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Report of the

Working Group on Zooplankton Ecology

Gijón, Spain
24–26 February 2003

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

EXECUTIVE SUMMARY

The Working Group on Zooplankton Ecology (WGZE) had a convivial meeting in Gijón with nine official Working Group members present, written submissions from some absent members and five local scientists who attended and contributed usefully to the proceedings. Luis Valdés was the perfect host and the facilities were excellent. We realised that our agenda was rather full. Also since four of the terms of reference (TORs b, g, h and j) related to submissions from absent members we could not at this meeting deal with all TORs as effectively as we would wish. However we have addressed all the tasks set for our WG in a positive and constructive manner.

We began by considering the annual ICES Zooplankton Status Report (Annex 4). The outgoing Chair Luis Valdés has done a fine job preparing this and collating updated contributions from owners of the monitoring data. The group recognised how hard Luis had worked on this and more effort would be needed in future since we have been making efforts to extend the time series data with inclusion of new series including phytoplankton time series. These efforts are proceeding with new contact details for owners of monitoring data being contributed by the WGHABD and WGPE, also from the co-ordinator of EU FP6 PLATO initiative. These contacts will be approached over the coming year and we hope to gather their metadata and examples of their data for inclusion in an extended Status Report in 2004. Thus we proposed,

- *the WGZE will continue intersessional work to extend collaborative inclusion of further data sets into the status report for future years,*
- *the name of the ICES Zooplankton Status Report should change to the ICES Plankton Status Report.*

The need for standardisation of the data and its presentation, how best to analyse, present and promote the Plankton Status Report was discussed. The WGZE, in collaboration with other concerned Working Groups, should aim to consider future developments and collaborative approaches to time series measurements and to data analysis and synthesis, aiming to integrate new sampling, technologies, methods and scales. This should include efforts to promote the Status Report as an element in ecosystem approaches to environment and resource management in the ICES area, alongside the Climate Status and other such Reports. In future, as the report expands, a thematic perspective on the data may be possible e.g. Fisheries, Eutrophication, Habitats etc. It was felt important for the WG and ICES to re-emphasise that sampling of zooplankton trophic levels in marine ecosystem monitoring plans and programmes should be encouraged, as often only physics, chemistry, phytoplankton and fish seem to be considered. WGZE actions were proposed to help enable this;

- *An outline of a paper addressing "What's happening to plankton in the North Atlantic", will be prepared. R. Harris, A. Lopez-Urrutia and A. Richardson will work on this intersessionally.*
- *The WG Chair will contact the Chairs of SGGOOS, PGNSP and REGNS highlighting to them the relevance of the ICES Plankton Status Report to their initiatives.*
- *Poster to be prepared for the ICES/PICES/GLOBEC Symposium in Gijón, by R. Harris and A. Richardson*
- *In future S. Hay and A. Richardson will provide assistance to L. Valdés in preparing the expanding Status Report*

After a period of debate and some uncertainty, ICES fulfilled the desire of the WGZE to publish the ICES Plankton Identification Sheets digitally on a CD. The group was delighted that a draft version on CD had been prepared and grateful to those, L. Valdés, A Lindley and particularly H. Dooley, whose efforts had produced this. There was a mixture of delight at the ease of use and disappointment at the lack of quality in the detail of many of the sheets. There was discussion about how this might be remedied and a systematic attempt was made to review the sheets. Overall it was agreed that the sheets needed to be scanned at a higher resolution, especially remembering that in taxonomic texts, distinguishing detailed morphological differences is the whole point.

There were constructive comments on the need for an improved introduction, links and movement between sheets to improve usability. We are very keen to see the draft version redone at higher resolution, hopefully in the near future as we had hoped that the CD would be ready for the May Symposium in Gijón or especially for the ICES Taxonomic Workshop in Plymouth in June 2003. We definitely expect that the job should be finished in time to distribute the CDs at the ICES ASC in 2003.

- *Ensure that a simple introduction for the ICES taxonomic leaflets is prepared once the final form is decided and that scan quality is assured.*
- *Ensure that the ICES Plankton Identification Sheets are rescanned to a higher quality and accuracy.*

Note – If ICES cannot achieve this then several members of the WGZE have volunteered to do the rescanning .

Regarding the ICES Metadata Guidelines T. O'Brian had supplied, there was general agreement that, with some provisos and refinements, they were good and acceptable to the WGZE. There was a feeling that there are perhaps too many fields and key subsets could be identified. It is useful to have ship name and cruise number and there is need for a metadata field related to environmental sensors on the sampling gear, we drafted a description.

The group appreciated the benefits of central and actively updated databases, and are in favour of data dissemination. There was however a debate and concern that the WGMDM and data centres (e.g. ICES, BODC and NODC) should get their heads together and standardise between themselves first. This we felt was better than each setting perhaps minutely different standards for scientists collecting the sought after data. Too much data shuffling inhibits the basic core science of sample collecting, sample and data analysis and publication activities. Also researchers have problems when data formats are imposed by outside agencies on their own, often long established systems. Consensus and compliance is best achieved when those asking for the data undertake such efforts through active collaboration, particularly over any format conversions required. It is fine to promulgate standards but it should be the task of expert data managers to reformat or otherwise accommodate the data provided. Often this activity can be an unfortunate burden on researchers who may well have neither time nor funding, especially when historical data is involved.

ICES has already adopted The ITIS taxonomic coding system, which fact rather outdates this TOR. The WG noted there are other forums and systems for species information coding and many years of discussion have evolved around questions of how taxonomists might agree to a common taxonomic information repository. It is hoped that in this era of globalisation some system such as ITIS may resolve into a final solution (is there a cure for ICES-ITIS?). The WGZE endorse the adoption of ITIS by ICES.

While the group appreciated the benefits of a central and actively updated taxonomic reference source as ideal, there were reservations. The major worries relate to the effort required to translate from existing coding systems and the time needed to update species names etc. This could have significant cost implications for many research groups, so acting as a brake on willingness to collate and submit data to database centres such as ICES. It is also true that other data centres may have alternative formats etc and that if ICES is setting a standard by adopting ITIS, then they could provide a service by translating between other and older coding systems and IT IS, perhaps as a web service.

Peter Wiebe opened the discussion on the review of climate change and Trans-Atlantic studies on *Calanus* with an introductory talk, "*Analyses of the consequences of ocean climate changes for zooplankton processes and community structure*". He emphasised that the Trans-Atlantic initiative had a focus wider than on *Calanus* alone. The aim was to update ideas from various North Atlantic GLOBEC studies, with the overall objective of looking holistically at the zooplankton populations in the whole ocean basin. Major projects, e.g. TASC, Mare Cognitum and USGLOBEC George's Bank, had produced much. However, synthesis for target species across the whole of the North Atlantic Basin is needed. Particularly important are linked models of both the physics and target species biology.

Progress on this topic since the last meeting of the WGZE, in Aberdeen, has included:

- Funding for the Phase IV of the USGLOBEC George's Bank study, in September 2002.
- Five projects have been funded.
- Conversations with the European Union and US NSF. These have centred on the concept of a workshop to bring together researchers from around the North Atlantic to discuss synthesis of data-sets and basin-scale modelling.
- At the ICES ASC in Copenhagen an ad hoc group met to develop this idea further.

From these intersessional activities emerged a proposal, for a workshop entitled "Workshop on the impact of basin-scale oceanography and climate-related processes on the dynamics of plankton and fish populations in the North Atlantic Ocean". Reykjavik is the proposed venue; Olafur Asthorsson had kindly agreed to act as local host.

There was considerable WGZE interest in and discussion of this TOR and the WGZE recommended support for the Workshop initiative, and the Working Group look forward to close and continuing cooperation as Trans-Atlantic activities developed further.

Xabier Irigoien opened discussion on the WGZE review of perturbations in coastal marine ecosystems and changes in zooplankton community structure due to human impacts, by presenting a real example of data from the Bay of Biscay. Fishing, agricultural and industrial inputs through runoff & rivers and anthropogenic contributions to climate change are the main human impacts on the plankton community structure here, as usually elsewhere. In addition recent events have now imposed a strong oil spill problem on the Bay of Biscay. This presented data and some presented by A. Richardson on SAHFOS CPR plankton data were discussed. It is evident that, while strong evidence exists of changes in plankton

communities, it is usually an extremely difficult and complex task to distinguish between climate effects, natural variation and human impacts.

There was much discussion of examples such as species introductions, algal blooms etc., and it was generally thought that in some cases clear evidence and understanding could be found. However the WGZE concluded that;

- More and longer time series are needed to understand ecosystem responses to impacts and climate effects.
- The development of indices (see TOR e) could be a way forward and is needed to simplify these issues.
- There should more integration of effort and data between monitoring and research studies (for example to make better use of expensive ship time and available technology).

Over the past few years the WGZE have suggested many indices to monitor the state of ecosystems, especially in relation to fisheries and environmental assessments. W. Melle gave an outline of the background and EcoQ Objective approach and on the justification criteria adopted for these. The topic raised some extensive debate on cases of collapsed or fading fisheries, the difficulties of defining useful metrics, particularly for parameters such as spatial integrity, and on the influence of economic factors. After much discussion it was decided that, of those the WGZE had proposed for zooplankton, the only index to satisfactorily meet the 8 WGECO recommended criteria for an EcoQ O was the index of zooplankton species abundance and diversity. Also, we noted that the basic measures required to achieve this index are those of taxonomic identification and species counts. This then allows calculation of other suggested indices and establishment of relationships with other ecological measures of environment, phytoplankton, trophic structure etc. It was agreed to propose this single index as an EcoQ, and to give advice about how to monitor it. Two aspects were considered to be essential, the index should be measured at least monthly to capture seasonal patterns and samples should be collected with a fine mesh (e.g. 53 micron mesh size), in order to capture the small organisms relevant to fish larvae feeding.

The group divided for a few hours to allow those WGZE members most closely involved to review arrangements for the Gijón Zooplankton Production Symposium. The afternoon review took the team around the venue and facilities, concluding with their meeting with the Deputy Mayor of Gijón. Conversations confirmed that the City of Gijón strongly supported the Symposium, and was particularly pleased by it's wide international characteristic. This support would include significant funding for certain activities, for which the Symposium organisers are very grateful.

The group was well satisfied with the local organisation and facilities. The plans in place should ensure an effective and productive Symposium. The response within the scientific community had been very strong with 450+ attendees expected from 50+ countries. This success had placed particular pressures on receipt of Abstracts, registration and structuring the scientific programme. The efficient role of the PICES Secretariat in this regard was warmly appreciated, as was Luis Valdés' continuing hard work as local host. Both PICES and GLOBEC have been able to offer partial travel support for students and attendees from Developing Countries. It was suggested that ICES might consider having similar funds in future to provide matching support. It was remarked that though ICES have an ICES/GLOBEC programme, also they are promoting links with PICES, yet the Copenhagen office had not been actively involved in practical planning for the Gijón Symposium. The main responsibilities had fallen to the PICES Secretariat and to a lesser extent to the GLOBEC IPO. There was some concern as to who would officially represent ICES at the Symposium in May.

Santiago de Hernandes Leon, though not present, has submitted a text outlining his expert views on the *state of the art of enzymatic activity methods to estimate plankton secondary production*. Without his presence as an expert in plankton physiology and biochemistry, the WG was short on competence to discuss the submission in any detail. However, some effort was made. It was decided that this important subject and Santiago's view should be revisited the following year, with him there as advocate for his position. The text of his review is included below.

He has decided that it is time to promote an international effort to bring together different researchers with the objective of meeting in a series of workshops, testing different enzymatic indices and biochemical approaches in plankton ecology, comparing them with classical physiological methods. Such approaches to process studies in marine ecology are becoming increasingly accurate and productive. This requires an important organizational and economic effort. In view of novel advances in methods and theory, Santiago has proposed that, within the framework of the Working Group on Zooplankton Ecology, a series of workshops should be organized to compare different methods that are and could be used as indices to assess physiological rates in the field. The proposal would follows a series of steps; from announcement, though national funding applications, through two workshops on sub-tropical and temperate areas, to a final workshop/symposium after some 4 years effort.

Although the schedule proposed is rather long, planning the activities, design of experiments, finding host laboratories and available research equipment etc will take the time. Comparison of different current techniques used or those being developed meantime would be an important contribution to the development of biological oceanography. For this reason the recommendation was to carry this TOR over to next year with the provision that Santiago Hernandez-Leon (and others with specialist interest) would be able to attend and lead the discussion.

At the previous WGZE meeting in Aberdeen 2002, Pat Kremer, a world-renowned expert on gelatinous plankton had proposed a TOR for the Gijón meeting on *sampling and analytical methodologies focussed on gelatinous zooplankton*. She felt that ICES is the appropriate organisation to help in the process of educating fisheries scientists to the fact that gelatinous zooplankton are not simply obscure and esoteric forms that have no relevance to fisheries. To that end Pat, despite being unable to attend the meeting had sent a written submission (see below).

In this she pointed out that gelatinous forms of plankton, due to size, fragility and patchy distributions, are inherently hard to sample and suffer from a bad image as "nuisance" for many researchers. This had resulted in a historic lack of interest and awareness of their importance, as well as a dearth of quantitative data on these organisms. She outlined a series of strategies to improve sampling and data acquisition for the gelatinous predators in the plankton. She also suggested that the WGZE might like to propose a theme session for the ASM in 2004 entitled "Gelatinous Zooplankton and Fish: Predators, Competitors, Prey, and Nuisance". This theme session would aim to elucidate especially the ways in which gelatinous zooplankton impact fish populations and their role in marine ecosystems generally. Also it would serve to raise the awareness of importance of gelatinous zooplankton

As part of the upcoming 3rd International Zooplankton Production Symposium, there will be a half-day workshop focusing on the theme session topic proposed. Although there was some animated discussion on the gelatinous plankton TOR, the meeting concluded that, without Pat Kremer being present in Gijón, the WGZE could not advance this TOR further at this time. The WGZE were keen and very supportive of this initiative. Generally they felt that the outcome of the symposium workshop would strongly influence any future WGZE, and other initiatives regarding the role and relevance of the gelatinous plankton. Also, given the consensus view that we focus on only one theme session proposal, then we decided to postpone this issue until next year, when symposium output and consideration of current research initiatives may be taken account of.

The group went on to discuss the various contacts and interactions with other ICES groups. A previous WGZE meeting had suggested a theme session on modelling of links and relations between phyto- and zooplankton, which aimed at achieving a modern overview of plankton modelling in a forum for modellers and plankton biologists to interact.

At ICES ASC there is support for multidisciplinary theme sessions, so we decided that the WGZE should aim for the future joint focus Theme Session for WG Recruitment Processes, WG Biological-Physical Interactions, WGPE and WGZE.

We also however decided that WGZE should choose one theme session to suggest for ICES ASC 2004.

It was agreed that WGZE should talk intersessionally with WG Recruitment Processes to further a joint theme session.

ACTION: Suggested theme session title to be submitted to ICES:

Larval fish growth, feeding and recruitment in relation to patterns and activity in plankton communities.

The WGZE Theme session proposal is a joint one between WGZE and WGRP (who are meeting by correspondence in 2002-3). After some input to our discussions from the WGRP, the WGZE felt that joint WG meetings are problematic when each has independent TORs plus joint discussion. Such a meeting becomes too long, with time too short to do justice to the TORs, also funds for such long meetings can be hard to find. Thus the idea of a Theme Session with joint WG sponsorship appears the best solution, giving options for more participants and interested parties to contribute. Proposals and issues arising then from the joint Theme Session could be addressed by further Study Groups, or subsets of partners from any relevant WGs, then dealing with joint approaches to single or closely related issues.

Our Theme Session title is deliberately general but very relevant to a broad church of interested parties and current research concerns. Plankton production as food supply for larval fish or through to adult pelagic fish is not yet well understood, while there are increasing demands to address fish stock issues in an ecological context. Within this theme title there are many issues of concern to fisheries and marine environmental managers and to attempts at synthesis and modelling in marine oceanography.

Examples include:

- Hydrobiological questions of temporal and spatial scales of population and metapopulation structures and the action and interaction between larval predators and their plankton prey.

- Plankton invertebrate predator fields and how, as competitors and predators, these may interact with fish population dynamics.

- Behaviours in plankton communities such as feeding in relation to say turbulence, diel migrations, patchiness etc.

- Climate change scenarios and match/mismatch between the adaptive physiological ranges of fish larvae and key zooplankton prey, examining growth and production at local to basin scales.

- Questions of how we might estimate and index plankton species diversity or productivity in ways meaningful to problems of fish larval/O-group growth, recruitment and fish stock management.

- Biochemical approaches in studies of food chains, individual growth and survival, diet selection and the relative trophic efficiencies of predators and prey.

- Address the increasing interest in the post larvae and 0-group stages, which feed in the plankton. Then, for demersal species, consider diet switch in settlement phases to the consumption of the settled elements of epibenthic species production.

- New technologies (acoustics/video) for investigating the relationships between fish larvae and zooplankton, both prey species and competitors or predators such as chaetognaths or jellies.

Both Working Groups need time to sound each other out as to where we go from here with research. Having a Theme session in 2004 could provide a good ground for future progress in this important area of research. If there is no chance in 2004, which could in any case be hard to organise on such a broad theme, then the WGZE would definitely like this suggested Theme Session to go ahead for 2005. The theme is central to both plankton ecology and fish larval/recruitment work and is essential to any attempts to consider larval fish in an ecosystem context for fish stock management purposes.

It was suggested that Steve Hay could co-Chair this theme session with a nominee from the WGRP.

With the WGZE approved aim of fostering expansion of the monitoring Status Report, the Chair had corresponded with Jennifer Martin of WGHABD, who have since passed on a list of people and monitoring efforts that could contribute to the ICES Annual Plankton Status Report. The WGZE Chair had also sent a note to the joint Chairs of the WGPE, who had included some detail of German monitoring in their 2002 Working Group report, with a request for further names, as monitoring data contacts. The WGZE is actively seeking collaboration on this issue of a combined and inclusive approach to the ICES Plankton Status Report, and are expecting this to be reflected in the 2004 ICES Plankton Status Report.

It was further suggested that WGPE could make a metadata table and a map of their data to contribute to the Plankton Status Report. Also, as a first step, we should ask willing phytoplankton monitoring people for chlorophyll measured through time since we contribute zooplankton sampled through time. Discussion with the Chair of the WG on Statistical Aspects of Environmental Monitoring implied that they were looking for activities to involve their talent with data producers in monitoring. It was proposed that the WGSAEM could be involved in preparing the paper about the Status Report, and perhaps use a critique of the Plankton Status Report as a basis for a general approach to statistical standards and approaches in monitoring work.

Andrew Kenny (CEFAS) had been in contact as Chair of the Regional Ecosystems Study Group for the North Sea (REGNS) (meeting 4–7 April in Nantes). Andrew had said that they were keen to explore all views and would be interested in the views of the WGZE. The Chair had highlighted the relevance of the Status Report and the WGZE hopes for its expansion, he had agreed to maintain contact and expressed the WGZE interest in the outcomes of the REGN meeting and hoped for feedback from the REGNS meeting. We decided that preparing an ICES WGZE poster for presentation, particularly at the 3rd International ICES/PICES/GLOBEC Symposium Zooplankton Production Symposium, and more generally at meetings and conferences. The WGZE felt we could advertise what we do and hopefully encourage participation and collaboration (a PowerPoint presentation could also be made).

ACTION: ***Poster to be prepared for the Symposium in May 2003, in Gijón, by Roger Harris and Anthony Richardson***

1 OPENING OF THE MEETING

The meeting was held at the Centro Oceanografico De Gijón (IEO), Gijón, Spain from 24–26 of February and was generously hosted by the director of IEO Luis Valdés, who is the outgoing Chair of this WG. The proceedings began at 09:00 on the first day. Luis welcomed the participants, told us about this new laboratory and explained his arrangements for the meeting. Steve Hay expressed the Group's thanks to Luis for his hard work and enthusiasm as Working Group member and Chair over past years, for his work in data collation and preparation of the Status Report and for his work in organising the meeting in Gijón. It was noted with pleasure that the last WGZE report had been reviewed and accepted as exemplary by the ICES OCC parent committee. Apologies were also noted from several WG members who had communicated regrets at being unable to attend this meeting.

