ICES WGZE REPORT 2008

ICES OCEANOGRAPHY COMMITTEE

ICES CM 2008/OCC:05

Ref. WGECO

Report of the Working Group on Zooplankton Ecology (WGZE)

31 March – 3 April 2008

Sète, France

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2008. Report of the Working Group on Zooplankton Ecology (WGZE), 31 March – 3 April 2008, Sète, France. ICES CM 2008/OCC:05. 79 pp.

Contents

Executive summary

The ICES Working Group on Zooplankton Ecology (WGZE) met at Le Grand Hôtel, Sète, France, from 31 March – 3 April 2008. The meeting was attended by 29 scientist representing 12 countries (Annex 1).

The ICES WGZE supports the PGEGGS survey plan for fish eggs and larvae and considers that the samples should also be used, conserved and made available to provide wide scale information on other components of the North Sea plankton. WGZE assumes the survey will deploy a flow metered 200 micron net with a double oblique tow profile. If so, then this is a good standard general mesozooplankton sampling method. Our advice on any requirement for additional plankton sampling is strongly dependent on what gear and time may be available to take other zooplankton samples, although in itself the survey is for plankton, albeit only one component.

In discussing methodology (ToRs e), (f), it was concluded that mesh size of sampling nets had a much greater influence on zooplankton biomass and composition than different sampling gears.

WGZE recognizes the strong need and value in efforts that preserve and consolidate taxonomic skills within the ICES community and globally. The WGZE supports the ICES Fiches Identification Sheets for Plankton and considers that the further development of such taxonomic identification resources and training are vitally important. The WGZE recommends that ICES provides active support for future developments of plankton taxonomy, through its publications committee and web presence. Also this effort should seek to be open source and freely available while establishing links to other web based sites and expertise as well as collaborations.

The Working Group on Zooplankton Ecology (WGZE) considers 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 (ToRs b), c), i). The purpose of producing such report is to give a global (ICES scale) and visual overview of zooplankton distributions for the preceding years (in the form of time series) with a brief interpretation of the ecological significance of these results. Important additions and improvements to the Plankton Report are planned. A species list in electronic format with a search engine has been produced covering 21 monitoring sites in addition to the CPR data for the North Atlantic. The search engine enables a search to be made for common species or groups within the North Atlantic. The Plankton Status Report will be published biannually; next one will be out in autumn 2008.

The WGZE is generally content with the New ICES Science Programme, although it felt that more attention should be given to advances in understanding climate forcing of recruitment variability through integration of field observations and laboratory experiments in coupled physical biological models. The group recommends that the prospect for operational application of these models be explicitly included in the science plan priority #2 (Table 1 in Draft ICES Science Plan (2009–2014)). A letter was sent to Drs Mike Sinclair (ICES first Vice-President) and Harald Loeng (Chair of Conc) with this recommendation.

Considering the OSPAR Climate Request (ToR a), the group reviewed the reviews made by WGECO and ACE and the Reports of two ad-hoc groups that were formed to address the request. In addition to the recommendations the group made in 2007

(ICES CM 2007/OCC:04, Annex 3), WGZE makes the following general recommendations to OSPAR (Annex 5):

- Long-term funding should be secured to maintain the few time series that exist at single sites and along transects, and to expand the CPR Survey with the aim of increasing the geographical coverage of zooplankton monitoring in the OSPAR area.
- The WGZE recommends that zooplankton species and biomass be included in the JAMP guidelines since there are compelling reasons for this information to be available to assess climate changes effects on the marine community and fishery resources.
- The WGZE considers that OSPAR should recognise the need of improving the monitoring of jellyfish in order to fill the gap of information on this ecologically group.
- While the WGZE recognise the ecosystem and foodweb significance of phytoplankton, mesozooplankton, fish, sea mammals and birds, the predatory invertebrate fauna must not be ignored. In taking an ecosystem approach to surveillance, monitoring and management in the OSPAR areas, one should take into account that invertebrate predators are critical to the health and productivity of marine ecosystems, and appear to be sensitive indicators of change.

In reviewing the OSPAR request for a 'Scoping report on summaries of the status of biodiversity', the group felt that for zooplankton the results of the status report with the top ten species list should cover the request in general. Further the group agreed on a list of monitoring activities and products that should be taken into account when considering the status of biodiversity.

The WGZE and the WGPBI next met in a joint meeting to discuss issues of mutual interest (ToR d). The aim of the meeting was to bring modellers and field scientists together to explore how data and models could be combined to elucidate mechanisms explaining observed variations in zooplankton and ecosystem dynamics. The meeting was divided into three sessions: Session 1 with presentations by WGPBI members intended to demonstrate the range of modelling techniques available to the community and a new observational technique; Session 2 where WGZE members presented available data sets and examples of statistical modelling approaches; and Session 3 with joint discussions on possible future interactions between the two groups. The discussions were lively with both groups recognising the ambitious agenda and the difficulties to reach clear conclusions. Abstracts for presentations are given in Annex 7. The group aims to address the outcomes of the joint meeting during its next annual meeting in 2009.

Final preparations were made for the 'Joint ICES/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic (WKZEM)' (Co-Chairs: Astthor Gislason, Iceland, and Gabriel Gorsky, France) (ToR g). The workshop will be held at the Hellenic Centre for Marine Research, Heraklion, Crete, Greece, from 27–30 October 2008. It will consist of three days with presentations and discussions, half day with discussions on perspectives and future plans, and a half day field trip). A website has been created with information about the Workshop (www.wkzem.net).

WGZE reviewed the progress of several other national and international projects such as progress in the formation of a new Phytoplankton Working Group (ToR h),

RAPID, Basin, and ongoing research activities at the Marine Biological Research Station in Sète, University of Montpellier.

A summary of the Terms of Reference for the meeting is given in Section 2 of the Report. All ToRs were met.

Astthor Gislason will complete his three-year term of Office as Chair of WGZE on 31. December 2008. The group held a vote to propose a replacement for him. Professor Mark C. Benfield was proposed and unanimously voted for as new Chair of the group.

The ICES WGZE proposes to meet next time from 30 March to 2 April 2009 at the Fareoes Fisheries Laboratory, Tòrshavn, Faroe Islands, kindly hosted by Dr. Eilif Gaard.

1 Opening of the meeting

The ICES Working Group on Zooplankton Ecology (WGZE) met at Le Grand Hôtel, Sète, France, from 31 March – 3 April 2008 at the kind invitation of Delphine Bonnet from the Université Montpellier. The meeting was attended by 29 scientists representing 12 countries (Annex 1).

Astthor Gislason (Chair) opened the meeting at 11:00 and welcomed the attending scientists. This was followed by a round of introductions and a welcome and comments on the housekeeping arrangements from Delphine Bonnet, the host.

2 Adoption of the agenda

The agenda for the WGZE meeting (Annex 2) followed the Terms of Reference adopted as a resolution by the ICES 2007 Annual Science Conference and Statutory Meeting. The agenda was reviewed and last minute adjustments were discussed. Thereafter, the agenda was adopted. The Terms of Reference for this meeting are to:

a) Consider the reports of the Ad Hoc Groups on;

- i) Hydrographic Attributes
- ii) Trend Analyses & Quantifying Relationships
- iii) Formulating Hypotheses and Predictions about Mechanisms
- iv) Selecting Species for More Intensive Investigations

and use their recommendations concerning (1) recommended time series, (2) analytical methods and suitable software, (3) hypotheses and guidance for their use, and (4) a suggested list of species for intensive study, to complete the assessment of changes in the distribution and abundance of marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature;

b) update the ICES plankton status report and consider ways of incorporating biophysical modeling approaches in interpretation;

c) prepare species lists from time series stations and/or areas in the ICES area;

d) report on approaches for combining field and laboratory data together with biological-physical models to examine processes controlling zooplankton populations;

e) compare and report on different nets and mesh sizes and their efficiency;

f) compare and report on different measures for zooplankton biomass from regions within the ICES area;

g) finalize preparations for the WGZE/CIESM Workshop;

h) review the planning of a new working group related to phytoplankton and microbial ecology;

i) produce an evidence based rationale for incorporating zooplankton monitoring into regulatory assessment frameworks;

j) assess and report on the outcomes of the 4th ICES/PICES/GLOBEC International Zooplankton Production Symposium;

k) provide expert knowledge and guidance to the ICES Data Centre (possibly via sub-group) on a continuous basis.

WGZE will report by 1 May 2008 for the attention of the Oceanography Committee, (with ToR a) reported to WGECO as soon as possible after the meeting.

After introducing the background of the ToRs and the Agenda, the Chair went through the list of Actions that arose during the last meeting of the group (ICES CM 2007/OCC:04). Most of these were carried out intersessionaly, while a few that relate to the Plankton Status Report are still in progress.

The Chair then told about the fate of a Theme Session proposal that the group made at its last meeting. The proposal – 'Evidence of global warming effects on zooplankton populations and communities, including larvae of benthic invertebrates and fish.' Conveners: Wulf Greve, Steve Hay and Peter Wiebe – was approved by the appropriate instances of ICES in the autumn of 2007 (Oceanography Committee and ICES Council) and is therefore on for the next ICES Annual Science Conference in Halifax, Canada. Astthor encouraged everyone to consider this theme session as a venue for presenting data and ideas.

3 Data management issues

Lead: Peter Wiebe, Rapporteur: Sophie Pitois

ToR k) Provide expert knowledge and guidance to ICES Data Centre (possibly via sub-group) on a continuous basis

The discussion opened with remarks from the Chair explaining that the ToR was given to the group by the ICES Data Centre. For our last meeting they gave us exactly the same ToR. The WGZE responded by forming a subgroup with Peter Wiebe, Todd O'Brien, and Steve Hay as members. The idea was that they should work intersessionally and thus be able to respond quickly to demands from the ICES data centre and others. Astthor said that last year the group had not received any request from the ICES data manager.

The proceedings then went on with a presentation of background information from Peter Wiebe, who informed about the new Head of the Data Centre, Neil Holdsworth, and activities within the Data Centre and the Working Group on Data and Information Management (WGDIM).

In October 2005 the ICES council adopted a new Data Policy having considered the following points:

a) ICES is committed to openness for the scientific process and to free access to scientific data;

b) ICES recognises that proper data interpretation requires insight into the sampling design, compilation, and analysis;

c) To ensure proper interpretation of the data, data sources may define access procedures either as a general policy or in relation to specific datasets;

d) By making the data publicly available, data contributors and users continue to make ICES the focal point for data in the NE Atlantic area and serve the scientific community.

ICES Data Policy of 2006 applies to data submitted from May 1, 2006. For data submitted prior to May 1st, 2006, data sources will be contacted individually and may specify access restrictions in agreement with ICES. The former Data Policy of

1994 can be found on the ICES web site. ICES Data Policy 2006 conforms to the IOC Oceanographic Data Exchange Policy.

The structure envisioned by the Data Centre is best described with the graph in Figure 1. The ICES website has also been redesigned to allow better access to the data.

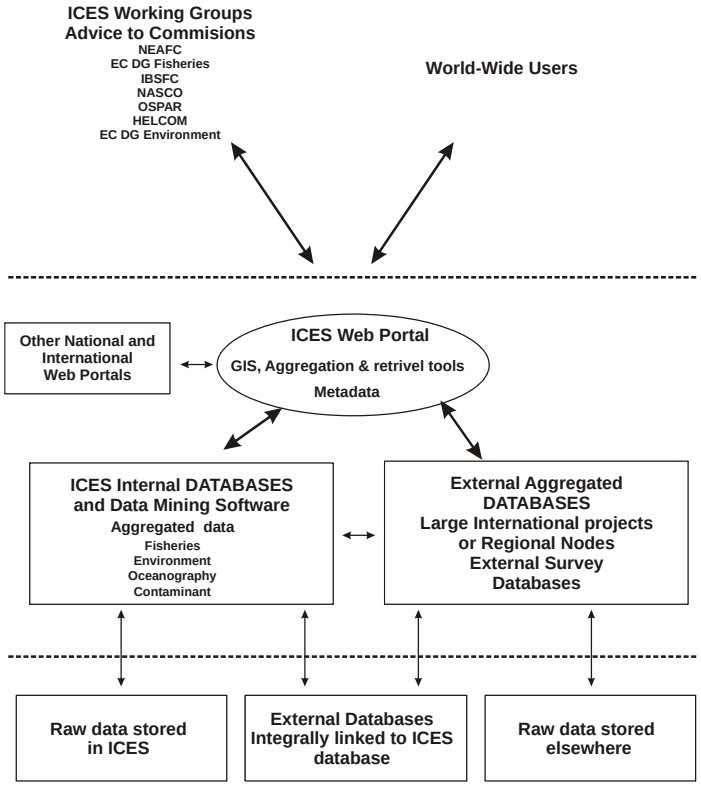

Figure 1. ICES Data Centre envisioned structure.

Data available include biological community and contaminants data in the Environment section; fish distribution from trawl surveys in the North Sea, Baltic Sea and Southern and Western part of the Atlantic Ocean, in the DATRAS database (this section also contains information on the surveys and how to submit data to the database); yearly catch records for over 200 species in the Northeast Atlantic Ocean (1973–1990) can be downloaded from the fish stats section. ICES uses the Interagency Taxonomic Information System maintained by the National Oceanographic Data Centre (NODC), National Oceanic and Atmospheric Administration (NOAA) for exchange of species information. Species codes or names can be found from ITIS or ICES web sites.

The following databases are available:

ICES Oceanographic Database and Services

The ICES Oceanographic Database and Services maintains various data banks including: ROSCOP (Cruise Summary), National water bottle equivalent hydro-chemistry-biology (329 parameters currently), National CTD data sets, Surface (underway) data, Project data sets (e.g., WOCE, NANSEN, PEX, OVERFLOW, ESOP, VEINS, JONSDAP) incorporating wide range of oceanographic data types, including ice, tracers, current meters, ADCPs etc. This databank is supplemented by an

inventory of cruise information, based on Cruise Summary Reports (CSR/ROSCOP), which summarize cruise activities in Member Countries related to physical oceanographic, marine biological, pollution, fisheries, and geophysical research.

ICES Data Centre Environment Data

The Data Centre currently accepts data on contaminants and biological effects (including fish disease) in biota (CF), seawater (CW), and sediment (CS), and biological community data (ZP, ZB, PP, PP).

DATRAS: DAtabase TRawl Survey

This database contains data from surveys covering the Baltic Sea, Skagerrak, Kattegat, North Sea, Channel, Celtic Sea, Irish Sea, Bay of Biscay and the eastern Atlantic from the Shetlands to Gibraltar over a period of up to 35 years. The database has been partially funded by the European Community Fifth Framework Programme (DATRAS QLRT-2001-00025).

InterCatch

InterCatch is a web-based system, to which fish stock coordinators and national data submitters from the North East Atlantic can have access. In InterCatch national institutes can upload national fish catches per area per time period per fleet etc. The data can be checked at any level. Fish stock coordinators can allocate sampled catch data to unsampled catches and aggregate all catch data. The aggregated output files can then be downloaded to the stock coordinators workstation. The files will be used as input for the stock assessment models.

ICES-FishMap

This is an online atlas of North Sea fish. The atlas covers 15 species and is divided into two sections: Basic and Advanced.

Diseases

The purpose of mapping the spatial distributions and temporal trends of fish and shellfish diseases is to give people, e.g., scientists, managers, laypersons and politicians, having interest in or needing information on this field the possibility of obtaining a rapid overview.

STATLANT

Catch Statistics – STATLANT Database Queries to be addressed to ICES Data Centre (info@ices.dk). Yearly nominal catches of fish and shellfish officially submitted by 20 ICES member countries in the Northeast Atlantic including over 200 species. ICES has published these data in Bulletin Statistique des Pêches Maritimes from 1903 to 1987 and for 1988 in ICES Fisheries Statistics. Commencing in 2000 the data are published on a CD-ROM containing data for the period 1973–2003. The Coordinating Working Party on Fishery Statistics (CWP) coordinates collection of these statistics under the STATLANT programme.

Zooplankton and issues related to WGZE

A discussion then took place related to how WGZE could contribute to data management issues. It was noted that the ICES strategic plan recognises 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) considers 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.

The purpose of producing such report is to give a global (ICES scale) and visual overview of zooplankton distributions for the preceding years (in the form of time series) with a brief interpretation of the ecological significance of these results. Reported results are supported by significant observations and trends based on time series sampling programmes from ongoing monitoring sites in the ICES region. Most of the graphs and data from different regions are presented here in the same format and data units were expressed as dry weight or in numbers per m2 ; so comparisons between regions can easily be made. Temperature can have a large influence on the community structure and production of zooplankton and can cause large seasonal, yearly and decadal changes in zooplankton population size. It was for this reason that data sets are presented here by affinities in temperature and biogeographical areas.

The following Zooplankton Status Reports (Acrobat PDF format) are available: 1999–2000; 2000–2001; 2001–2002. More recent reports are available as Cooperative Research Reports (i.e. CCR 276 – 2003/2004; CCR 281 – 2004/2005). Also available for download is an Electronic Document Collection of ICES Identification Leaflets for Plankton.

Previously, two ICES Expert Groups, Working Group on Data Management (WGMDM) and Study Group on Management of Integrated Data (SGMID), dealt with data management issues. These groups were disbanded in 2006, being replaced by the Working Group on Data and Information Management (WGDIM), chaired by Richard Ayers (UK) and Helge Sagen (Norway). ToR g) taxonomy was on the list of ToRs for WGDIM for this year, and the subject was discussed, but without a specific outcome. The WGDIM recognizes its importance and will return to it in future years.

One of the theme sessions for the ICES ASC in Halifax in 2008 was proposed by WGDIM: Theme session: R. Environmental and fisheries data management access and integration. Conveners: Christopher Zimmermann (Germany), Helge Sagen (Norway), and Peter H. Wiebe (USA)

This theme session provides an update on new approaches and endeavours by inviting database specialists, distributed data specials, visualisation specialists, end-users and others to present and/or demonstrate:

- Technical solutions for data integration;
- Novel ways to merge/integrate/distribute disparate data;
- Experience with use and visualisation of integrated data;
- Data quality assurance and indicators;
- Improved methods for displaying complex data sets
- Examples of successful applications
- Experience with historic data rescue

Peter Wiebe suggested that this would be a good opportunity to present a summary of the WGZE status report from the perspective of the data management and

integration issues encountered in creating it (it was suggested that Todd O'Brien might be the best person to present this).

Priscilla Licandro also raised the issue of the ease of accessing data and people downloading data who don't know what the data well enough, which could result in misuse of the data. Peter Wiebe said the emphasis here was for people to be able to access the data they wish to use in an easy way.

4 Advice to PGEGGS

Lead: Steve Hay, Rapporteur: Damien Eloire

Provide advice to PGEGGS on the value of collecting additional zooplankton samples during future North Sea ichthyoplankton surveys in 2009

The discussion opened with the Chair drawing the attention of the group to the last report of the ICES PGEGGS Report (ICES CM2007/LRC:13) requesting advice on the value of collecting additional zooplankton samples during future North Sea ichthyoplankton surveys in 2009.

The PEGGS group is planning an ichthyoplankton survey of the North Sea in 2009. It was determined that this planning is to be further considered at a PEGGS meeting in May 2008. The WGZE has been asked to advise PGEGGS on the value of additional plankton sampling. Given that the actual planned sampling has not yet been fully described, the WGZE assumes this will follow the previous protocols used in 2004. Without a better picture of the PGEGGS group's survey plans, the WGZE can only make general recommendations. To make more informed recommendations the WGZE needs to know survey times, where, how many stations, sampling gears and frequency etc.

WGZE Recommendation

The ICES WGZE supports the PGEGGS survey plan for fish eggs and larvae and considers that the samples should also be used, conserved and made available to provide wide scale information on other components of the North Sea plankton. WGZE assumes the survey will deploy a flow metered 200 micron net with a double oblique tow profile. If so, then this is a good standard general mesozooplankton sampling method. Our advice on any requirement for additional plankton sampling is strongly dependent on what gear and time may be available to take other zooplankton samples, although in itself the survey is for plankton, albeit only one component.

Besides the general support, there were several suggestions for additional sampling and methods. These included; ensuring coincident collection of chlorophyll samples, CTD deployments and surface thermosalinograph tracks, the use of a 'Zooscan' scanning and image analysis approach to collect and analyse the samples/subsamples, and to gather images for archival and later use. The use of the whole sample, or very preferably a subsample, to measure biomass should be considered. The easiest method suggested for biomass being to measure displaced (NOT settled) volume of the samples, or to use a proportionate-split subsample to process for dry weight determination. It was also suggested that smaller pup samplers mounted on the routine sampler frame (?Gulf 5 sampler), could be used to obtain additional samples, perhaps with a fine mesh such 65 or 100micron mesh. Such fine mesh samples would provide insight into the availability of nauplii and

other microzooplankton food for fish larvae. Another approach might be to conduct copepod egg production incubations on board and/or derive copepod female and egg counts from plankton samples.

There is no recent wide scale survey of the North Sea for zooplankton other than the near surface samples from SAHFOS CPR survey lines. Changes in plankton communities have proved the strongest evidence for marine ecosystem change and regime shifts in the ICES area and other seas. It is considered that the PGEGGS surveys would provide valuable full depth information which would support the CPR effort and the regularly sampled North Sea coastal time series monitoring sites, such as those at Helgoland and Stonehaven. The WGZE noted the fact that there are and have been many surveys for fish eggs and larvae collected as plankton samples. For example the 30 years of multinational, triennial ICES Mackerel Egg Surveys. Most have only been used for fish eggs/larvae but in many cases they remain as archived samples in European institutes. With increasing emphasis on ecosystem change related to climate and anthropogenic pressures such samples are an increasingly important and irreplaceable resource. While fish egg/larval surveys are funded regularly through the stock assessment process, it is rare that such extensive cruises are commissioned to investigate the pelagic marine ecosystem more generally. This is not an effective use of the time and expense invested in obtaining the samples, which are a resource with very considerable information potential. As well as consideration of analysis of such retrospective samples, all current and future egg/larval surveys, either in whole or in part., should be analysed for plankton species communities, or archived and made available for this.

