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26–29 March 2012

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Executive summary

The ICES Working Group on Zooplankton Ecology (WGZE) met at the University of Málaga, Spain from 26 to 29 March 2012. The meeting was hosted by Dr. Lidia Yebra of the Instituto Español de Oceanografia (IEO) and chaired by Piotr Margonski. It was attended by 32 scientists representing 13 nations. The objective of the meeting was to discuss and address the 13 terms of reference (ToRs) and to exchange information on recent activities in zooplankton ecology.

The specific task for the 2012 meeting was to exchange information of mutual concern and to discuss future collaborative plan with Working Group on Phytoplankton and Microbial Ecology (WGPME). Both groups agreed on cooperation during the preparation and further development of the Zooplankton and the Phytoplankton and Microbial Plankton Status Reports (ToRs c and d). Moreover, both groups recommended the joint workshop on synthesis of hydrographic, phytoplankton, microbial plankton and zooplankton time series to be held in late 2013.

As a part of progress in updating the Zooplankton Methodology Manual the first videos of zooplankton sampling/processing techniques (ToR a) were presented and discussed. It was agreed to continue inter-sessionally and complete this task in 2013. Review of allometric relationships relating zooplankton morphology (ToR b) resulted in conclusion that a global compilation of the allometric algorithms presently used by zooplankton experts need to be aggregated, listed, and their efficacy inter-compared. Summary of the status of blooms by gelatinous zooplankton in coastal and shelf ecosystems (ToR e) lead to the statement that there are many activities on gelatinous zooplankton in the ICES area, but no comprehensive overview of available datasets. Therefore, it was decided to continue by preparing the metadata on ongoing monitoring of gelatinous plankton. Certain groups of zooplankton (e.g. euphausiids, mysids, or meroplankton) are not currently monitored (ToR f). Lack of information on their distribution and biomass bias ecosystem models and is crucial for understanding of the whole food web. Using information already collected in the Zooplankton Status Report, a compilation of taxonomic categories including species and stages which are currently monitored will be prepared. Information on two German sorting centres was provided (ToR g). Participants agreed that a general overview would be a valuable product and should be updated and posted on the WGZE website. Groups discussed the relevant zooplankton indicators with utility for assessment of ecosystem quality (ToR h). Number of potentially useful zooplankton indicators were suggested especially in the Marine Strategy Framework Directive (MSFD) implementation context. Progress of the SGIMT was presented and discussed under ToR i. Several participants expressed their interest in creation of the taxonomic experts list, which could be developed as a joint task for WGZE and SGIMT. ToRs l and k addressed such issues as indicators of biodiversity and functional characteristics of the keystone species from the zooplankton studies perspective. Finally, group discussed the exploratory assessment of *Calanus finmarchicus* (ToR m). WGZE supported the idea of a focussed workshop, summarised the key topics to be included, and suggested co-convenors.

The next meeting of the WGZE will be held in Lowestoft, UK, 11–14 March 2013. Dr. Sophie Pitois (CEFAS) will be the local host.

1 Opening of the meeting

The ICES Working Group on Zooplankton Ecology (WGZE) met at the Facultad de Derecho, Universidad de Málaga, Spain from 26 to 29 March 2012. The local host was Dr. Lidia Yebra of IEO. The meeting was attended by 32 scientists representing 13 nations (for details see the List of Participants, Annex 1).

Meeting started on Monday at 09:00 with the plenary session between WGZE and the Working Group on Phytoplankton and Microbial Ecology (WGPME). Chairs of both groups, Bill Li (WGPME) and Piotr Margonski (WGZE), opened the meeting and welcomed the members and guests of the groups to Malaga.

Following a round of introductions, the participants were welcomed by Lidia Yebra and Xosé Anxelu G. Morán who summarized logistics of the meeting.

2 Adoption of the agenda

The agenda for the WGZE 2012 meeting (see Annex 2) followed the Terms of Reference adopted as a resolution by the ICES SCICOM and ICES Council in 2011.

The agenda had been circulated among the working group members prior to the meeting and incorporated most of the suggestions and comments. Last minute adjustments were discussed and the agenda was adopted by unanimous vote. The Terms of Reference for this meeting are to:

a) Review videos of zooplankton sampling/processing techniques as part of progress in updating the Zooplankton Methodology Manual;

b) Review allometric relationships relating zooplankton morphology to volume, mass, carbon and identify data needs, utility, and regional applicability of these equations;

c) Update and discuss expanded content for the 2012 Zooplankton Status Report and consider areas where the Phytoplankton and Zooplankton Status Reports could be harmonized;

d) Identify analytical approaches and the potential for publications arising from more advanced analysis of existing time-series data on phytoplankton, zooplankton, hydrography and climate;

e) Summarize the status of blooms by gelatinous zooplankton in coastal and shelf ecosystems;

f) Summarize regional examples of understudied zooplankton that may be ecologically important but which are not currently monitored;

g) Review the content of the summary of zooplankton sorting centres produced in the past year;

h) Identify relevant zooplankton indicators with utility for assessment of ecosystem quality;

i) Review the progress of the SGIMT;

j) Review the outcomes of theme sessions J and K from the 2011 Annual Science Conference;

k) Review and report on existing indicators of biodiversity that are linked to predictable changes in ecosystem function and/or to develop, assess and report on the feasibility and performance of such indicators;

l) Identify and report on functional characteristics that could lead to species being defined as 'keystone';

m) Discuss the exploratory assessment of *Calanus finmarchicus*.