Nine members representing five countries attended the ICES WGZE meeting (Annex 1). Also attending were four local participants from the IEO and the University of Oviedo.

2 ADOPTION OF THE AGENDA

The agenda for the WGZE meeting (Annex 2) followed the terms of reference adopted as resolutions by the ICES 2002 Annual Science Conference (90th Statutory Meeting). The WGZE will report to ACME and to the Oceanography Committee at the 2003 Annual Science Conference.

The terms of reference for this meeting are to:

a) review the preparation of the annual zooplankton summary status report: standardisation of data sets, critics and improvements.
b) approve and adopt guidelines for metadata standards for zooplankton data in the ICES area;
c) review climate change and Trans-Atlantic studies on *Calanus*;
d) review perturbations in coastal marine ecosystems and changes in zooplankton community structure due to human impacts;
e) evaluate possible biological indices of ecological significance for the fisheries and environmental assessment groups, taking into account the evaluation framework adopted by ACE (2000) and described by WGECO (2000, 2001);
f) evaluate the local organization and facilities for the ICES/PICES/GLOBEC Symposium;
g) consider sampling and analytical methodologies focussed in gelatinous zooplankton;
h) review state of the art of enzymatic activity methods to estimate secondary production in zooplankton.
i) review progress in the digitisation of the plankton leaflets;
j) consider the potential of ITIS as a common taxonomic system within ICES.

3 REVIEW THE PREPARATION OF THE ANNUAL ZOOPLANKTON SUMMARY STATUS REPORT: STANDARDISATION OF DATA SETS, CRITICISMS AND IMPROVEMENTS. TOR A

Lead: Luis Valdés, Rapporteur Anthony Richardson

It was noted that ICES would like to gather information on who is using the ICES WGZE Zooplankton Status Report and was interested in raising the profile of this Status Report. ICES may also be able to publish future reports. There was discussion of the form of the report and the disparities between sampling frequencies and data types. These served to emphasise the need for accurate metadata descriptions. It was also considered whether the data that is presented should concentrate on some standardised kinds of information and formats. Lutz Postel (not present) suggested by e-mail that zooplankton data presented could concentrate on copepod abundance in the top 30m. Roger Harris suggested that we could present the top 10 species (by abundance), and compare the long-term mean (as below).

Rank	Taxa	% total zooplankton 1988–2001	Yearly average N/m^3 1988–2001	% total zooplankton 2002	2002 average N/m^3
1	Pseudocalanus	12.43	391	17.38	658
2	Oithona	11.7	368	15.59	590
3	Oncaea	10.43	328	3.06	116
4	Paracalanus	10.40	327	8.85	335
5	Cirripede nauplii	9.38	295	7.95	301
6	Temora	8.74	275	15.51	587
7	Acartia	6.29	198	7.87	298
8	Evadne	6.01	189	1.82	69
9	Appendicularia	2.51	79	1.40	53
10	Corycaeus	2.35	74	2.61	99
Total		**80.24**	**2524**	**82.04**	**3106**
Total Zooplankton N/m^3			**3144**		**3785**

Some consideration was given to how useful it could be to compare the top 10 species in different places.

Another suggestion from PML/IEO was to superimpose the average seasonal cycle (including 10 and 90th percentiles) on the time series graphs currently presented in the report

The group emphasised need for the number of time series in the Status Report to be expanded, to bring in other zooplankton time series, from countries not yet included e.g. France. We also noted that we must work with other working groups, particularly the WGPE and WGHABD to introduce phytoplankton time series as had previously been agreed in earlier years. We noted that the WGPE report for 2002 had already included some German monitoring data and that communications with the WGHABD were in progress to investigate possible additional datasets. The existence of extensive American time series from Narragansett (Ted Smayda) and Boston harbour (Jeff Turner) were also noted. Many monitoring sites, including most of those already in the report, involve a mix of sampling often including physical, chemical and phytoplankton information alongside zooplankton data.

ACTION: ***the WG ZE will continue intersessional work to extend collaborative inclusion of further data sets into the status report for future years.***

It was also agreed that the name of the report would in future need to change to be more inclusive. We agreed that initially the report could include chlorophyll as the index of phytoplankton biomass, as most of the time series measure chlorophyll. Perhaps where data were available, total numbers of dinoflagellates and diatoms might be included. It was again emphasised that the primary need was to collate and present the metadata describing available datasets and their owners.

ACTION***: The name of the ICES Zooplankton Status Report will change to the*** **ICES Plankton Status Report**.

Anthony Richardson suggested that the metadata table created for proposed EU framework VI network PLAnkton Time series Observations (PLATO), which includes contact names and email addresses, could also be used to contact contributors. This is in keeping with the aims of PLATO. Anthony Richardson promised to send this metadata table to Luis Valdés and Steve Hay (note - received March 2003, S Hay).

It was noted that while we need to ensure consistency with our data and metadata formats, we should heed the advice of Peter Wiebe who suggested that it is better to have databases that are responsive to the different formats that researchers use. He cited the example of the JGOFs/GLOBEC database, which holds a wide diversity of data formatted in many ways, but has generic means to collate and extract the data for analyses and presentation. There followed some discussion of the large efforts/costs needed to convert into another "standard" data format when much time series data may have been stored in a proprietary format for many years. It was also noted that the WGMDM were in process of formulating metadata standards for biological data, including plankton data (TOR j). We agreed that we still need to

standardise units and the way data is presented in the Plankton Status Report. It was felt that this would be more likely to happen if we wrote a scientific paper based on the Annual Status Report. It was strongly felt that preparing a paper is a good way to bring the Report and the data to the attention of a wide audience and to formulate standards for the time series. It was suggested that a TOR for next year could be;

***How to visualise and analyse plankton monitoring datasets? Approaches, multivariate and others. (This was later changed to - Consider future developments and collaborative approaches in time series measurements and interpretation*).**

ACTION: ***An outline of a paper addressing "What's happening to plankton in the North Atlantic", will be prepared. Roger Harris, Angel Lopez-Urrutia and Anthony Richardson will work on this intersessionally.***

It was accepted that the Status Report has been a lot of effort for Luis Valdés. It was agreed that Steve Hay and Anthony Richardson would help Luis with the data collation and preparation of the Report for next year. The discussion of this TOR concluded by noting that standardising the data required for the Status Report will help minimise the work needed each year. We also considered future approaches to the growing dataset and it was suggested that the whole could perhaps also be arranged thematically (e.g.: indicators for climate change, over-fishing, etc.), which would help to focus stakeholders attention on particular areas of concern to the research community and resource managers.

The discussions on day three around TOR b revisited the Status Report briefly and began by noting SGGOOS interest in our Plankton Status Report. This emphasised our agreed need to ensure accurate and consistent data reporting standards. The group felt strongly that it is important to keep and promote data collection on higher trophic levels than phytoplankton in GOOS, and in other ecosystem monitoring initiatives. However, achieving near real time data reporting for plankton is almost impossible given the need for taxonomic sample analyses. The problems and time scales are different for different analysis types and across different trophic levels. The use of modern technological advances in video and computer image analysis techniques, such as?, may allow in the near future some degree of taxonomic resolution for plankton sampling. Otherwise, acoustic or particle sizing techniques such as Optical Plankton Counters or flow cytometry data may provide further data. However in most cases, including all the existing time series, real time zooplankton analyses take days, weeks or months to get to the reporting phase. The group was convinced that ways must be found to incorporate zooplankton data into the plans, data collection and interpretative schemes which are adopted by management, advisory and policy bodies. We emphasise that ocean or coastal observation systems are aimed at an enhanced state monitoring and awareness, improved management of resources and impacts and improved understanding of marine ecosystems, not only at operational oceanography.

- **ACTION:** ***The WG Chair will contact the Chairs of SGGOOS, PGNSP and REGNS highlighting to them the relevance of the ICES Plankton Status Report to their initiatives.***

4 REVIEW PROGRESS IN THE DIGITISATION OF THE PLANKTON LEAFLETS. TOR I

Lead: Luis Valdés, Rapporteur Anthony Richardson

Zooplankton Taxonomic Fisches Sheets

It was recognised that a lot of discussion had gone on around the issue of the digitisation of the ICES Identification Sheets. The group had appreciated the offer of ETI in Amsterdam to assist in the preparation and dissemination of this information and hoped that ICES might maintain links with ETI. In the end ICES (Harry Dooley) agreed to undertake the task of scanning the sheets and putting the results onto a CD. This had been done and the WGZE were requested to review the output CD. The scanned versions of the sheets were passed as subsets to pairs of WG members to review. An initial look excited praise for the format, in that it makes the information very easy to access and disseminate. However a closer look at the CD content brought to light some quality problems and consensus on the need, before publication, for the ICES leaflets to have an informative but simple Introduction added. It was determined that this should include some information on limitations of the identification sheets and a reference list to more contemporary taxonomic literature, experts and sources where this can be made available. There was also a request that the end of each sheet page should have a return button to the index to make use easier.

ACTION: ***Ensure that a simple introduction for the ICES taxonomic leaflets is prepared once the final form is decided and that scan quality is assured.***

Steve Hay sent an email to Bill Turrell (Chair of ICES Publications Committee) who had contacted the group to inquire about progress. In this he said that the WGZE appreciate ICES efforts, but they will probably need to rescan the sheets.

Essentially the sheets have been scanned at too low a resolution and some text and drawing details were not legible. The group's reviews rapidly showed up a range of unacceptable faults, which are especially so given the need for detail required in the product's use. The comments regarding the quality of the scanned plankton sheets were sent direct to the ICES Secretariat. There was some worry about how long it would take to get the sheets rescanned given that there was a need to have this done before the Taxonomic Workshop in June 2003. There were offers from some of the WG members to rescan the sheets if ICES were unable to do so. There is a need for these sheets at the ICES Taxonomy Workshop in June, where the CD version could be distributed then further distributed at the ICES/PICES Zooplankton Production Symposium in Gijón and at the ICES ASC. It was agreed that S Hay would contact Harry Dooley to see if the situation could be resolved.

ACTION: ***Ensure that the ICES Plankton Identification Sheets are rescanned to a higher quality and accuracy.***

5 APPROVE AND ADOPT GUIDELINES FOR METADATA STANDARDS FOR ZOOPLANKTON DATA IN THE ICES AREA. TOR B

Lead: Steve Hay, Rapporteur Peter Wiebe

Include ***Consider the potential of ITIS as a common taxonomic system within ICES.*** **TOR j.**

Todd O'Brian of NODC who attended the WGZE meeting in Aberdeen Scotland in March 2002 proposed these TORs for 2003. Unfortunately, he was unable to attend the meeting this year and the material he intended to present to the Working Group was not present in on the first day of the meeting when the initial discussion of these TORs was conducted. Initial discussion was therefore brief and was revisited on day three (see later text).

The Chair began the discussion by noting that ICES data managers are looking at reporting formats for biological data especially in recent times in light of the ICES/ HELCOM Baltic Sea monitoring requirements. He noted that M. Sœrensen of ICES was asking the WGZE for assistance in obtaining access to raw data so that she could assess examples of formats typically being used by investigators in the research community. The discussion returned to the formats used for the data presented in the Status Report and the need for feedback from other ICES groups about them and on data reporting generally.

The group noted that ICES want to increase their compilation of biological data, and they want raw data. Data-type examples of our data are easily obtainable from the status report and from the ICES Cooperative Research Report produced for the WGZE seagoing workshop, which ICES has on CDs. The group was concerned that if ICES insists on people putting their results into an ICES standard format, many people won't do it. Successful data centres nowadays take data in any format and then they sort it out, whereas ICES want data organised into their format and then sent to them. Already many send their data for example to BODC and NODC data centres so much data is already held in standardised formats.

There was discussion on the role/relevance of ICES as a data manager and some question as to whether ICES is going to be a project manager for GOOS. Some thought that ICES is not the place of choice to store (non-fish) biological data, which is often complex as compared with physical/chemical/fisheries data, and there is debate as to whether ICES have the infrastructure to do this. The group agreed to make the point that a top-down approach in terms of expecting researchers to submit their data to ICES in an ICES standard format would not be likely to work well. ICES data managers need to take any data available and then they should accept the task of transfer into the formats they need.

Lack of information about metadata or ITIS on day 1 stymied the discussion and it was decided delay further talk on metadata until later. Meanwhile an Email query to T. O'Brian requested that he send to the meeting the guidelines that he was to have presented.

6 CONSIDER THE POTENTIAL OF ITIS AS A COMMON TAXONOMIC SYSTEM WITHIN ICES. TOR J

The ITIS taxonomic system discussion was also hampered by the lack of information available initially. Several group members raised concerns regarding missing species and how the ITIS list was updated, and how long this might take. Also, there were concerns about how to link taxonomic data with species abundance data or with associated environmental and genetic information. Concerns were also raised on how to incorporate historical use of synonyms and regarding the fact that many zooplankton data have species analyses to the level of developmental stages for copepods for example. It appears that ICES has already adopted ITIS as its coding system, although there was some question about this given the TOR. There are other forums and systems for species information coding and many years

of discussion have evolved around questions of how taxonomists might agree to a common taxonomic information repository. It is hoped that in this era of globalisation some common system such as ITIS may resolve into a final solution to many such problems.

While the group appreciated the benefits of a central and actively updated taxonomic reference source as ideal, there were reservations. The major worries relate to the effort required to translate from existing coding systems and the time needed to update species names etc. This could have significant cost implications for many research groups, so acting as a brake on willingness to collate and submit data to database centres such as ICES. It is also true that other data centres may have alternative formats etc and that too much data shuffling inhibits the basic core science of sample collecting and analysis activities. Again it was stated that, as researchers have problems when data formats are imposed by outside agencies. Consensus and compliance is best achieved when those asking for the data undertake such efforts through active collaboration, particularly over any format conversions required.

In addition, the group sought information about ITIS by visiting the ITIS web site (www.itis.usda.gov) and reviewing the information presented there. This proved an effective way to dispel a number of mis-conceptions that members of the working group had regarding the structure of the taxonomic system being created and how it is updated. Two members of the group (W. Melle of IMR, Bergen and S. Hay of FRS, Aberdeen) said that their organizations were beginning the process of adopting the ITIS system and that they thought that it would be a good move towards international standards.

There follows a short, slightly modified, summary of the ITIS system, as taken from the ITIS web site.

"The goal of ITIS, the Integrated Taxonomic Information System is to create an easily accessible database with reliable information on species names and their hierarchical classification. The database will be reviewed periodically to ensure high quality with valid classifications, revisions, and additions of newly described species. The ITIS includes documented taxonomic information of flora and fauna from both aquatic and terrestrial habitats.

An ITIS Steering Committee directs two technical work groups - the Database Work Group (DWG) and the Taxonomy Work Group (TWG). The DWG is responsible for the database design and overseeing development of the system to meet the requirements of the ITIS partners. The TWG is responsible for the quality and integrity of the database information. In addition to the database, the working groups have created "Taxonomic Workbench" software designed for easy entry and manipulation of taxonomic data. The TWG hopes to promote collaboration among, and provide a point of focus for, taxonomists, scientific institutions, and taxonomic information users.

For each scientific name, ITIS will include the authority (author and date), taxonomic rank, associated synonyms and vernacular names where available, a unique taxonomic serial number, data source information (publications, experts, etc.) and data quality indicators. Expert reviews and changes to taxonomic information in the database will be tracked. Geographic coverage will be worldwide with initial emphasis on North American taxa. The TWG is coordinating its efforts with several national and international biodiversity programs."

TOR *b - guidelines for metadata standards* - was revisited later, on day 3 of the meeting.

(See Annex 3 - the meta data protocol (based on Todd O'Brien's submitted draft)

The WGZE returned then to the issue of metadata standards for zooplankton data. The Group was asked to approve a draft write-up of the standards, submitted by e-mail (Annex 3). There was discussion about the document and how it related to the complex set of format standards that were being produced by the ICES Working Group on Marine Data Management. It was not clear to what extent the guidelines provided by T. O'Brian complemented the ICES format or were redundant. Fields in the suggested metadata standard from NODC (from Todd O'Brien) is broadly similar to that produced by ICES. The outline of the ICES formats brought to the meeting was not sufficient to allow a proper comparison at the meeting. Luis Valdés agreed to cast an experienced eye over the draft and commented on it later. These comments are as follows:

- We have to remember that metadata should describe and include the minimum information that make the data useful for future users.
- The structure of metadata is correct, following a hierarchy from metadata-fields relating to: the entire cruise - station - methods - sample processing - and results.
- The impression is that the example given at the end of the draft metadata description is quite poor.

- Comparing the table of metadata that we include in the ICES Plankton Status Report, as:

  "Country, Monitoring programme,
  Sampling location, Latitude (N), Longitude (E-W),
  Period of data available, Frequency (number of cruises/year),
  Depth of sampling (m), Station Depth (m),
  Gear/diameter (cm), Mesh size (μm),
  Contact person, Email address,
  Location of data, Observations (*)",

  against the fields requested by Todd in his draft metadata standard, we can recognise many fields, and others can be incorporated easily if needed. We should understand that the Plankton Status Report table of metadata was included to help the reader to understand the results for each time series, and so it contains only the most essential fields. As a practical example, the IEO database (for details contact Luis Valdés) fulfils all the information criteria listed in Todd's Draft Metadata.

There was general agreement that the guidelines Todd O'Brian had supplied were good as far as they went and that most investigators would normally record the information, but not necessarily in the exact order presented. There was a feeling that there are perhaps too many fields and key subsets could be identified. It was particularly noted that it is useful to have ship name and cruise number and there is also need for a metadata field related to environmental sensors on the sampling gear. It was agreed to draft a description of this, as follows:

Metadata - ***fields relating to ancillary environmental sensors on the sampling gear***

- Describe the environmental sensor(s) used providing
- Gear name (i.e. thermometer, CTD, fluorometer etc.), manufacturer name and model number.
- What was the sampling rate (Hz) of environmental data acquisition?
- What calibration data /factor was used or is available?

In summary, it was agreed that the metadata information guidelines and the ITIS taxonomic system were acceptable to the WGZE. There was a rather frustrated feeling this subject cold be overdone and that the WGMDM and data centres (e.g. ICES, WODC, BODC and NODC etc) should get their heads together and standardise between themselves, rather than each setting their standard for the field scientists collecting the data.

7 REVIEW CLIMATE CHANGE AND TRANS-ATLANTIC STUDIES ON *CALANUS*. TOR C

Lead: Peter Wiebe, Rapportuer Roger Harris

Peter Wiebe opened the discussion with an introductory talk, "*Analyses of the consequences of ocean climate changes for zooplankton processes and community structure*". The presentation began by emphasising that the Trans-Atlantic initiative had a focus wider than on *Calanus* alone. The aim was to update ideas that have come out of the various North Atlantic GLOBEC studies, with the overall objective of looking holistically at the zooplankton populations in the whole ocean basin. A number of major projects, for example, TASC, Mare Cognitum and USGLOBEC George's Bank, had resulted in significant data sets. However, information had not been synthesised for target species across the whole of the North Atlantic Basin. Particularly important would be linked models of both the physics and the biology of target species in the region.

Progress on this topic since the last meeting of the WGZE, in Aberdeen, has included:

- Funding for the Phase IV of the USGLOBEC George's Bank study, in September 2002.
- Five projects have been funded.
- Conversations with the European Union and US NSF. These have centred on the concept of a workshop to bring together researchers from around the North Atlantic to discuss synthesis of data-sets and basin-scale modelling.
- At the ICES ASC in Copenhagen an ad hoc group met to develop this idea further.

From all these intersessional activities emerged a proposal, for a workshop entitled "*Workshop on the impact of basin-scale oceanography and climate-related processes on the dynamics of plankton and fish populations in the North Atlantic Ocean*". Reykjavik is the proposed venue, Olafur Asthorsson had kindly agreed to act as local host.