5 Zooplankton methodology

Lead: Sophie Pitois, Rapporteur: Eilif Gaard

ToR e) Compare and report on different nets and mesh sizes and their efficiency

Peter Wiebe reported on an ICES/GLOBEC seagoing workshop in Storfjorden, western Norway carried out in June 1993. An inter-comparison between several sampling gear and mesh sizes was carried out with the German R/V 'A. v. Humboldt' and the Norwegian R/V 'Johan Hjort '. The results corroborate the results of earlier studies and emphasize the necessity to pay particular attention to the mesh size and also speed of tow as it relates to extrusion of smaller zooplankton through the net mesh and avoidance of the mouth of the samplers by the larger ones. On the other hand, various net types of similar size and mesh size produced similar estimates.

In conclusion, mesh size of the net had a major influence on the zooplankton biomass and composition for this community. However, different vertical, oblique and multiple opening and closing net systems (WP-2, Bongo, MOCNESS, Multinet, LHPR) produced similar estimates when operated with comparable mesh-sized nets (180–200 μm).

ToR f) Compare and report on different measures for zooplankton biomass from regions within the ICES area

A discussion followed to address ToR f). Zooplankton biomass can be estimated based on dry weight, wet weight, length-weight regressions and volume displacement.

Priscilla Licandro presented results on biomass measurements, based on dry weight and length-weight regressions. Direct measurements of total dry weight biomass are preferable. Length-weight regression equations are often used but these have been measured only for a limited number of zooplankton species, and are often significantly different from total dry weight. Attention was also drawn to changes in lengths of zooplankton individuals when preserved in formaldehyde.

Wet weight measurements or wet weight-length regression equations may significantly bias zooplankton biomass, particularly at big spatio-temporal scales. Biomass dry weight significantly varies between groups of similar shape and size, and biomass DW of co-generic species may also be significantly different. Hence, size is not a good descriptor of zooplankton biomass, without information on species diversity and zooplankton community composition.

Displacement volume is sometimes used as a direct measure of zooplankton biomass. However if gelatinous zooplankton or phytoplankton is abundant this may lead to overestimation of the zooplankton biomass.

Luis Vales showed some results from a study on comparison between displacement volume and dry weight on Spanish coastal and oceanic samples. These study showed the following correlations of $R^2 = 0.61$ for oceanic samples, and $R^2 = 0.72$ for coastal samples. Further comparison between wet weight and dry weight showed the correlations $R^2 = 0.76$ for ocean samples, and $R^2 = 0.92$ for coastal samples

WGZE discussed the different methods on biomass estimates. In conclusion, comparison between methods (displacement volume, wet weight, dry weight) may give relatively reliable biomass information when it is done in the same area by the same institute. However, comparison between different areas may show significant differences.

The ICES Plankton Identification Sheets

The WGZE noted that the editorship of ICES Plankton Fiches Identification Sheet series has passed from Alistair Lindley to Steve Hay from 2008. The WG wishes to thank Alistair for his hard work and to express its support for Steve in his new task.

Steve Hay, the new editor for the ICES Plankton Identification Sheets, gave an overview of his vision for the Sheets in the future. There is at present a sharp decline in taxonomic expertise throughout the ICES area. Even if imaging analysis techniques are becoming more widely used, fundamental taxonomic knowledge is still needed.

Steve Hay suggested that one solution to this problem could be to do develop some kind of consensus between experts, by moving into web-based approach. He suggested that a group of expertise, which is working through a web-based system, could be a step forward.

Recommendation

WGZE recognizes the strong need and value in efforts that preserve and consolidate taxonomic skills within the ICES community and globally. The WGZE supports the ICES Fiches Identification Sheets for Plankton and considers that the further development of such taxonomic identification resources and training are vitally important. The WGZE recognises that it will be essential to establish this in a modern web-based format, which provides for far greater options and flexibility in obtaining and maintaining expert content, editorial management, information dissemination and interaction for users. There are many existing efforts throughout the global

internet to promote plankton taxonomy and to provide web based resources for plankton and taxonomy generally. Some examples are included in Annex 3.

The WGZE recommends to ICES that ICES provides active support for future developments of plankton taxonomy (phytoplankton as well as zooplankton), through its publications committee and web presence. Also this effort should seek to be open source and freely available while establishing links to other web based sites and expertise as well as collaborations.

Zooplankton Identification Manual for North European Seas (ZIMNES)

As an example of web based approach Jens Rasmussen and Steve Hay presented to the WGZE a new, developing, open source site, ZIMNES (Zooplankton Identification Manual for North European Seas), which aims to provide web based taxonomy tools for the northeast Atlantic area. The web-site is under development by expertise from several UK institutes and is hosted at SAHFOS in Plymouth UK (WWW.sahfos.ac.uk/taxonmanual/index.php).

ZIMNES includes e.g. 1) Image collection; 2) Taxonomic tree; 3) Species description; 4) Glossary; 5) New system; 6) Help pages; 7) Web links.

In near future there will be added a discussion forum also more on background information and literature.

WGZE recommends that there under ICES is set up a similar or other web-based identification guide. Steve Hay, editor of the ICES plankton identification sheets is willing to suggest future developments on such a system.

6 ICES Plankton Status Report

Lead: Todd O'Brien, Rapporteur: Ann Bucklin

ToR b) Update the ICES plankton status report and consider ways of incorporating biophysical modelling approaches in interpretation

ToR c) Prepare species lists from time series stations and/or areas in the ICES area

ToR i) Produce an evidence based rationale for incorporating zooplankton monitoring into regulatory assessment frameworks

Astthor Gislason gave the background saying a few words on the history of this Report: For 2001–2004, these reports were published as Annexes to the Annual Report of the WGZE. In 2005 and 2006, WGZE published these reports in the ICES Cooperative Research Reports series. In 2007, this was the aim, but there were problems due to gathering all the data in a timely manner. So no report was published for 2007. At the 2007 ASC in Helsinki, WGZE asked ICES (Oceanography Committee, Publication Committee) to publish this report every other year in the ICES Cooperative Research Reports series, to give sufficient time for data gathering and analysis. ICES approved this request. The editors will be Todd O'Brien, Angel Lopez-Urrutia, Peter Wiebe, and Steve Hay.

Luis Valdes said that the final report must be submitted to ICES by the end of June. Todd O'Brien said that the aim was to complete a first draft by 5 June.

As to ToR b), (to consider ways of incorporating biophysical modeling approaches in interpretation), the Chair noted that modeling will also be discussed in the Joint

WGZE-WGBBI Session on Thursday. Damien Eloire will in his presentation address ToR c) (prepare species lists from time series stations and/or areas in the ICES area), as will Catherine Johnson in her presentation on Compiling species lists. An answer to ToR i), (produce an evidence based rationale for incorporating zooplankton monitoring into regulatory assessment frameworks), should be a by byproduct to this discussion.

Todd O'Brien led the discussion that followed on the Plankton Status Report, telling the group about progress as to data gathering and data analysis. He made the important point that this year, data submission is proceeding well for a timely report preparation.

Todd went on to outline some limitations with the presentations of annual anomalies in the earlier Reports. Part of the problem was that the anomaly numbers could not be higher than 1 and less than -1. This is now improved by logging the data. Another problem with using actual data was that outliers had great impact on anomaly. Solution was to use monthly anomalies to calculate annual anomaly.

In the coming report much of the illustrations will be in histograms, which allow easier recognition of interesting results to explore further. Values are divided into 20 categories based on dividing by N, not the values themselves. Todd said the method is robust, as demonstrated by an analysis of a Japanese Odate (Oyashio) dataset.

There is need to add more data sets/countries and expand area of report. In last years' report a list of the 10 most abundant species was added for several areas. This should be expanded. Several new datasets have been added:

1) NMFS MARMAP dataset for Georges Bank, Gulf of Maine, Southern New England, and Mid-Atlantic Bight site.
2) A data set from Skagerrak since 1994, with sampling twice per month. Contact person Tone Falkenhaug, IMR, Norway.
3) Russian Baltic data; once per year measurements; recently restarted time-series. There are four sites. Contact person Larisa Latvinchuk, Zoological Institute RAS, Russia.
4) Bermuda Atlantic Time-Series Study (BATS) station, a 13-year, ongoing oceanographic time series situated in the western North Atlantic subtropical gyre, or Sargasso Sea.
5) Portugeese site. One site off Cascais Portugal. Cotact person Antonina dos Santos, IPIMAR, Portugal.
6) Greenland site: 30 year time-series ended in 1984, but may have started again.

In addition, the following data sets will probably be coming soon:

1) Gulf of St Lawrence: New stations in continuing time-series from Eric Head and Pierre Pepin, DFO, Canada.
2) Mediterranean Sites added from various countries. Contact persons Maria Grazia Mazzocchi (Italy), Maria-Luz Fernandez de Puelles, Gabriel Gorsky (France). There may be other data sets soon available from e.g. Croatia and Greece.

Todd went on to describe comparisons between adjacent stations/sites where monthly samples are available. Some sites show good correlation for displacement

volumes, while for others the relationship is less clear. Using anomalies would probably allow better comparison. Other areas sites show good correlation for biomass but less so for abundance. Todd noted that in this comparison actual data were used and by comparing anomalies a better correlation may be found. The issue will be pursued further in the coming report.

Todd said that a tool kit from the SCOR working group can be used to compare time series data to indices, but can't yet see anything meaningful. A discussion on this will be added to the report.

The plan is also to add to the Report a discussion as to how biophysical parameters will impact results. When environmental data are lacking, model data should be used or other older time-series data.

An issue that was raised is the need to provide more detail on individual site descriptions, Chlorophyll, Temperature and Salinity and look for correlations.

Peter Wiebe said that the Helgoland and Brookhaven and L4 data series should be compared. In answer to this Steve Hay noted that these datasets have not be compared yet, nor the data published.

It was noted that the map of times series sites at the WGZE website was limited as it doesn't show new sites. This should be improved

A discussion followed on the public availability of the data used in the Plankton Status Report. Peter Wiebe started the discussion on this asking whether the data from the time series sites can be made openly available? Todd answered that the WGZE could maybe release monthly anomalies (or other aggregate form of the data) that would encourage people to use the data, and perhaps encourage new research topics.

Peter Wiebe said that since some of these data are in the public domain, they could certainly be on line. For other sites, ask whether the data can be made public. Peter felt that is in the best interest of everyone to get a quick start on making these data public.

Priscilla Licandro said that the SHAFOS published CPR data by subarea. SHAFOS could provide data from a few subregions that were of interest. She asked if any regions would be of particular interest? Probably not feasible to do all the 40 regions of the CPR survey in the North Atlantic.

Todd O'Brien answered that the CPR data would be very useful for the middle of ocean, or to fill in empty areas, where national time series were not available.

Delphine Bonnet said that may be we should consider to include CPR areas near time-series sites for comparative purposes.

Peter Wiebe felt that the CPR data should be aggregated, based on correlations between regions. The data could possibly be aggregated to single point for each correlated area. The aggregated data would then be the ones published in the Report.

Priscilla Licandro said she would consider how much work this would represent, and consider this aggregative approach.

Roger Harris said that he support Peter's view, namely that as much of these data should be made available as possible. Start with aggregated data, but move as quickly as possible to more resolved data. As to the BATS data, they should be

included if at all possible, because of their high interest for biogeochemists, although they are a bit south of the usual ICES region.

Peter Wiebe said that he agreed with Roger on this. BATS anomalies should be compared with other more northerly time series sites. He asked if there was a plot to show the relationship among the time-series data? Are there any interesting trends? Note that for hydrographic data, there is an overall and ubiquitous trend toward warming. Do we see a similar basin-wide trend in zooplankton?

Todd O'Brien answered that we don't know yet based on analyses that have been done. He proposed to do this for the next report (2010?), not for this one.

Jens Rasmussen asked if the 20 intervals used to classify the data from the time series station were separately for each time series.

Todd O'Brien answered that they were. So the intervals were different for each time series, but are useful as a visual aid to see the highs and lows in the time series. Note for the Odate time series, this presentation allows easier recognition of pattern.

Jens Rasmussen said that this point should be emphasized to the data users so the will realize they are different for the different datasets. Jens thought that maybe the axis and color-coding be changed.

Todd O'Brien answered that the SCOR WG is proposing to 'freeze' intervals as new data comes in, so can see the changes. Could do something like that.

Priscilla Licandro said that if data were standardized, we should consider changing the scales.

Todd O'Brien answered that he will experiment with what is best: changing as new data come in or not.

Compiling species lists: perspectives from a database manager

The proceedings then went on with a presentation 'Compiling species lists: perspectives from a database manager' by Mary Kennedy and Catherine Johnson, Fisheries and Oceans Canada, presented by the latter author.

The goal of the work is to produce species lists for time-series collections in order to identify biogeographical differences.

Topics addressed in the talks included.

How to define the *spatial range* of an area for which a species list is to be defined. Should lat/long polygons or shapefiles be used? There is concern that if only time-series data are used, some species from the region may be missed. One possibility would be that WGZE recommend on relevant regions for each time-series site.

Which samples should be included: A decision was made to include only zooplankton, net sizes 100–500 um from most gear, but excluding CPR. Metadata include information on how were the samples analyzed (for all species or just for the target species), and how the sample was split and subsampled. Splitting is significant as it relates to the risk of missing rare species. Important to check metadata records for the samples of interest, thereafter decide which samples be included in a species list.

How to *standardize species names:* It is important to check for spelling variation (accents etc), synonyms, name changes, etc. and to consider the taxonomic authority. One way is to assign each species a number initially, and then check ITIS (Integrated

Taxonomic Information System). ITIS may be used to obtain standardized spelling and valid name and position in the taxonomic tree.

Species registries: Local register of marine species from literature and databases helps to quality control, spot incorrect identifications by biogeographical expectations. ERMS (The European Register of Marine Species, http://www.marbef.org/data/erms.php) and NARMS (The North Atlantic Register for Marine Species, http://www.vliz.be/Vmdcdata/narms/), parts of which are derived from derived from the MarBEF (http://www.marbef.org), and WRMS (World Registry of marine Species, http://www.marinespecies.org/, which may be most authoritative). WGZE could have a role in helping getting information into WRMS or whichever is felt most appropriate.

The presentation ended with an overview of *data portals*. They can be used to find other sources of data, and also may be a way to disseminate WGZE data. Catherine described two data portals, OBIS (Ocean Biogeographic Information System, http://www.iobis.org/) and GCMD (Goddard Space Flight Centre, http://gcmd.nasa.gov/). WGZE could have a role in submitting presence/absence data to OBIS, or submit polygons for OBIS.

Jens Rasmussen asked what criteria used in defining the polygons.

Catherine Johnson answered that probably best to use bathymetry or hydrography, but this is a lot of work.

Cabell Davis asked what is the merit in having standardized polygon? Why not just draw your own?

Catherine Johnson answered that polygons do increase the potential for making species comparisons, but that the polygons may need not be standardized.

Erica Head felt it could be convenient to have a standard box around time-series sites.

Peter Wiebe said that these polygons were already defined for Georges Bank and Scotian Shelf.

Catherine Johnson said that perhaps one should keep a record of polygon used for studies, so they can be compared with earlier studies.

Zooplankton taxonomic list of the ICES zooplankton time series

The group was then given a second interesting presentation 'Zooplankton taxonomic list of the ICES zooplankton time series' by Damien Eloire.

Last year, WGZE agreed to combine all the species lists into a single file. This turned out to be rather difficult. Some lists were unpublished. The lists were not consistent between different studies and different time series. Sometimes the lists used different names and different taxonomies. To start to work, Damien used ICES, MARBEF, and Razoul's (copepods only) websites. He also added lists from his previous collaborations with Mediterranean colleagues.

The list now includes 21 stations or transects plus the CPR data. About 660 species, with 1500 categories including all taxonomic levels from kingdom to subspecies. data are stored in an Excel spreadsheet with all hierarchical levels. Damien has made an XLS macro to query the spreadsheet and demonstrated to the group how to use it to find common species among different lists. There is a simple search engine with pull-down menus for taxonomic levels; can search for species or groups. This search tool can be used to find the same species or groups in different datasets, by selecting a

species and all of the time series. It is also easy to see a list of species or groups common with particular or all sites.

Asked by Erica Head if Damien had submitted this to OBIS, Damien answered no.

A discussion followed as to which source for species names etc. to use when there is disagreement among them, and which sites should be included in this effort.

It was noted that the species lists could be analyzed with the PRIMER software, but differences between species lists may render this difficult. An interesting approach for the Plankton Status Report would be to make a species abundance ranking and compare among different stations. PRIMER is one software that can be used to analyze this.

Damien Eloire said the XLS file is available to anyone who would like to use it.

Priscilla Licandro said that Damien's work could be utilized in relation with ongoing taxonomic work in the Mediterranean.

Astthor Gislason, the Chair, said that this was an Impressive work and especially likes how easy it is to retrieve the common species from the different sites. This is particularly useful for WGZE.

Steve Hay felt that underlying the issue of species names is the difficulty that all lists – ICES, ITIS, ETI, ERMS, etc. – have different standards. The lists are not updated regularly, yet researchers still just pick a list and use it. Researchers can't possibly know the geographic/spatial extent and taxonomic diversity of these lists. Steve felt it would be best to start with local experts, who will know their area best. Start locally within the WGZE areas of expertise for validation of the lists.

Roger Harris felt that the group should accept that work is 'in progress' or incomplete, but thought we should aim at making it more widely available for use by WGZE in particular.

Erica Head said that the concept of the 'top 10 list of species' needs to have some rules about species names or categories. This should be discussed further, to resolve whether 'groups' (e.g. barnacle larvae) should be counted as 'species' for this purpose.

There was some consensus that what is of most use are individual species, not aggregates or groups, especially for biogeographic analysis. But it is realized that there are cases where even the adults cannot be easily distinguished.

7 New ICES structure

Lead: Luis Valdés, Rapporteur: Astthor Gislason

Provide comments on Draft ICES Science Plan

The session opened with a note from the Chair informing that he had received a letter from Mike Sinclair ICES first Vice President and Harald Loeng Chair of Consultative Committee informing about ongoing restructuring of ICES and the updated Science Plan that was presented to the Delegates during their 19–20 February 2007 meeting. Astthor said that this document would be used to define the new ICES structure and thus it was important that comments be provide if there were any. Astthor said that ICES is asking for comments by 11 April (deadline for comments later prolonged to Friday 25 April) so an answer has to be formulated during this meeting.

Before discussing which comments or thoughts the group would have on the Science Plan, Luis Valdes presented some background information on the new ICES structure.

He started by drawing the attention of the group to Article 1 of the ICES convention (12 September 1964) that states that the role of ICES is:

'(a) to promote and encourage research and Investigations for the study of the sea particularly those related to the living resources thereof; (b) to draw up programmes required for this purpose and to organise, in agreement with the Contracting Parties, such research and investigations as may appear necessary; (c) to publish or otherwise disseminate the results of research and investigations carried out under its auspices or to encourage the publication thereof.'

He also pointed out that the ICES Vision according to the New ICES Strategic Plan:

'*An international community of scientists that is leading the provision of sound and credible science to improve understanding of marine ecosystems and their relation to humanity*'

So ICES has two important functions to perform *Science* and give *Advice* The statements outlined in the ICES convention and in the ICES Vision should serve as guidelines for the work within ICES.

Luis then went on to describe the old ICES structure (Figure 2). In this structure the seven Science Committees are under the Council while the three Advisory Committees are under MCAP (ICES Management Committee for the Advisory Process).

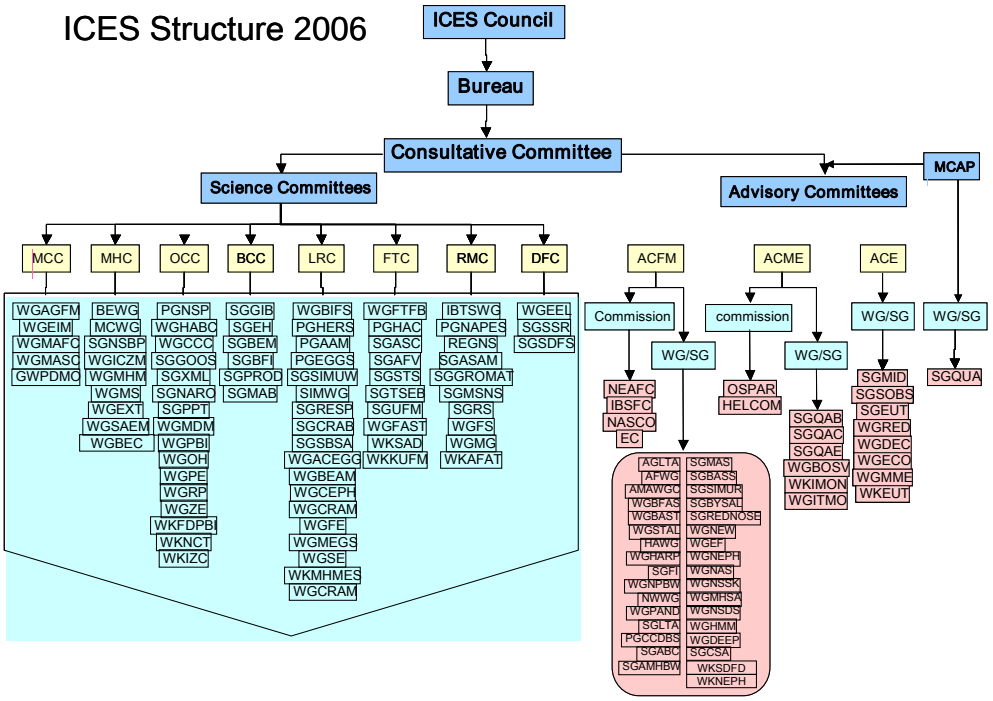

Figure 2. The former ICES Structure.

