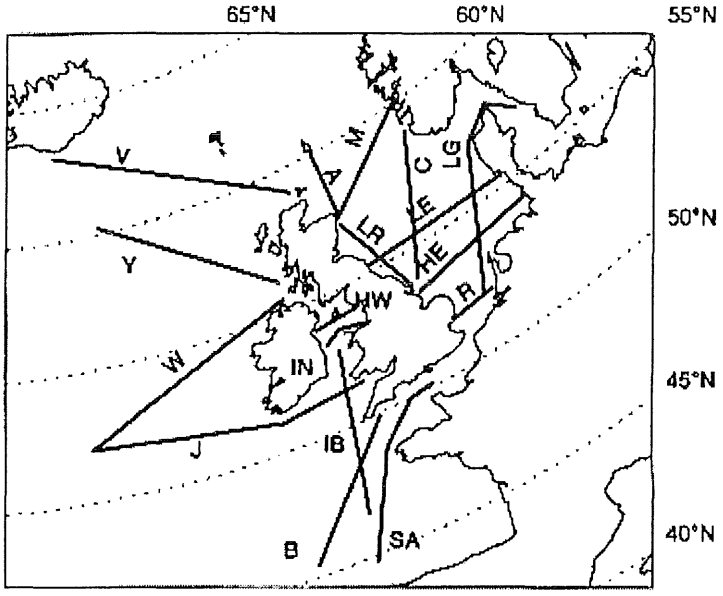
ANNEX 5

DISTRIBUTION OF MONITORING PROGRAMMES IN THE ICES AREA




September 1994-present
Zooplankton stock assesment
1981-1994
June survey
(Now every
other year)
Louisburg line
Halifax line
GLOBEC
1994-present
54
52
50
48
46
44
42
40
74
72
70
68
66
64
62
60
58
56
54





Standard CPR tow routes sampled during 1995.