The main aims will be:

- Through discussions of the circulation and transport of biological, chemical, and physical properties in the deep basin and shelf seas of the Northern North Atlantic, to develop a plan for determining what processes control the population dynamics of zooplankton and fish species across the entire North Atlantic basin.
- To create an action plan for the development of conceptual and quantitative models capable of elucidating ecosystem dynamics and responses on a broad range of space and time scales, and hold promise for the identification of mechanisms and new hypotheses concerning the linkages between the environment, zooplankton, and fish.
- To identify mechanisms that will lead to increased understanding of the effects of climate variability and climate change on the distribution, abundance, and production of the target organisms.
- To develop a plan for the synthesis of data sets including; occurrence, abundance, and distribution of target species and the processes that regulate the occurrence, abundance and distribution of target species.
- To create a plan for the implementation of physical/biological models of the North Atlantic Ocean that are basin-scale and include the shelf seas.
- To develop strategies to investigate the relationships between climate-indices and trends in biological components
- To identify indices to characterize environmental and ecosystem status and change including those that may be incorporated into the assessment of the fish stocks in the region.
- To encourage Trans-Atlantic exchange, collaboration, and team building between scientific investigators.

The planned format of the meeting will include:

Plenary Talks on cross-cutting issues and Working Group discussions on, Modelling Issues - Physical models: Coupling shelf seas to NATL basin, Biological models: NPZ, species specific, Important biological features to model, and Data synthesis Issues - Data sets that need to be combined/integrated, Field verification of model results, Important features in field data that models should portray.

The expected outputs will be:

1) Background documents supporting the need for basin-scale studies,
2) An Implementation Plan for a basin-scale North Atlantic programme.

About 40 people are expected to attend the Workshop. The main international links that are sought will be with, Canada-GLOBEC, USGLOBEC, ICOS, TASC, Mare Cognitum, PNDR, WGCCC, German GLOBEC, UKGLOBEC, Southern Ocean GLOBEC, US NE Pacific GLOBEC and USGLOBEC George's Bank.

Following the presentation there was general discussion of the proposal. The question of whether data assimilation would be included and the importance of linkage between the large-scale (open ocean) and the small-scale (shelf) processes were emphasised. It was agreed that these were important challenges and important to the success of the effort. A question was raised as to what had become of the Framework VI Expression of Interest, "PATSY". The proposer, Keith Brander, was unable to attend the WGZE meeting, so there was no up-to-date news, and we concluded that the EoI was probably in the same position as the thousands that had been submitted. Some other EU Framework VI initiatives were noted and considered. The UK NERC MARPROD / UKGLOBEC programme initiative was also mentioned. In this study, which has transatlantic collaboration as a critical programme element, the dynamics of key *Calanus* and *Euphausiid* species populations are being, surveyed, studied and modelled in relation to North Atlantic, basin scale climate forcing, hydrography, and dynamic biology elements such as trophic structure and production processes.

The outcome of the discussion of this TOR was that the WGZE recommended support for the Workshop initiative, members would contribute to the suggestion of names for possible participants, and the Working Group would look forward to close and continuing cooperation as Trans-Atlantic activities developed further.

8 REVIEW PERTURBATIONS IN COASTAL MARINE ECOSYSTEMS AND CHANGES IN ZOOPLANKTON COMMUNITY STRUCTURE DUE TO HUMAN IMPACTS. TOR D

Lead: Xabier Irigoien, Rapporteur Angel Lopez-Urrutia

Xabier Irigoien started the discussion by presenting an example of the Bay of Biscay where fishing, agricultural and industrial inputs through runoff & rivers and anthropogenic contributions to climate change are the main human impacts on the community structure. In addition recent events have now imposed a strong oil spill problem on the Bay of Biscay.

There are many regional data that could be used to address the problems posed in this TOR:

- Time series data exist in Santander, Cudillero, although no time series exist on the Basque coast.

- Continuous plankton recorder routes complement these data with a broader temporal scale.

- Surveys for anchovy eggs cover a wide area of the eastern Bay of Biscay once a year. It is proposed to analyze these samples for zooplankton abundance and taxonomic composition. Some initial analyses results were presented for the years 1995 and 2001:

  The main hydrographic features in the area are the bloom off the Gironde (due mainly to freshwater nutrient inputs), the frontal system at around 100m isoline and the shelf break front.

Irigoien showed examples of the abundance and distribution of several zooplankton species. *Oithona helgolandica* was very abundant on the shelf, less abundant at more oceanic locations and increases are observed in frontal systems while it is less abundant toward the open sea. *Acartia clausi*, a coastal neritic species, showed strong interannual differences. *Calanus helogolandicus*, also has clear differences between years. A quite surprising result is that *Calanoides carinatus* was more abundant than *Calanus* in 2001 while in 1995 it showed very low abundance. Therefore *Calanoides carinatus* could be a target species to detect interannual changes. Gelatinous zooplankton showed a similar response to that of *Calanoides*: very few in 1995 and very abundant in 2001. These strong interannual differences show response to the fact that 1995 was much colder than 2001. In 2001 there was a strong input from the river while this was much lower in 1995, also in 2001 there was stronger upwelling and offshore transport.

Structures recognized in the zooplankton were also apparent in fish eggs distribution. In conclusion, it appears difficult to see human impact when there are such strong climatic or physical signals in zooplankton abundance and distribution. Having obtained a long list of zooplankton species present, the future effort would be to identify what species are good indicators of perturbations and human impacts in this marine environment.

The point was raised that most of the results show an interesting climate signal but very few effects of human impact and that it is very difficult to distinguish these different effects. The direct effects of human activity may be easy to be measured (e.g. how many fish are removed) but it is not so easy to identify indirect effects. It was suggested that the use of models would allow more holistic understanding of the indirect effects. He was sceptical on achieving identification of human impacts from an ecosystem perspective using simple indexes (except for eutrophication or biotoxic effects where ratios on rates could indicate more than measures of absolute rates).

It was indicated that in the United States the harmful algal blooms have been related to human effects and also modelled. These blooms have a significant social effect through impact on fisheries. Zooplankton also responds to these perturbations, *Acartia* coming from areas with harmful blooms seem to have developed strategies to become more resistant.

Transport of zooplankton in ballast water and introduction of invasive species as a consequence is a perturbation that can be identified easily and there are numerous examples. It was commented that policies suggesting that ballast water should be replaced in oceanic areas could have strong impact in introducing oceanic species into areas where they are not present naturally. Steve Hay pointed out that the Black Sea is the clearest example on how introducing new species causes incredible change in the ecosystem with important socioeconomic consequences.

Changes in meroplankton species in the North Sea have also been reported and Greve has shown very nicely the changes in timing and duration of meroplankton spawning season.

The discussion highlighted the relevance and importance of time series to enabling understanding of basic patterns, before changes from the normal conditions can be detected. Also, for modelling, time series are crucial to feed and test the models. In a limited economic climate we need to find compromises, determine which are key areas where time series should be maintained and then argue and decide to investigate the right places, scales and species.

The high costs of sea time were pointed out and that logistical constrains on maintenance of time series suggest the need to take benefit of the sampling opportunities during fish stock assessment or other cruise programs. There are often serious staff and taxonomic skills difficulties to overcome to get samples analysed. There are also many samples and information already collected that could be further investigated or revisited, cheaply relative to the costs of sea-going studies. We don't have enough people with taxonomic expertise to analyze samples and sample archiving is often rudimentary. It was pointed out that automatic counting systems could help to analyze the stored samples quickly. However, what it is actually needed is more taxonomic expertise and work. High technology could help but it is often as expensive or cannot resolve enough detail. A strong benefit of the high-tech approaches is that they can provide rapid background data, which enables targeted (smaller) sample sets to be analysed.

Anthony Richardson showed some Continuous Plankton Recorder data, as examples of demonstrable effects of perturbations in coastal marine ecosystems and changes in plankton community structure due to human impacts. He gave two examples. *Coscinodiscus wailesii* appeared first some years ago in the English Channel off Plymouth yet now it is one of the most abundant diatoms in the North Sea CPR samples. His second example was of the meroplankton on European shelf seas. Echinoderm larvae in the North Sea have been increasing since the fifties. Trawling disturbance of benthic community structure could be a cause for this increase. Trawling may modify the sea bed, cause differential mortality rates and favours production of opportunistic species. Other theories suggest the increases are related to the phytoplankton biomass increases, changes in bloom timing or new production export. Changes in patterns of phytoplankton abundance have been detected by examination of CPR silk colour.

The long-term trends in echinoderm larvae abundance within the standard CPR boxes for the North Atlantic show that their abundance has not increased in the western Atlantic, the increase is apparent only in the North Sea. The time of echinoderm larvae peak abundance is more widespread throughout the season and the peak appears earlier during the later part of the last decade. NAO index and maximum echinoderm larva abundance are very well correlated, probably through the higher SST in years of high NAO. The way ahead now is to try to identify whether these changes are climate or fishing effects or both.

The ensuing discussion reached the following final conclusions:

- It is an extremely difficult and complex task to distinguish between climate effects and human impacts.
- More and longer time series are needed to understand ecosystem responses to impacts and climate effects.
- The development of indices (see TOR e) could be a way forward and is needed to simplify these issues.

9 EVALUATE POSSIBLE BIOLOGICAL INDICES OF ECOLOGICAL SIGNIFICANCE FOR THE FISHERIES AND ENVIRONMENTAL ASSESSMENT GROUPS, TAKING INTO ACCOUNT THE EVALUATION FRAMEWORK ADOPTED BY ACE (2000) AND DESCRIBED BY WGECO (2001). TOR E

Lead: Webjorn Melle, Rapporteur Xabier Irigoien

Webjorn Melle introduced the subject with a presentation about the EcoQs proposed by OSPAR. He outlined a brief history of these EcoQs, including the conceptual framework to describe and set EcoQs. The EcoQs have also to be considered in the frame of the Key Ecological Properties defined during the Convention on Biological Diversity (CBD), 1992, Rio and the 1995 Jakarta Mandate on Marine and Coastal Biological Diversity:

1) Biological diversity
2) Ecological functionality
3) Spatial integrity

Examples of EcoQs used in the North Sea were given. Webjorn presented the evaluation criteria that have been suggested by the WGECO, examples of evaluation of different indices and the list of possible indices that has been proposed by this group in the past, which were to be evaluated.

Following the WGECO advice, metrics of EcoQs should met the following 8 criteria:

- Relatively easy to understand by non-scientists and those who will decide on their use;
- Sensitive to a manageable human activity;
- Relatively tightly linked in time to that activity;
- Easily and accurately measured, with a low error rate;
- Responsive primarily to a human activity, with low responsiveness to other causes of change;
- Measurable over a large proportion of the area to which the EcoQ metric is to apply;
- Based on an existing body or time series of data to allow a realistic setting of objectives.Relate to a state of wider environmental conditions.

The list of zooplankton indices proposed by the WGZE in the past is:

1) The **timing and duration of zooplankton reproductive seasons** can be influenced directly by changes in physical variables (i.e. temperature), in turn influencing the structure of the food web.
2) The **abundance of copepods, generally or specifically** (i.e. *C. finmarchicus*), is likely to be most meaningful if **expressed as a ratio** (a value between 0 and 1). The units of abundance may be either biomass or numbers, as each has a different meaning.
3) The **ratio between large and small copepods** (in terms of both numbers and biomass) could be a meaningful index. Perhaps a size fraction ratio of the zooplankton may be a more meaningful index, this warrants further discussion.
4) The **slope of the normalised biomass spectrum** is an indication of community size structure. Another index might express the spectrum of abundance with size.
5) **Species abundance and diversity indices** need to define the target group in order to be meaningful. Unless the target groups are standardized, comparison between studies will not be useful. Discussion:

The discussion observed that some of the key ecological properties defined were directly translated from terrestrial ecology and were not that useful in planktonic systems. Reminded that the metric has also to be related to human activity, we noted that it would be difficult to find metrics covering parameters such as spatial integrity.

There are some statements like “sensitive to a manageable human activity” that were difficult to define. Some examples include influences such as eutrophication, climate change (although not truly manageable, the effects could be), geophysical exploration and fishing effort and impacts.

We considered whether some of the indices the group had previously proposed would met the criteria, and also the necessity to distinguish between direct and indirect indices. Many marine ecosystem processes are driven from the bottom up, and indices at scales useful to management of human activities such as fisheries may not be directly observable or suited to be expressed as functional relationships. Many biological responses to change are often non-linear and complexes of relationships with environmental variability or between biota are common.

The problem posed was to what extent such indices may help in managing fisheries. It seems clear that economic pressure will always tend to overcome scientific advice. In practical terms, many see the only way forward and to retain sustainable fisheries is to set up and conserve protected areas. At the moment almost all of the major fisheries are in decline. Although there are many theories, some systems (e.g. cod in Canada) have collapsed. It is often suggested that fisheries will stop when not economically viable, however an ecological point of no return may be reached before that point. After ten years of no fishing there is no sign of recovery for the Canadian cod fishery, although the indices suggested that some of those years should have resulted in good recruitment. This probably indicates our poor understanding of the recruitment mechanisms. We were reminded that the herring recovery was mainly based on a successful recruitment year, and that there was at the time no obvious index which distinguished that particular year. It was pointed out that in most cases zooplankton collections use too large a mesh to capture many of the plankton organisms relevant to the feeding fish larvae. It was agreed that further research on the recruitment mechanisms was needed.

In the case of protected areas, the establishment of appropriate indices could be useful both to establish such areas and to monitor the evolution of changes in those areas.

The group proceeded to evaluate the zooplankton proposed indices against the 8 criteria previously mentioned.

It was immediately obvious that most of the proposed indices would not pass the criteria. WGZE then discussed the extent to which the 8 criteria were useful if the intention was ecosystem management, not direct fish population management. There was also discussion about the importance of having as many relevant indices as possible to gain broad perspective, to feed models and to improve understanding of the system. Some of the group argued that it was important to specify and simplify the parameters to be measured during monitoring programmes.

After further discussion it was decided that the only index to satisfactorily meet the 8 criteria was the 5th - **Zooplankton species abundance and diversity index**. It was also noted that the basic measures required are those of taxonomic identification and species counts, which also allow calculation of other suggested indices and relationships with other ecological measures of environment, phytoplankton, trophic structure etc.

It was agreed to propose this index as an EcoQ, and to give advice about how to monitor it. Two aspects were considered to be essential:

A) to have a coverage of the seasonal changes (so sampling at least once a month) and
B) to use a fine mesh to collect the samples (53 μm) in order to make sure that the zooplankton size classes relevant to fish larvae recruitment are collected.

Discussion followed on the necessity to standardise length – weight transformations and P. Wiebe presented the software used in Woods Hole that includes algorithms for a large number of taxonomic categories. The software is freely available upon request.

After evaluation of the list of zooplankton related indices proposed and following the 8 criteria advanced by the WGECO, the WGZE agreed It was considered that this index had the highest scores and met all the criteria.

The WGZE recommend that Zooplankton Species Abundance and Diversity fulfils the criteria as an index to be measured and so should be considered for EcoQ status.

It is also recommended the index should be measured at least monthly and samples should be collected with a fine mesh (e.g. 53 micron mesh size), in order to capture all the small organisms relevant to fish larvae feeding.

10 EVALUATE LOCAL ORGANIZATION AND FACILITIES FOR THE ICES/PICES/GLOBEC SYMPOSIUM. TOR F

Lead: Roger Harris, Rapporteur Luis Valdés

On the Wednesday afternoon the group divided. Luis Valdés lead, with Roger Harris as Rapporteur, a visit to the Gijón Palacio de Congresos where the 3rd International Zooplankton Production Symposium titled *"The role of Zooplankton in Global Ecosystem Dynamics: Comparative Studies from the World Oceans*", ICES/PICES/GLOBEC Symposium will be held in May. Peter Wiebe and Xabier Irigoien, both of whom are Session Convenors for the Symposium, accompanied them. The afternoon began with a tour of the Palacio de Congresos guided by the Director. The main Lecture Theatres, meeting rooms and other facilities were reviewed. The general conclusion was that the facilities were excellent and that the plans were well in hand. There was then some discussion of the provision of lunch on site during the Symposium and it was concluded that an outside caterer should be encouraged to provide a simple sandwich/buffet lunch to avoid large numbers of participant having to leave the Symposium facility during the lunch break. The Palacio de Congresos is well equipped with presentational facilities. Speakers will be encouraged to bring their talks on CD-ROM for loading onto the computers the day before their Session. It was noted that there was ample space for the poster displays and technical exhibits.

There followed a tour of Gijón guided by the tourist bureau, which enabled the location of some of the hotels on the Symposium list to be viewed. It was concluded that there was good range of hotels, both in terms of price, and also proximity to the Congress Centre. Even those who chose to stay in the old centre of Gijón would only have a pleasant 25-minute walk along the seafront to the Symposium venue.

The afternoon concluded with a meeting with the Deputy Mayor of Gijón. Conversations confirmed that the City of Gijón strongly supported the Symposium, and was particularly pleased by it's wide international characteristic. This support would include significant funding for certain activities, for which the Symposium organisers are very grateful.

The outcome of the afternoon's evaluation was that the group was well satisfied with the local organisation and facilities. The plans in place should ensure an effective and productive Symposium. The group noted that the response within the scientific community had been very strong with 450+ attendees expected from 50+ countries. This success had placed particular pressures on receipt of Abstracts, registration and structuring the scientific programme. The efficient role of the PICES Secretariat in this regard was warmly appreciated, as was Luis Valdés' continuing hard work as local host. Both PICES and GLOBEC have been able to offer partial travel support for students and attendees from Developing Countries. It was suggested that ICES might consider having similar funds in future to provide matching support. It was remarked that though ICES have an ICES/GLOBEC programme, also they are promoting links with PICES, yet the Copenhagen office had not been actively involved in practical planning for the Gijón Symposium. The main responsibilities had fallen to the PICES Secretariat and to a lesser extent to the GLOBEC IPO. There was some concern as to who would officially represent ICES at the Symposium in May.

11 REVIEW STATE OF THE ART OF ENZYMATIC ACTIVITY METHODS TO ESTIMATE ZOOPLANKTON SECONDARY PRODUCTION. TOR H:

Introduced by Steve Hay, Santiago Hernandez Leon was not present but sent written submission

The Working Group found that they did not have sufficient specific expertise to effectively discuss this TOR. However, they noted a document on "Intercomparison exercise to measure physiological rates in the field", which had been submitted by Santiago Hernandez-Leon the proposer of the recommendation at the Aberdeen WGZE. The main text of this is reproduced below.

Submission to the group by Santiago Hernandez-Leon

During the last 30 years the bio-oceanographic community has been engaged in the search for indices of physiological processes. This has been with the aim of obtaining the necessary amount of data to map the variability of these processes in relation to oceanic features such as fronts, eddies and filaments, while avoiding classical and time consuming physiological experiments on board.

During the last two decades of the 20th century, some simple methods became quite popular among oceanographers. Measurement of gut fluorescence as an index of grazing rates is still very widespread despite the numerous problems related to the method. Pigment destruction rate in zooplankton guts is not constant and therefore difficult to evaluate. However, the comparison of egg production rates and pigment ingestion rates suggests that the gut pigment method underestimates pigment ingestion by no more than a factor of two. Thus, a destruction of 50% can be assumed. Gut evacuation rates are also not constant but they are related to temperature and gut content. The application of the method in the field, although not straightforward, could give a picture of grazing in the ocean. The possibility to store and easily measure a large amount of samples warrants its use for mapping.

Another popular approach is the egg production method to measure growth rates. This method relies on the assumption that the production of eggs by females is related to growth of zooplankton. The method shows that egg production responds to the variability of food in the environment but unfortunately does not always correspond with the growth of the different stages of copepods. The ability to use the method to identify differences in productivity among different areas is an advantage. However, the method requires 24h incubations making it very hard or almost impossible to map productivity in relation to oceanographic structures.

Based mainly on measurements of RNA and DNA and enzymatic activities many biochemical methods were also developed. The former method and its relation to growth has given rise to an important body of literature not only in the field of zooplankton but also in icthyoplankton research. The results are rather contradictory and while some authors found a correlation with growth, others fail.

Enzymatic methods are the chemical basis of the physiological rates, they measure a rate, have good replicability and are rapid and cheap to measure. However, the relationship between measures of the enzymatic and the physiological rates presents numerous problems. The ratios between both measurements are variable although, in this case, predictable in relation to the food richness in the environment and the amount of substrate being metabolised by the organisms. These results suggest that an important variability in the ratios is due to the standard methods used to measure enzyme activities.