After the 2006 ICES Council meeting it was decided to review the ICES Strategic Plan, the ICES Advisory Committees and the ICES Science Structure (ConC).

The present scientific structure of ICES has been thoroughly analysed. The main conclusion from the process is that Expert Groups are functioning relatively well, while a problem area has been identified at the intermediate level of the Science

Committees in terms of insufficient integration. Also, there has been criticism that ConC has been practicing micromanagement and has not had sufficient time for strategic thinking, cross-fertilization and foresight. It is therefore recommended that structural, procedural and managerial changes are required.

The 2001 ICES Strategic Plan established three implementation steps:

- To prepare a multi-year action plan. The Action Plan was published in 2002.
- Monitor performance. This step was not achieved, only some indicators to evaluate the work of the expert groups were given.
- Update the ICES Strategic Plan on a regular basis.

On the meeting of the ICES Consultative Committee September 2007 (ICES CM 2007/CONC:01) a draft of the ICES Scientific Strategic Plan, prepared by a subgroup consisting of the Chairs of the Marine Habitat (MHC) and Fisheries Technology (FTC) Committees and the HoS (Adi Kellermann), was discussed. A result of these discussions was a recommendation by the Consultative Committee that a subgroup be established to further develop the Science Strategy for ICES, building on the comments from the national delegates. The subgroup will meet twice before the midterm meeting of ConC in 2008 in order to finalise the ICES Strategic Science Plan. Representatives from both science and advice will be part of the group.

Luis said that the updated ICES Strategic Plan for 2008 will be overarching and give the scope for an updated Science Plan, Advisory Plan and Secretariat Plan.

The updated ICES Strategic Plan for 2008 would probably include the following strategic goals:

1) The ICES science programme should function as the leading network for marine science in the North Atlantic and develop links globally, to provide the science in support of policy decisions and management actions now and in the future.
2) The ICES science programme should become the vanguard collecting the science to enable strategic planning for emerging and anticipated science issues, in order to provide strategic advice to governments and funding agencies.
3) ICES should lead the development of methods and tools needed in support of operational ecosystem observation services, in order to improve the understanding of climate change and impacts to our oceans and marine ecosystems.
4) ICES should develop methods and tools needed to support the implementation of marine strategic initiatives in the North Atlantic with the aim of achieving sustainable use and conservation of biodiversity.

Luis then went on to describe an outline for a New Science Structure of ICES. It is recommended to continue to have three levels in the science programme (Figure 3) (ICES CM 2007/CONC:01):

- The Upper level (*Consultative Committee – ConC*) should be the primary body that provides science integration between the Science and Advisory bodies within ICES. ConC should provide the overall synthesis of emerging and anticipated science needs that serve to advise governments and agencies on necessary science objectives and activities. ConC should develop a strategic vision of what science is needed to move the member

countries forward, what should be national science priorities, and how can existing elements be integrated. ConC should determine how to make ICES more attractive to scientists than it is now to ensure basis for future advice. ConC should address the science the advisory committee believes is needed and the science which the committees and programmes believe should be integrated into the advisory process. In addition, ConC should consider directions provided by Council. ConC should develop the ICES Science Strategy and identify key areas that require further development, review and plan the ICES Science Programme, review ToRs for Science Committees and Programmes, promote ICES as a leading marine science organization and be the Scientific Steering Group for the ASC. ConC should report to the Council and Bureau.

- The intermediate level of ICES Science should consist of two elements; *Science Committees* which are responsible for the core activities of ICES science that require long term or regional objectives/strategies and outcomes (e.g. planning and survey groups, ecology and oceanography, standards) and *Science Programmes* which deal with cross-cutting and interdisciplinary issues that require prompt synthesis, advice and/or solutions. Committees and Programmes represent networks for the development and integration of science within and across disciplines. They can and should involve both institutional and academic participants. The ToRs of Science Committees should include overseeing activities of EGs with a focus on developing a synthesis of disciplinary-based or regional science that should form the basis for development of Science Strategies and Position, as well as approaches that should be incorporated to improve the current advisory process. Science Committees provide a mechanism for coordinating national work requiring international oversight as well as in the development of strategies for emerging or anticipated issues. Science Committees, through ConC, should provide the impetus to identify emerging and anticipated science issues that could form the basis for the development of Science Programmes. Science Programmes deal with issues that require the resources of more than one member state and more than one Committee. Their structure should be flexible and they should serve to coordinate existing the activities of existing EGs to address key science issues. Their ToRs are linked to ongoing activities in national institutions but may also embark into existing third-party funded projects. Their timelines will be limited (3–6 years). Their output should serve ConC and the Science Committees in the review and development of the Science Strategy to better coordinate long term activities required by ICES and in the development of national management plans in critical issues. Science Programmes will report to ConC.
- The *Expert Groups* should be the operational level within the ICES science structure. The Expert Group level conducts the scientific evaluation and analysis necessary to achieve the Science Strategy. It should respond and report on their ToRs and will be the level where most of the good ideas for new science will take place, and a key task will be to identify knowledge gaps and report them to the to the rest of the organization.

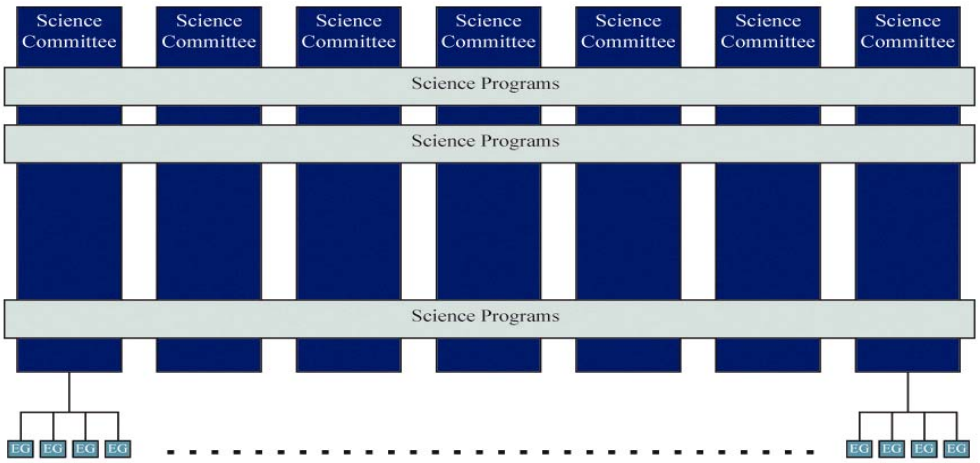

Figure 3. The new ICES structure. Expert groups, Committees and Programmes within ICES: The Building Blocks of the New ICES Structure.

Luis then aired some thought as to how Science could help ICES. Science is built into the Advisory Process as every application in assessment is be built on scientific results that require process understanding. Science can contribute to connecting disciplines and addressing complex issues. Scientific deduction would be involved in the creation of models in order to provide and improve forecasting capabilities. Scientific thinking is also involved in the development of new observation and measurement techniques. And Science is also involved in data handling, processing and visualization. Other areas where science can help include: to link observations across societal benefit areas; identify gaps in observations research; provision of long time series of observations; provision of in-situ data for validation, harmonized formats, etc; bridging gaps between science and application.

Luis ended his presentation of the New ICES Structure by giving an overview of the Prioritized Research themes that have been identified by ICES (Draft ICES Science Plan 2009–2114), noting that the first eight might very well become 'Programmes of Science':

1. Climate Change Processes: Impact of climate change on the distribution, physiology and behaviour of marine biota from coastal areas to the deep ocean.
2. Operational ecosystem modelling combining operational oceanography, ecosystem and population processes) leading to comprehensive assessments and medium term forecasts (3–5 year horizon).
3. Climate Change Predictions: Predictions of the responses of marine ecosystems within the ICES area to climate change scenarios, with attention to region shifts and changes in trophic structure. Investigate the response of marine ecosystems within the ICES area to climate change scenarios, with attention to regime shifts and change in the trophic structure.
4. Ecosystem Surveys: Integration of surveys and observational technologies into operational ecosystem surveys in support of EAM.
5. Invasive Species: Introduced and invasive species, their impacts on ecosystems and interactions with climate change.

6. Cumulative Impacts in coastal zone: Population and Community level impacts of marine contaminants, eutrophication, population and community.
7. Spatial Planning: Development of rigorous approaches for marine spatial planning, including evaluation of the effectiveness of management practices (e.g. MPAs), and their value to the conservation of biodiversity.
8. Indicators: Identify the indicators, models and methods required to ensure high quality advice for integrated ecosystem management.
9. Life History: Integration of life history information in support of EAM.
10. Coastal Habitat: Importance of coastal zone habitat to commercial fish population dynamics.
11. Renewable energy: Impact of the development of renewable energy resources (e.g. wind, hydropower, tidal, and wave) on marine habitat and biota.
12. Biodiversity: Functional role of biodiversity, and its value as an indicator of the health of the ecosystems.
13. Socio-economic: Provide a socio-economic evaluation of ecosystem goods and services, and forecast the impact of human activities.
14. Top-down Control: Investigation of the role of top predators (marine mammals, seabirds and large pelagics) in the functioning of marine ecosystems, including the impacts of human perturbations.
15. Mariculture: Impacts of mariculture on local productivity, genetic patterns, diseases and biodiversity.
16. Fishing: Characterization and mitigation of the ecosystem impacts of fishing on the environment and non-target species.
17. Sensitive ecosystems: Identify management criteria and knowledge gaps dealing with sensitive ecosystems (e.g. deep sea corals, seamounts, Arctic) and rare or data poor species.

Following Luis's presentation, a discussion followed on the New Science Structure. It was realized that in the reformed structure, the Science Programmes will be cross-disciplinary and have a significant and important role to play within ICES. There was general content as to the Science Programmes, although some concern was raised that recruitment of exploited stocks should be included somewhere in the Science Programmes. During the meeting a letter was drafted to Mike Sinclair ICES first Vice President and Harald Loeng Chair of Consultative Committee expressing these concerns (Annex 4).

8 OSPAR climate request

Lead: Priscilla Licandro and Eilif Gaard, Rapporteur: Cabell Davis

ToR a) Consider the reports of the Ad Hoc Groups on i) Hydrographic Attributes; ii) Trend Analyses and Quantifying Relationships; iii) Formulating Hypotheses and Predictions about Mechanisms; iv) Selecting Species for More Intensive Investigations; and use their recommendations concerning (1) recommended time series, (2) analytical methods and suitable software, (3) hypotheses and guidance for their use, and (4) a suggested list of species for intensive study, to complete the assessment of changes in the distribution and abundance of marine species in the OSPAR

maritime area in relation to changes in hydrodynamics and sea temperature

An overview and introduction to the problem was provided by Priscilla Licandro. The background:

In November 2006, a meeting in OSPAR MASH (Marine protected Areas, Species and habitats) agreed on the text for the request, and in December 2006, the WGZE was tasked by ICES to answer the request. The OSPAR climate request was for the WGZE:

'To prepare an assessment of what is known of the changes in the distribution and abundance of marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature. The assessment should look at ecologically indicative species, including the threatened and declining species identified by OSPAR, for which adequate time series data exist, in order to assess to what extent there have been changes in distribution, population and condition of species going beyond what might have been expected from natural. The aim is to prepare an overview of as a major contribution towards JAMP ('Joint Analytical Model Programme') Product BA-3 and material that can be included in the Quality Status Report in 2010'.

This request was interpreted by ACE, ACME, and OSPAR to include: 1) ecologically indicative species, i.e., species that show responses to hydrodynamics and temperature on the spatial and temporal scales given below; 2) species that OSPAR have listed as threatened and declining; 3) only changes that can be attributed directly or indirectly to human activities; 4) the spatial coverage includes the OSPAR area on scales ≥100 km, and smaller scales may also be included provided that the changes are exceptionally severe; 5) temporal coverage includes the last 50 years with an emphasis on the last 10–20 years. The original OSPAR request is for a short referenced report of about 5 pages of text and about 5–10 figures.

In March and April 2007, WGZE prepared an answer to the OSPAR request (ICES CM 2007/OCC:04, Annex 3). This work was led by Priscilla Licandro.

In April/May 2007, the Report was reviewed by WGECO (Working Group on Ecosystem Effects of Fishing Activities) (ICES CM 2007/ACE:04) and synthesized by ACE (Advisory Committee on Ecosystems) (ICES Advice 2007 Book 1). The WGECO recommendations were included in the report of ACE, May 2007.

In May 2007, ACE laid out plans for further work. This included the formation of ad-hoc groups to deal with specific issues. The plan was to form four groups: Hydrographic Attributes, Trend Analyses and Quantifying Relationships, Formulating Hypotheses and Predictions about Mechanism, Selecting Species for More Intensive Investigations)

In September 2007 (ASC Helsinki), there was a planning meeting of ACE Chair (Mark Tasker) and Chairs of Expert Groups that had been tasked to deal with the request. Identification of people for Ad-hoc groups followed.

In winter of 2007, the ad-hoc groups worked by correspondence. Priscilla Licandro, Eilif Gaard, Jesus Cabal and Mike Heath were the WGZE representatives in one group, Study Group on Working Hypotheses Regarding Effects of Climate Change, SGWRECC.

In March 2008, a draft Report of the Working group dealing with Formulating Hypotheses and Predictions about Mechanism, SGWRECC, was published. To date only two of the ad-hoc groups have delivered their reports (Hydrographic Attributes

(ICES 2008, Working document); Formulating Hypotheses and Predictions about Mechanism, SGWRECC (ICES CM 2008/ACOM:43)).

The task now is to consider the reviews made by WGECO and ACE and use this together with the Reports of the ad-hoc groups in order to revise the Report that the group made last year.

On 6–13 May 2008, the WGECO will then meet to peer review the WG Reports, and if everything goes according to plans, final advice of ICES will be issued in summer 2008 (firm date not yet agreed).

Pricilla Licandro reviewed last year's WGZE report to OSPAR. The temporal and spatial scales in the 2007 WGZE OSPAR report reflected the strong focus on the CPR data. That report was based on CPR and other time series, including phytoplankton. WGZE was tasked to include phytoplankton as there is no longer a phytoplankton working group. The report also included changes in zooplankton and phytoplankton population abundance, with the decrease in *Calanus finmarchicus* abundance given as an example. Other examples included the increase in North Sea meroplankton like echinoderm larvae with a concomitant decrease in holoplankton. The northward shift in *Calanus finmarchicus* and other cold-water species in the North Sea was noted. In addition, an increase in gelatinous plankton was noted. The change in distribution of plankton, fish and other trophic levels, and the shift in food web structure were also reported.

The group noted that the main comments raised by WGECO and ACE in the reviews on the WGZE report was that it 1) focused on the CPR data, alternative sources of data should be considered; 2) geographic coverage should be increased; and 3) the information gap as to gelatinous zooplankton (ICES CM 2007/ACE:04, ICES Advice 2007 Book 1).

The group also noted with dissatisfaction that the WGZE recommendation that zooplankton should be included as mandatory sampling in the OSPAR region had been deleted from the WGECO/ACE reports. Priscilla Licandro commented that zooplankton should be a standard mandatory variable in the management of OSPAR region, and the WGZE agreed. WGZE also agreed that the analysis of plankton data should allow testing of nine hypotheses (listed in the report).

The final draft of the SGWRECC report was presented to the WGZE. It included two terms of reference:

1) Develop hypotheses on ecosystem responses to climate change and other major drivers.

2) Develop hypotheses about future potential for plankton/climate change scenarios.

The main hypotheses were related to climate change. A subset of these hypotheses were related to plankton, and A few members of WGZE including Mike Heath contributed to developing these hypotheses.

1) Climate changes are associated with plankton geographic changes

2) Climate change is resulting in decline in abundance of zooplankton.

Future changes that are expected in the plankton in relation to climate change are the following:

1) Changes in temperature can increase invasive species abundance.

2) Zooplankton phenology will change due to increased stratification.

3) Match-mismatch between plankton cycles and fish production will be affected by climate change.

4) Community changes will be difficult to predict.

5) Increased ocean acidity will decrease the abundance of calcareous organisms.

The WGZE agreed with the text on zooplankton in the SGWRECC report. It was agreed that the hypotheses presented were worth pursuing further.

Astthor Gislason informed that the WGZE annual report should be submitted to ICES by 1 May in time for the WGECO meeting 6–13 May. Astthor also informed about the following guidance that he had received from Cristina Morgado, ICES secretariat by e-mail, regarding the further work on the OSPAR Request: 1) all OSPAR areas should be analysed, although more detailed data can be available for a given region (e.g. North Sea); 2) if possible, select indicative species showing responses to hydrodynamics and temperature on a time and spatial scale; 3) also if possible select species for more intensive investigation. The WGZE should produce a separate document (a chapter in the report body) like last year. The task was to update and improve last year's work based on comments from WGECO and incorporating the work of the ad-hoc groups.

In summary, the WGZE agreed that the comments of WGECO and ACE, as well as the work of the two ad-hoc groups with reports should be taken into consideration in the further work. There was consensus that the spatial coverage needed to be expanded. For this, Priscilla Licandro will include data from the Norwegian Sea from Webjörn Melle. Peter Wiebe will provide rationale for why WGZE should not be responsible for phytoplankton assessments. Steve Hay will provide data on gelatinous zooplankton and comments on use of existing ichthyoplankton samples for obtaining zooplankton data. Steve Hay and others will provide Priscilla with examples of how gelatinous organisms are important in climate change and fisheries contexts. As to the gelatinous animals, Gaby Gorsky said there is data available from the Mediterranean on jelly animals from the last 40 years and note in paper format from the last 200 years. He noted during the last 10 years or so, gelatinous plankton has been high in abundance. Astthor Gislason agreed that the added references on gelatinous zooplankton will be valuable.

Steve Hay suggested we need to consider the request for selecting species to target for climate change effects, and suggested that we consider the species *Centropages typicus* and *Calanus helgolandicus/finmarchicus*. Priscilla Licandro suggested that we use criteria for species and list examples, and the group agreed.

Astthor explained the geographic extent of the OSPAR region (Figure 4) which includes the North-East Atlantic, extending westward to the east coast of Greenland, east to the continental North Sea coast, south to the Straits of Gibraltar and north to the North Pole. The region does not include the Baltic Sea and the Belts or the Mediterranean Sea and its dependent seas.

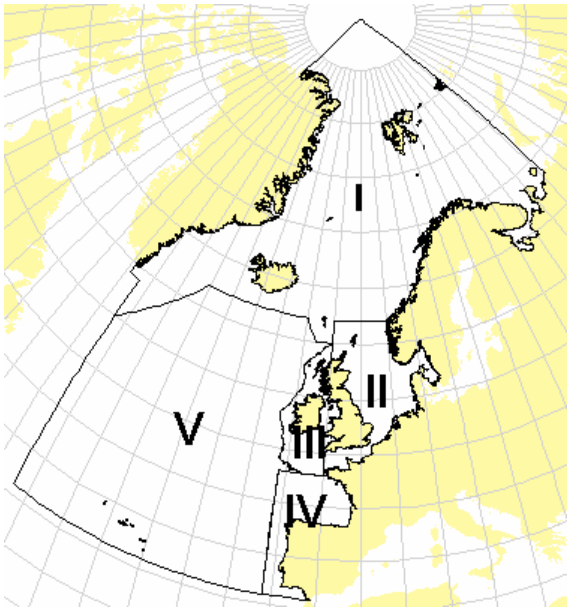

Figure 4. Map showing the OSPAR Maritime Area with division into subregions.

There followed a group discussion of plankton changes in each of the OSPAR regions, and a subsequent draft outline of a revised report. Priscilla Licandro took on the task of collating all the available information and discussion points, incorporating the comments made by WGECO and the work of the ad-hoc groups into a new document. It was agreed that it be sent out to the group for comments before final submission to ICES in April/May. The finalized document ('A further report on the assessment of changes in the distribution and abudnance of plankton in the OSPAR maritime area') was sent to WGECO 5 May and is attached as Annex 5.

9 OSPAR request for an assessment on the status of biodiversity

Lead: Astthor Gislason, Rapporteur: Webjörn Melle

Consider OSPAR request for a Scoping Report on summaries of the status of biodiversity

The Working Group considered the OSPAR request for a Scoping Report on summaries of the status of biodiversity in the OSPAR region: 'To contribute to the development of a possible request for the 2008 ICES work programme, through the preparation of an initial scoping report on the possible contents and methods that ICES would use to prepare a set of concise expert summaries of the quality status of the main components of biodiversity in each of the OSPAR Regions (seabed habitats and their associated communities; plankton, fish communities, marine mammals, seabirds and reptiles) (no more than 1 page per Region) as a contribution to the QSR 2010, if this request was included in the 2009 ICES Work Programme.' (2008 ICES Work programme, request no. 14)

The deadline for the initial response was short and the Chair of WGZE, Astthor Gislason, responded by email 7 March 2008, which was further developed by ACE based on answers from several WG chairs. The WG reviewed the answer from ICES to OSPAR and had no further comments to that.

The Group then discussed methods and contents for summaries of the quality status of the main components of biodiversity in the OSPAR Regions. The Group expressed

that for zooplankton the results of the status report with the top ten species list should cover the request in general. Further the Group agreed on a list of monitoring activities and products that should be taken into account when considering the status of biodiversity:

- Gather information about habitats
- Evaluate composition and structure of zooplankton by regions (taxonomic lists)
- Develop/identify classification schemes for biodiversity (species richness and diversity indices)
- Produce biodiversity maps
- Produce distribution maps
- Evaluate long-term changes in community structure/diversity
- Use DNA barcoding for identifying species
- Identify invasive/non-indigenous species and range changes
- Identify indicator species and range changes
- Resolve difficult taxonomic entities (e.g. *Pseudocalanus* spp.)
- Organize information at the appropriate spatial scales for monitoring and maintaining biodiversity

The WGZE recognised the problem arising from the lack of a phytoplankton ecology working group within the ICES system. The WGZE will also include information on phytoplankton diversity in the report when available.