3 Plenary sessions of the Working Groups on Zooplankton Ecology (WGZE) and Phytoplankton and Microbial Ecology (WGPME)

Leads: Bill Li (WGPME) and Piotr Margonski (WGZE); Rapporteurs: E. Head, S. Putzeys, A. Da Cruz, P. León and M. Benfield

There were two joint WGZE-WGPME plenary sessions during the meeting: the first one on Monday was to exchange of information of mutual concern; the second on Thursday to discuss and establish the collaborative plan.

It started with Bill Li presentation on mutual concerns in the context of the ICES Science Plan. The general question about the area of scientific concern that interest us (e.g. trophic interactions, physical effects, bottom-up vs. top down control) has to fit into the ICES overall framework. Some time ago all the ICES Expert groups were indicated their scientific interests in relation to the ICES Science Plan. By comparison of the results provided by our both groups it is clear that two topics received the highest scores from both groups (11: Climate change processes and predictions of impacts and 12: Biodiversity and health of marine ecosystems).

Bill posed the following questions to members of both WGs:

1) What other areas do members of the two groups think we should consider?

2) Microzooplankton seem to have fallen between the cracks. What should we be doing about them? For example, should we make a special effort – identify a special activity?

The following discussion concentrated first on microzooplankton. It was mentioned that WZGE dealt with this issue before but with rather minor success by e.g. trying to identify microzooplankton time series data. There was also a Theme Session at one of the recent ICES ASC but it was not well attended. One of the possible solutions could be to consider microzooplankton in the context of trophic interactions, e.g. Calbet and Landry (2004) reported that microzooplankton controls phytoplankton production, i.e. 60–70% of phytoplankton is grazed by microzooplankton. It leads to the very important questions at the global level: how will this be affected by climate change?

One of the possible joint efforts might be microzooplankton-focused symposium to which the key participants should be invited.

In addition to the effects of climate change on microzooplankton and the coupling between primary and secondary production which are important issues, we should also include higher levels (e.g. krill). There are also other important questions/issues:

- Role of toxic algae and their effects on zooplankton grazing, and how these will be influenced by climate change;
- Climate change will lead to changes in phytoplankton composition. If lipid rich copepods are important – how will changes in phytoplankton composition (species and biochemical) affect lipid accumulation by the lipid storing copepods and their predators? I.e. what will be the biochemical effects of climate change at different trophic levels?

- Role of microzooplankton in larval fish feeding, i.e. how important are they?
- There is a discussion about the "microbial loop": is there any work relating to this in the fisheries context? Where is the "link and sink" idea these days? How much of the carbon (that enters the microbial loop) is cycled versus how much is being respired as CO_2;
- The size spectrum idea would provide a good cross disciplinary approach, e.g. does climate change influence size spectrum?
- Do warmer oceans mean more parasites, more fungi, more viruses?
- Climate change affects timing of the bloom, the composition of the bloom and the role of microzooplankton;
- CPR has shown (North Sea) an increase in the cholera bacterium (*Vibrio* spp.): is this due to climate warming?
- Spring blooms seem to be happening earlier these days, which may lead to mismatches with zooplankton life cycles. This might mean more flux to the benthos.

Communication with modellers is very important. We have to identify the descriptors they really need. There is a disconnect between what the modellers need vs. what biologists provide them. There are questions about real (i.e. *in situ*) temperature responses, prey switching and functional relationships in general, versus what is measured under controlled conditions in the lab. Such studies give/need information at all trophic levels. Modellers need a lot of information that we cannot really provide, e.g. we do not even know the upper temperature limit for the survival of *Calanus finmarchicus*. In general, we do not know what controls the distribution and abundance of any single species in the ocean. That is why we need modellers and biologists get together to try to answer this question at a local scale as a start, and perhaps for single species first.

The ecosystem approach to fisheries management is another big issue. Plankton is still not included there. We could think about which indicators are needed in terms of phytoplankton, microzooplankton and mesozooplankton for fisheries management.

Both groups gathered many high frequency data series presenting the various temporal and spatial patterns. We should concentrate on questions such as matches vs. mismatches and whether primary production is enough to support secondary production etc.

Ocean acidification is a big up and coming topic at every trophic level. At the ASLO meeting in Salt Lake City (in February), there were a lot of talks about acidification. Many showed that the effects would not be that dire especially for fish. Should we be looking to make assessments of the health of the ecosystem in general (i.e. considering warming, acidification, trophic interactions)?