Recently, it has become evident that enzymatic methods provide good estimations of e.g. respiration rates when the enzyme studied is not limited by intracellular substrates. The *in vitro* measurements of enzymes being practised by biological oceanographers today are maximum activities under saturated substrate concentrations, thereby equivalent to the measurement of enzyme concentrations. In nature, the cells of organisms may often be substrate limited and

therefore the extrapolation of enzyme activities *in vitro* to those *in vivo* is not straightforward. The relationship between enzymatic activities and respiration rates is known to vary with body size within the same species. Also, the influence of different isozymes within species with different K_m and V_{max} values will introduce uncertainty in the assay of activities.

A successful application of enzymatic methods as indices of physiological processes in zooplankton is still conceivable in view of the effect of substrates on the relationship with physiological rates, although much work should be done in order to calibrate and compare among different assays proposed in the literature. Only for oxygen consumption rates have different authors have proposed succinate dehydrogenase, electron transfer system (ETS) activity and citrate synthase (CS) activity. Other simple methods such as the measurements of chitobiase activity as an index of growth rates are also emerging. Thus, it is time to promote an international effort to bring together different researchers with the objective of testing different indices and compare them with classical physiological methods. This will require an important organizational and economic effort.

In view of the novel advances, it is proposed that within the framework of the working group on zooplankton ecology (WGZE), a series of workshops should be organized to compare different methods that are and could be used as indices to assess physiological rates in the field. The proposal would include the following different steps:

- Announcement and call for interest to the research community (months 1 to 6).
- Period for application of the different research groups to their national agencies in order to obtain the necessary budget as a special action (months 6 to 18).
- Period for proposals from different laboratories to host the workshops (months 1 to 12). Two workshops seem to be necessary: one in a temperate area and another in warm (subtropical) waters.
- Workshops to be held during months 24 and 32. About 8 months are necessary to process all the data in order to avoid possible problems and to think about improvements.
- Preparation of manuscripts (months 36 to 48).
- Final workshop: discussion and publication (month 48).

Although the proposed schedule is rather long, it will allow planning of all the different activities with enough time to design the different experiments, to accommodate the host laboratories for the venue and to have the necessary research equipment available. The comparison of different techniques used at present or arising in the meantime will be an important contribution to the development of biological oceanography.

The WGZE meeting concluded that, without specific competence within the members of the WGZE present in Gijón, the group could not advance this TOR further. It was also noted that the proposal from Santiago Hernandez-Leon included a quite ambitious series of workshops, which would involve funding and organising. While the WGZE were generally very supportive of such practical initiatives, they felt that the issue could not be advanced without Santiago being present to answer questions on logistics etc.

For this reason the recommendation was to carry this TOR over to next year with the provision that Santiago Hernandez-Leon (and others with specialist interest) would be able to attend and lead the discussion.

12 CONSIDER SAMPLING AND ANALYTICAL METHODOLOGIES FOCUSSED ON GELATINOUS ZOOPLANKTON. TOR G

Introduced by Steve Hay, Rapporteur Doug Sameoto

This TOR was also somewhat compromised in that the proposer Pat Kremer, from the previous year's meeting, was not present. She did however submit a statement for discussion.

STATEMENT RELEVANT TO TOR g - by Pat Kremer

Assume we accept the premise that gelatinous zooplankton (specifically medusae, ctenophores, and pelagic tunicates) are an integral and important part of the plankton community, deserving to be monitored and enumerated on a par with other pelagic organisms. The challenge then becomes how to monitor and enumerate them effectively, given the patchy, often fragile and episodic nature of these animals. Two major problems exist that prevent getting maximal meaningful data on the distribution and abundance of gelatinous zooplankton from current sampling programs:

a) There is a systematic **bias** against the enumeration of gelatinous animals as a part of many sampling and monitoring efforts. Put simply, those involved in both fish and zooplankton or ichthyoplankton surveys mostly consider net contents to be ruined if dominated by jellies. Basic measurements, such as identification, preservation and even simple measures such as overall displacement volume are often not made. Furthermore, even qualitative notes on presence/absence or particularly high abundance of gelatinous animals seldom become part of subsequent data reports and publications. This leads to a severe under-reporting of sampled gelatinous zooplankton. Several of the gelatinous taxa such as scyphomedusae are relatively large in size but patchy in their distribution. Although conspicuous in fish trawls, as invertebrates not fish, they are generally of little interest to many involved in sampling fish. This taxonomic bias can also extend to zooplankton surveys. If large numbers of jellies are conspicuous in an area, sampling is sometimes even avoided, moving to where the jellies are less abundant and the zooplankton samples can be "cleaner".

b) The **sampling scale and equipment** is often inappropriate for large gelatinous zooplankton. Most zooplankton sampling targets small animals, filtering on the order of a hundred cubic meters per tow. Large predatory jellies, such as scyphomedusae, are distributed on a different spatial scale from small invertebrates, so much of the zooplankton sampling effort is not appropriate to these large zooplankters. An additional problem is with the sampling equipment itself. Fragile forms, such as many species of ctenophores, are often destroyed in the process of net collection, making them impossible to enumerate. Furthermore, many lobate ctenophores dissolve when exposed to formalin or alcohol, further selecting against them in routine zooplankton surveys.

There are several relatively simple, inexpensive ways that data gathering on the distribution and abundance of gelatinous forms can be improved greatly:

1. Personnel in charge of existing sampling programs (e.g. those routinely contributing data to ICES) need to appreciate the importance of small changes to their existing sampling protocols that would appreciably increase information about gelatinous zooplankton, that is currently being lost.
2. Whenever large numbers of gelatinous zooplankton are collected (as a part of any sampling program), a representative sample should be preserved (for identification purposes) and a quantitative measurement made of the total wet volume collected (most of which will be discarded). If this information on the gelatinous plankton is not included as part of the normal database for the sampling program, the wet volume and the location of the preserved samples should become part of the metadata included for national/international databases.
3. Databases on fish, ichthyoplankton, and zooplankton need a straightforward way to access whatever information exists about abundant forms of gelatinous zooplankton, even if the information is not in the same format as most of the taxa that are enumerated. (**see #2**).
4. Whenever possible, zooplankton sampling programs should have the capability of using large, non-filtering cod ends on their nets to be able to sample medusae and ctenophores in relatively good condition. Although these nets need not be used routinely, they will give much better data on gelatinous taxa. Also, if larger samples can be taken, the data on the larger forms will be stronger.
5. As many gelatinous forms are conspicuous and numerous, a procedure for citizens to report sightings can increase our information on some taxa appreciably. With minimal training, fisherman, recreational boaters and beachcombers can contribute valuable qualitative information. With a little training even fish biologists may learn to identify common species of jellyfish.

It is essential to be realistic in our attempt to increase data on the distribution and abundance of gelatinous zooplankton. Therefore it is important to minimize the changes necessary to impose on existing sampling programs, especially any changes that incur additional costs. Much more could be learned if we simply did not lose information about discarded animals that are already collected routinely. If the various sampling programs (i.e. those related to fisheries) were convinced of the importance of making small changes to the way they handled samples containing gelatinous zooplankton, much more could be learned quickly and inexpensively about both the distribution and abundance of the dominant gelatinous forms.

Part of the challenge is to convince scientists involved in the various sampling programs of the relevance of gelatinous zooplankton to their personal scientific interests and other wider concerns. ICES is the appropriate organisation to help in the process of educating fisheries scientists that gelatinous zooplankton are not simply obscure and esoteric forms that have no relevance to fisheries. To that end Pat Kremer proposed that the WGZE might like to propose a theme session for the ASM in 2004 entitled "Gelatinous Zooplankton and Fish: Predators, Competitors, Prey, and Nuisance**"**. This theme session should include a variety of oral presentations and posters that aim especially to elucidate the various ways in which gelatinous zooplankton could impact fish populations. Both invited and contributed papers at this theme session would serve to raise the awareness of a wide range of scientists to the importance of considering gelatinous zooplankton, the ways in which they interact with fish and fisheries and the importance of their role in marine ecosystems generally.

As part of the upcoming 3rd International Zooplankton Production Symposium, there will be a half-day workshop focusing on the topic proposed above as a theme session for 2004. At this workshop, at least 20 scientists from around the world will discuss what we currently know and do not know. Preparation for the workshop as well as discussion at workshop itself should identify key topics and scientists to be included in the ASM Theme session. With this preparation, we anticipate that the theme session will be of high quality, hopefully making a significant impact on the ICES member nations and community of scientists, sensitising them to the importance of gathering more and better data on the distribution and abundance of gelatinous zooplankton.

The above was read and a number of points discussed. The group agreed that these most enigmatic of plankton were hard to sample, hard to measure and preserve and yet they often constitute such a large predatory biomass that they exert strong local influences on zooplankton and ichthyoplankton survival and productivity. They also influence energy transfer to fish and higher predators, rates of particulate and nutrient fluxes and they often exert top down ecosystem controls that are currently impossible to quantify due to lack of data. It was noted that many ephemeral pelagic medusae have long lived, planktotrophic, benthic polyps, these, alongside the many holobenthic cnidarians, may exert local influences on benthic productivity, and in local inshore areas, perhaps plankton productivity and nutrient fluxes etc, again in largely unquantified ways. Steve Hay noted that research on jellyfish was increasing, mentioning the EU funded EUROGEL project coordinated by Ulf Baamstedt at IMR Bergen which focuses on both the fundamental roles of jellyfish in marine ecosystems and on their socioeconomic effects, particularly on fisheries, aquaculture and tourism.

In relation to Pat Kremer's submission, Steve noted that he had worked up scyphomedusae data over a number of years in the seventies and early eighties, collected as by-catch from ICES International Young Gadoid Surveys in the North Sea. There was also published work on jellyfish by-catch from fishing trawl surveys in the Northwest Pacific, which time series data had been related to climate changes in the region. The well-known and catastrophic effects of introduced jellyfish species on the Black Sea ecosystem was highlighted as an obvious indicator of the importance of jellyfish. It was observed too that the large, herbivorous and explosively productive salps were important in many open sea areas and as seasonal influxes into shelf seas. The salps tiny relatives the larvaceans are important microplankton feeders, they also feature in many larval fish diets.

The technical problems of sampling gelatinous organisms were discussed. Mention was made of using various kinds and sizes of closed cod ends on plankton nets to minimise damage. Also there is the promise of new direct observation sampling techniques to replace or reinforce net sample collections. The use of video, real-time image analysis and holographic sampling systems was an active development area along with use of multi frequency acoustic methods. These techniques may at last allow continuous or semi-continuous sampling and understanding of the notoriously patchy distributions of jellyplankton and their relation to hydrographic structures and mesoplankton distributions across a wide range of scales.

The WGZE meeting concluded that, without the presence of the WGZE member proposing this **TOR h** being present in Gijón, or sufficient other experts, the group could not advance this TOR further at this time. There will be a half-day workshop focusing on the topic proposed above as a theme session for 2004 that at the Zooplankton Production Symposium. The WGZE were very supportive of this initiative. Generally they felt however that the outcome of the workshop would strongly influence any future WGZE, and other initiatives regarding the role and relevance of the gelatinous plankton. Also, given that the consensus was that one theme session proposal should be our focus, then we decided to postpone this issue until next year, when symposium output and consideration of current research initiatives may be taken account of.

13 DISCUSSION OF LINKS WITH OTHER WORKING/STUDY GROUPS AND INITIATIVES, SUGGESTION FOR THEME SESSION FOR 2004

Both of the ICES Working Groups on phytoplankton: WGPE and WGHABD had also expressed interest in collaborating with the WGZE. The Chair pointed out that a previous WGZE meeting had suggested a theme session on plankton modelling related to links between phyto and zooplankton which aimed at achieving a modern overview of plankton modelling and a forum for modellers and plankton biologists to interact. However, with the setting up of the Working Group on Physical-Biological Interactions it might be more productive to set up a joint session with this WG and the combined ICES plankton WGs. It was however suggested that a joint meeting with four working groups could lead to each country/institution only sending one person and there would be too many TORs to get through, many of which would not be interdisciplinary or jointly relevant. When the WGPE and WGZE met in Bergen, the whole meeting took longer than usual because there were separate times for each group followed by a joint session.

At ICES ASC there is support for multidisciplinary theme sessions, so we could aim for the future to have one bringing joint focus for Working Group on Recruitment Processes, Working Group on Biological-Physical Interactions, WGPE and WGZE.

The WGZE report from the meeting in Bergen 2001, mentioned ideas on theme sessions which have not all been pursued and there followed some discussion of these. Discussion raised the thought that advances in theoretical pelagic ecology are lagging compared with terrestrial understanding and efforts. Bringing together modellers, oceanographers and field biologists to look for new ideas and approaches could help to highlight critical areas for advances in theory and experiment.

There was some concern that a theme session might not generate enough tangible output, however it was thought that if a theme session was done well it could have a Special Issue as an output. Thomas Miller (Co-Chair of Working Group on Recruitment Processes) had responded positively to an approach from the Chair enquiring as to how the WGRP wished to proceed with their TOR references to working with the WGZE. He suggested that a combined meeting is less useful than a theme session at a conference – we agreed with this.

It was agreed that WGZE should talk intersessionally with WG Recruitment Processes to further a joint theme session.

We decided that WGZE should choose one theme session to suggest for ICES ASC 2004.

Suggested theme session title to be submitted to ICES:

Larval fish growth, feeding and recruitment in relation to patterns and activity in plankton communities.

It was suggested that Steve Hay could Co-Chair this theme session with a nominee from the Working Group on Recruitment Processes.

The Chair had corresponded with Jennifer Martin of WGHABD, who have since passed on a list of people and monitoring efforts that could contribute to the ICES Annual Plankton Status Report. The WGZE Chair had also sent a note to the joint Chairs of the WGPE with a request for further collaboration on this issue of a combined and inclusive approach to the ICES Plankton Status Report. Hopefully we could get some more names, as monitoring data contacts, from the ICES WGPE, who had included some detail of German monitoring in their 2002 WG report.

There followed some discussion of what kind of phytoplankton data could go into the report. It was noted that chlorophyll was usually measured, total diatoms, total dinoflagellates, numbers or biomass might be provided. A possibility was raised that some WGHABD people may just be able to provide say *Alexandrium* abundance – is this what we want? It was also suggested that the phytoplankton people should perhaps organise what they think should be in the ICES Plankton Status Report.

It was emphasised that the collation of the metadata is the first thing to aim for in the Plankton Status Report, with example or standard data initially as a secondary goal. If WGPE would like to contribute to the Plankton Status Report they could make a metadata table and a map of their data. Perhaps as a first step we should ask willing phytoplankton monitoring people for chlorophyll measured through time since we contribute zooplankton sampled through time.

We agreed that there is a need to share the load of producing the Status Report. Steve Hay and Anthony Richardson agreed to assist Luis Valdés in this.

The Chair noted that he had briefly spoken with the Chair of the WG on Statistical Aspects of Environmental Monitoring. This group is fairly new and looking for applied problems. After some discussion, the Chair agreed to approach this WG, ask to see their reports and consider how we collaborate with them. It was proposed that they could be involved in preparing the paper about the Status Report, and perhaps use a critique of the Plankton Status Report as a basis for a general approach to statistical standards and approaches in monitoring work.

The Chair also noted that Andrew Kenny (CEFAS) had been in contact as Chair of the Regional Ecosystems Study Group for the North Sea (REGNS) (meeting 4–7 April in Nantes). Andrew had said that they were keen to explore all views and would be interested in the views of the WGZE. The Chair had highlighted the relevance of the Status Report and the WGZE hopes for its expansion, he had agreed to maintain contact and expressed the WGZE interest in the outcomes of the REGN meeting and hoped for feedback from the REGNS meeting.

There was a suggestion that by preparing a ICES WGZE poster for presentation particularly at the ICES/PICES Zooplankton Production Symposium, and more generally at meetings and conferences, the group could advertise what we do and hopefully encourage participation and collaboration. We considered that the information should be simple; working group name, mission statement, current members, examples of outputs, contact details. It was agreed that this

would be useful for future events and further that a PowerPoint presentation could also be put together. Roger Harris and Anthony Richardson suggested that this could be done in Plymouth.

ACTION: ***Poster to be prepared for the Symposium in Gijón, by Roger Harris and Anthony Richardson***

14 MEETING IN 2004

The 2004 WGZE meeting was discussed and while several venues were mentioned none was decided on in Gijón. Through post meeting correspondence, Prof. Wulf Greve has kindly offered to host the 2004 WGZE meeting which will take place; 5–8 April 2004, at the German Centre for Marine Biodiversity, c/o DESY Gebäude 3, Notkestraße 85 D-22607 Hamburg, Germany, Tel: +49–40–8998–1870, Fax: +49–40–8998–1871, e-mail: wgreve@meeresforschung.de

Dr Maria Emilia **Cunha** (IPIMAR, Portugal) also kindly suggested that the meeting could be held in Portugal. We thank her for her kind offer and might hope that she would be able to host our Working Group meeting in 2005.

15 ACTIONS, RECOMMENDATIONS AND DRAFT RESOLUTIONS

The WGZE will continue working for the achievement of the following actions and deliverables:

ACTIONS determined from discussion so far:

ACTION: *the WGZE will continue intersessional work to extend collaborative inclusion of further data sets into the status report for future years.*

ACTION*: The name of the* ICES Zooplankton Status Report *will change to the* ICES Plankton Status Report.

ACTION: *An outline of a paper addressing "*What's happening to plankton in the North Atlantic*", will be prepared. Roger Harris, Angel Lopez-Urrutia and Anthony Richardson will work on this intersessionally.*

ACTION: *The WG Chair will contact the Chairs of SGGOOS, PGNSP and REGNS highlighting to them the relevance of the ICES Plankton Status Report to their initiatives*.

ACTION: *Ensure that a simple introduction for the ICES taxonomic leaflets is prepared once the final form is decided and that scan quality is assured.*

ACTION: *Ensure that the ICES Plankton Identification Sheets are rescanned to a higher quality and accuracy.* Suggested TORs for the WGZE meeting in 2004

ACTION: *Poster to be prepared for the Symposium in Gijón, by Roger Harris and Anthony Richardson*

RECOMMENDATIONS

The WGZE recommends that Zooplankton Species Abundance and Diversity fulfils the criteria as an index to be measured and so should be considered for EcoQ status.

It is also recommended the index should be measured at least monthly and samples should be collected with a fine mesh (e.g. 53 micron mesh size), in order to capture all the small organisms relevant to fish larvae feeding.

The WG on Statistical Aspects of Environmental Monitoring should be involved with the WGZE in preparing the paper about the ICES Plankton Status Report, and perhaps WGSAEM should use a critique of the Plankton Status Report as a basis for a general approach to statistical standards and approaches in monitoring work.

DRAFT RESOLUTIONS

Theme session - WGZE suggest a joint (with WGRP) theme session for the ICES ASM in 2004:

Larval fish growth, feeding and recruitment in relation to patterns and activity in plankton communities. It was suggested that Steve Hay could co-Chair this theme session with a nominee from the WGRP.

Terms of Reference for 2004

There was some animated discussion on future TORs and more were put forward than could possibly be accommodated in one meeting. This enthusiasm during debate evolved into the following suggestions which cover review of plankton research and methods as well as maintaining and developing collaborative approaches and the useful products of the WGZE, particularly the ICES Plankton Status Report.

The **Working Group on Zooplankton Ecology** [WGZE] (Chair: Steve Hay, UK) will meet in Hamburg, Germany, from 5–8 April 2004 to review:

a) Review and update the annual ICES Plankton Status Report, including extending the time series with new sites, phytoplankton series and advances in monitoring technology.

b) Consider future developments and collaborative approaches in time series measurements and interpretation.

c) Review impacts of climate change on plankton communities using biological indicators, with special consideration of fisheries.

d) Review publications and outputs from the ICES /PICES /GLOBEC Symposium (Gijón, May 2003) and the implications for plankton research.

e) Review the achievements of the ICES Zooplankton Taxonomic Workshop (Plymouth, June 2003).

f) Review and consider new technologies for identification and enumeration of plankton species.

g) Review state of the art of enzymatic activity methods to estimate plankton secondary production.