ICES has decided to fund the digitation of pre-1914 data. This was decided following a proposal by Erica Head and Catherine Johnson, Canada. The Working Group suggests other data sets that may be digitised to be conveyed to Erica Head. The review of the work was suggested as a ToR for next year's meeting. It was further suggested the collections of samples existing in the institutes should be reported to the Group and an overview made as an inventory on the next year meeting.

Barcoding for CoML: Assessing Zoo-plankton Diversity

Dr. Ann Bucklin (USA), project leader of CMarZ (Census of Marine Zooplankton: a Census of Marine Life project), presented 'CMarZ and DNA Barcoding for CoML: Assessing Zooplankton Diversity'. Dr. Bucklin outlined the goals and accomplishments of CMarZ from 2004 to present, including sampling throughout the global oceans, taxonomic analysis of holozooplankton, and DNA barcoding (which she described as determination of a DNA sequence to be used for species identification and discrimination). Dr. Bucklin recommends inclusion of DNA barcoding in all marine biodiversity surveys, and is seeking support from ICES – especially the WGZE – for the broad establishment and implementation of this policy. Dr. Bucklin reported 20% completion toward the CMarZ goal of DNA barcoding of all 7,000 described species of holozooplankton. Following the presentation she suggested biodiversity and molecular methods to be the subject of a Theme Session during the 2009 ASC. This was approved by the Group and a provisional title for the Theme session was suggested: Biochemical, biogeochemical, and molecular approaches to zooplankton ecology and species-biodiversity. The Theme session, if approved by ICES, will be co-convened by Steve Hay (UK), Janna Peters (Germany) and Ann Bucklin (USA) (Annex 6).

10 Joint meeting of WGZE and WGPBI

ToR d) report on approaches for combining field and laboratory data together with biological-physical models to examine processes controlling zooplankton populations

The joint meeting was held at the Hotel Port Marine, Sète, 2 April 2008 and was attended by 29 members of the Working Group on Zooplankton Ecology (WGZE) and 24 members of the Working Group on Modelling Physical-Biological Interactions (WGPBI).

The aim of the meeting was to bring modellers and field scientists together to explore how data and models could be combined to elucidate mechanisms explaining observed variations in zooplankton and ecosystem dynamics. Thus the joint meeting builds on the separate strengths of the WGZE and WGPBI, to further our understanding of zooplankton and ecosystem dynamics by combining data and models from these two WGs.

The meeting was divided into three sessions: Session 1 with presentations by WGPBI members intended to demonstrate the range of modelling techniques available to the community and a new observational technique; Session 2 where WGZE members presented available data sets and examples of statistical modelling approaches; and Session 3 with joint discussions on possible future interactions between the two groups. The abstracts are given in Annex 7.

10.1 Session 1: Modeling (WGPBI)

Lead: Uffe H. Thygesen, Rapporteur: Charles Hannah

Hannah gave an overview of WGPBI's history and philosophy. There was a lively discussion that ranged across issues such as model validation and the need for the involvement of observationalists and experimentalists in the modelling process.

As part of the joint session with WGZE, Tom Osborn gave a talk entitled 'Holographic techniques for predator prey interaction and physical/biological coupling.' The talk summarized recent developments in the digital holography and illustrated how new digital holographic techniques can be used to study behaviour, feeding and physical/biological interactions for copepods, nauplii, diatoms and dinoflagellates.

Sinerchia discussed the Lagrangian Ensemble methodology and the VEW (Virtual Ecology Workbench) software for simulating the entire ecosystem using individual based models. Simulations at an Azores site, under stationary annual forcing, showed that after an initial transient period, the ecosystem converges to an attractor, in which the inter-annual variation of species biomass or demography is lower than the demographic noise (<15%). The biomasses were comparable with observations at a nearby site. Overall the simulations were intrinsically stable, ergodic and provided a good signal:noise ratio.

Neuheimer discussed the application of an age-within-stage population dynamics model to investigate the cause of the dramatic decline in *C. finmarchicus* naupliar abundance in May followed by an increase in June, every year on Georges Bank. She showed that the use of field-estimated mean mortality rates results in modeled abundance that are in error by over an order of magnitude and that time-varying and spatially explicit mortality rates were required to reproduce observed naupliar

densities. These temporal variations in mortality appeared to be correlated with *C. finmarchicus* female abundance, which suggest that cannibalism as a major regulatory factor of naupliar abundance.

Fennel's contribution aimed at bridging biogeochemical models and fish-production models, by coupling a NPZD-model with a fish model. The Baltic Sea was chosen as an example system, where the main fish dynamics is covered by two prey species (sprat and herring) and one predator (cod). The dynamics of the fish model is driven by size dependent predator-prey interactions. The linkage of the model components is established through feeding of prey fish on zooplankton and recycling of fish biomass to nutrients and detritus. He used the NPZD plus Fish model (NPZDF) to discuss how the choice for parameterization of the fish in an NPZD model affects the simulations. The model truncation affects not only the zooplankton mortality but also the dynamics of nutrients and detritus.

Moll presented the coupling of a 3d regional NPZD model with a stage resolved model of *Pseudocalanus elongates* that competes with the bulk zooplankton. The *P. elongates* then provides food for an individual based model of larval sprat. The presentation focused on the validation of the zooplankton component of the simulations. In particular, Moll raised the question of how to validate a stage resolved zooplankton model. He was able to show that the model is able to calculate reliable stage development and abundances of *P. elongatus* as well as the range of bulk zooplankton biomass, and thus the ratio of population biomass to total biomass. In the German Bight, the population is below 20% in spring. The ratio increases up to 30% during summer. The number of generations was estimated from peaks in egg abundance to about 4–7 generations of *P. elongatus* in the southern North Sea.

Moll had several questions for the audience, in particular

1) Is the comparison at Helgoland Reede affected by island effects, not covered in the simulation?
2) What other long-term station data are available on the northwest European continental shelf?
3) Do we have robust estimations of generation numbers as an integrative measure? The number of generations produced during the year integrates many biological processes and has the potential to bypass the classic zooplankton sampling problem of being under resolved in space.
4) What are your suggestions for better ways of comparison (e.g. generation time and number of generations)?

10.2 Session 2: Data (WGZE)

Lead: Astthor Gislason, Rapporteur: Arno Pollumae

Astthor Gislason opened the session with a short presentation of WGZE, introducing the history of the group, the attendance statistics and most important products over the years.

Mark C. Benfield gave an overview of zooplankton sample collection methods, past and present. In order to answer the questions: what are the numbers and kinds of zooplankters in the sea at any given time and place and how it varies with time and space; a variety of sampling gears and methods have been developed during the last century. The history, basic design and working principles of plankton nets (single,

non-opening/closing, opening/closing, multinets, specialized nets and traps, plankton recorders), pumps, optical systems (particle counters and imaging systems) and high-frequency acoustics, were presented with many pictures and animations. Strengths and weaknesses of every sampling gear type were pointed out as well as the kind of data that derive from the different approach. Mark ended his presentation by drawing the attention of the group to a recent review by Wiebe and Benfield 2003 (From the Hensen net toward four-dimensional biological oceanography, Progress in Oceanography 56) as further reading on the topic.

Eilif Gaard described the inventory of existing or known zooplankton and ambient data series from North Atlantic and Mediterranean Sea. Most of the North Atlantic series presented are included in Plankton Status Report. Eilif said that in the North Atlantic, there is generally good temporal and spatial coverage of hydrography, nutrients, phytoplankton abundance and zooplankton biomass, but less data on rates and processes. The knowledge gaps and data needs were acknowledged in many aspects for such fields as biochemistry, ecosystem functioning and exploited resources.

In the discussion that followed, Gaby Gorsky said that very high-resolution zooplankton data were available from off Villefranche, data collected since 1966 five times per week. Andreas Moll (WGPBI) noted that he now knew much more about where to find good data for model verification. The question was asked how to include rate measurements in long-term monitoring programs? The answer seems to be that it is complicated to acquire such data and therefore they tend to be missing from the monitoring series.

Roger Harris discussed available data sets from laboratory studies. There are existing large data-sets, where data from multiple experiments are compiled (e.g. within the US GLOBEC programme). However, Laboratory experiments have a specific purpose, and are usually designed to test a specific hypothesis, so the data generated may not necessarily be appropriate for models. Large projects such as US GLOBEC and TASC (Trans-Atlantic Study of *Calanus finmarchicus*) may be sources of zooplankton experimental data, but the data-sets may not be easily accessible, and long term availability is a problem. Roger continued to say that some of the best data were literature compilations. Some examples are: Bunker and Hirst (2004). Hirst and Kiørboe, (2002). Hernandez-Leon, *et al*. (2008), Hernandez-Leon and Ikeda (2005), Buitenhuis *et al*. (2006).

Roger ended his presentation by describing an initiative to work with a few publishers of scientific journals to implement a Data Submission System (DSS) where authors are required to submit raw data directly to a long-term data-base in order as part of the publication process.

A discussion followed where it was noted that there is already a system, where links in articles are leading to databases not hosted by the publisher but somewhere else.

Cecilie Broms showed a few examples how multivariate techniques could be used to extract information from field data. Ecologists often need to analyze the response of several species (response variables) in an ecosystem on several environmental factors (explanatory variables) simultaneously, so they end up with multivariate methods. One multivariate method is ordination – arrangement or ordering of species and/or sample units along gradients. Ordination is a family of methods and there is a choice of sub-methods. An example was presented how ordination methods were used to relate the geographic distribution of *C. finmarchicus, C. glacialis* and *C. hyperboreus* in the Norwegian Sea and adjacent areas to environmental variables.

Jeff Runge concluded Session 2 by talking about what biological questions the models should address. He identified three families of biological questions about pelagic marine ecosystems: 1) questions about biogeochemical fluxes and carbon sequestration; 2) questions about community ecology including multispecies trophic interactions and top down effects; 3) and questions about bottom up controls on primary productivity and higher trophic level population dynamics, noting that the last question, addressed by coupled physical-biological models, appeared to be particularly appropriate to top priorities of the new ICES Science Plan, including impact of climate change on the distribution, physiology and behaviour of marine biota. Jeff concluded his talk by saying that modelling integrates knowledge across scientific disciplines. He said that there is need for collaboration among disciplines, and that simulations provide predictions that can be tested against data. The computer could be a medium for communicating to non-experts and experts the complex synthesis of system knowledge.

10.3 Session 3: Future collaboration between WGZE and WGPBI

Lead: Charles Hannah, Rapporteur: Cabell Davis

To lead off this discussion, Peter Wiebe presented a BASIN slide showing conceptualization of sampling system. He discussed the rationale for BASIN, including the need to sample the deep basins; the shelves are sampled fairly well. There is a need for a comparative approach in sampling the shelf and basin ecosystems, as they are connected.

Erica Head said that comparative ecosystem and model analysis is being done in the U.S. via the CAMEO program. Elizabeth North said Moll's example of physical models and ecosystem dynamics indicated that physics most important.

Andreas Moll said that of the seven 3d circulation models he examined, only 2 models had a cost comparison done, i.e., only 10% of models had been validated. Charles Hannah showed slide describing what validation is, saying it is a process. Moll explained why it is a process: when you change a state variable, you need to change validation for whole new model. You need to validate the model for all state variables. Charles Hannah said that is why modellers are so attached to their own models.

Steve Hay said that we also have an emotional connection with the data! He has seen the process of model validation, and there is a need for more data, new processes, etc.

Charles Hannah showed that the modelling policy includes experimentalists/-empiricists.

Anna Neuheimer asked in comparing model and data, what is the truth? In answer to that, Cabell Davis suggested that Hannah show the 'What is truth' slide Dan Lynch presented at the GLOBEC Pan Regional meeting in Boulder Colorado, USA, 27–30 November 2006. The slide shows a triangle, with the truth at the top vertex and model and data at the two bottom vertices (Figure 5). There is error in both the data and the model. We are comparing models-data misfit, in hopes of being closer to the truth.

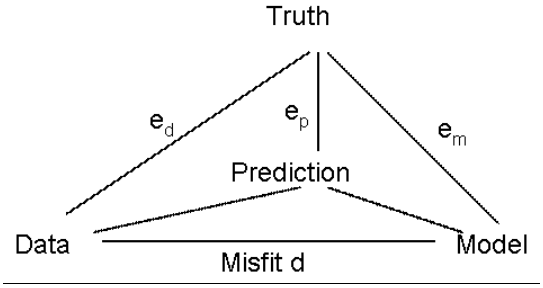

Figure 5. Relationships between models, data, and reality (modified from D. Lynch's presentation at the GLOBEC Pan Regional Meeting, 27–30 November 2006 in Boulder, Colorado, USA).

Catherine Johnson said that one of the products of a model is the identification of weak areas of data. The models are needed to point out where we need to sample and what is most sensitive to measure. This modelling can provide important information for the observationalists. Steve Hay said that there is never enough data and that it is probably not possible to conduct enough experiments. We need to know what are the functional relationships?

Jeff Runge asked a philosophical question: what level of detail is needed? What level do you need to validate the model, can you come up with simple metrics, red, green, yellow. Charles Hannah stressed need for iterative interactions between modellers and observationalists. How detailed does the model need to be? There is no method for determining this level.

Elizabeth North considered a thought experiment: design an experiment using modeling approach, and observation system simulation experiment. Use the model of BASIN to design experiments. Andreas Moll said that approach is valid for well validated models but for unvalidated models you need data first to validate the model, so use literature. Priscilla Licandro agreed with Elizabeth North saying that we need validation in this way.

Erica Head said we can use conceptual models. She asked what are the hypotheses of basin? Michael St. John answered that one hypothesis focuses on the biogeochemical processes associated with spring bloom.

Elizabeth North asked what recommendations can we provide ICES? Following up on this Todd O'Brien asked what data modellers need. Charles Hannah answered we don't know. It depends on the model.

Uffe Thygesen suggested using crude model with 1st guess at parameters to design sampling. We need to be specific about which questions the model needs to answer and how to test the model.

Catherine Johnson said that optimal design of monitoring programs has been abandoned because the underlying question is changing over time. For example sampling for larval fish randomly may not provide data for zooplankton, so there is need to change sampling plan.

Peter Wiebe said we need to use models to help design field program, but for the N Atlantic basin, we don't have enough data to do this. The spatial coherence is 500–1000 km from CPR data. Coupling to shelf seas depends on shelf-ocean exchange. He referred to Benjamin Planque's thesis work. Catherine Johnson said that Scotian shelf coherence scales are 100km along shore, but resolution is limited.

Steve Hay said the state of community structure needs to be studied. Key species are the usual focus, but what about community structure? Are there modellers studying the species interactions and succession of species? Michael St John said that plankton functional group models of including succession are being developed. Charles Hannah said that prior studies have found that models with greater than 60 species lead to greater stability.

Mark Benfield asked that Todd O'Brien tell the modelling group how to access his online database. Todd O'Brien then gave a presentation on the copepod database availability, the same information he had presented earlier in the WGZE meeting, but it was very useful for the modellers to see and was well-received. The data can be accessed via the WGZE and Copepod websites (see WGZE report for further details).

WGPBI members were very impressed by the new NOAA Coastal and Oceanic Plankton Ecology, Production and Observation Database. COPEPOD is an online, global coverage plankton database (O'Brien 2005) that can be found at http://www.st.nmfs.noaa.gov/plankton/index.html. The goal is to provide an integrated data set of quality-controlled, globally distributed plankton abundance, biomass and composition data, along with co-sampled environmental data. The maps of biomass are fascinating. In addition to data distribution maps the site offers a variety of content summaries and searching options.

Astthor Gislason asked what joint regional projects are possible. Peter Wiebe said we need trans-regional studies combining data and models.

Elizabeth North said that one of the outcomes of the larval fish workshop earlier in the week was the recognition of the need to quantify mortality in larval fish. She suggested having a joint session on mortality of fish, zooplankton, and phytoplankton. Peter Wiebe said that we have great NWA GLOBEC data set on mortality of larval fish.

Luis Valdes, as Chair of ICES Oceanography Committee, congratulated the WGPBI and WGZE for their excellent work as working groups and in the joint meeting.

At the end of the session, the group thanked Delphine Bonnett for her hard work and excellent job in hosting the joint meeting.

11 Other relevant national and international projects

11.1 WKZEM Workshop

ToR g) finalize preparations for the WKZEM Workshop

Lead: Astthor Gislason, Rapporteur: Solvita Strake

The group was introduced to the subject by the Chair. The name of the workshop is 'Joint ICES/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic (WKZEM)' (Co-Chairs: Astthor Gislason, Iceland, and Gabriel Gorsky, France). The Chair emphasised that the name of the Workshop reflects that two parallel organisations, ICES and CIESM, are involved in the organisation. A website (www.wkzem.net) has been created by Todd O'Brien, with important information about the workshop, such as dates, scientific programme, topics, deadlines and information about travel and lodging. Due to the capacity of the meeting rooms the number of participants will have to be limited to 50–60 persons.

Astthor then went quickly through the history of the workshop: The idea was first put forward by Gabriel Gorsky at the 2005 meeting of the group in Lisbon. A formal proposal to ICES was made the following year, which was approved by the Council the same year. An announcement was sent out to the scientific community on 7 August 2007, and a Workshop Web page published 14 January 2008.

The members of the scientific advisory committee of the Workshop are: Ioanna Siokou-Frangou (Greece), Nejib Daly-Yahia (Tunisia), Roger Harris (UK), Steve Hay (UK), Kremena Stefanova (Bulgaria), Luis Valdés (Spain).

The Workshop will be held at the Hellenic Centre for Marine Research, Heraklion, Crete, Greece, 27–30 October 2008. It will consist of 3 days with presentations and discussions, half day with discussions on perspectives and future plans, and a half day field trip).

The agenda will include 1) Comparative zooplankton ecology of the North Atlantic and the Mediterranean Sea; 2) Overview of on-going time series programmes in both regions; 3) Harmonization of methods, overview of experimental work; 4) Appearance or disappearance of species vs. global warming; 5) Autecology of key species; 6) The marine food web from microzooplankton to small pelagic fish.

15 May 2008 is set as deadline for abstracts submission.

After Astthor's introduction, a discussion followed on funding opportunities. Astthor told the group that he had asked ICES for support, but not unexpectedly ICES answered that it did not sponsor/cover expenses for the holding of Expert Group meetings.

Gabriel Gorsky mentioned that the CIESM people had funds to cover all the expenses for five participants.

Roger Harris said that he and Ioanna Siokou had applied to Eur-Oceans (European Network of Excellence for Ocean Ecosystem Analysis) and secured €6000, that should cover bus transport, coffee breaks and maybe partly the excursion.

Mark C. Benfield thought that the 'Total Foundation for Biodiversity and the Sea' may be interested in funding the WGZEM workshop.

The following discussion revealed that support may also be sought in national or bilateral funds, like the French company, TOTAL.

Astthor Gislason then went on to present different options as to outcomes or deliverables of the workshop. As a minimum we must produce a workshop report to both ICES and CIESM. Additional deliverables could include publication of accepted presentations in the ICES Cooperative Research Series, JORD (an on-line journal www.obs-vlfr.fr/Journal/index.php/JORD), or a Scientific Journal, either as a single review article or as a collection of papers.

A discussion followed on these different options. Priscilla said that emphasis should be put on papers with a comparative approach involving either field work or methodology.

Astthor Gislason said that if we decided to go for publication in a scientific journal we might consider having the deadline for paper submission c. three months after workshop so as to enable people to complete their papers after having received critique at the presentations. Priscilla Licandro answered that if we want comparative work to evolve involving presentations from the workshop then we would need more than three months, maybe rather one year

Gabriel Gorsky said that first we needed to get people together and only after that we can discuss about the papers. Gabriel emphasised that the workshop was an important step forward.

Roger Harris asked how we should decide who would be allowed a presentation (if oversubscribed). What procedure or rule will be applied. Astthor answered that comparative work will be prioritised. He said that in most cases abstract should describe the data, what you are going to do, what you found out, and these would have to be used in order to select participants. Gabriel Gorsky said that the Steering Committee would have a role in the selection process.

Todd O'Brien suggested that abstract should be posted online with one figure per abstract. Would serve as to attract audiences and safe paper. Priscilla Licandro supported the view that abstracts be put to internet

Astthor Gislason summarised the discussion on deliverables as follows: It is the consensus of the group that in addition to a conventional Workshop Report to ICES and CIESM, selected presentations and/or extended abstracts of all presentations be published in the ICES Cooperative Research Report Series. Publication in the on-line journal JORD will also be considered.

11.2 New phytoplankton Working Group

ToR h) review the planning of a new working group related to phytoplankton and microbial ecology

Lead: Astthor Gislason, Rapporteur: Arno Pollumae

Astthor Gislason introduced the background for this ToR, namely that in 2006 the WGPE was dissolved due to lack of commitment, and in 2007 a new group formed (the Planning Group on Phytoplankton and Microbial Ecology, PGPYME), lead by John Steele, Franciscus Colijn, and Ted Smayda, whose task was to prepare the ground for a new ICES Working Group on Phytoplankton and Microbial Ecology (to start 2008). PGPYME worked by correspondence in 2007, with contacts made to WGPBI, WGZE, WGHABD and WGRP. On the initiative of Luis Valdes Chair of OCC, WGZE seeked help in preparing for a new Phytoplankton Working group by identifying people in the different laboratories that might be interested in working in such a group. At the 2007 ASC in Helsinki John Steele presented a report of the limited progress made (ICES CM 2007/OCC:01). Although not successful in developing a new Phytoplankton Working Group, the group made an important contribution by proposing a Theme Session for the 2008 ASC in Halifax that was approved by ICES: 'Incorporating microbial dynamics in studies of shelf ecosystems', Conveners: John Steele (US), Franciscus Colijn (Germany), and Carlo Heip (the Netherlands). PGPYME is dissolved from 2007.

In the discussion that followed it was noted that active phytoplankton specialists are already preoccupied in WGHABD and probably there are not enough interested persons to make another group. So maybe the solution would be to extend the topics of WGHABD. Anyway the WGHABD have more knowledge and relation to phytoplankton and is thereby more suitable community to discuss a new phytoplankton working group than the WGZE. WGZE had the same ToR on its last meeting, and to our understanding we have done our best and cannot do more in the current situation.

11.3 4th ICES/PICES/GLOBEC International Zooplankton Production Symposium

ToR j) assess and report on the outcomes of the 4th ICES/PICES/GLOBEC International Zooplankton Production Symposium

This ToR was not discussed during the meeting, as a report has already been made to ICES (ICES CM 2007/C:X). The symposium – The 4th International Zooplankton Production Symposium, 'Human and Climate Forcing on Zooplankton Populations' – was co-sponsored by the International Council for the Exploration of the Sea (ICES), North Pacific Marine Science Organization (PICES) and Global Ocean Ecosystem Dynamics Project (GLOBEC), and was held in May 28 – June 1, 2007, at the Congress Centre in Hiroshima (Japan), gathering 334 participants from 56 countries from around the world.

The symposium was a great success with a total of 139 oral presentations being given and 12 invited talks. Parallel to the oral presentations, two poster sessions exhibited 292 posters during the Symposium.

A selection of the best symposium papers will be published in a volume of the ICES Journal of Marine Science in late 2008, invited Guest Editors are Shin-ichi Uye and Mike Dagg (PICES,)Roger Harris (GLOBEC) and Luis Valdés (ICES).

11.4 SCOR Working Group 130: RAPID

Mark C. Benfield told the group about the SCOR Working Group 130, that was established in 2007 to advance our capacity to use computers to identify plankton from images collected with in situ and laboratory instruments. The Working Group consists of taxonomists, zooplankton ecologists, software and hardware developers, and computer scientists representing 13 nations. The first meeting was held in Hiroshima following the Zooplankton Production Meeting. The group is currently working to develop a flexible open-source software toolbox that is capable of taking a user through a sequence of steps that begin with acquisition of images and culminates in taxonomically-explicitly groupings of organisms. The next meeting will be held in Sao Paolo Brazil in May 2008.

11.5 The Basin Programme

Lead: Peter Wiebe, Rapporteur: Roger Harris

Peter Wiebe provided a brief update on the current status of BASIN, Basin-scale Analysis, Synthesis and Integration. This initiative seeks to foster a coordinated joint US, Canadian and EU research programme in the North Atlantic basin. In his introduction it was noted that BASIN had very much developed out of some of the data networking activities encouraged by the WGZE. BASIN is highly relevant to the future interests of the WGZE.

The justification and rationale for BASIN is the scale of influence of global change and the added value of co-coordinating the scientific activities of the EU and North American countries to assess, predict, and mitigate the impact of climate and anthropogenic forcing on marine ecosystems and services of the North Atlantic. A crucial step towards such a coordinated approach is the development of a Science Plan and Implementation Strategy whereby jointly funded international projects can be supported. The BASIN programme will seek to:

- understand and simulate the population structure and dynamics of broadly distributed, and trophically and biogeochemically important plankton and fish species in the North Atlantic ocean;
- resolve the impacts of climate variability on marine ecosystems and the feedbacks to the climate system, and to develop understanding;
- develop models that will advance ocean management.

Support for BASIN, to hold four meetings in 2007, has been provided by the US NSF and an EU Specific Support Action (SSA) (6th Framework Programme Sub-Priority 1.1.6.3). The scale of influence of global change and the added value of coordinating the scientific activities of the EU and North American countries to assess, predict, and mitigate the effects on marine ecosystems of the North Atlantic and their services is the justification for the development of the SSA.

These workshops build on the actions identified in the 2005 BASIN Workshop in Reykjavik jointly funded by NSF and EUR-OCEANS. Full details of the outcome of the Reykjavik meeting can be found in the report (Wiebe, P.H., R.P. Harris, M.A. St. John, F.E. Werner and B. de Young. (Eds.). 2007. BASIN. Basin-scale Analysis, Synthesis, and INtegration. GLOBEC Report 23 and U.S. GLOBEC Report 20. 1–56pp). http://www.globec.org/structure/multinational/basin/BASINweb.pdf.

The further development of the programme goals began at the first SSA meeting held in Hamburg in January 2007 and was continued at a second meeting held 1–3 May, 2007, in Chapel Hill North Carolina. These meetings involved open discussion in working groups with experts from both the EU and North America. The approach taken towards the development of a plan for BASIN begins with:

- The assessment of the status of climate-related ecosystem research in the North Atlantic Basin and associated shelf seas;
- Identification of the gaps in systematic observations and process understanding of atmospheric and oceanic parameters;
- Identification of the potential for consolidation of long-term observations from EU and international databases for modeling and prediction.

BASIN will focus on resolving the natural variability, potential impacts and feedbacks of global change on the structure, function, and dynamics of ecosystems. The programme will also seek to improve the understanding of marine ecosystem functioning. Improved understanding and modeling will be applied to the development of new and improved approaches to ecosystem-based management. BASIN will contribute significantly to the Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan via the development of comprehensive, coordinated, and sustained observations of the earth system, improved monitoring of the state of the earth, increased understanding of earth processes, and enhanced prediction.

The report, from the Hamburg meeting, can be found at: http://web.pml.ac.uk/globec/structure/multinational/basin/Reports/Hamburg_MeetingRpt.pdf.

The report summarizes the activities and discussions from this first of four BASIN SSA meetings. The purpose of this first European meeting was to start the process leading to the development of a Science Plan that would enable the integration and advancement of observation, monitoring, and prediction of ecosystems of the North Atlantic basin and shelf seas in order to assess the impact of climate variability and

change on their processes. A number of questions for potential further development were identified during the Hamburg Workshop. These include:

- How will climate change, as manifested through changes in, e.g., temperature, stratification, transport, etc., influence the phenology of features such as the spring bloom, the flux of carbon to the deep ocean, and interactions between trophic levels? How do these dynamics differ from the shelf to the open basin? What are the potential feedbacks to climate?
- Has the harvesting of resources such as fish stocks resulted in a restructuring of marine ecosystems? How do these changes in ecosystem structure influence the sequestering of carbon in the deep ocean and on the continental shelves as well as the resilience of these ecosystems?
- How are the populations of phytoplankton, zooplankton, and icthyoplankton influenced by the present large-scale basin circulation and what is the influence of changes of the oceanic and atmospheric climate on their population dynamics?
- How do the overwintering strategies of organisms, involving both vertical and horizontal migration, lead to the observed patterns of community structure?

The second BASIN SSA Workshop was held at Chapel Hill, North Carolina, 1–3 May, 2007. The goal was to build upon previous and ongoing research in the North Atlantic, integrating and synthesizing the results of these programmes, thus determining the mechanisms that link zooplankton, fish, ocean biogeochemistry, climate and environment at ocean basin scales. The Hamburg meeting had primary input from European participants, with limited representation of North American scientists. The Chapel Hill meeting built on the Hamburg results with greater representation from North Americans than from Europeans. Key issues were:

- Assess and report on the status of climate-related ecosystem research in the North Atlantic basin and associated shelf seas (from Georges Bank to the Barents Sea and the North Sea shelf) conducted intensively over the past decade particularly through national GLOBEC programmes (US, Canada, UK, Germany), GLOBEC related projects (ICES, Mare Cognitum), and EU projects, particularly ICOS and TASC.
- Identify and document gaps in systematic observations and understanding of atmospheric and oceanic parameters, necessary to improve forecasting of ecosystems in the North Atlantic and associated shelves.
- Identify via the development of a meta-database the potential for consolidation of long-term observations from North American, EU and other international databases for the modelling and in particular prediction of the dynamics of North Atlantic and associated shelf ecosystems and their services (biogeochemical and exploited resources).
- Consider the feasibility of producing a science plan for the future development a BASIN research programme on:
- Resolving the natural variability, potential impacts and feedbacks of global change on the structure, function, and dynamics of the ecosystems of the North Atlantic Basin and associated shelf seas;

- Improving the understanding of marine ecosystem functioning in North Atlantic Basin and associated shelf seas;
- Developing ecosystem based management strategies that incorporate the effects of global change and hence contribute to the sustainable use of the marine resources of the North Atlantic Basin and associated shelf seas.

The report, from the Chapel Hill meeting, can be found at: http://web.pml.ac.uk/globec/structure/multinational/basin/Reports/ChapelHill_rpt.pdf

Further information, documents, and news of the development of the BASIN programme can be found at:

http://web.pml.ac.uk/globec/structure/multinational/basin/basin.htm

A small group met for a subsequent writing meeting in Amsterdam, 28–30 January, 2008, to start work on a Science Plan and Implementation Strategy. It is envisaged that this will be structured around three fundamental questions which will drive the envisioned research:

Question 1. How will climate variability and change – for example changes in temperature, stratification, transport, acidification – influence the seasonal cycle of primary productivity, trophic interactions, and fluxes of carbon to the benthos and the deep ocean?

- How will the response to these changes differ across the basin and among the shelf seas?
- More specifically, how are the populations of phytoplankton, zooplankton, and higher trophic levels influenced by large scale ocean circulation and what is the influence of changes in atmospheric and oceanic climate on their population dynamics?
- What are the consequences of changes in ecosystem structure and dynamics for climate?

Question 2. How do life history strategies of target organisms, including both vertical and horizontal migration, contribute to observed population dynamics and community structure and how are these life history strategies affected by climate variability?

- How will life history influence the response of key species to anthropogenic climate change?

Question 3. How does the removal of exploited species influence marine ecosystems? Under what conditions can such harvesting result in substantial restructuring of shelf or basin ecosystems, i.e., alternate stable states?

- Do such changes extend to primary productivity and nutrient cycling?
- How is resilience of the ecosystem affected

Deliverables anticipated as a result of the BASIN programme, which will be articulated in the Science Plan and Implementation Strategy include:

1. Enhanced basin-scale coupled physical/biological operational model systems.
2. Hindcasts of the state and variability of North Atlantic ecosystems for past 50 years.
3. An estimate of the current state and variability of North Atlantic ecosystems.

4. Report on the response of the North Atlantic ecosystem to climate change.
5. An assessment of the ecosystem connectivity of the North Atlantic.
6. An assessment of the effects of upper trophic levels on carbon cycling.
7. Report on key species and their forces and feedbacks.
8. Estimates of local (shelf) versus remote (deep ocean) natural and anthropogenic effects on forage fish production.
9. Improved decision support tools for pelagic fish stocks based on basin-scale forcing.

It is proposed to hold a further writing meeting in the summer of 2008 with a view to having a final Science Plan and Implementation Strategy completed by the fall of 2008. This will then be published in the GLOBEC Report Series.

11.6 Facilities and scientific research topics at the Marine Biological Research Station Sète, University of Montpellier

Professor Behzad Mostajir, CNRS (France's National Centre for Scientific Research), University of Montpellier, then gave an interesting presentation of the MICRObial food WEB research group (MICROWEB) of the 'ECOsystèmes LAGunaires' laboratory (ECOLAG). ECOLAG is a coastal research laboratory that is associated with CNRS, the University of Montpellier 2, and IFREMER. The research foci of ECOLAG are:

- Coastal ecology, including microbial food web functioning, planktonic and benthic ecology,
- Toxic algae physiology and ecology,
- Pathogen bacterial physiology and ecology,
- Crustaceans and fishes ecology, physiology and immunity.

Professor Behzad Mostajir is the leader of the MICROWEB group, which is one of the six research groups of ECOLAG. MICROWEB has the following general objectives:

- The interactions between microbial organisms within or between communities and their responses to changing environments due to local or global anthropogenic stressors (light, temperature, nutrients, pH, mixing, etc.).
- The transfer of microbial C fluxes towards the upper trophic level is also studied by our group by investigating the trophic relationships between microbes and mesozooplankton (e.g. copepods).
- The ability to study the microbial food web and its biological components as a whole is critical to gaining insights on the functioning of marine ecosystem.

Professor Mostajir thenwent on to describe the research projects of MICROWEB. These include studies on ecosystem functioning, trophic studies, studies on environmental stresses of marine organisms.

Professor Mostajir then told the group about the MEDIMEER programme (MEDiterranean platform for Marine Ecosystem Experimental Research). Using mesocosms MEDIMEER seeks to quantify and qualify physical, chemical and biological forcing on the biodiversity, interactions and functioning of aquatic food webs. The MEDIMEER mesocosms are ideally placed in Sète. The mesocosms are of different sizes from 1–20 l to up to 50 m^3. Professor Mostajir then went on to describe

several interesting research projects that are carried out using the facilities of MEDIMEER. One example is a project to study biodiversity and food web functioning; another example a project to study the effects of global changes (ultraviolet-B radiation and temperature increases) on the microbial food web.

Professor Mostajir ended his presentation by informing about a Network of leading MESOcosm facilities to advance the studies of future AQUAtic ecosystems from the Arctic to the Mediterranean (MESOAQUA). The network is lead by Professor Jens C Nejstgaard (University of Bergen) and has participants from six institutions in five countries.

12 Summary discussion, future plans

12.1 Election of new Chair

Astthor Gislason will complete his three-year term of office as Chair of WGZE on 31 December 2008. The working group held a vote to propose a replacement for him.

Dr Mark C. Benfield, Associate Professor, Department of Oceanography and Coastal Sciences, Coastal Fisheries Institute, Louisiana State University, USA, was proposed and unanimously voted for as new Chair of the group. Mark C. Benfield is a longstanding and active member of the WGZE and has kindly agreed to lead the group through the next term.

12.2 Recommendations

The ICES Working Group on Zooplankton Ecology recommends to the Oceanography Committee the following Theme Sessions for the 2009 ICES Annual Science Conference. Supporting information is given in Annex 6.

'Biochemical, biogeochemical, and molecular approaches to the study of plankton ecology and species diversity.' Convenors: Steve Hay (UK), Janna Peters (Germany), and Ann Bucklin (USA).

Other recommendations (Advice to PGEGGS, support for ICES Fiches Identification Sheets and for developing them into a modern web-based format) are included in Annex 10.

12.3 Draft resolutions

WGZE Terms of Reference proposed for 2009

After discussion of future ToRs, the following suggestions were made, 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 (Annex 8):

a) Produce a summary of recent developments in plankton research and monitoring (e.g. seasonality, abundance, community structure, biodiversity, evidence/rationale for incorporating zooplankton in monitoring) with a view to further analysis and subsequent publication.

b) Assess and report on the outcomes of WKZEM, the ASC 2008 theme session Q, and the 2008 WGZE/WGPBI joint meeting.

c) Provide expert knowledge and guidance to ICES Data Centre on a continuous basis including a progress on the digitizing project and begin an inventory of historical data and samples.

d) Update the ICES Plankton Status Report and report on the progress of linking the Status Report data to the ICES data centre.

e) Review progress in zooplankton taxonomy with particular reference to developments within ICES.

Proposal for publication of the proceedings of the WKZEM Workshop

WGZE proposes that the Proceedings of the Joint ICES/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic (WKZEM) (Co-Chairs: Astthor Gislason, Iceland, and Gabriel Gorsky, France), be published in the ICES Cooperative Report Series. Supporting information is given in Annex 9.

12.4 Next meeting (2009)

It is proposed to hold the next meeting (2009) of the Working Group on Zooplankton Ecology at the Faroese Fisheries Laboratory, Tórshavn, Faroe Islands, from 30 March to 2 April 2009, kindly hosted by Dr Eilif Gaard of the Faroese Fisheries Laboratory.

13 Closure of the meeting

Astthor Gislason (Chair) thanked all members for their contributions and the stimulating discussions. He also thanked the colleagues of the University of Montpellier for their contributions and Dr. Delphine Bonnet for her kind hospitality and the excellent organisation at every stage. Astthor looked forward to seeing the participants at the meeting next year.

The meeting was closed at 13:00 on 3 April 2008.

14 References

Buitenhuis, *et al*. 2006. Biogeochemical fluxes through mesozooplankton. Global Biochemical Cycles. 20.

Bunker, and Hirst, 2004. Fecundity of marine plankton copepods: global rates and patterns in relation to chlorophyll a, temperature and body weight. Marine Ecology progress Series 279:161–181.

Hirst, and Kiørboe, 2002. Mortality of marine planktonic copepods: global rates and patterns. Marine Ecology Progress Series 230: 195–209.

Hernandez-Leon, Fraga, and Ikeda, 2008. A global estimation of mesozoo-plankton ammonium excretion in the open ocean. Journal of Plankton Research (submitted).

Hernandez-Leon, and Ikeda, 2005. A global assessment of mesozooplank-ton respiration in the ocean. Journal of Plankton Research, 27:153–158.

ICES. 2006. Zooplankton monitoring results in the ICES area, Summary Status Report 2003/2004. Ed. by Luis Valdes, Todd O'Brien and Angel López-Urrutia. ICES Cooperative Research Report, No. 276. 34 pp.

ICES. 2006. Zooplankton monitoring results in the ICES area, Summary Status Report 2004/2005. Ed. by Luis Valdes, Todd O'Brien and Angel López-Urrutia. ICES Cooperative Research Report, No. 281. 43 pp.

ICES. 2007. Planning Group on Phytoplankton and Microbial Ecology (PGPYME). By correspondence. ICES CM 2007/OCC:01. 2 pp.

ICES. 2007. Report of the 4th International zooplankton production symposium. ICES CM 2007/C:X. 14 pp.

ICES. 2007. Report of the Consultative Committee (ConC), September 2007. ICES CM 2007/ConC:01. 75 pp.

ICES. 2007. Report of the Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea (PGEGGS), By Correspondence. ICES CM 2007/LRC:13. 14 pp.

ICES. 2007. Report of the Working Group on Zooplankton Ecology (WGZE), 26–29 March 2007, Riga, Latvia. ICES CM 2007/OCC:04. 66 pp.

ICES. 2007. Report of the Working Group on Ecosystem Effects of Fishing Activities (WGECO), 11–18 April, 2007. ICES CM 2007/ACE:04. 162 pp.

ICES. 2007. Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2007. ICES Advice. Books 1 – 10. 1,333 pp.

ICES. 2008. Draft ICES Science Plan (2009–2014). 22 February 2008. 14 pp.

ICES. 2008. Report of the Study Group on Working Hypotheses Regarding effects of Climate Change (SGWRECC), By correspondence. ICES CM 2008/ACOM:43. 34 pp.

ICES. 2008. Hydrographic Attributes of the OSPAR Sub-Regions. Working document by ICES Working Group on Oceanic Hydrography. January 2008. 13 pp + figures.

O'Brien, T.D. 2005. COPEPOD: A Global Plankton Database. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-73, 136p.