Supporting Information

Priority:	The activities of this group are a fundamental element of the Oceanography Committee, fundamental to understanding the relation between the physical, chemical environment and Living Marine Resources. Thus the work of this group must be considered of very high priority.
Scientific Justification:	a) This is a repeating task established by the Working Group in 2000 to monitor the zooplankton abundance in the ICES area. The material presented under this item will be utilised to prepare the annual Summary Plankton Status Report in the ICES area. Reporting results are supported by significant observations and trends based on time series sampling programmes. Efforts are in hand to expand the report, particularly to include phytoplankton. b) The metadata and example time series contained in the Plankton Status Report will be preserved and available to ICES in the present and future. The data collation effort is growing, alongside expanding national and international demands for monitoring data. There is a present need to describe and achieve quality standards in sampling and sample analyses. Soon if not already the data set is large enough for overview and synthesis. This effort should take account of advances in statistical techniques and employ a wide collaboration and skills base in data analyses and interpretation. c) Global warming is forcing important changes in marine ecosystems. Many indications including shifts in spatial distribution of *Calanus* and other plankton populations and communities in the North Atlantic Ocean have been related with variability in ocean climate. There have also been significant shifts in fish population distributions and harvest yields. It is an appropriate time to review the evidence and to consider future and associated research directions. Discussion on the selection, interpretation and validation of planktonic ecosystem monitoring tasks and status indices needs to be continued. d) The 2003 ICES/PICES/GLOBEC Symposium will be a major international event. Zooplankton Production is a widely studied and highly relevant topic in marine research and for marine ecosystem and population management. This 3rd such Symposium looks to be as well attended and productive as the previous ones. The outcomes will be important to the future aims and plans for plankton research. As the originators of the Symposium the WGZE should assist in producing a review of the output and issues

	highlighted. e) The Taxonomic Workshop June 2003, Plymouth /SAHFOS is an important training and meeting opportunity for planktologists, introducing experts and new techniques. f) Weakness in current methods is often the shortage of funds, skills and time needed to undertake taxonomic analyses of plankton samples. We need to review the ways and means of indirect or *in-situ* plankton sampling, for species abundance, size, biomass etc., Also to consider advantages for rate measurements for trophic studies, growth, production, mortality etc. and for behavioural research. g) This was not properly considered at the 2003 meeting, yet we agreed it is a timely call for action in an advancing and widely relevant area of study where the expertise is diffuse internationally and very specialised. The techniques have come on a long way recently and give hope for new approaches to linking biomass with activity and production in marine environments, therefore it needs to be dealt with more fully.
Relation to Strategic Plan:	This working group's efforts embrace the scientific objective of understanding the physical, chemical, and biological functioning of marine ecosystems. The group facilitates discussion, collaboration and exchange of ideas and information needed for perspective and synthesis on one hand and enhancement of specific skills and methods on the other
Resource Requirements:	The Working Groups programme encompass the ongoing work of all its members, hence there are no additional resource requirements beyond those required for the meeting.
Participants:	The group has a small core membership, and is making efforts to attract broader participation.
Secretariat Facilities:	Web site maintenance to highlight contact details and activities and publish outputs for the WGZE
Financial:	None specified apart from the annual WGZE and Plankton Status Report's reproduction costs
Linkages to Advisory Committees:	The Group reports to ACME, mainly for the provision of scientific information on Ecosystems but welcomes input from other committees
Linkages to Other Committees or Groups	Links with the WGRP, WGPE and WGHABD are established and contact is maintained. WGMDM is advising on metadata guidelines for plankton biology data along with ICES data managers. The Plankton Status Report is of interest and practical use to a range of interested groups within ICES and beyond. Increasingly marine research, marine management and even marine institutes are re-aligning to take an ecosystem view, this will encourage linked and collaborative approaches between many working and study groups.
Linkages to Other Organisations:	PICES, GOOS and GLOBEC have many activities of very close interest to the activities of this group. Contact is maintained.

ANNEX 1: LIST OF PARTICIPANTS

ICES Working Group on Zooplankton Ecology
Aberdeen, 23–26, February 2003

Dr Roger Harris Plymouth Marine Laboratory Prospect Place West Hoe Plymouth PL1 3DH United Kingdom Tel: +44 (0) 1752 633400 Fax: +44 (0) 1752 633101 e-mail: rph@pml.ac.uk	Mr. Steve Hay Aberdeen Marine Laboratory PO Box 101 Aberdeen AB9 8DB United Kingdom Tel: +44 (0) 1224 876544 Fax: +44 (0) 1224 295511 e-mail: S.Hay@marlab.ac.uk
Dr Luis Valdés Instituto Español de Oceanografía Centro Oceanográfico de Gijón Po Box 4055 33213 Gijón Spain Tel: +34 985 308672 Fax: +34 985 326277 e-mail: luis.valdes@gi.ieo.es	Mr. Anthony Richardson SAHFOS Citadel Hill The Hoe Plymouth PL1 2PB United Kingdom Tel: +44 (0) 1752 633265 Fax: +44 (0) 1752 e-mail: ANR@mail.pml.ac.uk
Mr. Angel López-Urrutia Plymouth Marine Laboratory Prospect Place West Hoe Plymouth PL1 3DH United Kingdom Tel: +44 (0) 1752 633400 Fax: +44 (0) 1752 633101 e-mail: alop@pml.ac.uk	Dr. Peter Wiebe Woods Hole Oceanographic Institution M.S. # 33 Woods Hole, MA 02543 USA Tel: 508 28 92 313 Fax:508 45 72 169 e-mail: pwiebe@whoi.edu
Dr Webjorn Melle PO Box 1870 Institute of Marine Research Nordnes , N-5024 Bergen Norway Tel: +47 55 238444 Fax: +47 55 238584 e-mail: webjoern.melle@imr.no	Dr. Doug Sameoto Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth NS B2Y 4A2 CANADA Tel: +1 9 02 426 3272 Fax: +1 902 426 9388 e-mail: SameotoD@mar.dfo-mpo.gc.ca
Dr. Xabier Irigoien AZTI - Technological Institute for Fisheries and Food Herrera kaia Portualde z/g 20110 PASAIA - (Gipuzkoa) SPAIN Tel.: +34 943 004800 Fax +34 943 004801 xirigoien@pas.azti.es	Also Attending: José Luis Acuña Fereiaudez (Univ of Oviedo, Spain) Ricardo Anadón (IEO, Gijón, Spain) Enrique Nogueira Garcia (IEO, Gijón, Spain) Xose Anxelu G Moran (IEO, Gijón, Spain) ?Josu M? Rodriguez (IEO, Gijón, Spain)
Apologies from WGZE members unable to attend but providing written submissions: Todd O'Brien, Eilif Gaard, Astthor Gislason, Wulf Greve, Pat Kremer, Lutz Postel, Santiago de Hernandes Leon	

ANNEX 2: AGENDA AND PROGRAMME

Day 1

24/02/03 a.m.

Introduction from Luis Valdés

1) Lead Luis Valdés, Rapporteur Anthony Richardson

   TOR a. Review the preparation of the annual, zooplankton summary status report: standardisation of data sets, critics and improvements.
   Include **TOR i.** Review progress in the digitisation of the plankton leaflets.

2) Lead: Steve Hay, Rapporteur Peter Wiebe

   TOR b. *Approve and adopt guidelines for metadata standards for zooplankton data in the ICES area.*

   Include **TOR j.** *Consider the potential of ITIS as a common taxonomic system within ICES.*

24/02/03 p.m.

3) Lead Peter Wiebe, Rapportuer Roger Harris

   TOR c. *Review climate change and Trans-Atlantic studies on Calanus.*

4) Lead Xabier Irigoien, Rapporteur Angel Lopez-Urrutia

   TOR d. *Review perturbations in coastal marine ecosystems and changes in zooplankton community structure due to human impacts.*

Day 2

25/02/03 a.m.

1) Lead: Webjorn Melle, Rapporteur Xabier Irigoien

   TOR e. *Evaluate possible biological indices of ecological significance for the fisheries and environmental assessment groups, taking into account the evaluation framework adopted by ACE (2000) and described by WGECO (2001).*

2) Lead: Roger Harris, Rapporteur Luis Valdés

   Luis, Roger, Peter and Xabier – who are closely involved with the Symposium go off to;

   TOR f. *Evaluate the local organization and facilities for the ICES/PICES/GLOBEC Symposium*.

25/02/03 p.m.

3) Lead Steve Hay, Rapporteur Doug Sameoto

   TOR g. Consider sampling and analytical methodologies focussed on gelatinous zooplankton.

4) Intro. Steve Hay - Santiago de Hernandes Leon not present but sent written submission

   TOR h. Review state of the art of enzymatic activity methods to estimate secondary production in zooplankton.

Day 3

26/02/03 a.m.

Particularly consider links, submissions from and relations to other working/ study groups and initiatives and consider suggestions for Theme Sessions

AOB – Discuss matters arising, revisit Metadata formats (TOR b)

26/02/03 p.m.

Reporting - arrange venue for WGZE 2004 meeting. Draft and formulate suggestions for future TORs.

ANNEX 3: WGZE METADATA GUIDELINES FOR (ZOO) PLANKTON DATA

DRAFT, 24 February 2003

What is plankton metadata and why is it important?

Plankton "metadata" is ancillary information about and related to the plankton data itself, such as the methods and processes involved in measuring or observing these "data" and the conditions under which it was sampled. For zooplankton data, this can be key information, such as net mesh size or a specific sample processing protocol, which specifies the target species and relative content of that data. This additional information is needed to examine and utilise the plankton data in a meaningful and appropriate way. While this information was available at the time of the sample collection, present in a log book or cruise report, special effort must be made to ensure that this metadata remains with the data indefinitely, preferably in a digital form stored with the data itself. By doing this, the quality and usability of the plankton data are preserved for present and future application and study.

What is the purpose of this document?

The Working Group on Zooplankton Ecology (WGZE), with guidance from the Working Group on Marine Data Management (WGMDM), is providing these general metadata guidelines for plankton data collected and submitted to ICES. The existence of such guidelines will ensure that quality and usable plankton data sets will be preserved and available to ICES in the present and future. The metadata fields in this document do not cover every possible metadata type, nor will every plankton data type include all of these metadata fields. Instead, these fields are intended to serve as an example of the types of information (metadata) important towards preserving the highest level of quality and understanding within the zooplankton data. It should also be noted that while these guidelines were written for zooplankton data, they are also highly appropriate for other plankton types (*e.g.*, phytoplankton and bacteria. These may tend to have less emphasis on gear type and greater emphasis on the microscope and/or staining techniques used in processing them).

(ZOO) PLANKTON DATA GUIDELINES:

The fields below represent many of the most common metadata fields important to preserving high quality plankton data. These fields are not necessarily complete nor is every field mandatory. Many of these data-fields may be better stored along with each station or tow within the plankton data sheet itself. The intent is to describe the general types of information that should be preserved either within the data or as a separate metadata or cruise summary.

Metadata-fields relating to the entire CRUISE:

This is general information relating to the sampling cruise. This information may help link these data to physical and chemical measurements taken on the same cruise (but stored in a separate data file or location), and can also give credit to the investigators participating in the cruise.

- Name of the ship
- Investigator-designated Cruise Identifier (e.g., "9801 Leg 1", or "Froggy Fjord 1993")
- Associated Project
- Associated Institute
- Principal investigator(s) for cruise
- Other responsible investigators, and their variable(s)
- If a cruise or data report is available describing the data collection and processing, this can be referenced or, when possible, supplied with the data.

Metadata-fields relating to a specific STATION:

This is specific information relating to the position and time of the sampling station, along with the weather conditions and other details observed during the sampling.

- **Station latitude and longitude** (noting any hemisphere indicators such a "N" for North or negative (-) for South, etc.)
- **Station Month, Day, Year**
- **Station Time** (designated as "local", "GMT/UTC", "ship", etc)
- Investigator-designated **Station Identifier** (e.g., "Station 1x", "Station 2x", ...)
- Optional general station time (twilight, midnight, day, morning)
- **Meteorological Observations** (windy, wavy, cloudy, sunny)
- **Station Sounding** (bottom depth)
- Information about any other supplementary/complementary data collected at the same time (same station) should also be supplied (i.e., a note that "CTD and nutrient samples were also made at this station")
- **Note any affecting instances or corrections applied** (e.g., "a substantial phytoplankton bloom was present at this station" or "a larger net mesh size was used at this station due to frequent clogging by gelatinous zooplankton")

Metadata-fields relating to the NET TOW or BOTTLE CAST:

This information describes the towing (or bottle deployment) methods and procedures.

- **Towing Method** (horizontal, vertical, oblique)
- **Towing depth-range** (a range of starting and ending depths for each net or bottle), or the wire angle and wire out during the tow
- Towing Duration (minutes or hours)
- Towing Distance (in metres)
- Average Towing Speed (knots or metres per second)
- **Note any affecting instances or corrections applied** (e.g., "the gear hit the bottom midway through the tow")

Metadata-fields relating to the SAMPLING GEAR:

This information describes the sampling gear employed, with key metadata fields such as the effective mesh size of the sampler.

- **Describe the sampling gear used**, providing a literature reference if available
- If using a "standard" net (e.g., a NORPAC net) was used, be sure to note any modifications to this net
- **What net mesh size was used** (usually in microns)
- What was the net opening shape (square or circular) and the opening mouth area or diameter
- **Was a flowmeter used?** When and how was is calibrated?
- **Note any affecting instances or corrections applied** (e.g., did the flowmeter break or the codend crack)

Metadata-fields relating to SAMPLE PROCESSING:

This information describes the sample processing methods and protocols.

- **What volume of water was filtered to yield this sample** (i.e., from the flowmeter or calculated via mouth area and towing distance, or estimated because the flowmeter failed)
- **How were samples preserved**, and in what (e.g., 5% buffered formalin)
- **How were samples processed** (summarize the counting, weight, or volume method)?
- **Was the sampled split** (via Folsom splitter or other method)? What was the size of the final aliquot?
- **Were large plankters removed** prior to making biomass measurements? Was a size or volume criteria used in deciding what to remove and what could remain?

- Investigator-designated tow, net, or sample identifier (e.g., “Sample 1035 from Net 5”)
- **Note any affecting instances or corrections applied** (e.g. “eggs and fragments were not counted”)

Metadata-fields relating to SAMPLE ITSELF:

This measured plankton data fields should be clear enough to be understood by others with slightly less expertise and situational knowledge than the original investigator. The tow most common mistakes are not providing units for each measurement (*e.g.,* “number per cubic meter” or “milligrams wet mass per sample”), and not providing clear column headings for the data (*e.g.,* what is “CfcV” and “HetBact”?)

- Provide the units for each measurement (*e.g.,* #/liter, #/m3, #/m2, mg/m3, mg/haul, ...)
- If taxonomic codes, symbols, or abbreviations are used in the data, provide a translation table to help reduce possible misunderstandings of the taxa (e.g., “CfcV” = *“Calanus finmarchius* copepodite V*”, ...)*
- Is an estimate of final uncertainty of the data known? (This is a JGOFS thing, I am not sure if it applies to plankton data.)

Additional formatting and metadata suggestions are available through the Formatting Guidelines for Oceanographic Data Exchange (http://www.ices.dk/ocean/formats/getade_guide.htm) prepared by the IOC's Group of Experts on the Technical Aspects of Data Exchange (GETADE).

An example metadata summary:

Here is a brief metadata summary based on a zooplankton present in the JGOFS AESOPS online data system. Note that without looking at Dagg (1993), it does not appear that a net mesh size is provided.

Principal Investigators: Michael Dagg and Juanita Urban-Rich

Project/Study: US JGOFS Antarctic Environments Southern Ocean Process Study (AESOPS)
Antarctic Polar Front Zone (APFZ) Process 1 and 2 cruises aboard R/V Roger Revelle cruises 7 (Process 1) and 9 (Process 2)

Cruise: “Kiwi-7”

Sampling Gear: Bongo Net

Sampling Procedure: Vertical bongo nets were taken in through the upper 200 m. The general sampling procedure is described in Dagg (1993). The codend contents were preserved with 10% buffered formaldehyde. Replicate aliquots of the sample were counted in the laboratory such that 30 of the dominant large copepod species were counted and greater than 1000 zooplankton per sample counted. An aliquot of the cod-end contents was filtered onto 153 micron Nitex and frozen in liquid nitrogen at sea for dry weight analysis in the laboratory. Copepods were sorted by species, rinsed, dried and weighed on a Cahn microbalance for dry weights.

Dagg, M. J. 1993. Grazing by the copepod community does not control phytoplankton production in the subarctic Pacific Ocean. Progress in Oceanography, 32, 163-183.

ANNEX 4: ZOOPLANKTON MONITORING RESULTS IN THE ICES AREA, SUMMARY STATUS REPORT 2001/2002

Prepared by the ICES Working Group on Zooplankton Ecology

Editor: Luis Valdés

Data provided by:

David G. Mountain, Doug Sameoto, Astthor Gislason, Anthony Richardson, Eilif Gaard, Webjorn Melle, Lutz Postel, Steve Hay, Wulf Greve, Roger Harris, Angel L. Urrutia, Luis Valdés and M. Teresa Alvarez-Ossorio

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Contents:

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1. Background

The ICES strategic plan recognised the ICES role in making scientific information accessible to the public in addition to the fisheries and environmental assessment groups. Thus, during the 1999 Annual Science Conference a general request was made from ICES to the Oceanography Committee Working Groups to develop data products and summaries that could be provided on a routine basis to the ICES community via the ICES web site. The Working Group on Zooplankton Ecology (WGZE) consider as a priority action to produce a summary report on zooplankton activities in the ICES area based on the time series obtained in the national monitoring programmes.

This is the third summary on zooplankton monitoring results in the ICES area. It continues a pilot study to further develop uses for and disseminate results from the ongoing time series monitoring programmes in the ICES region. The main objectives this year were:

- Update the collections up to December 2002
- Include ancillary data in the metadata tables

Additionally we also improve this year report with a new series on the Norwegian sea, tables on the ten top zooplankton species annual (2002) variability in the series of Plymouth and Helgoland and the inclusion of seasonal and year-to-year variability in some regions of two target species: *Acartia clausi* and *Calanus helgolandicus*

2. Regional coverage

The information collated by the ICES WGZE on, zooplankton sampling programmes in the ICES area include 5 fixed stations and 27 standard sections (approx. 200 sampling stations) distributed on the continental margins of both America and Europe and covering from the temperate latitudes south of Portugal to the boreal regions north of Norway. In addition, there are several fixed CPR routes that cover coastal and oceanic waters in the Atlantic. The sampling networks and the collections used in this report are shown in Figure 1.

As shown in the time series collections presented here, zooplankton abundance is very variable between years. Temperature can have a large influence on the community structure and production of zooplankton and can cause large seasonal, annual and decadal changes in zooplankton population size and species distribution. Other factors that explain biogeographical differences in species distribution, in plankton abundance and in biological processes are the extend of exposure to sun light, the timing of the spring bloom, the length of the season of water column stratification, etc. It was for these reasons that data sets included in this report are presented by affinities in temperature and biogeographical areas, which correspond to regional seas or basins.

The main characteristic of the zooplankton monitoring programmes is the temporal resolution of observations. Zooplankton is also sampled with a variety of nets, over a variety of temporal and spatial scales, so a comprehensive interpretation of the data sets requires information on metadata to describe the content, quality, and other data characteristics (sampling gear, mesh size, depth, sampling site, dates, ancillary data, person responsible for the data, etc.) are included in Section 5. These metadata will help a reader locate and understand the data presented in this document.

Data are presented in abundance or biomass and units used are ind m^{-2} or m^{-3} (7 data sets), g DW m^{-2} (5 data sets), with only one data set expressed as abundance in number of organism per sample, and another expressed in plankton volume (ml m^{-3}). Abundance and biomass are structural variables that allow for an easy comparison.

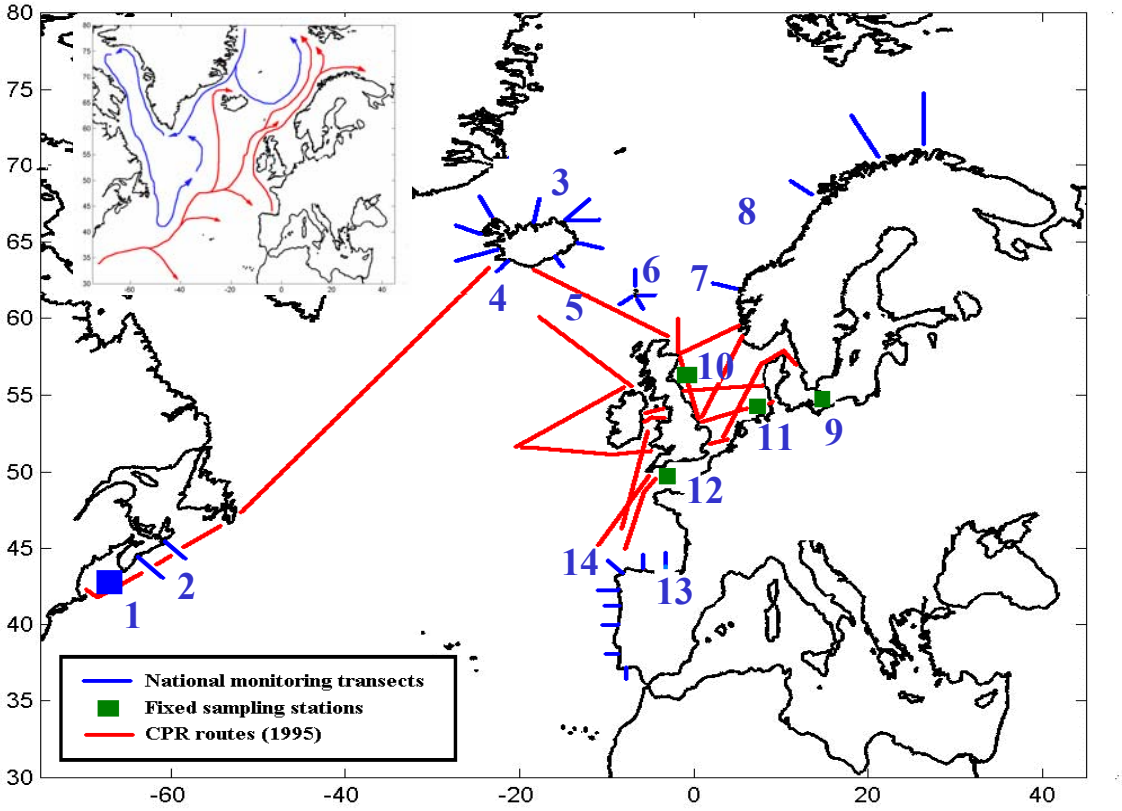

Figure 1. Zooplankton sampling network in the ICES area (only sampling programmes reported in the WGZE); numbers make reference to the collections used in this report. Map in the upper left corner represents the schematic general circulation of the North Atlantic.

3. Regional descriptions

Western Atlantic

Area 1: Georges Bank

The Northeast Fisheries Science Center conducts two types of zooplankton monitoring programmes, operated by the Laboratory in Narragansett. The first is CPR transects across the Gulf of Maine and across the shelf from New York City towards Bermuda. Currently some of the recent data from this programme are being reviewed.

The second type of monitoring is by Bongo net (333 µm mesh) samples collected four to six times per year over the shelf region. A number of possible indices could be provided. Two examples are presented here, showing the plankton displacement volume on Georges Bank in the early spring and early autumn (Figure 2). Indices of abundance for specific species or taxonomic groups could also be provided (e.g. *Calanus finmarchicus*, amphipods, euphausids, cnidarians).

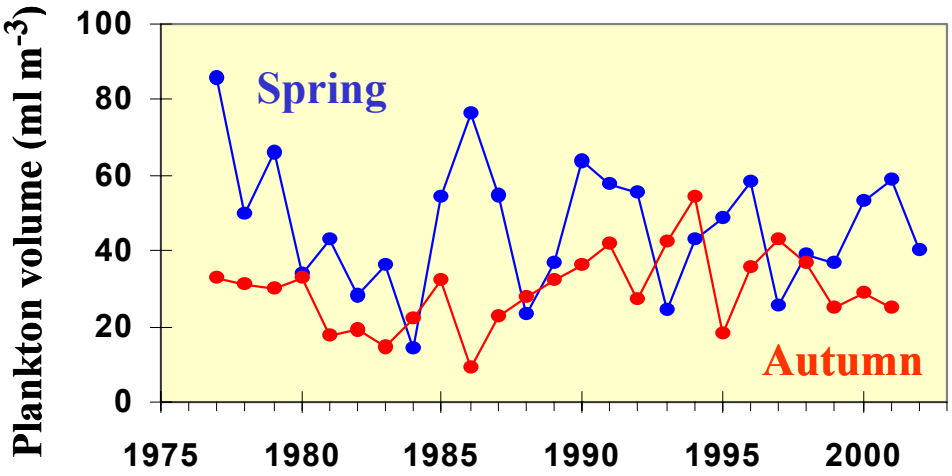

Figure 2. Plankton displacement volume on Georges Bank in the early Spring and early Autumn.

Area 2: Emerald Basin (West Atlantic, Scotian Shelf)

Zooplankton are sampled twice a year (spring-summer and fall-winter) with a variety of nets and optical instruments, the main sampling net being a 0.75 m diameter ring net mounted with a 200 µm mesh. Sampling is carried out on a number of stations on a series of transects that run perpendicular to the coast of Nova Scotia across the Scotian Shelf. The most frequently sampled station is in Emerald Basin, a deep basin approximately in the center of the shelf. These data are used to monitor long-term changes in the levels of zooplankton species abundance. A stock status report on the state of the phytoplankton and zooplankton in Canadian Atlantic waters is prepared every year. This report is also published on the web at http://www.dfo-mpo.gc.ca/csas/Csas/English/Status/general.htm.

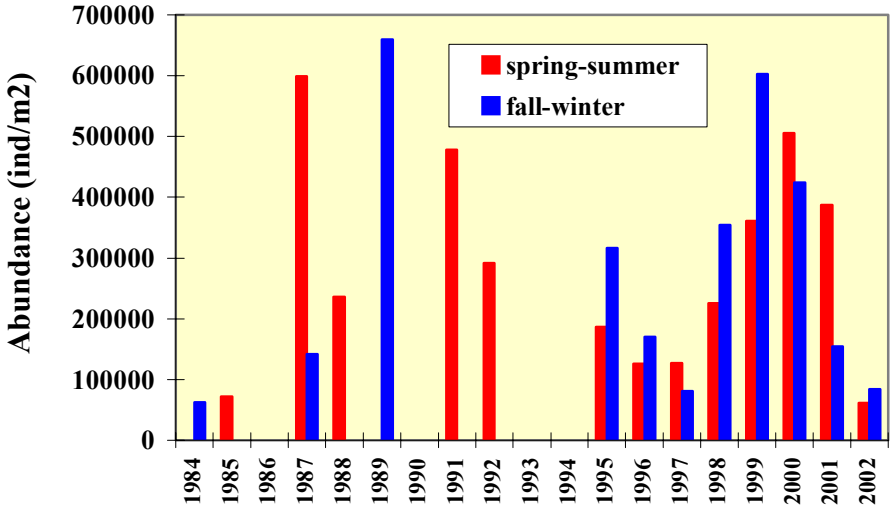

Figure 3. Abundance of zooplankton in Emerald Basin (1984–2001).

It is believed that the size of the autumn population of *Calanus finmarchicus* in Emerald Basin is a good indicator of the size of the population on the Scotian Shelf during the previous spring and summer (Sameoto and Herman, 1990). The *C. finmarchicus* population declined between 1995 and 1997 to reach the historical low levels of 1984. During 1998 and 1999 the population had recovered reaching maximum levels in autumn of 1999 but again populations declined to a low in 2002. *C. finmarchicus* accounts for a significant portion of total zooplankton, which shows the same general pattern in abundance (Figure 3). The temperature anomaly at 50 m in June and the numbers of *C. finmarchicus* appeared to be related, showing that, as the temperature increased, there was generally an increase in the size of the *C. finmarchicus* population.

Icelandic-Norwegian basin

Areas 3 and 4: Siglunes (North Iceland) and Selvogsbanki (South Iceland)

The Icelandic monitoring programme for zooplankton consists of a series of transects perpendicular to the coastline. Sampling of the transects 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 in total. Zooplankton investigations are carried out at these stations every year in May-June. Long-term changes in zooplankton biomass at Siglunes transect from the north of Iceland and at Selvogsbanki from the south are shown in Figure 4. At Siglunes the values are averages from 8 stations, while on Selvogsbanki the values represent averages from 5 stations.

At the Selvogsbanki transect the zooplankton biomass showed a peak during the early 1980s while a low was observed during the late 1980s. Peaks were also observed around 1995 and 2000. The time period between the zooplankton peaks on the Selvogsbanki transect has been 5–10 years.

North of Iceland (Siglunes transect) the high values of zooplankton in the beginning of the series dropped drastically with the onset of the Great Salinity Anomaly of the 1960s. Since then zooplankton biomass has varied with highs at approximately 7–10 years intervals. The highest and lowest values differ by a factor of about 24. The last peak in zooplankton biomass occurred around 2000.

The zooplankton biomass north of Iceland is influenced by the inflow of warm Atlantic Water to the area. Thus, in warm years, when the flow of Atlantic Water onto the northern shelf is high, the zooplankton biomass is almost two times higher than in cold years, when this inflow is not as evident (Astthorsson and Gislason 1998, Astthorsson and Vilhjalmsson 2002). The reason for this may be the better feeding conditions of the zooplankton due to increased primary production in warm years, advection of zooplankton with the Atlantic Water from the south, and faster temperature dependent growth of the zooplankton in warm years. During both 2000 and 2001, when the biomass of zooplankton north of Iceland was particularly high, the inflow of warm Atlantic water onto the northern shelf was also high. South of Iceland the links between climate and zooplankton biomass are not as evident as north of Iceland. Most likely the variability off the south and west coasts is related to the timing and magnitude of the primary productivity on the banks which in turn are influenced by the freshwater efflux from rivers and wind force and direction.

Comparison with other data from the northern North Atlantic shows that observed zooplankton biomass in spring is descriptive of the mean copepod biomass in that year. Recent research also shows that the variation of zooplankton biomass in the Icelandic area is in tune with long term variability of zooplankton abundance over a much larger area, i.e. in the northern North Atlantic in general (Astthorsson and Gislason 1995).

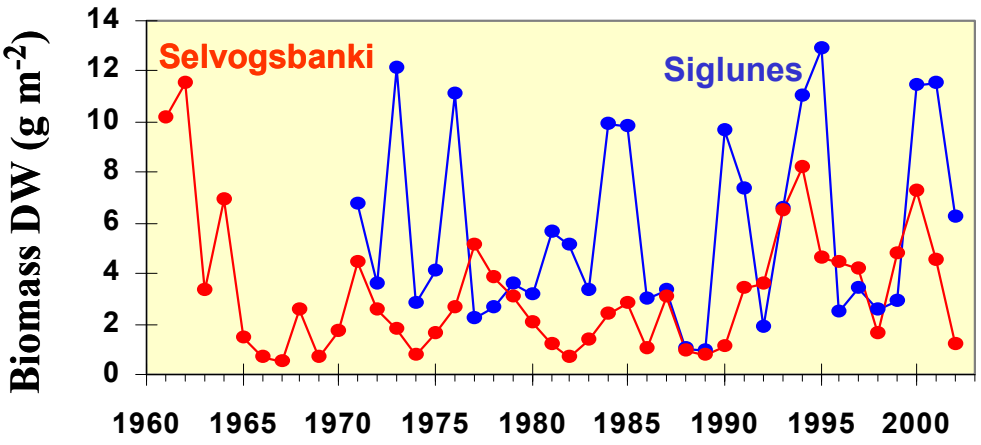

Figure 4. Year to year variability of zooplankton biomass at Siglunes and Selvogsbanki.

Area 5: Iceland-Scotland CPR line

The series shown in Figure 5a is for total copepods along a CPR route between the north of Scotland and Iceland during the period 1958–2001. In the Scotland-Iceland area, the mean total copepod abundance in 2001 was 197.8 individuals per sample (~3 m^3), almost half below the overall mean for the series of 344.7 individuals per sample. There appears to be extended low periods (<250 individuals per sample) in 1970–1973 and 1988–1990, with only occasional high (>800 individuals per sample) periods in 1960 and 1985. Interestingly, the maximum and minimum abundances were only three years apart, with 1985 having the highest abundance of 994.8 individuals per sample and 1988 having the lowest of 57.6 individuals per sample. Without adjusting for autocorrelation, there is a significant negative slope ($p<0.05$, $n=44$), although the variance explained is only ~15%. Thus, there is considerable additional variability in the time series unaccounted for by the negative trend.

Acartia spp. is the most important species in terms of abundance, accounting for the 41% of the total abundance of copepods. Year to year variability of this species is shown in Figure 5. *Acartia spp* abundance in 2001 was 91.6 ind 3 m^{-3}, which represent one third below the annual average (142.8 ind 3 m^{-3}). The decreasing trend evidenced in the time series mirrors the trend obtained for the total copepods.

Calanus finmarchicus is the ninth species in terms of abundance and in 2001 this species account for 5.7 ind m^{-3} against the 11.3 ind m^{-3} of the 1958–2001 mean. Linear trend for *C. finmarchicus* has not statistical significance. Other important species (among the ten top species) that in 2001 render abundances below the average were *Limacina retroversa*, *Oithona spp*., and *Pseudocalanus elongatus*. However, other species such as *Evadne spp*., *Foraminifera*, *Appendicularia* and echinoderm larvae were found in higher abundances than the 44 years average.

(http://www.npm.ac.uk/sahfos/sahfos2.html).

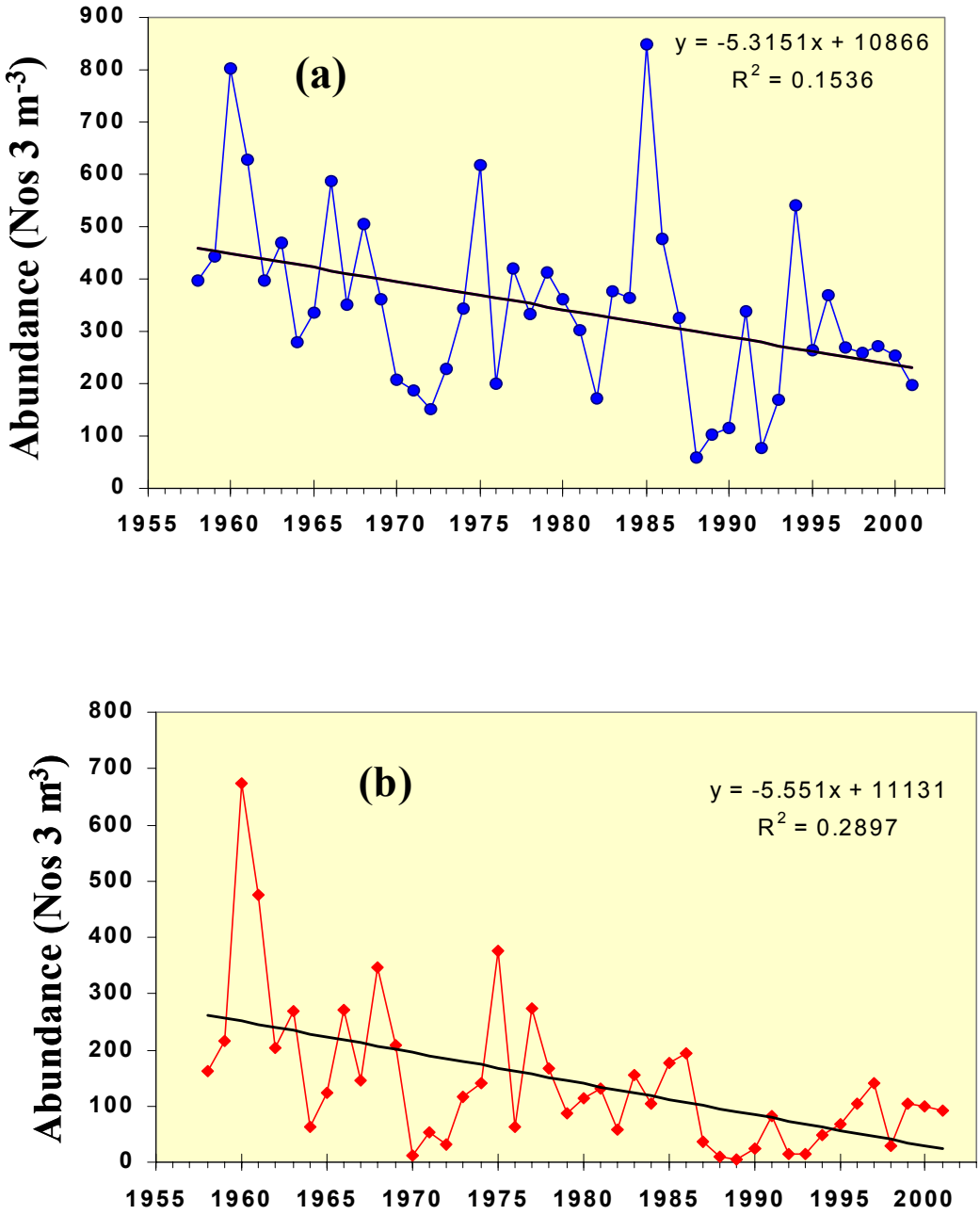

Figure 5. a) Year to year variability and long-term trend of copepod abundance in the CPR route Iceland-Scotland (58–64ºN, 3–18ºW) and b) Year to year variability and long-term trend of Acartia spp. abundance in the same CPR route.

Area 6: Faroe Islands

The Faroese Fisheries Laboratory operates 4 standard sections radiating northwards, eastwards, southwards and south-westwards from the Faroes. These sections are sampled 4 times per year: in February, May, June/July, and November.

The northwards section, from the Faroes into the southern part of the Norwegian Sea, contains 14 stations with a distance of 10 nautical miles between each station. The southernmost end of the section is on the shelf, and contains essentially neritic zooplankton. The abundance of oceanic zooplankton (mainly *Calanus finmarchicus*) is highly

variable between years. From the slope and northwards, the southernmost part of the section covers warm Atlantic Water, while the northernmost part of the section covers cold East Atlantic Current Water. Thus, the oceanic part of the section covers two quite different water masses: warm water in the southernmost part and colder water in the northernmost part.

Figure 6 shows the average zooplankton biomass in the upper 50 m in these two water masses in the oceanic part of the section in May 1990–2002. Values of abundance in 2002 were in the average of the long term mean. C. *finmarchicus* is the dominant species in both water masses. With the exception of 1993 the biomass was clearly higher in the cold water mass in the northern part of the section than in the warmer southern part. The reason is a higher abundance of overwintered *C. finmarchicus* (CV and adults) together with some *Calanus hyperboreus* in the northern part. In the Atlantic water, much fewer large individuals are present, but a higher numbers of small (recruit) stages in May. Since the reproduction starts earlier in the southern part of the section, the total numbers of *C. finmarchicus* are higher on average in the Atlantic water than in the East Icelandic Current Water, despite the lower biomass.

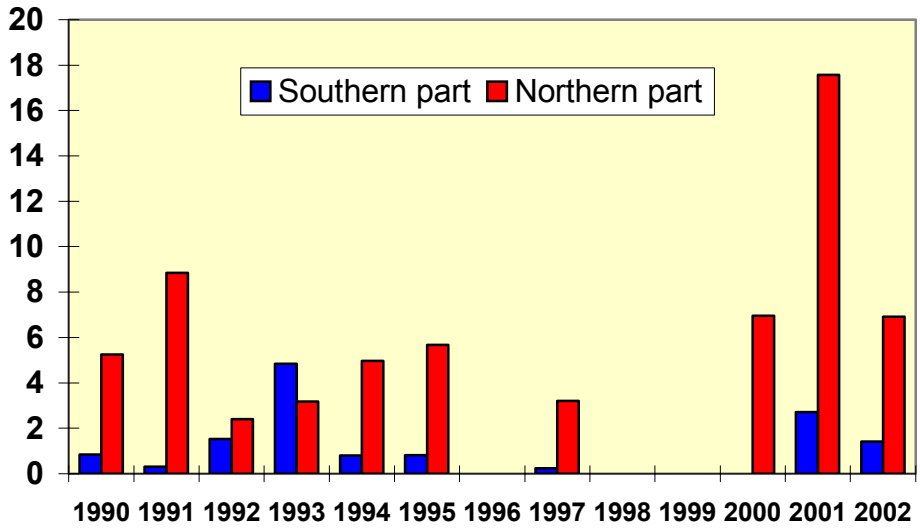

Figure 6. a) Zooplankton biomass at the ocean in the Atlantic water (southern part) and East Icelandic Current water (northern part) on section North in May 1990–2001. No data from 1996, 1998 and 2000 south. b) Zooplankton biomass on the Faroe shelf in late June 1991–2001.