Annex 1: List of participants

Name	Address	Phone/Fax	Email
Ann Bucklin	University of Connecticut - Avery Point 1080 Shennecossett Road Groton, CT 06340 USA	+ 860-405-9208	ann.bucklin@uconn.edu
Arno Põllumäe	Estonian Marine Institute Tallinn Estonia	+3726718974	arno@sea.ee
Ástþór Gíslason (*Chair)*	Marine Research Institute PO Box 1390 Skúlagata 4, IS-l21 Reykjavík Iceland	+354-552-0240	astthor@hafro.is
Cabell S. Davis	Woods Hole Oceanographic Institution Mail Stop 33 Woods Hole, MA 02543 USA	508-289-2333	cdavis@whoi.edu
Catherine Johnson	Fisheries and Oceans Canada Bedford Institute of Oceanography P.O. Box 1006, Dartmouth, NS, B2Y 4A2, Canada	1 (902) 426-0753	JohnsonC@mar.dfo-mpo.gc.ca
Cecilie Broms Årnes	Institute of Marine Research Postbox 1870 Nordnes 5817 Bergen Norway	(+47)55236991	cecilie.broms.aarnes@imr.no
Damien Eloire	Plymouth Marine Laboratory (PML) Prospect Place The Hoe Plymouth PL1 3DH UK	44 (0)1 752 633 466	dmelo@pml.ac.uk
Delphine Bonnet	UMR 5119 CNRS- Université Montpellier II Université Montpellier II Case 093, Place Eugène Bataillon 34095 Montpellier Cedex 05 France	+33 4 67 14 47 63	dbonnet@univ-montp2.fr
Eilif Gaard	Faroese Fisheries Laboratory, Box 3051, FO-110 Torshavn, Faroe Islands	(+298) 353900	eilifg@frs.folv
Erica Head	Bedford Institute of Oceanography Department of Biological Oceanography Challenger Drive, P.O. Box 1006, Dartmouth Nova Scotia, B2Y 4A2 Canada	+01-902-426-2317	heade@mar.dfo-mpo.gc.ca

Name	Address	Phone/Fax	Email
Gabriel Gorsky	Observatoire Océanologique LOV - UMR 7093 BP 28 06234 Villefranche-sur-Mer Cedex France	04 93 76 38 16	gorsky@obs-vlfr.fr
Heike Helmholz	GKSS Research Centre Inst. for Coastal Research/Operational Systems Marine Bioanalytical Chemistry Max-Planck-St. 21502 Geesthacht Germany	04152/87-1844	heike.helmholz@gkss.de
James J. Pierson	Horn Point Laboratory University of Maryland Center for Env. Science 2020 Horns Point Rd Cambridge, MD 21613 USA	410-221-8218	jpierson@hpl.umces.edu
Janna Peters	University of Hamburg Institute of Hydrobiology and Fishery Science Olbersweg 24 D-22767 Hamburg Germany	+49(0)172 - 4015639	janna.peters@uni-hamburg.de
Jeff Runge	School of Marine Sciences University of Maine Gulf of Maine Research Institute 350 Commercial Street Portland, ME 04101 USA	(207) 228-1652	jeffrey.runge@maine.edu
Jens Rasmussen	FRS Marine Laboratory Aberdeen PO Box 101, Victoria Road Aberdeen AB11 9DB Scotland UK	+44 (0) 1224 295440	J.Rasmussen@marlab.ac.uk
Jörn Schmidt	Leibniz-Institute of Marine Sciences Kiel Marine Ecology Fishery Biology Duesternbrooker Weg 20 24105 Kiel Germany	+49 431 600 4557	jschmidt@ifm-geomar.de
Luis Valdés	Centro Oceanográfico de Gijón Instituto Español de Oceanografía Avda. Príncipe de Asturias 70 bis 33213 Gijón, Asturias Spain	+34 985 308 672	luis.valdes@gi.ieo.es
Maria Manuel Angélico	INIAP/IPIMAR Fisheries Research Institute Lisboa Portugal	+ 351 213027068	angelico@ipimar.pt

Name	Address	Phone/Fax	Email
Mark C. Benfield	Louisiana State University Dept of Oceanogr. and Coastal Science Room 2181 Baton Rouge, LA 70830 USA	+1 225-578-6372	mbenfiel@lsu.edu
Michel Harvey	Maurice Lamontagne Institute Fisheries and Oceans Canada 850, route de la Mer CP 1000 Mont-Joli Québec, Canada G5H 3Z4	418-775-0677	harveym@dfo-mpo.gc.ca
Peter Wiebe	Woods Hole Oceanographic Instituion MS#33 Woods Hole, MA 02543 USA	+1 508 289 2313	pwiebe@whoi.edu
Priscilla Licandro	SAHFOS The Laboratory Citadel Hill Plymouth, PL1 2PB United Kingdom	+44 (0) 1752 633289	PRLI@sahfos.ac.uk
Roger Harris	Plymouth Marine Laboratory Prospect Place Plymouth, PL1 3DH United Kingdom	+44 1752 633400	rph@pml.ac.uk
Solvita Strake	Institute of Aquatic Ecology University of Latvia Daugavgrivas 8 LV 1048 Riga Latvia	+371 761 0850	solvita@hydro.edu.lv
Sophie Pitois	CEFAS Lowestoft Laboratory Lowestoft Suffolk, NR33 0HT United Kingdom	+44 (0) 1502 527785	sophie.pitois@cefas.co.uk
Steve Hay	Fisheries Research Services Marine Laboratory Aberdeen Scotland United Kingdom	44 1224 295448	haysj@marlab.ac.uk
Todd D. O'Brien	NOAA - NMFS - Science & Technology Marine Ecosystem Division USA	301) 713-2363 x174	Todd.OBrien@noaa.gov
Webjørn Melle	Institute of Marine Research Nordnesgt. 50 P.O. Box 1870 Bergen Norway	+47 55 23 84 77	webjoern.melle@imr.no

Annex 2: Agenda

Monday 31 March

11:00–12:00 **OPENING, AGENDA, ANNOUNCEMENTS**

12:00–13:30 Lunch

13:30–14:15 **DATA MANAGEMENT ISSUES**

(Lead: Peter Wiebe, Rapporteur: Sophie Pitois)

ToR k) provide expert knowledge and guidance to ICES Data Centre (possibly via sub-group) on a continuous basis

14:15–15:00 **ADVICE TO PGEGGS**

(Lead: Steve Hay, Rapporteur: Damien Eloire)

Provide advice to PGEGGS on the value of collecting additional zooplankton samples during future North sea ichthyoplankton surveys in 2009

15:00–15:30 Coffee break

15:30–18:00 **ZOOPLANKTON METHODOLOGY**

(Lead: Sophie Pitois, Rapporteur: Eilif Gaard)

ToR e) compare and report on different nets and mesh sizes and their efficiency

ToR f) compare and report on different measures for zooplankton biomass from regions within the ICES area

- Presentation: Steve Hay: The ICES Plankton Sheets
- Presentation: Priscilla Licandro: Comparison of zooplankton biomass measured as dry weight and wet weight

Tuesday 1 April

9:00–10:30 **ICES PLANKTON STATUS REPORT**

(Lead: Todd O'Brien, Rapporteur: Ann Bucklin

ToR b) update the ICES plankton status report and consider ways of incorporating biophysical modelling approaches in interpretation

ToR c) prepare species lists from time series stations and/or areas in the ICES area

ToR i) produce an evidence based rationale for incorporating zooplankton monitoring into regulatory assessment frameworks

- Presentation: Catherine Johnson: Compiling species lists
- Presentation: Damien Eloire: Zooplankton taxonomic list of the ICES zooplankton time-series

10:30–11:00 Coffee break

11:00–12:00 **NEW ICES STRUCTURE**

(Lead: Luis Valdés, Rapporteur: Astthor Gislason)

Provide comments on Draft ICES Science Plan

12:00–13:30 Lunch

13:30–15:00 **OSPAR CLIMATE REQUEST**

(Lead: Priscilla Licandro and Eilif Gaard, Rapporteur: Cabell Davis)

ToR a) Consider the reports of the Ad Hoc Groups on

i) Hydrographic Attributes

ii) Trend Analyses and Quantifying Relationships

iii) Formulating Hypotheses and Predictions about Mechanisms

iv) Selecting Species for More Intensive Investigations

and use their recommendations concerning (1) recommended time series, (2) analytical methods and suitable software, (3) hypotheses and guidance for their use, and (4) a suggested list of species for intensive study, to complete 'the assessment of changes in the distribution and abundance of marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature;

15:00–15:30 Coffee break

15:30–17:00 **OSPAR CLIMATE REQUEST (Cont)**

17:00–18:00 **OSPAR REQUEST FOR AN ASSESSMENT ON THE STATUS OF BIODIVERSITY**

(Lead: Astthor Gislason, Rapporteur: Webjörn Melle)

Consider OSPAR request for a Scoping Report on summaries of the status of biodiversity

- Presentation: Ann Bucklin: Barcoding for CoML: Assessing Zooplankton Diversity

Wednesday 2 April

JOINT MEETING OF WGZE AND WGPBI

ToR d) report on approaches for combining field and laboratory data together with biological-physical models to examine processes controlling zooplankton populations

Session 1 Modeling (WGPBI) (Lead: Uffe H Thygesen, Rapporteur: NN)

09:00 Hannah: Overview of WGPBI

09:10 Osborne: Holographic imagery of turbulence and plankton (action item 11)

09:30 Woods: The LERM-ES model

09:50 Neuheimer: Modelling juvenile *Calanus finmarchicus* on Georges Bank: Where have all the nauplii gone?

10:10 Fennel (title TBA)

10:30–11:00 Coffee break

11:00 Werner and Hannah: Skill assessment for Coupled Physical-Biological Models of the Coastal Ocean (action item 15)

11:15 Discussion

11:30 End of session

Session 2 Data (WGZE) (Lead: Astthor Gislason, Rapporteur: Arno Pollumae)

11:30 Astthor Gislason: Overview of WGZE

11:40 Mark C. Benfield and Jörn Schmidt: Data collection methods

12:00–13:30 Lunch

13:30 Erica Head and Eilif Gaard: Available data sets: field studies

13:50 Roger Harris and Xabier Irigoien: Available data sets: laboratory studies

14:10 Webjörn Melle and Cecilie Broms Årnes: Statistical analysis

14:30 Jeff Runge and Catherine Johnson: Modelling needs – which questions should the models answer?

14:50 Discussion

15:00 End of session

15:00–15:30 Coffee break

Session 3 Future collaboration between WGZE and WGPBI (in Breakout Groups) (Lead: Charles Hannah and Cabell Davis, Rapporteur: NN)

15:30–17:30 Joint discussion

18:30–19:30 Boat Tour

Thursday 3 April

9:00–10:30 **OTHER ISSUES**

ToR g) finalize preparations for the ICES/CIESM Workshop

(Lead: Astthor Gislason, Rapporteur: Solvita Strake)

ToR h) review the planning of a new working group related to phytoplankton and microbial ecology

(Lead: Astthor Gislason, Rapporteur: Arno Pollumae)

- Presentation: Mark C. Benfield: SCOR Working Group 130: RAPID

The Basin Programme

(Lead: Peter Wiebe, Rapporteur: Roger Harris)

Presentation of facilities and scientific research topics at the Marine Biological Research Station Sète, University of Montpellier

(Lead: Delphine Bonnet)

10:30–11:00 Coffee break

11:00–13:00 **SUMMARY DISCUSSION, FUTURE PLANS**
Election of new Chair
Consideration of Terms of Reference for 2009
Suggestions for future ASC Theme sessions, Workshops etc.
Next meeting

13:00 **FINISH**

Annex 3: Some examples of web pages for plankton taxonomy

There are many existing efforts throughout the global internet to promote plankton taxonomy and to provide web based resources for plankton and taxonomy generally. Examples include:

- http://www.planktonnet.eu/en/home/
- http://www.hib.no/avd_al/naturfag/plankton/english/about/index.html
- http://www.cmarz.org/index.html
- http://www.e-taxonomy.net/
- http://www.eti.uva.nl/
- http://www.biology.duke.edu/hydrodb/index.html
- http://invertebrates.si.edu/copepod/
- http://www.obs-vlfr.fr/~gaspari/copepods_guide/
- http://copepodes.obs-banyuls.fr/index.php
- http://www.liv.ac.uk/ciliate/intro.htm
- http://ocean.iopan.gda.pl/ostracoda/index.php
- http://planktonweb.ifas.ufl.edu/
- http://www.copepoda.uconn.edu/
- http://www.luciopesce.net/copepods/
- http://www.marinespecies.org/index.php
- http://www.marbef.org/data/erms.php
- http://www.marinebarcoding.org/
- http://www.itis.gov/

Annex 4: Letter to Drs Mike Sinclair and Harald Loeng

Dr Mike Sinclair
ICES First Vice-President

Dr Harald Loeng
Chair of Consultative Committee

Reykjavik, 15 April 2008

Dear Drs M. Sinclair and H. Loeng

The WGZE commends the ICES Council Working Group for their hard work and insight in generating a set of priorities that captures the range of research subjects needed to develop an ecosystem approach to sustainable fisheries management. During its annual meting in Séte 31 March – 3 April 2008, the Working Group discussed advances in understanding climate forcing of recruitment variability through integration of field observations and laboratory experiments in coupled physical biological models. It recommends that the prospect for operational application of these models be explicitly included in the science plan priority #2 (Table 1 in Draft ICES Science Plan (2009–2014)). Three other small edits (comma after modelling and deletion of stray parenthesis in priority 2; substitute 'regime' for 'region' in priority 3) are recommended.

The following text is taken from Table 1 in the Draft ICES Science Plan (2009–2014), with our suggestions underlined.

2. Operational ecosystem modelling, combining operational oceanography, ecosystem and population processes leading to comprehensive assessments and medium term forecasts(3–5 year horizon), including environmental conditions for recruitment success (5.4.1)
3. Climate Change Predictions: Predictions of the responses of marine ecosystems within the ICES area to climate change scenarios, with attention to regime shifts and changes in trophic structure. Investigate the response of marine ecosystems within the ICES area to climate change scenarios, with attention to regime shifts and change in the trophic structure (5.3.1)

Yours sincerely

Astthor Gislason
(Chair of the ICES WGZE)

Annex 5: WGZE Report on the assessment of changes in the distribution and abundance of plankton in the OSPAR maritime area

April 2008

Assessment of changes in the distribution and abundance of marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature

A FURTHER REPORT ON THE ASSESSMENT OF CHANGES IN THE DISTRIBUTION AND ABUNDANCE OF PLANKTON IN THE OSPAR MARITIME AREA

PREPARED BY THE ICES WORKING GROUP ON ZOOPLANKTON ECOLOGY

Editors: Priscilla Licandro[1], Steve Hay, Heike Helmholz And Peter Wiebe

([1] Sir Alister Hardy Foundation for Ocean Science (SAHFOS), The Laboratory Citadel Hill, Plymouth, PL1 2PB, United Kingdom)

1. Introduction

The ICES Working Group on Zooplankton Ecology (ICES WGZE) produced in April 2007 a response to a specific request of OSPAR to assess and report on changes in the distribution, population abundance and condition of plankton in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature (Annex 3 of ICES WGZE report 2007, ICES CM 2007/OCC:04). The assessment was revised by WGECO (ICES Advice 2007, book 1) and ICES set up four Ad Hoc Groups of expert that were expected to develop a common framework for interpreting the results (ICES 2008 Working document, ICES CM 2008/ACOM:43).

In the present report ICES WGZE (i) revises the activity of the Ad Hoc Groups (paragraph 2.1), (ii) replies to the comments of WGECO synthesized in the Report of ACE 2007 (paragraph 2.2) and (iii) provides final recommendations in relation to the OSPAR request (paragraph 2.3).

2. Changes in the distribution and abundance of plankton in response to environmental variables in the OSPAR marine area

ToR a) consider the reports of the Ad Hoc Groups on;

I. Hydrographic Attributes

II. Trend Analyses and Quantifying Relationships

III. Formulating Hypotheses and Predictions about Mechanisms

IV. Selecting Species for More Intensive Investigations

and use their recommendations concerning (1) recommended time series, (2) analytical methods and suitable software, (3) hypotheses and guidance for their use, and (4) a suggested list of species for intensive study, to complete 'the assessment of changes in the distribution and abundance of marine species in the OSPAR maritime area in relation to changes in hydrodynamics and sea temperature.

2.1 Consideration of the reports of Ad Hoc groups

WGZE considered the reports of the Ad Hoc groups mentioned in the ToR: i) Hydrographic attributes and iii) Formulating Hypotheses and Predictions about Mechanisms that were available at the time of the WGZE meeting. No reports were available from the groups on ii) Trend Analyses and Quantifying relationships and iv) Selecting Species for More Intensive Investigation, as they did not meet before the WGZE meeting.

WGZE was aware of the hydrographic characteristics of the OSPAR sub-regions which have been described by the Study Group on Hydrographic attributes. Studies done within the WGZE community did already relate some hydroclimatic time series indicated from that Study Group to the changes reported in the plankton in the OSPAR area (see assessment of changes in the distribution and abundance of plankton in the OSPAR maritime area, Annex 3 of ICES WGZE report 2007).

A few members of the WGZE were actively involved in the Study Group on Working Hypotheses Regarding Effects of Climate Change (SGWRECC, ICES CM 2008/ACOM:43). The report of the SGWRECC and in particular (i) the hypotheses describing how the plankton could be altered by climate change and (ii) the patterns

that would be expected in the plankton data, were largely discussed during the WGZE meeting. Finally, the WGZE agreed that all nine hypotheses are worth investigating further, using the plankton time series available in the OSPAR area.

WGZE considered it important to provide some indications in relation to ToR iv) suggesting some zooplankton species that could be selected for more intensive investigation.

In particular the following categories should be targeted:

- dominant zooplankton genus/species that have shown significant changes in their spatio-temporal distribution in relation to hydroclimatic changes (e.g. the copepods *Calanus helgolandicus, C. finmarchicus, C. hyperboreus, Centropages typicus*);
- zooplankton groups that have increased due to hydroclimatic changes (e.g. meroplanktonic larvae of decapods or echinoderms, gelatinous filter feeders and gelatinous carnivorous);
- non native plankton species that have expanded their distribution possibly in relation to hydroclimatic changes (e.g. the cladoceran *Penilia avirostris*).

2.2 Reply to comments of WGECO and new information about changes in the distribution and abundance of plankton in relation to changes in hydrodynamics and sea temperature in the OSPAR area

WGZE reply to the following comments from WGECO to WGZE and synthesized by the Advisory Committee on Ecosystem (ACE) (ICES Advice 2007, book 1). For this, WGZE provide new information that is intended to complement the assessment produced during 2007 (see Annex 3 of ICES WGZE report 2007).

1) Limitation of CPR in sampling phytoplankton and importance of monitoring the micro-plankton component of plankton

The WGZE has focused on assessments of zooplankton for the status reports and for the OSPAR request the CPR data set was the primary source of information that most nearly provides both the time frame and spatial coverage requested. While the OSPAR Joint Assessment and Monitoring Programme has no stipulation about the collection of zooplankton data in the OSPAR region, it does mandate the collection of the 'composition, abundance, and biomass of phytoplankton' as well as the 'frequency and intensity of planktonic bloom', and it set area-specific abundance assessment levels for phytoplankton indicator species and chlorophyll a, an indicator of phytoplankton biomass. The WGZE recommends that these data be aggregated and assessed for the requested information.

2) Advantage of increasing the geographic coverage to offer a more complete picture of zooplankton change in the OSPAR area

Some regions in the OSPAR area, particularly the northernmost regions, are not well covered at present by the CPR sampling or by any other monitoring program. For this reason some information on the effect of climate on changes of zooplankton biomass in the Norwegian Sea has been provided here, on the basis of ICES coordinated surveys of the Norwegian Sea. Data collected during these surveys, which are done annually in May since 1995, have shown a progressive decrease in zooplankton biomass since 2002, mainly in Arctic waters, that are likely to be related to hydroclimatic variability (Working Document 1). In the Norwegian Sea the average biomass of zooplankton in Atlantic water in May used to be significantly

correlated with the average NAO for the March-April period the previous year, but the relationship has broken down since 2003.

Studies on the connection between hydroclimatic variability and plankton in different sub-regions of the Nordic Seas indicate a connection between zooplankton biomass and (i) the inflow of Atlantic water in the Barents Sea and in the waters north of Iceland and (ii) the East-Icelandic current in the Norwegian Sea (e.g. Gaard *et al*., 2006).

Any change in the hydrodynamic systems indicated above is likely to have consequences on the plankton in those regions.

3) Information gap on gelatinous zooplankton

The WGZE recognise that, while relatively poorly studied, the pelagic Cnidaria (Jellyfish), are a major plankton group. Increasingly they show changes in species distributions and abundances related to observed and anthropomorphic changes in ocean climate and health. WGZE recognises that most plankton studies concern the phytoplankton and mesozooplankton. The Jellyfish though, are among the most abundant marine predators in virtually all seas in terms of abundance, biomass and in their functional effectiveness as predators and competitors of fish. Some species have already caused major ecosystem disturbances when introduced to new areas. Perhaps the best example being the ctenophore *Mnemiopsis leydii*, originating along the American east coast, introduced in 1980s and 1990s into the Black and Caspian Seas (Shiganova *et al*., 1998). This voracious invader is now increasingly being found in the Baltic Sea and continental coastal North Sea from Bergen to the Netherlands (Faasse *et al*., 2006; Javidpour *et al*., 2006; Leppakoski *et al*., 2002).

Jellyfish are very often population bloom species, known as co-responsive with climate indices (Attrill *et al*., 2007; Brodeur *et al*., 1999; Goy *et al*., 1989; Hay, 2006; Lynam *et al*., 2004, 2005a; Mills 1995, 2001; Molinero *et al*., 2005). In areas with heavy commercial fishing (Benguela, Japan Sea, Bering Sea, North Sea) there have been indications that increased populations of jellyfish may replace or supplant the declining fish (Lynam *et al*., 2006; Pauly *et al*., 1998). This may inhibit fish stock recovery and have major ecosystem and economic consequences (Brodeur *et al*., 2002; Hay *et al*., 1990; Lynam *et al*., 2005b; Purcell and Arai, 2001; Purcell, 2005). Jellyfish may often exert strong predation pressure on the herbivore zooplankton, in competition with many planktivorous fish, bird and mammal populations. This top down control of mesozooplankton has been demonstrated as significantly reducing herbivorous control of phytoplankton growth; thus potentially exacerbating problems with algal blooms and eutrophication when jellyfish blooms occur (Arai, 2001).

By definition, Cnidaria species, (cnida = stinging cells) are toxic to varying degrees. This fact and their swarming behaviours mean that they have major health and economic impacts which range from rendering tourist resorts and beaches uninhabitable and often dangerous, affecting fishing operations and personnel, clogging seawater intakes (e.g. power station cooling), and increasingly causing very significant mortalities of sea farmed fish in almost all marine fish aquaculture areas. Such aquaculture losses may run to many millions per annum in investment and lost production; with poorly understood chronic and sublethal effects on fish growth also likely. Often such aquaculture losses are associated with influxes of oceanic Cnidaria into shelf and coastal seas. In November 2007, having already caused major tourist resort impacts in the western Mediterranean, large swarms of *Pelagia noctiluca* invaded the Irish Sea and western coastal waters of Ireland and Scotland, severely

impacting several salmon farms. Such incidents are not unprecedented, with other oceanic and coastal cnidarian species also being known causes of mortalities in farmed fish (e.g. *Muggiaea atlantica, Apolemia uvaria, Solmaris corona* and *Aurelia aurita*) along with toxic algal blooms (Greve 1994, Båmstedt *et al*., 1998).

In warmer waters associated with climate-change scenarios the frequency of jellyfish is expected to increase (Atrill *et al*., 2007). The temperature increase may affect different phases of jellyfish reproduction (strobilation period, survival of polyps and production of ephyrae) (Purcell, 2007); allow overwintering (Houghton *et al*., 2007)

There is a very rapidly growing interest in cnidarian plankton, with increasing studies and publications also in the OSPAR area. These include recent publications on the population dynamics and distribution of dominant scyphozoan medusae in the southern North Sea, west coast of Denmark, western Norway and in the Irish and Celtic Seas (Barz and Hirche 2007; Doyle *et al*., 2007; Hosia and Båmstedt, 2007; Møller and Riisgard, 2007).