Area 7 and 8: Svinøy and the Norwegian Sea

Four fixed transects are sampled within the "IMR Monitoring Programme": 2 transects into the Norwegian Sea [the Svinøy transect (15 stations) and the Gimsøy transect (10 stations)] and 2 transects in the Barents Sea [the Fugløya-Bjørnøya transect (7 stations) and the Vardø-North transect (8 stations)]. Transects are sampled at various frequencies: the Norwegian Sea transects 4–10 times/yr and the Barents Sea transects 3–5 times/yr. Additionally the Norwegian Sea is surveyed in May and July-August, both surveys ca. 50–100 stations. Data are stored at the HELIX database at IMR. Periodic reports are made annually to the Ministry of Fisheries and to the IMR´s "Havets Miljø" (Annual Report on Marine Environment).

The development of zooplankton biomass in spring at the Svinøy transect showed very small variations among years in the period 1997–2001 (Figure 7), and the maximum biomass in early summer varied from 8 to 9.3 g DW m^{-2}. In 2002, the maximum biomass as an average for all stations was 11.32 g DW m^{-2} (28–30 April) higher than previous years. In April the highest biomasses were observed at the innermost 3 shelf stations (11.7–18.8 g DW m^{-2}), and the 5 westernmost deep ocean stations (9.95–30.22 g DW m^{-2}). The remaining stations, both at the shelf and deep ocean, showed rather low biomasses, varying between 1.94 and 8.3 g DW m^{-2}. In July 2001 there was a clear trend towards higher biomasses at the ten easternmost stations. Last year this trend was not so clear, the average July biomass of the six easternmost shelf/slope stations was 6.99 g DW m^{-2}, while the 10 westernmost deep ocean stations showed an average of 4.57 g DW m^{-2}.

Due to the still reduced coverage of the Svinøy transect (4 and 5 times in 2001 and 2002, respectively) no firm conclusions can be made with previous years with regard to the zooplankton development.

Figure 7b shows the zooplankton biomasses in the Norwegian Sea 1994–2002 based upon the July-August surveys. The biomasses vary from 5.1 (1998) to 10.8 g DW m^{-2} (1994). Contrary to previous years when large parts of the Norwegian Sea were surveyed, the last year estimate is based upon very few stations from two transects (the Svinøy transect and a transect along 69°20´N).

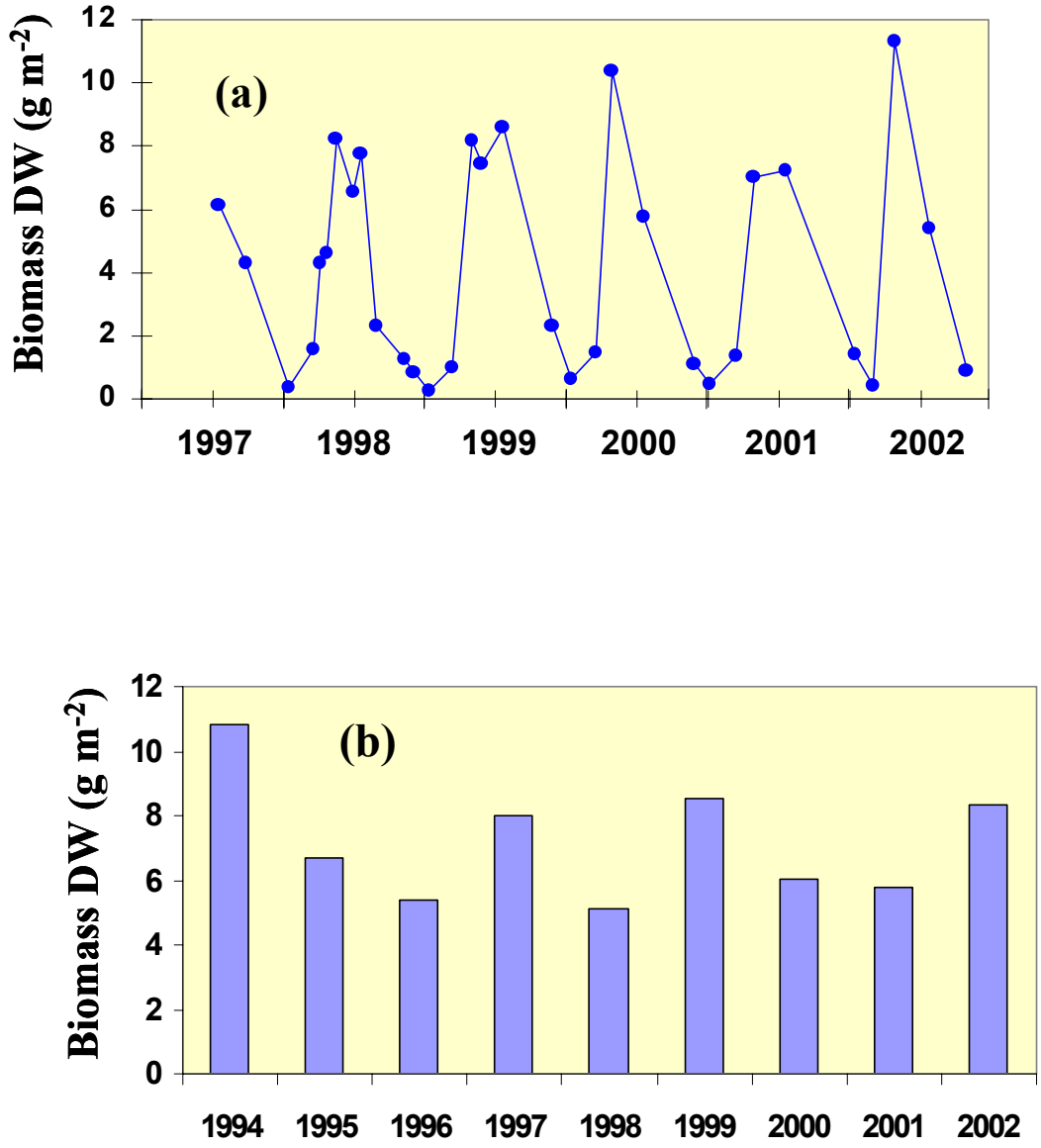

Figure 7. Zooplankton biomass at Svinøy transect (a) and Norwegian Sea (b).

Baltic Sea

Area 9: Arkona Basin (Germany)

The Baltic Sea Monitoring Programme (BMP) consists of 24 international stations. The stations cover the different sub-areas of the Baltic Sea from the south-westerly Mecklenburg Bay to the north-easterly Gulf of Finland. Each station is sampled at least 4 times a year, but laboratories of all Baltic States contribute to the BMP increasing the amount and the frequency of data. Data are stored at HELCOM (Helsinki Commission) and will be stored at ICES in the future. Periodic Assessment Reports are prepared every 5 years by contributions of all HELCOM member states (http//www.helcom.fi; HELCOM, 1996).

For purposes of illustration, one station (54°55`N, 13°30'E) has been chosen from the data base (Figure 8). This station is sampled from the surface down to 25 m or to the depth of the seasonal thermocline (30 m). The total series covers the period from 1973 to the present. In some years the sampling coverage is quite poor (e.g. 1995 and 1996). Variations in the range 10000–50000 ind m^{-3} are typically observed during the seasonal cycle in the western Baltic Sea. Peaks of plankton observed in spring 1983, 1988, 1995, 1998, 2000 and 2002 were because of mass developments of rotifers, which often happened after mild winters. In spite of these peaks, the cladoceran *Bosmina coregonii* is the dominant species during summer when water temperature reaches 16 ºC (HELCOM, 1996). Although no statistical trend is observed, 4 of the 6 spring peaks mentioned above occurred during the last 8 years.

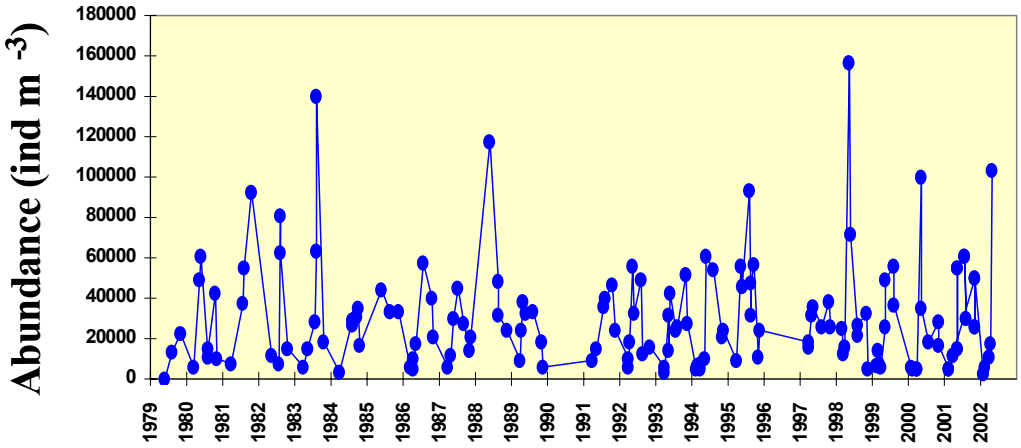

Figure 8. Zooplankton abundance at Arkona Basin (Baltic Sea) in 1999–2002.

North Sea and English Channel

Area 10: Stonehaven (Scotland, NW North Sea)

The Stonehaven sampling site is located at 56º57.80'N 002º06.20'W, approximately 5 km offshore from Stonehaven which is a fishing harbour 28 km to the south of Aberdeen. The water depth at the site is 50 m. Sampling for hydrographic parameters, concentrations of inorganic chemical nutrients and the abundance of phytoplankton and zooplankton species has been carried out on a weekly basis off Stonehaven since January 1997. The objective of the programme is to establish a monitoring base for assessing the status of the Scottish coastal waters ecosystem, and the responses to climate change. Comparison of the results with archive regional data on temperature, salinity and nutrients and phytoplankton biomass, indicates that the site off Stonehaven provides a reasonable index of the state of the coastal waters. The biological data illustrate the consistencies and variability in seasonal succession of plankton species and their abundance. It is evident that there are significant differences among seasons and years.

The water column at the sampling site remains well mixed throughout much of the year, except when in late summer and autumn when surface heating and settled weather often cause temporary thermoclines to appear. The seasonal minimum temperature generally occurs in the last week of February/first week of March. Water movement is generally southerly with quite strong tidal currents. In the late summer and through autumn of most years, water with a high Atlantic Ocean content passes down the Scottish East Coast. These events are particularly observable in the salinity signal. For example 1997 showed a strong salinity increase in the late summer whereas 1998 showed very little. These influxes often bring oceanic species in: for example the chaetognath *Sagitta serratodentata* and the siphonophore *Muggiea atlantica* are indicators of this oceanic influence.

The seasonal pattern of plankton production is clearly evident in these data, as is the variability among years in its extent. Nutrient data also show strong seasonal cycles but again there is interesting inter-annual variability evident. This is also seen in the variations observed in the phytoplankton and chlorophyll data (Figure 9a). Large differences can be seen between years in the observed biomass of many common species of zooplankton, with a general increase from 1997–2000 (Figure 9b) but a lower observed abundance overall in 2001 and 2002.

The time series, although short, is at a fairly high observational frequency, this allows insight into the seasonal dynamics and succession of species throughout the annual cycle. This provides an excellent background against which to carry out process studies, modelling and comparisons with other sites. Data also provide assessment of the extent of local variability and allow consideration of the local effects of broader patterns of ocean climate change.

Several zooplankton species are of particular interest in that they show wide variations in their abundance. For example the important common copepod genus *Calanus* is represented by two species off Stonehaven. Firstly and most abundantly in the spring and summer is *C. finmarchicus*, an important species in that the large spring influx and production provides food for fish larvae in spring. However, its congener *C. helgolandicus*, a more southern species and generally most abundant in summer and autumn, has increasingly shown evidence of increased productivity and extended survival through the winter months. This is most likely a reflection of changes in the physical environment through the last few months of the year, with faster or slower cooling of the sea affecting the strongly temperature-dependent physiology of these small plankton. Interannual variability in over-winter survival is likely to affect the population dynamics for a number of species, and may "kick start" the production cycle when it begins in spring each year. Such dynamics may have for example, considerable implications for larval survival and recruitment to fish populations as well as consequences for assessments of the effects of local eutrophication pressures on the coastal marine ecosystems of eastern Scotland.

Data are regularly processes in the FRS MLA database and some of these data are displayed on the MLA web site (http://www.marlab.ac.uk/Montoring/Stonehaven/Stoneframe.html) and published in periodic reports (e.g. Heath *et al.*, 1999).

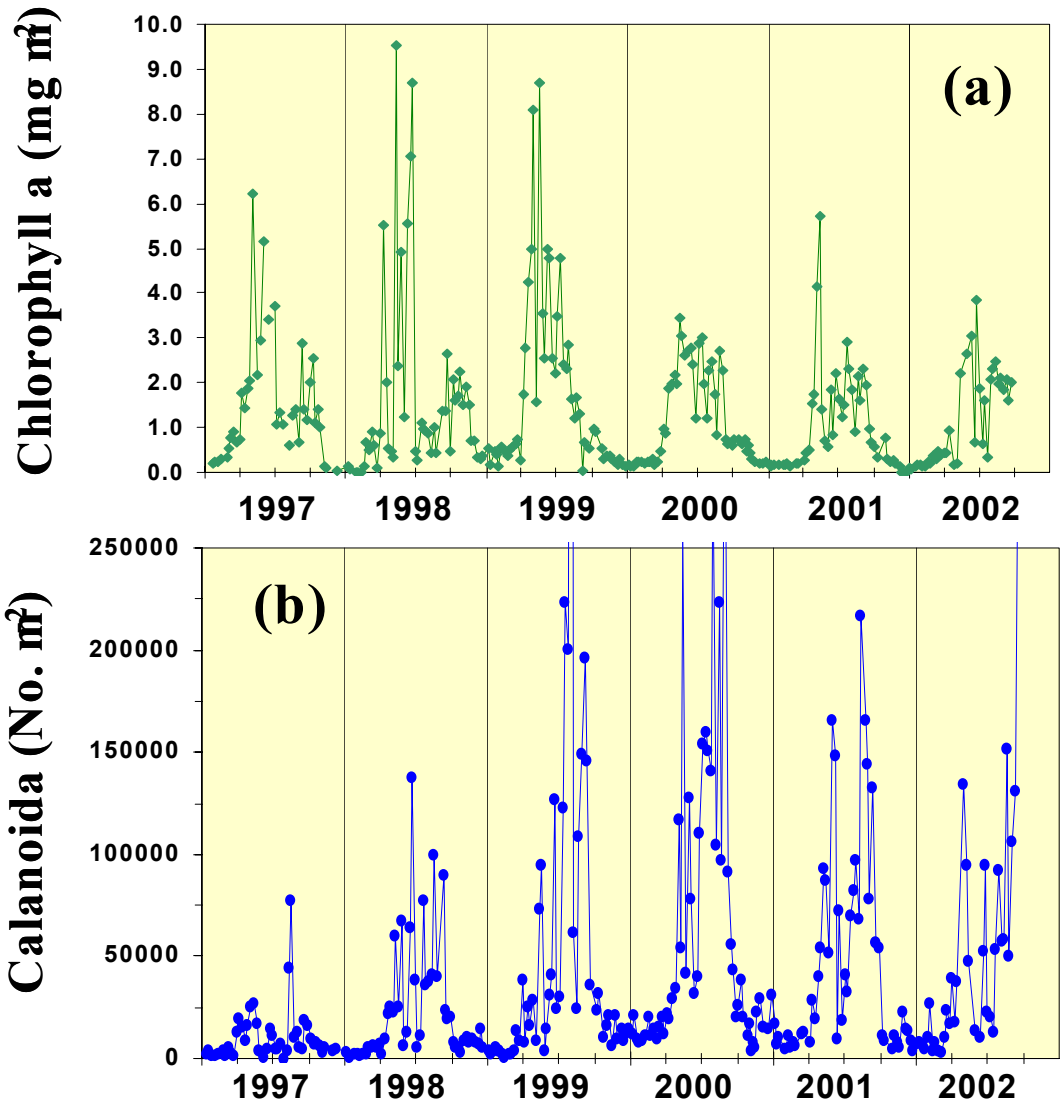

Figure 9. Weekly abundance of Chlorophyll a (a) and copepods (Calanoida) (b) during 1997–2002 at Stonehaven sampling site (North Sea).

Area 11: Helgoland (SE, North Sea)

Since 1975 every Monday, Wednesday and Friday two oblique plankton net samples (150 µm, 500 µm) have been collected at the station Helgoland Roads (54°´11´18”N, 7°54´E), Helgoland being the only offshore island of the North Sea. Almost 400 taxonomic entities of holoplankton and meroplankton (benthic-and fish-larvae) are counted.

Time-series were started within the Biologische Anstalt Helgoland and have been continued after the institutional re-organisation in a cooperation of the German Centre for marine Biodiversity, the Federal Maritime and Hydrographic Agency and the Biologische Anstalt Helgoland.

The purpose of the program is the documentation of plankton population dynamics for the recognition of regularities and variances in the abundance distribution. This will allow plankton prognoses in season, dimension and finally abundance, and for the detection of biodiversity changes possibly caused by external forcing. Examples of results using several analytical techniques, types of information extracted from the data and models on prognosis for zooplankton dynamics on several time-scales can be found in Greve (1994), Greve *et al*. (1998) and Heyen *et al*. (1998).

Acartia clausi represents a significant fraction of the total calanoid copepods. The annual cycle of *A. clausi* during 2002 can be observed in Figure 10 (a), and their abundances compared against the mean weekly abundance on the 20-year time series 1975–1994. 2002 showed an earlier start in the development of small calanoid copepod population (e.g. *A. clausi*) and a lower abundance than the average of the time series. The population of the warm water cladoceran *Penilia avirostris* was abundant again by the fourth consecutive year and must be regarded as a neozoan member of the community of the German Bight now. In the meroplankton, echinoderm larvae (Asteroidea, Ophiuroidea and Spatangoidea) had an earlier start of season and an increased autumnal abundance (Figure 10 (b)).

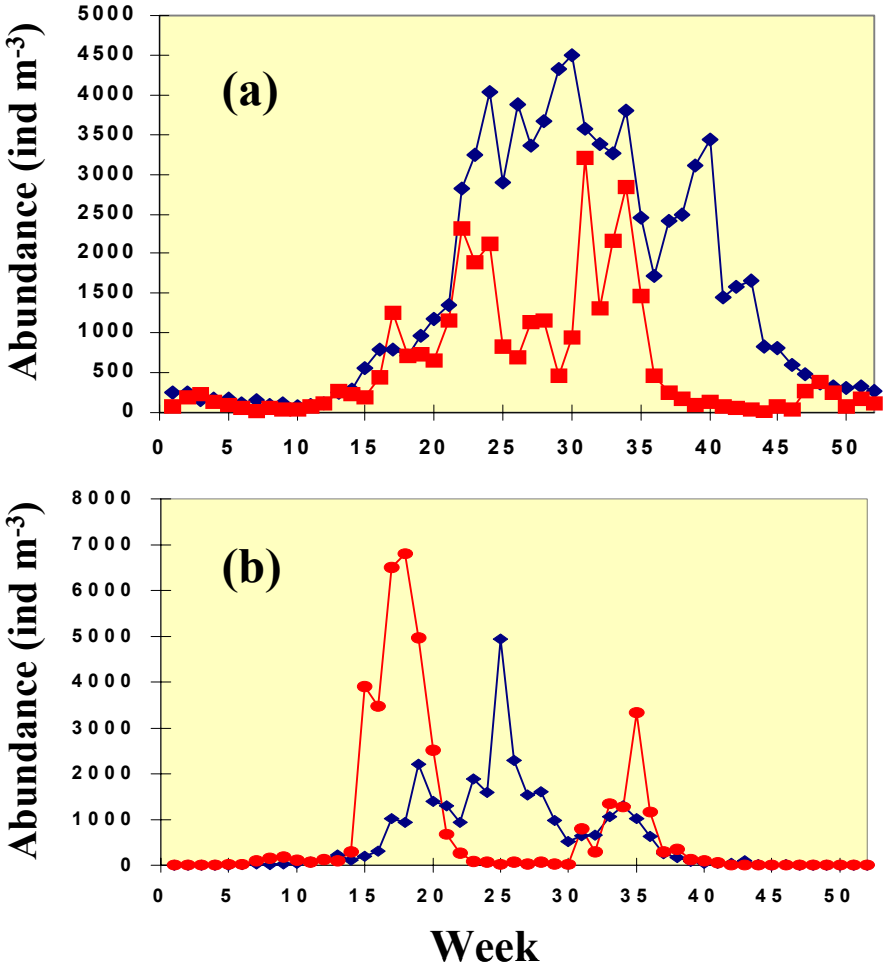

Figure 10: (a) *Acartia clausi* population dynamics during 2002 (red line) compared with the mean weekly abundances of the years 1975–1994 (blue line). (b): Echinodermata larvae abundance during 2002 (red line) compared with the mean weekly abundances of the years 1975–1994 (blue line).

Area 12: Plymouth (English Channel)

Zooplankton monitoring data are collected at a station (L4) situated about 15 miles SW of Plymouth in the English Channel. This station is about 50 m deep and influenced by seasonally stratified and transitional mixed-stratified waters (Pingree and Griffiths, 1978). Duplicate zooplankton samples are collected weekly with a 200 µm WP2 net towed vertically from 50 m to the surface. Animals are counted and identified to genera or species level under dissecting microscope. L4 zooplankton data are complemented with other environmental parameters such as temperature and phytoplankton. The L4 data are maintained at the Plymouth Marine Laboratory and is publicly available through a data CD and a web site, www.pml.ac.uk/L4. This is the end result of a project funded by the NERC thematic research programme Marine Productivity. L4 data has also been used for a number of seasonal studies into population dynamics,

reproduction and feeding (Green *et al.,* 1993, Pond *et al.*, 1996, Irigoien *et al.*, 2000 a, b) in order to have a better understanding of the mechanisms underlying the changes in the long-term trends.

The ten dominant taxa at L4 have been ranked according to their annual mean proportion of the total zooplankton N m^{-3} (Table I). Over the time series, *Pseudocalanus* has been the most abundant making up 12% of the total population. In 2002 its population has increased by 40% compared to the yearly average. The *Temora* population for this year has doubled that of its yearly average levels. The *Oncaea* population has had the highest decrease in 2002 of 64%, this is closely followed by *Evadne* with a 63% decrease. The only other species in the top ten with a decreased population is that of *Appendicularia* with a decrease of 34%. The ten top taxa take up a higher proportion of the total population in 2002 (82%) compared with the annual mean of 80%.

Rank	**Taxa**	**% total zooplankton 1988 – 2001**	**Yearly average N/m^3 1988 – 2001**	**% total zooplankton 2002**	**2002 average N/m^3**
1	Pseudocalanus	12.43	391	17.38	658
2	*Oithona*	11.70	368	15.59	590
3	*Oncaea*	10.43	328	3.06	116
4	*Paracalanus*	10.40	327	8.85	335
5	*Cirripede nauplii*	9.38	295	7.95	301
6	*Temora*	8.74	275	15.51	587
7	*Acartia*	6.29	198	7.87	298
8	*Evadne*	6.01	189	1.82	69
9	*Appendicularia*	2.51	79	1.40	53
10	*Corycaeus*	2.35	74	2.61	99
Total		**80.24**	**2524**	**82.04**	**3106**
		Total Zooplankton N/m^3	**3144**		**3785**

Zooplankton abundance (Figure 11) at L4 shows a decreasing trend from 1988 to 1995, which starts to pick from then until 1999. This recovery was mainly due to two autumn developing small species of copepod, *Euterpina* sp. and *Oncaea* sp. During the years of relatively low zooplankton abundance, the development of the spring species *Pseudocalanus* sp. and *Acartia* had been relatively low. The higher abundance of *Cirripede* nauplii from 1995 to 1998 and 2000 to 2001, contributes greatly to the total population when *Pseudocalanus* sp. and *Acartia* abundance in spring is sometimes low. *Paracalanus parvus* – a late autumn/winter species – has also added to the recovery of the zooplankton population since 1995. In 1999 there was a decline in the Zooplankton population, with the top ten species (Table 1) all below their typical average values (apart from *Temora* and *Corycaeus*, which showed little variation). However, 2000, 2001 and 2002 shows a recovery in Zooplankton population abundance comparable to that after 1995.

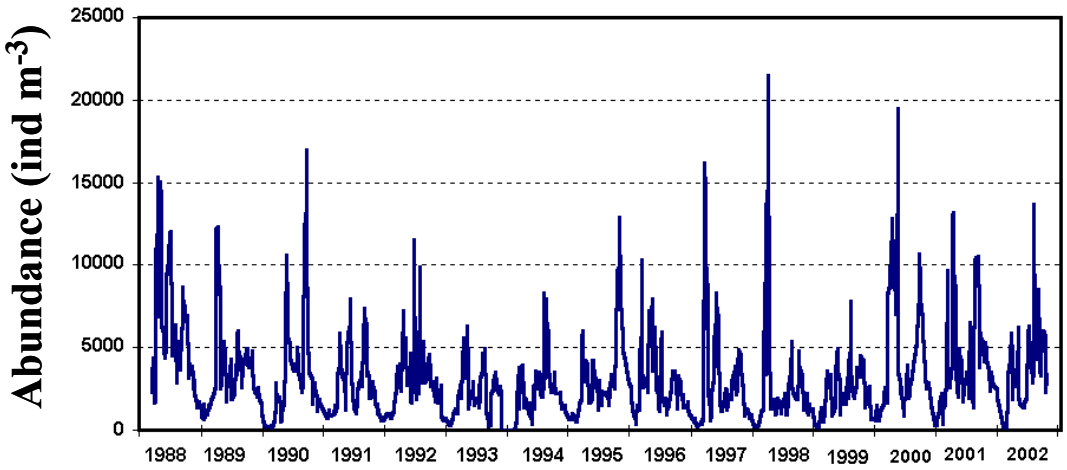

Figure 11. Weekly zooplankton abundance at station L4 (Plymouth, Celtic Shelf).

The year to year variability of *Calanus helgolandicus* and *Acartia clausi* are shown in Figure 12. Monthly abundances of both species are overimposed on the mean monthly values and 10 and 90% percentiles for the time series 1988–2002. Variability against the annual average can then be oberserved. High variability can be seen in some years, for example in 1990 for *Acartia clausi* and in 2002 for *Calanus helgolandicus* the abundance is more than double that of the 90th percentile. A period of low abundance can be observed for both species during the years 1994, 1995, and 1996, this mirrors the low abundance of the total zooplankton at this time.

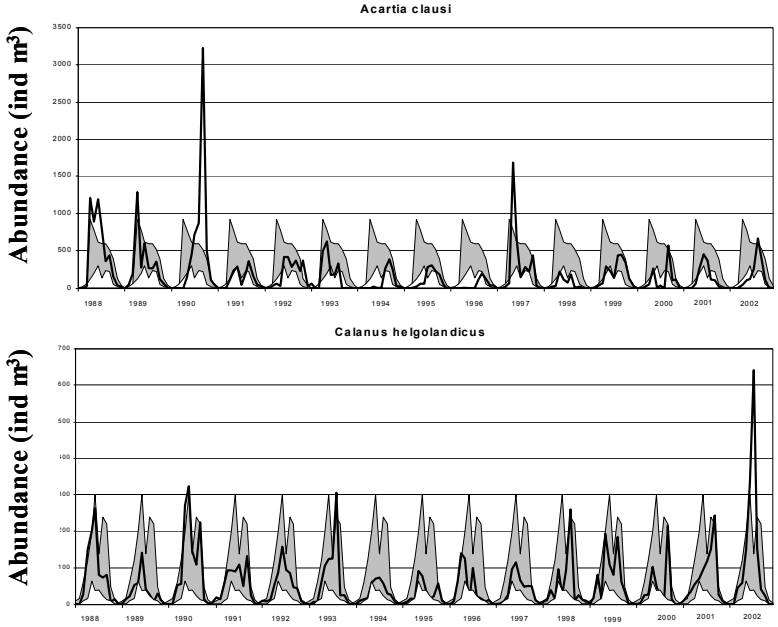

Figure 12. Year to year variability of *Acartia clausi* and *Calanus helgolandicus* at station L4 (Plymouth, Celtic Shelf). Monthly abundances of both species are over imposed on the mean monthly values and 10 and 90% percentiles for the time series 1988–2002.

Bay of Biscay and Iberian coast

Area 13: Santander (Southern Bay of Biscay)

Four transects are monitored in the ICES area off the Spanish coast. This involves an extensive physical, chemical and biological monthly sampling series at each site, with special attention to the sampling and analysis of hydrographical parameters, nutrients, chlorophyll *a*, and phytoplankton and zooplankton species. Data are regularly entered in the IEO databases, and hydrographic and nutrients data are also available in the ICES database. Depending on the transect, the time series extend from 1988 (A Coruña and Vigo), 1991 (Santander) and 1994 (Asturias) to the present.

Long-term changes of zooplankton abundance at Santander show a slight decreasing trend (Figure 13). The result is in opposition to the upward trend showed by the water column stratification index (Lavín *et al.*, 1998). This relationship between zooplankton and environmental conditions highlight the importance of the longer duration that the water column remains stratified could have in limiting the interchange of nutrients from deeper to surface waters and consequently limiting the growth of phytoplankton and zooplankton (Valdés and Moral, 1998). A similar relationship between an increasing trend in the water column stratification and a decline of zooplankton biomass was reported by Roemmich and McGowan (1995) at the Californian coast (CalCOFI series).

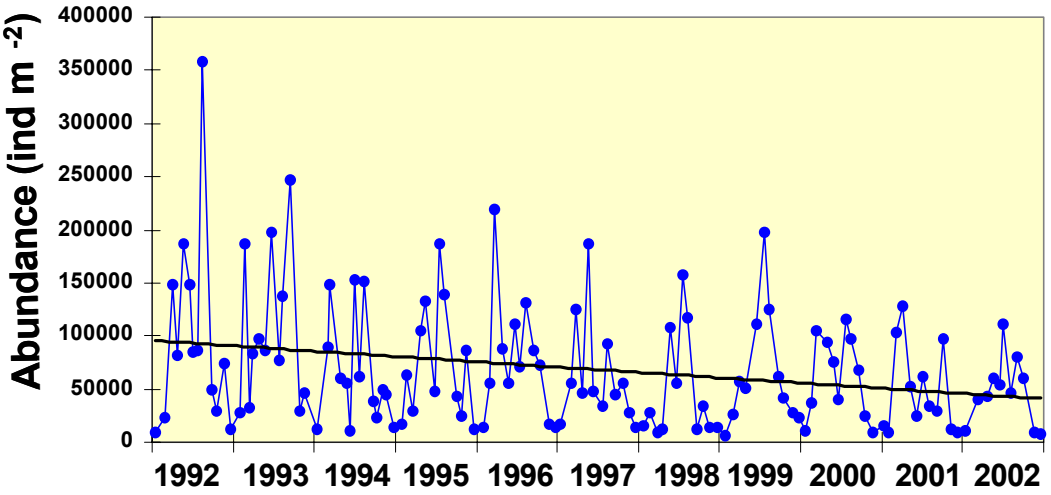

Figure 13. Monthly zooplankton abundance in a neritic station off Santander.

Area 14: A Coruña (NW Iberian Peninsula)

In the coastal and neritic regions off Galicia (NW Spain) the classical pattern of seasonal stratification of the water column in temperate regions is masked by upwelling events from May to September. These upwelling events provide zooplankton populations with favourable conditions for development in the summer months, the opposite of what occurs in other temperate seas in this season of the year. Nevertheless, upwelling is highly variable in intensity and frequency, and shows a substantial year-to-year variability.

Zooplankton values in A Coruña (Figure 14) differ to that in Santander (Figure 13): zooplankton abundance is higher in A Coruña and the time series does not show any trend. Both characteristics are partly due to the influence of the seasonal upwelling, which prevents the water column from properly stratifying, reinforces the input of nutrients to the photic layer, enhances the growth of phytoplankton populations and therefore enhances the growth of zooplankton populations. [Note that the time series shown in Figure 14 is composed of two curves, one for the zooplankton >250 µm, and the other for zooplankton >200 µm].

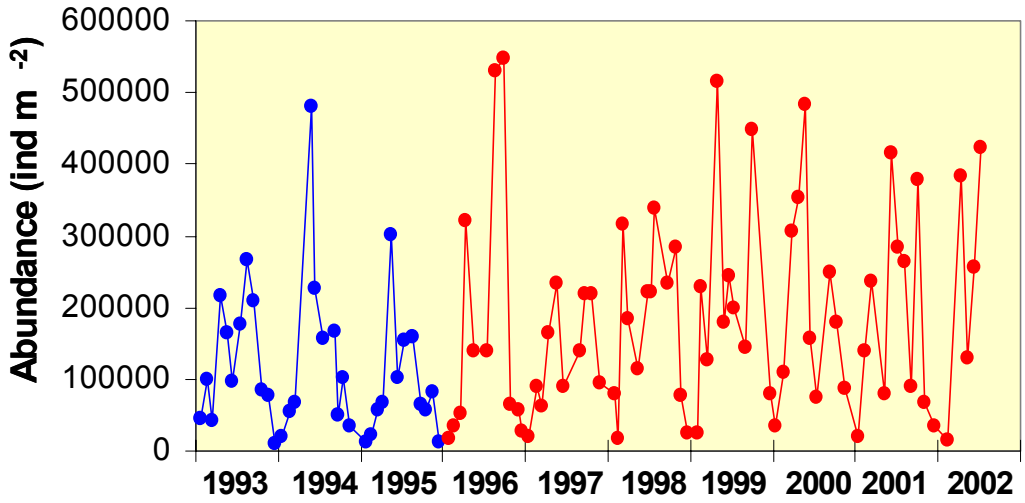

Figure 14. Monthly zooplankton abundance off A Coruña. (blue line= 250 µm mesh size; red line = 200 µm mesh size).

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5. Characteristics of the collections used (Table of Metadata)

Country	**USA (1)**	**CANADA (2)**	**ICELAND (3)**	**ICELAND (4)**
Monitoring programme	NFSC, Narragansett, RI	Scotian Shelf	MRI-Iceland	MRI-Iceland
Sampling location	Georges Bank	Emerald Basin	Siglunes-transect	Selvogsbanki-transect
Latitude (N)		43º 57' N	*	*
Longitude (E-W)		62º 57' W	*	*
Station Depth (m)		265	*	*
Period of data available	1971-ongoing	1984-ongoing	1961-ongoing	1971-ongoing
Frequency (number of cruises/yr)	4–6 per year	random	Yearly (1 May-June)	Yearly (1 May-June)
Gear/diam (cm)	Bongo net	ring/ 75	1971–91: Hensen; 92-pres:WP-2	1971–91: Hensen; 92-pres:WP-2
Mesh (µm)	333	250	200	200
Depth of sampling (m)		0–265	0–50	0–50
Ancillary data		hydrography, nutrients, fluorescence, PAR	hydrography, nutrients, chlorophyll	hydrography, nutrients, chlorophyll
Contact person	David G. Mountain	Doug Sameoto	Astthor Gislason	Astthor Gislason
Email address	dmountai@whsun1.wh.whoi.edu	sameotod@mar.dfo-mpo.gc.ca	astthor@hafro.is	astthor@hafro.is
Location of data		bio/chem database BIO	database MRI	database MRI
Observations (*)			Transect of 8 stns from 66°16'N, 18°50'W (bottom depth: 80m) - 68°00'N, 18°50'W (bottom depth: 1045m)	Transect of 5 stns from 63°41'N, 20°41'W (bottom depth: 46m) - 63°00'N, 21°28'W (bottom depth: 1004m)

Country	ICELAND-SCOTLAND (5)	FAROE (6)	NORWAY (7)	NORWAY (8)	GERMANY (9)
Monitoring programme	Continuous Plankton Recorder	FFl-Faroe Islands	IMR-Bergen	IMR-Bergen	IOW
Sampling location	Iceland - N Scotland Transect	Faroe Shelf	Svinøy transect Norway	Norwegian Sea	Arkona Basin, Baltic Sea
Latitude (N)	62º 30' N to 58º 50' N	62º20 N to 64º 30' N	*	*	54º 55'N
Longitude (E-W)	18º W to 4º 30' W	6º 05' W	*	*	13º 30'E
Station Depth (m)	*	50–100	*	*	48
Period of data available	1946-ongoing	1989-ongoing	1993 -onging	1994-ongoing	1973-ongoing
Frequency (number of cruises/yr)	approx 12, some missing mon/yrs	Yearly (late June)	6–10	July-August surveys	Seasonally (4)
Gear/diam (cm)	CPR, aperture 1.24 cm x 1.24 cm	1990–1991 Hensen 1992-present WP2	WP-2 (56)	WP-2 (56)	WP-2
Mesh (µm)	280	200	200	200	100
Depth of sampling (m)	7–10	0–50	0–150	0–150	
Ancillary data		hydrography, nutrients, chlorophyll	hydrography, nutrients, chlorophyll	hydrography, nutrients, chlorophyll	
Contact person	Chris Reid	Eilif Gaard	Bj. Ellertsen	Bj. Ellertsen	Lutz Postel
Email address	pcre@wpo.nerc.ac.uk	eilifg@frs.fo	bjornar.ellertsen@imr.no	bjornar.ellertsen@imr.no	lutz.postel@io-warnemuende.de
Location of data	SAHFOS database	FFL	Helix database, IMR	Helix database, IMR	German Ocean Data Centre, IOW
Observations (*)			Transect of 15 stns from 62°22'N, 5°12'E (bottom depth: 160m) - 64°40'N, 0°00'W (bottom depth: 2695m)	Large areas of the Norwegian Sea are surveyed every year. Bottom depth varies between stations	

Country	UK (10)	GERMANY (11)	UK (12)	SPAIN (13)	SPAIN (14)
Monitoring programme	FRS-MLA	BSH and DZMB	L4-PML/UK	IEO-SPAIN	IEO-SPAIN
Sampling location	Stonehaven, Aberdeen	Helgoland	Plymouth	Santander	La Coruña
Latitude (N)	56° 57.80' N	54º 11.18N	50° 15' N	43° 34.4' N	43° 25.3' N
Longitude (E-W)	02° 06.80' W	7º 54E	4° 13' W	3° 47.0' W	8° 26.2' W
Station Depth (m)	50		50	110	77
Period of data available	1997 - ongoing	1975-ongoing	1988–1997*	1991-ongoing	1990-ongoing
Frequency (number of cruises/yr)	Weekly (52)	Monday, Wednesday and Friday	Weekly (~40)	Monthly (12)	Monthly (12)
Gear/diam (cm)	Bongo/40	Hydrobios and Calcofi	WP2	Juday 50	Juday 50
Mesh (µm)	200	150 and 500	200	250	1971–96: 250; 96-pres: 200
Depth of sampling (m)	47		50	50	50
Ancillary data	hydrography, nutrients, chlorophyll	hydrography, nutrients, chlorophyll, pigments (recently)	hydrography, CNH, chlorophyll, *Calanus* egg Prod.	hydrography, nutrients, chlorophyll, phyto. cells.	hydrography, nutrients, chlorophyll, phyto. cells.
Contact person	Steve Hay	Wulf Greve	Roger Harris/X. Irigoien	Luis Valdés	Maite Alvarez-Ossorio
Email address	haysj@marlab.ac.uk	wgreve@meeresforschung.de	rph@ccms.ac.uk	luis.valdes@gi.ieo.es	maite.alvarez@co.ieo.es
Location of data	SERAD, FRS MLA		PML/CCMS	Database SIRENO IEO	Database SIRENO IEO
Observations (*)			Later samples in process		