2.3 Final recommendations of WGZE to OSPAR

WGZE finally recommends that long-term funding are guaranteed to maintain the few time series that exist at single sites and along transects, and to expand the CPR Survey with the aim of increasing the geographical coverage of zooplankton monitoring in the OSPAR area.

New CPR routes may be set up in the Arctic between Norway and Svalbard in mid 2008, providing information on plankton in the northernmost regions of the OSPAR area.

The WGZE recommends that zooplankton species and biomass be included in the JAMP guidelines since there are compelling reasons for this information to be available to assess climate changes effects on the marine community and fishery resources.

In addition, the WGZE considers that OSPAR should recognise the need of improving the monitoring of jellyfish in order to fill the gap of information on this group. While of course the WGZE recognise the ecosystem and foodweb significance of phytoplankton, mesozooplankton, fish, sea mammals and birds, the predatory invertebrate fauna must not be ignored. In taking an ecosystem approach to surveillance, monitoring and management in the OSPAR areas, one should take into account that invertebrate predators are critical to the health and productivity of marine ecosystems, and appear to be sensitive indicators of change.

3. References

Arai, M. N., 2001. Pelagic coelenterates and eutrophication: a review. Hydrobiologia 451 (Dev. Hydrobiol. 155): 69–87.

Attrill,M. J., Wright, J. and M. Edwards. 2007. Climate-related increases in jellyfish frequency suggest a more gelatinous future for the North Sea. Limnol. Oceanogr., 52(1), 480–485.

Båmstedt, U., Helge Fosså, J., Martinussen, M.B., and A. Fosshagen, 1998. Mass occurrence of the physonect siphonophore *Apolemia uvaria* (LESUEUR) in Norvegian waters. Sarsia, 83: 79–85.

Barz, K., and H. J. Hirche, 2007. Abundance, distribution and prey composition of scyphomedusae in the southern North Sea. Mar. Biol. 151, 1021–1033.

Brodeur, R. D., C. E. Mills, J. E. Overland, G. E. Walters and J. D. Schumacher. 1999. Evidence for a substantial increase in gelatinous zooplankton in the Bering Sea, with possible links to climate change. Fish. Oceanogr. 8: 296–306.

Brodeur, R. D., H. Sugisaki and G. L. Hunt. 2002. Increases in jellyfish biomass in the Bering Sea: Implications for the ecosystem. Mar. Ecol. Progr. Ser. 233: 89–103

Doyle, T., Houghton J., Buckley S., Hays G and J. Davenport, 2007. The broad-scale distribution of five jellyfish species across a temperate coastal environment. Hydrobiologia 579, 29–39.

Goy, J. P. Morand, and M. Etienne 1989. Long-term fluctuations of *Pelagia noctiluca* (Cnidaria, Scyphomedusa) in the western Mediterranean Sea. Prediction by climatic variables. Deep-sea Research, 36 (2): 269–279.

Faasse, M.A., A.H.M. Ligthart and K.M. Bayha, 2006. The first record of the ctenophore *Mnemiopsis leidyi* in Dutch estuaries: an unrecognized invasion? Aquatic Invasion.1(4): 270–277.

Gaard, E., Gislason, A., Melle, W. 2006. Iceland, Faroe and Norwegian coasts. In: The Sea: Ideas and Observations on Progress in the Study of the Seas. Volume 14. Interdisciplinary Regional Studies and Syntheses. Edited by Allan R. Robinson and Kenneth H. Brink. Harvard University Press, Cambridge. pp 1077–1109.

Greve, W. 1994. The 1989 German Bight Invasion of *Muggiaea atlantica*. Ices J. Mar. Sci, 51: 355–358.

Hay, S. J., J. R. G. Hislop and A. M. Shanks, 1990. North Sea scyphomedusae: summer distribution, estimated biomass and significance particularly for 0-group gadoid fish. Neth. J. Sea Res., 25: 113–130.

Hay, S. 2006. Marine Ecology: Gelatinous Bells May Ring Change in Marine Ecosystems. Current Biology, 16 (7).

Houghton J, Doyle T, Davenport J, Lilley M, Wilson R and G. Hays, 2007. Stranding events provide indirect insights into the seasonality and persistence of jellyfish medusae (*Cnidaria: Scyphozoa*). Hydrobiologia 589, 1–13.

Hosia, A. and U. Båmstedt, 2007. Seasonal changes in the gelatinous zooplankton community and hydromdusa abundances in Korsfjord and Fanafjord, western Norway. Mar. Ecol. Progr. Series 351, 113–127.

ICES. 2007. Report of the Working Group on Zooplankton Ecology (WGZE), 26–29 March 2007, Riga, Latvia. ICES CM 2007/OCC:04. 66 pp.

ICES. 2007. Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2007. ICES Advice. Books 1 – 10. 1,333 pp.

ICES. 2008. Report of the Study Group on Working Hypotheses Regarding effects of Climate Change (SGWRECC), By correspondence. ICES CM 2008/ACOM:43. 34 pp.

ICES. 2008. Hydrographic Attributes of the OSPAR Sub-Regions. Working document by ICES Working Group on Oceanic Hydrography. January 2008. 13 pp + figures.

Javidpour, J., Sommer U. and T. Shiganova, 2006. First record of *Mnemiopsis leidyi* in the Baltic Sea. Aquatic Invasion. 1(4): 299–302.

Leppakoski, E., S.Gollash and S. Ollenin, Eds. 2002. Invasive aquatic species in Europe. Distribution, impacts and management, Kluwer Academic Publishers

Lynam, C. P., S. J. Hay, and A. S. Brierley, 2004. Interannual variability in abundance of North Sea jellyfish and links to the North Atlantic Oscillation. Limnol. Oceanogr. 49: 637–643.

Lynam, C. P., S. J. Hay, and A. S. Brierley, 2005a. Jellyfish abundance and climatic variation: Contrasting responses in oceanographically distinct regions of the North Sea, and possible implications for fisheries. J. Mar. Biol. Assoc. UK 85: 435–450.

Lynam C.P., Brierley A.S., Heath M.R. and S.J. Hay, 2005b. Evidence for impacts by jellyfish on herring survival in the North Sea. Mar. Ecol. Prog. Ser. 298: 157–167.

Lynam, C.P., Gibbons, M.J., Axelsen, B.E., Sparks, C.A., Coetzee, J., Heywood, B.G. and A. Brierley, 2006. Jellyfish overtake fish in a heavily fished ecosystem. Curr. Biol. 16 (6).

Mills, C. E. 1995. Medusae, siphonophores, and ctenophores as planktivorous predators in changing global ecosystems. Ices J. Mar. Sci. 52: 575–581.

Mills, C. E. 2001. Jellyfish blooms: Are populations increasing globally in response to changing ocean conditions? Hydrobiologia 451: 55–68.

Moeller, F. L. and H.U. Riisgaard, 2007. Population dynamics, growth and predation impact of the common jellyfish *Aurelia aurita* and two hydromedusae, *Sarsia tubulosa* and *Aequorea vitrina*, in Limfjorden (Denmark). Mar. Ecol. Progr. Series 346, 153–165.

Molinero J. C., F. Ibanez, E.Buecher S. Souissi and P. Nival, 2005. North Atlantic climate and northwestern Mediterranean plankton variability. Limnol. Oceanogr. 50: 1213–1220.

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese and R. Torres, 1998b. Fishing down marine food webs. Science 279: 860–863.

Purcell, J. E. and M. N. Arai, 2001. Interactions of pelagic cnidarians and ctenophores with fish: a review. Hydrobiologia 451: 27–44.

Purcell, J. E. 2005. Climate effects on formation of jellyfish and ctenophore blooms: A review. J. Mar. Biol. Assoc. UK 85: 461–476.

Purcell, J.E. 2007. Environmental effects on asexual reproduction rates of the scyphozoan *Aurelia labiata*. Mar. Ecol. Progr. Series 348: 183–196.

Shiganova, T. A. 1998. Invasion of the Black Sea by the ctenophore *Mnemiopsis leidyi* and recent changes in pelagic community structure. Fish. Oceanogr. 7: 305–310.

Working Document 1: Zooplankton in the Norwegian Sea

Webjörn Melle (Institute of Marine Research, Bergen, Norway)

Zooplankton biomass distribution in the Norwegian Sea has been mapped annually in May since 1995 (ICES 2006). Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). The May cruise is the ICES coordinated international survey of the Norwegian Sea ecosystem. Figure 1 shows distribution of zooplankton biomass during the ICES coordinated surveys of the Norwegian Sea ecosystem in May 2006.

ICES (2006) report on an analyses of zooplankton biomass based on Norwegian zooplankton samples from the upper 200 m. Total zooplankton biomass (g dry weight m^{-2}) in May was averaged over sampling stations within three water masses, Atlantic water (defined by salinity >35 at 20 m depths), Arctic water (salinity <35, west of 1.4°E) and Coastal water (salinity <35, east of 1.4°E) (Figure 2). In Atlantic and Arctic water masses zooplankton biomass decreased to a minimum in 1997. Thereafter zooplankton biomass increased again and remained relatively high except for a temporary reduction in 2001. After 2002 there has been a continuous reduction and in 2006 the second lowest biomass during the time series was measured. Reduction in biomass has been most notably in Arctic water, and in 2006 the lowest biomass during the time series was observed. Due to reduced cruise time the Arctic water mass was not sampled in 2001 and 2004. Zooplankton biomass in Arctic water is generally higher than in Atlantic and coastal water, but in 2002, 2005 and 2006 the biomass in Arctic and Atlantic water equalled. In 2005 the highest biomass of the Norwegian Sea was found in coastal water. In the coastal water mass, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the temporal pattern of variation in biomass is different from the other two water masses.

In the Norwegian Sea the average biomass of zooplankton in Atlantic water in May is significantly correlated with the average NAO for the March-April period the previous year (Figure 3). However, the model has consistently overestimated the biomass since 2003. This may be related to changes in the processes underlying the relationship. March-April is the period when the primary production in the Norwegian Sea is initiated and the major reproductive period for many important zooplankton species such as *Calanus finmarchicus* and krill.

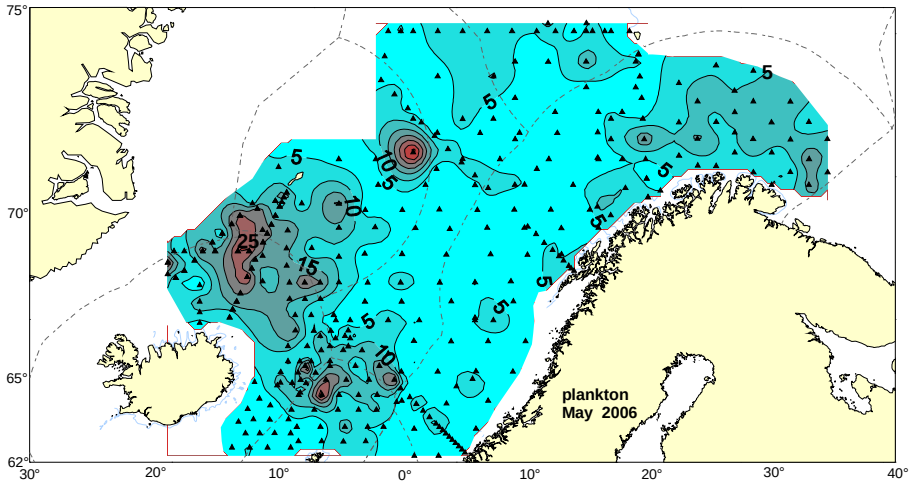

Figure 1. Distribution of zooplankton biomass (g dry weight m^{-2}) in the upper 200 m. Sampled by WP2 net hauls during the ICES coordinated surveys of the Nordic and Barents Seas ecosystem in May 2006.

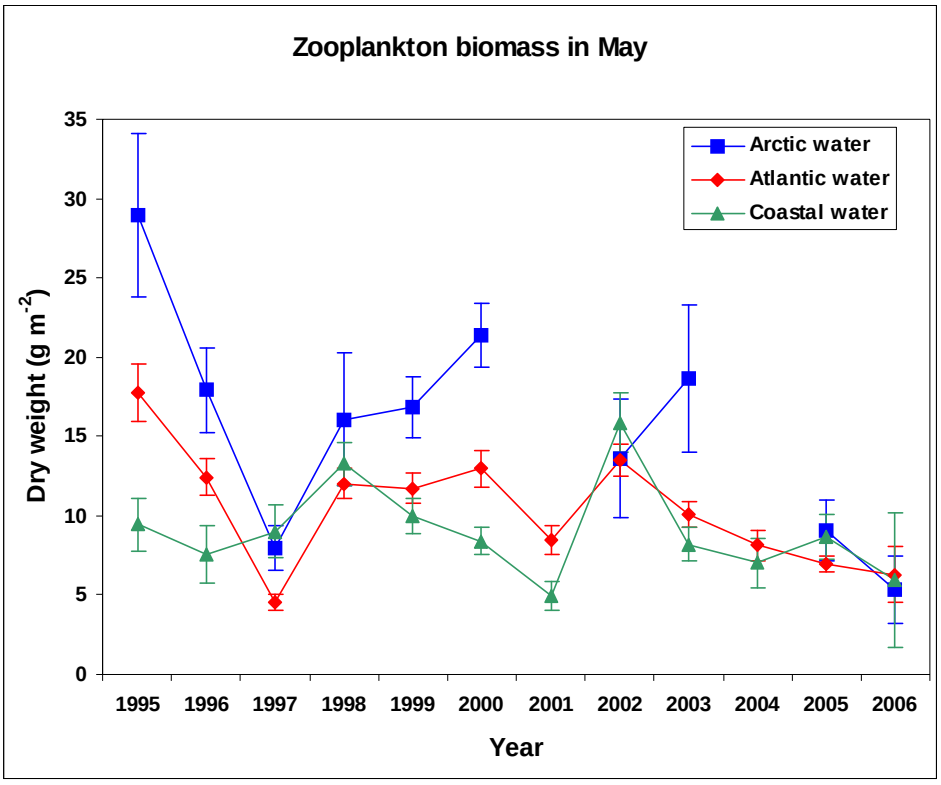

Figure 2. Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

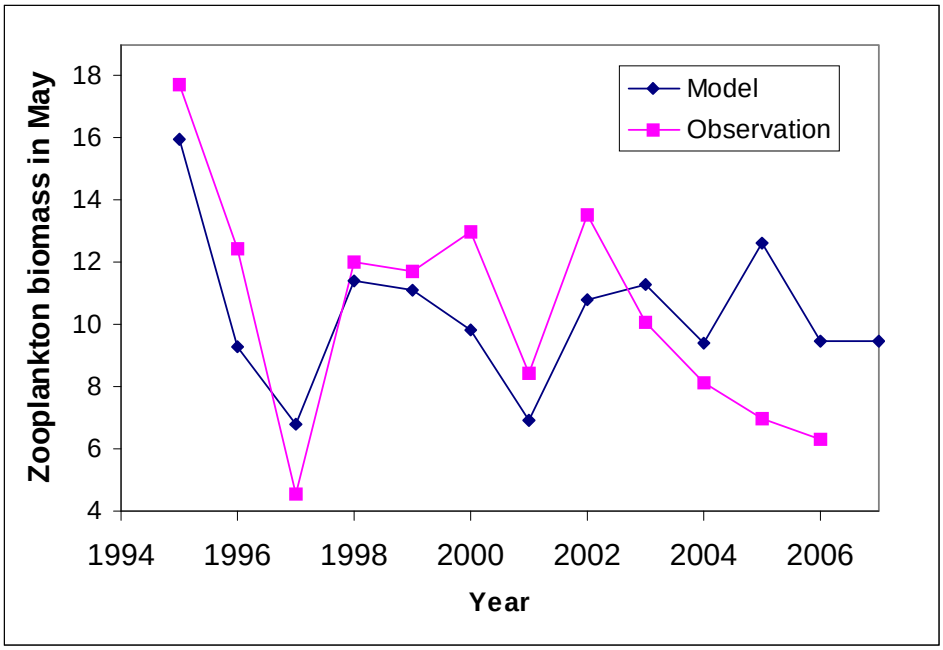

Figure 3. Zooplankton biomass in May observed and modelled. Model: Biomass (yrn+1) = 2.3*NAO yrn+10.1. R2=0.44, P=0.02.

Annex 6: Theme Session Proposal for 2009 ASC

The Working Group of Zooplankton Ecology (WGZE) proposes the following Theme Session for the ICES 2009 Annual Science Conference:

Biochemical, biogeochemical, and molecular approaches to the study of plankton ecology and species diversity

Convenors: Steve Hay (UK), Janna Peters (Germany), and Ann Bucklin (USA)

Supporting information

Marine ecology and the study of biodiversity are increasingly benefiting from novel biochemical, biogeochemical, and molecular approaches and techniques. Plankton species diversity can be accurately assessed using molecular approaches, including DNA barcoding and community metagenomics. Material flow (e.g., nutrient uptake) and trophic relationships in pelagic food webs can be traced using biochemical markers, trace element composition and stable isotopes. Other biochemical approaches include correlation of dietary components and food quality with vital rates and recruitment success; histochemical and enzyme kinetic assays to gain insight into physiological condition, growth, and impacts of biotoxins and pollutants. Gene expression analysis using quantitative PCR and DNA microarrays can reveal impacts of environmental variability. These and other technical advances are transforming plankton population and community ecology, and improving our understanding of species diversity, distribution, abundance and adaptability.

The new knowledge gained is critical for determining marine ecosystem function and health; understanding global biogeochemical cycles; and modeling and predicting impacts of climate change, acidification, and associated stressors. Marine ecosystem analysis must include accurate information on species-level diversity, distribution, and abundance, as well as species-specific processes and transfer rates.

Specifically this session would explore biochemical, biogeochemical, and molecular studies that:

1) Characterize plankton species diversity, distribution, and abundance;
2) Determine the effects of environmental variability on individuals and populations in terms of physiological condition and vital rates; and
3) Investigate material transfer and trophic relationships in pelagic food webs, especially in relation to climate change.

This session will be in partnership with the Census of Marine Zooplankton (CMarZ) a project of the Census of Marine Life. It will contribute to ICES mandates for determining the status of marine biodiversity and understanding impacts of climate change in the North Atlantic region.

Annex 7: Abstracts of presentations at WGZE/WGPBI Joint Meeting

Holographic imagery of turbulence and plankton

Tom Osborn (Johns Hopkins University, Baltimore Maryland, USA)

Holograms observe the particles in the sample volume by scattering coherent light from the particles. This technique allows observation of many small particles in a relatively large three-dimensional volume. The comparison with microscopy is that while the resolution in the plane of the particle is the same, the resolution in the third dimension is not limited by the optical depth of field of the imaging system. Thus, holographic techniques for studying the plankton community have the advantage of seeing the small particles in a sample volume that is both wide and deep relative to the particle size.

A major breakthrough came with the development of numerical techniques for analyzing the holograms, which obviated the need for an optical bench to reconstruct the image by sending light through the film. The new, high resolution, high frame rate, digital cameras make ideal data capture vessels. Upon collection, the holograms are digital and not film based. The reconstruction can proceed directly using the numerical developments. These developments have enabled holographic, PIV movies. These movies allow us to study behaviour, feeding and physical/biological interactions for copepods, nauplii, diatoms and dinoflagellates.

- Movies were shown of a nauplii attempting, but failing, to capture a food particle.
- The feeding currents of a copepod were shown in real time while the creature sank through the water. The data were then all centered on the copepod and the close circulation pattern of the feeding currents became apparent.
- Spatial distributions of dinoflagellates were shown to be random in the absence and presence of prey, but the distribution of predator to prey spacing is not random. It was shown how the behaviour of different species and strains of dinoflagellates changes with the introduction of prey and with time after the introduction.

Some movies are available at: http://www.me.jhu.edu/~lefd/shc/shc.htm

A good reference that will lead to other interesting papers is:

Sheng, J., E. Malkiel, J. Katz, J. Adolf, R. Belas, and A. Place. 'Digital Holographic Microscopy Reveals Prey-Induced Changes in Swimming Behavior of Predatory Dinoflagellates'. Proceedings of the National Academy of Sciences (PNAS) 104. 44 (2007):17512–17517.

'LERM' – The first LE plankton ecosystem model with four trophic levels

Matteo Sinerchia and John Woods

LERM (Lagrangian Ensemble Recruitment Model) is an individual-based model designed to be integrated under the Lagrangian Ensemble metamodel which creates virtual ecosystems. It was created on the Virtual Ecology Workbench. LERM includes a classical food chain composed of phytoplankton (diatom), herbivorous zooplankton (calanoid copepod), carnivorous zooplankton (Loligo) and top predators, which are

all modelled explicitly. The model uses phenotypic equations for all biological functions, including the physiology and behaviour of individual plankters. These equations were derived from the scientific literature.

Simulations were run at an Azores site under stationary annual forcing. After an initial transient period, the ecosystem converges to an attractor, in which the inter-annual variation of species biomass or demography is lower than the demographic noise (<15%). The emergent biomasses were comparable with observations at a close site. LERM is intrinsically stable, ergodic and provides a good signal:noise ratio.

The Virtual Ecology Workbench (VEW) is a software tool that makes it easy for biological oceanographers to create one-dimensional mathematical simulations of the plankton ecosystem in a mid-ocean mesocosm. It uses the Lagrangian Ensemble metamodel (Woods 2005), which computes emergent demography and biofeedback from individual-based models comprising phenotypic equations for the biological functions of each species in the modelled plankton community. The VEW is designed to be used by scientists who have no skills in computer programming; the VEW automatically writes Java code from phenotypic equations written in familiar form. Nor does the user need to be skilled in ecosystem modelling: the VEW automatically manages such tasks as chemical budgeting.

Modelling juvenile *Calanus finmarchicus* on Georges Bank: Where have all the nauplii gone?

A. B. Neuheimer, W. C. Gentleman, and C. Galloway

Calanus finmarchicus dominates the copepod biomass and is a key link between primary production and higher trophic levels throughout the North Atlantic. On Georges Bank, the early life stages are a major prey source for larval cod and haddock, and peak fish spawning coincides with peak naupliar abundance in March/April. Data for *C. finmarchicus* repeatedly demonstrate a dramatic decline in naupliar abundance in May and an increase in June in every sub-region of the Bank. Understanding the cause of this trend is critical, as shifts in timing of the seasonal cycle of *C. finmarchicus* may lead to mismatch in co-occurrence with larval fish.

We use an age-within-stage population dynamics model to investigate the factors controlling the observed temporal variation in *C. finmarchicus* nauplii. The model incorporates temperature- and food-dependent development rates, field-estimated egg production rates (EPR), and female abundance based on observations of the U.S. Global Ocean Ecosystem Dynamics (GLOBEC) program. Use of field-estimated mean mortality rates results in modelled abundance that is erroneous by over an order of magnitude. This data/model discrepancy cannot be explained by food limitation or variation in egg production. Instead, time-varying and spatially explicit mortality rates are required to reproduce observed naupliar densities. These temporal variations in mortality appear correlated with *C. finmarchicus* female abundance, implying cannibalism as a major regulatory factor of naupliar abundance. Our results indicate the need for higher temporal and spatial resolution in mortality estimates. Moreover, this biological control of *C. finmarchicus* populations must be considered as an indirect avenue for the effects of climate change.

Food web modelling – from nutrients to fish

Wolfgang Fennel (Leibniz Institue for Baltic Sea Research, (IOW) Rostock, E-mail: wolfgang.fennel@io-warnemuende.de)

Modelling of marine ecosystems was broadly divided into two branches – biogeochemical and fish production models. The biogeochemical models see the fish only implicitly as mortality rates, while fish production models see the lower food web basically through prescribed food, e.g. copepod biomass.

The contribution aims at bridging biogeochemical models and fish-production models, by coupling a NPZD-model with a fish model. The Baltic Sea is chosen as an example system, where the main fish dynamics is covered by two prey species (sprat and herring) and one predator (cod). The dynamics of the fish model is driven by size dependent predator-prey interactions.

The linkage of the model components is established through feeding of prey fish on zooplankton and recycling of fish biomass to nutrients and detritus. The model, which is in the current stage basically a box model, conserves strictly mass.

Experimental runs with fishing mortality and nutrient loads provide scenarios of fish catches in response to nutrient inputs. The relatively complex NPZDF-model makes it possible to analyse the choices for parameterizations of unresolved processes in truncated NPZD models in the light of a full food web representation. The model truncation affects not only the zooplankton mortality but also the dynamics of nutrients and detritus.

The model refers to the example of the Baltic Sea, but the approach can well be adjusted to other systems.

Zooplankton modelling in the German Bight during GLOBEC-Germany with a view to study sprat larvae growth – do we simulate copepod abundance correctly?

Andreas Moll, Christoph Stegert, Markus Kreus and Wilfried Kühn

The talk introduced the investigation of lower and higher trophic levels of the North Sea ecosystem, which are both influenced by their physical and biological environment. Copepods were focused due to their key role within the ecosystem acting simultaneously as predator and prey item within the food web. An improved ECOHAM version (ECOlogical Model, HAMburg) has been developed to simulate the North Sea ecosystem and to study the temporal development and spatial variability of zooplankton biomass and abundance. The zooplankton was enhanced by a stage-structured population representing *Pseudocalanus elongatus* competing to the rest zooplankton biomass. Simulated three-dimensional fields were analysed to investigate the regional distribution of primary and secondary production in relation to the locally different stratification and circulation characteristics and their influence on population dynamics and total zooplankton biomass. Using reported weight-length relationships we gained a size-resolved spectrum of food items, which served as input for a coupled transport and individual-based growth model (IBM) for fish larvae. The IBM predicts growth and survival of larval sprat (*Sprattus sprattus*) depending on local prey availability and hydrodynamical conditions in the German Bight. The ecosystem model determined high variability of the different zooplankton prey size classes due to the physiological succession of copepod stages resulting in

alternating match/mismatch patterns of prey for the sprat larvae, which could not be resolved using zooplankton biomass only. Due to this application of simulated zooplankton abundance data we questioned the reliability of three-dimensional zooplankton biomass and abundance data. Thus, in the second part of the talk an extensive comparison to German Bight observations were presented. The total zooplankton biomass was compared to monthly mean values derived from abundance counts obtained from CPR surveys for 1°x1° boxes. The zooplankton biomass resembled the observed annual cycle for most boxes. Measurements of copepod abundances were available from the GLOBEC Germany surveys in 2004. Counting was done during seven cruises between February and October at numerous stations in the German Bight. Copepodite abundances were gained by Bongonets, while for the nauplii data from Multinet hauls were used. Comparing the annual cycle of model stage groups with those from field abundances one can see, that the model computed the high variability of the data, though the model tended to generate higher abundances. By comparing the development in space and time, the simulation showed less spatial variance but more peaks within the annual cycle. Finally, the simulated abundance data for *P. elongatus* were compared with observations at Helgoland Reede, and the simulation showed similar structure of fast increase followed by a slower decrease for 'several generations'. Such undulating development of simulated abundances could not be measured during the GLOBEC-Germany cruises. This validation of influential state variables gives confidence that the model is able to calculate reliable stage development and abundances of *P. elongatus* as well as the range of bulk zooplankton biomass, and thus the ratio of population biomass to total biomass. In the German Bight, the population is below 20% in spring. The ratio increases up to 30% during summer. The number of generations was estimated from peaks in egg abundance to about 4–7 generations of *P. elongatus* in the southern North Sea. For the discussion with the ICES group WGZE the following questions were intensively illustrated. 1) How can we compare observed field abundances with simulation results? 2) Is the comparison to Helgoland affected by island effects, not covered in the simulation? 3) What other long-term station data are available on the northwest European continental shelf (NECS)? 4) Do we have robust estimations of generation numbers as an integrative measure? And 5) What are your suggestions for better ways of comparison (e.g. generation time and number of generations)? The WGZE Chair summarized the discussions by proposing intense bi-lateral cooperation with WGZE members providing zooplankton observations in the NECS area.

Mesozooplankton sample collection methods

Mark C. Benfield (Louisiana State University, Baton Rouge, Louisiana USA), Jörn Schmidt (Leibniz-Institute of Marine Sciences, Duesternbrooker Weg 20, 24105 Kiel, Germany) and Peter H. Wiebe (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA)

At the end of the 19th century, Victor Hensen, a pioneering zooplanktologist posed two fundamental questions: What are the numbers and kinds of things in the sea at any given time and place? And how does this material vary from season to season and year to year. In 2007 these are basically the same questions that we are still attempting to answer. Hensen was armed only with simple plankton nets while our toolbox has evolved to include single and multi-net systems, plankton pumps, imaging systems and high-frequency scientific echosounders.

Plankton are inherently patchily distributed in space and time. Consequently, sampling their distributional patterns poses certain challenges. The ingenuity of zooplankton ecologists has produced a diverse array of sampling devices. This presentation summarizes the following general groups: (1) Nets: single, non-opening/closing; single, opening/closing; multiple opening/closing; LHPR/CPR; specialized nets and traps; pumps; (2) optical systems; particle counters; 2D imaging systems; 3D imaging systems; and (3) high-frequency acoustics. The principle of operation of each type of system was summarized. Each system has strengths and weaknesses which are summarized with respect to whether they: provide a physical sample, their vertical and horizontal resolution, the level of taxonomic resolution they provide, potential for avoidance by target organisms, degree of damage to fragile taxa, ability to detect rare taxa, and sample processing time.

Available field data sets from the North Atlantic and the Mediterranean

Eilif Gaard (Faroese Fisheries Laboratory, Faroe Islands) and Erica Head (Bedford Institute of Oceanography, Canada)

Time series on field data set on zooplankton and ancillary data from the North Atlantic and the Mediterranean Sea were described. In addition to the Continuous Plankton Recorder data, collected since 1946, a large number of national monitoring programs are collecting zooplankton and ancillary data (usually hydrography and chlorophyll and/or phytoplankton) on continental shelves. Most of these time series have been operated since the early or mid 1990s, although a few data sets go back to 1950s and 1960s and 1970s. Most data are from shelf areas, although some monitoring programs run in oceanic areas, e.g. a section across the Labrador Sea and a broad-scale monitoring program in the Norwegian Sea. In most cases samples are collected seasonally or once a year, but for some monitoring programs the samples are collected more frequently, e.g. in the Helgoland and Stonehaven monitoring programs in the North Sea, in the Atlantic Zone Monitoring Program at coastal stations on the Scotian and Newfoundland shelves and in the Gulf of St Lawrence and also in the Mediterranean Sea. Detail information on zooplankton monitoring programs in the North Atlantic is available on www.wgze.net and on Mediterranean Sea monitoring on www.ciesm.org/marine/programs/zooplankton.htm. While zooplankton abundance and composition is relatively well monitored, especially for shelf areas, monitoring data on processes are scarce.

Available Data Sets: Laboratory Studies

Roger Harris (Plymouth Marine Laboratory, UK) and Xabier Irigoien (AZTI, Spain)

Laboratory experiments have a specific purpose, and are usually designed to test a specific hypothesis, so the data generated may not necessarily be appropriate for models. With this reservation in mind available data sets were reviewed briefly. Large projects such as US GLOBEC and TASC (Trans-Atlantic Study of *Calanus finmarchicus*) may be sources of zooplankton experimental data, but the data-sets may not be easily accessible, and long term availability is a problem. Some of the best sources of data are from individual literature compilations such as those by Hirst and Kiørboe (2002) on zooplankton mortality and Hernandez-Leon and Ikeda (2005) on respiration. Finally new approaches were considered, for example the idea of a single source of data for parametrizing species of key interest for ecosystem end-to-end

modeling being developed as part of EUR-OCEANS, and an initiative to work with a few publishers of scientific journals to implement a Data Submission System (DSS) where authors are required to submit raw data directly to a long-term data-base in order as part of the publication process. In conclusion it was questioned whether current modelling approaches are reasonable for systems where species interact? Perhaps simple mesocosm experiments should be proposed with two or three species to see if models considering only external forcing are able to produce accurate predictions. See as an example Beninca *et al.* 2008 (Nature 451:822–825).

Statistical analysis – some examples

Cecilie Broms and Webjørn Melle (Institute of Marine Research, Bergen, Norway)

At the ICES WGZE-WGPBI joint session 2008, the presentation 'Statistical analysis – some examples' was given. The objective of the presentation was to give an introduction to some statistical methods used by ecologists, and the main focus was on ordination and other regression methods. Background-theory of the different methods was complemented by showing examples from field studies. Ecologists often want to analyse the response of several species (response variables) in an ecosystem on several environmental (explanatory) variables by using multivariate analysis. One multivariate method is ordination, which is a family of gradient analyses. Principal component analysis (PCA, indirect ordination) was used to describe the geographic distribution of *Calanus finmarchicus, C. glacialis* and *C. hyperboreus* in the Norwegian Sea and adjacent areas. ThePCA scores, plotted in maps of the investigated area, showed that *C. finmarchicus* had highest concentrations in the Norwegian Sea Gyre. Redundancy analysis (RDA, direct ordination) was used to gain quantitative knowledge on how *Calanus* species and stages respond to the physical environment of the Norwegian Sea and adjacent areas. The results were presented in a triplot. *C. glacialis* and *C. hyperboreus* were negatively correlated to temperature and found in Arctic water. Old copepodite stages of *C. finmarchicus* were related to high-salinity Atlantic water. The young *C. finmarchicus* stages, on the other hand, were negatively related to older stages, and associated with Norwegian Coastal water. The reason for this is not clear, but it might be that Coastal water offers good recruitment conditions for *C. finmarchicus*, or that advection of young stages into Coastal water is high. Generalized additive model (GAM) was used to examine demographic responses of *Calanus* on environmental variables, and to examine *Calanus* life cycle. GAM extends generalized linear models and use smoothing operators to fit smooth non-linear relationships. Young copepodite stages had highest concentrations in the phytoplankton bloom, and the demographic response of *C. finmarchicus* coincided with one generation per year.

Needs from models: approaches to the biological questions

Jeffrey A. Runge (School of Marine Sciences, University of Maine and Gulf of Maine Research Institute, 350 Commercial Street, Portland, Maine, 04101 USA) and Catherine L. Johnson (Bedford Institute of Oceanography, Department of Fisheries and Oceans, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4H2, Canada)

We identified three families of biological questions about pelagic marine ecosystems: questions about biogeochemical fluxes and carbon sequestration, questions about

community ecology including multispecies trophic interactions and top down effects, and questions about bottom up controls on primary productivity and higher trophic level population dynamics. The latter, addressed by coupled physical-biological models, appear to be particularly appropriate to top priorities of the new ICES Science Plan, including impact of climate change on the distribution, physiology and behaviour of marine biota, operational ecosystem modelling combining oceanography, ecosystem and population processes, and climate change predictions. Using the coastal Gulf of Maine as an example, we briefly review advances in coupled NPZ, zooplankton life cycle and larval fish trophodynamic modelling. Applying the rhomboid approach discussed by de Young *et al*. (2004: Science 304:1463–1466), we suggest that a system of linked, coupled physical-biological models could be developed into operational ecosystem modelling, providing decision support tools for questions about bottom up climate impacts on population dynamics, the outlook for environmental conditions affecting recruitment, sources and sinks among spawning areas, and transport of planktonic stages of invasive species.

Annex 8: Proposed Terms of Reference for the 2009 WGZE meeting

The Working Group on Zooplankton Ecology [WGZE] (Chair: M. C. Benfield, USA) will meet in Tórshavn, Faroe Islands from 30 March – 2 April 2009 to:

a) Produce a summary of recent developments in plankton research and monitoring (e.g. seasonality, abundance, community structure, biodiversity, evidence/rationale for incorporating zooplankton in monitoring) with a view to further analysis and subsequent publication.

b) Assess and report on the outcomes of WKZEM, the ASC 2008 theme session Q, and the 2008 WGZE/WGPBI joint meeting.

c) Provide expert knowledge and guidance to ICES Data Centre on a continuous basis including a progress on the digitizing project and begin an inventory of historical data and samples.

d) Update the ICES Plankton Status Report and report on the progress of linking the Status Report data to the ICES data centre.

e) Review progress in zooplankton taxonomy with particular reference to developments within ICES.

WGZE will report by 1 May 2009 for the attention of the Oceanography Committee, ACE and ACME.

Supporting Information

Priority:	The activities of this group are a basic element of the Oceanography Committee, fundamental to understanding the relation between the physical, chemical environment and living marine resources in an ecosystem context. Reflecting the central role of zooplankton in marine ecology, the group members bring a wide range of experienced expertise and enthusiasm to bear on questions central to ICES concerns. Thus the work of this group must be considered of very high priority and central to ecosystem approaches.

Scientific justification and relation to action plan:	a) The central ecosystem role of zooplankton and demonstratable links with climate change are increasingly realized. The sample and data collation effort for zooplankton is growing, alongside expanding national and international demands for monitoring data. There are moves and projects proposing global syntheses, regional ecosystem assessments ad autecological studies of key species across latitudinal ranges. These projects, syntheses and global collaborations must be enabled and supported. b) The Joint WGZE/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic (WKZEM) to be held in Crete, Greece, 27–30 october 2008, will be a major international event. 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 outputs and issues highlighted. Similarly, as the proposers of Theme Session Q for the 2008 ASC, and as one half of the joint WGZE/WGPBI meeting in April 2008 we would like to follow up on progress made in these events. c) Within ICES ICES and generally, data management of biological inforation needs to be reviewd and ongoing efforts and consutations discussed. d) This is a repeating task established by the Working Group in 2000 to monitor the plankton abundance in the ICES area. The material presented under this item updates and expands the annual Summary Plankton Status Report in the ICES area. Reported results are significant observations and trends based on a wide range of time-series sampling programmes. Efforts are in hand to expand the report spatially and to include phytoplankton and elementary physics and to facilitate comparative analyses and setting monitoring standards and recommrndations. e) The WGZE has been very active in defending taxonomic skills in the ICES region (e.g. promoting taxonomic training courses, producing zooplankton checklists, ecological indices based on zooplankton diversity and collating data of zooplankton abundance at a wide distributed network of sampling sites). With this ToR the group seeks to work towards the development and enhanchement of the existing ICES Fiches Identification Sheets and for developing them into a modern web-based format.
Resource requirements:	Resource required to undertake the activities of this group is negligible. However, ICES must be committed to provide some sponsorship and support for workshops, publication costs for the Plankton Status Report, and the 4th Zooplankton Symposium.
Participants:	The group has an enthusiastic core membership, and is successfully making efforts to attract broader participation both across ICES nations and across relevant skills The Group is normally attended by some 20–25 members and guests.
Secretariat facilities:	None, beyond communication support.
Financial:	Beyond the publication costs for the Plankton Status Report and the Proceedings of the WKZEM Workshop, no other current financial implications.
Linkages to advisory committees:	The Group reports to the Oceanographic Committee, ACE and ACME (information also relevant to some ACFM aims) Mainly WGZE provides scientific information on plankton and ecosystems and welcomes input from other committees , working/ study groups etc..
Linkages to other committees or groups:	Any and all working and study groups interested in marine ecosytem monitoring and assessments, modelling and/or plankton studies, including fish and shellfish life histories and recruitment studies. Strong working links have been developed between WGZE and Mediterranean colleagues (CIESM).

Linkages to other organizations:	Links with the WGMDM, WGRP, WGCCC, WGPE and WGHABD are intended and some contact is maintained. The WGZE input to REGNS is an ongoing effort. The Plankton Status Report is of interest and practical use to a range of interested groups within ICES, PICES, CIESM, GOOS and GLOBEC with other national and international research groups and agencies. Increasingly marine research, marine management and even marine institutes are re-aligning to take an ecosystem view. These linked and collaborative approaches between many working and study groups must be encouraged. IGBP, SCOR, ESF, COML/ CMarZ, and others have research activities meetings etc., of interest and relevant to the activities of the WGZE. Contacts are maintained through networking and collaborative activities.

Annex 9: Draft resolution for an ICES internal publication

The proceedings from the '**Joint ICES/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic (WKZEM)'**, edited by members of WGZE and CIESM, as reviewed and approved by the Chair of the Oceanography Committee, will be published in the *ICES Cooperative Research Report* series. The estimated number of pages is 80.

The Working Group on Zooplankton Ecology agrees to submit the final draft of the proposed publication by 1 July 2009.

Extension of this deadline can be requested up to one month before the deadline's expiration. If an extension of the deadline is not agreed upon or if the final draft is not forthcoming, the ICES Secretariat will have the option of cancelling the resolution.

Supporting Information

Priority:	This draft resolution enhances the value of the WKZEM Workshop, and makes it an official and citable ICES product.
Scientific Justification:	The Cooperative Research Report series offers a good venue for the publication of the proceedigns from the Workshop, making it available to the scientific community as a citable publication.
Relation to Strategic Plan:	This resolution will contribute towards Scientific Objectives; 1a (Describe, understand and quantify the state and variability of the marine environment in terms of its physical chemical and biological processes.); 1b (Understand and quantify the role of climate variability and its implications for the dynamics of the marine ecosystems); 5c (Co-ordinate international, monitoring and data management programmes which underpin ongoing ICES core science.); 4c (To publicise the work of ICES and the contributions that ICES can make for its stakeholders, and for the wider public audience, regarding the understanding and the protection of the marine environment), and Institutional Objective 6 (Make ICES' scientific products more accessible to the public.)
Resource Requirements:	Cost of production and publication of a 80 page CRR
Participants:	
Secretariat Facilities:	Help with document preparation/publication. Final editing.
Financial:	
Linkages To Advisory Committees:	ACOM, and Publications Committee
Linkages To Committees Groups:	Oceanography Committee
Linkages to Organisations	CIESM

Annex 10: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. WGZE nominates Professor Mark C. Benfield (USA) as next Chair of WGZE	OCC, Council
2. Advice to PGEGGS	OCC, PGEGGS
3. Develope the ICES Fiches Identification Sheets towards a modern web-based format	WGZE, OCC, Publications Committee
4. Theme Session for 2009 ASC	OCC
5. ToRs for 2009 WGZE Annual Meeting, Tórshavn, Faroes	WGZE, OCC
6. Publication of WKZEM Proceedings in ICES Coop. Res. Rep.	WGZE, Publications Committee

Annex 11: Technical Minutes from the WGECO Meeting

Review report of Section 8 and Annex 5 of Working Group on Zooplankton Ecology (WGZE) report:

The review took place during the WGECO meeting from 6–13 May 2008.

Reviewers: Jake Rice (Chair)

Catherine L. Scott

Ellen L. Kenchington

Gerjan Piet

Keith Brander

Stuart I. Rogers

Øystein Skagseth

Secretariat: Cristina Morgado

The reviewers provided written comments to Section 8 and Annex 5 of the WGZE report. This section is related to WGZE ToR a).

General comments

Section 8 and Annex 5 of WGZE report provides a cohesive breakdown of the observed and potential effects of climate change/climate variability. They build upon the WGZE report presented in 2007 and consider the input of the WGOH and SGWRECC. The group identify issues, positive and negative, with the use of Continuous Zooplankton Recorder (CPR) and broach the use of other time series and reports to better understand changes in zooplankton abundance and distribution.

Information gaps, such as gelatinous fauna, are identified. Reasoned recommendations for the continuation of long term data collection of zooplankton data are presented highlighting their importance in the ecosystem.

It is fairly clear that future requests of this kind will require more detailed dialogue between the WG and the group carrying out the overview and analysis in order to ensure that there is a common basis and methodology and that the WG is clear about what information is required. A common source of data and products on changes in ocean climate is an essential part of this.