Bill Li thanked everyone for the good discussion and asked them to think about these points and more over the next 2–3 days, to lead to a discussion of the way forward in our final plenary.

Thursday discussion on future collaborative plan started with a summary of the ideas identified on Monday compiled by Erica Head and Peter Wiebe:

1) Role of microzooplankton in controlling primary production and reciprocal – toxic algae affecting zooplankton production – Will there be climate effects?

2) Link and Sink: Proportion of carbon respired versus flowing into higher trophic levels? What will happen under climate change?

3) Size spectra of plankton communities - Is climate change changing the slopes?

4) Health of marine ecosystems – what should be observed and how assessed?

5) Bloom timing, magnitude and fate (e.g. to pelagic regime or benthos) – How might these change with climate change? What will happen to systems currently dominated by lipid-rich copepods (e.g. Gulf of Maine)?

6) There is a disconnect between what is measured and what modellers use – e.g. functional relationships between phytoplankton and zooplankton, responses to environmental variables.

7) What limits the distribution and abundance of phytoplankton and zooplankton in the ocean?

8) Implementing regional models – what descriptors are needed for those models?

9) Integrated assessments and their application across the North Atlantic. How to represent plankton in the integrated approach to fisheries management?

10) Synthesis activities/publications based on the zooplankton status report.

11) Symposium focused on synthesis of hydrographic, phytoplankton/microbial and zooplankton time-series observations.

Initial discussion identified that these topics were broad and probably represented too much for the groups to tackle at once. Some of the topics could be consolidated. Therefore, Bill Li stressed that discussion forward should be on the prioritization and the implementation.

As the theme sessions tend to lack a clear product. Therefore, a workshop seems to be much better way to implement the WGZE–WGPME collaborative plan and it should focus on topics which are ready for synthesis. This could lead to the major synthesis per review paper as the most substantial output of the suggested workshop. There is a strong case for idiosyncratic case studies that could illustrate the concepts/ mechanisms within one or more of the topics.

There is a good opportunities for supporting additional analyses of collect time series beyond those already existing and should to consider how to synthesize data across, hydrography, phyto- and zooplankton, maybe there are techniques that allow comparisons among time series with different lengths. This may be one area that crosses themes and it should be beyond the current state of Status Reports. A lot of people will probably be interested in participating in a workshop focused on the synthesis of hydrographic, phytoplankton/microbial and zooplankton time-series observations. The workshop should be organised at ICES HQ due to good facilities and their assistance with logistics. To consider the outcome from the next Status Reports, the workshop should be planned for the fall of 2013.

The following discussion concentrated of focusing the workshop topics.

As a result, both groups suggested a Workshop on Synthesis of hydrographic, phytoplankton, microbial plankton and zooplankton time series in the North Atlantic and adjacent seas to:

a) Review plankton and hydrographic time series data in ICES and adjacent areas;

b) Define time series analysis techniques;

c) Analyse variability and trends in plankton and hydrographic conditions;

d) Analyse variability and trends in taxa distribution and phenology;

e) Review trophic interactions amongst taxonomic or functional groups within the time-series;

f) Discuss pan-regional trends;

g) Prepare one or more synthesis papers that summarize the state of lower trophic levels and their relationship to hydrography and other environmental properties.

The Workshop will be chaired by Lidia Yebra, Spain (WGZE), and Alexandra Kraberg, Germany (WGPME) (for details see the Annex 5 of this report).

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4 ToR a - Review videos of zooplankton sampling/processing techniques as part of progress in updating the Zooplankton Methodology Manual

The group met to discuss potential ways to build upon the strengths of the Zooplankton Methodology Manual. At the last meeting of the WGZE we agreed to produce some example videos that could serve to illustrate methodologies that lend themselves to hands on explanations. The group watched several videos that were examples of approaches that could be used to produce short "how to do it" films related to topics in the Zooplankton Methodology Manual. One video illustrated how to split a plankton sample. Another dealt with deploying a net equipped with a flow-meter.

The group agreed that this medium provided a potentially valuable means of conveying information about techniques that could otherwise not be communicated via text. One advantage of such videos is that they can readily be translated into different languages with little effort and no need to change the content of the video. Given the language skills within the WGZE and beyond, such videos could become a shared resource for a very large community.

The group discussed the need to move this beyond the pilot stage and produce a series of how-to videos. This activity needs to be done via correspondence. Mark Benfield agreed to coordinate activities so that a series of pilot films could be ready for the next meeting of the WGZE.

5 ToR b - Review allometric relationships relating zooplankton morphology to volume, mass, carbon and identify data needs, utility, and regional applicability of these equations

Leads: Christina Augustin and Lutz Postel (by correspondence); Rapporteur: Peter H. Wiebe

The hierarchy of doing a quantitative analysis of plankton samples was described. Determination of total biomass zooplankton with some measure of bulk biomass is a starting point. The measures with increasing accuracy include, volumetric (settled

volume, displacement volume), and gravimetric (wet mass, dry mass, ash free dry mass, and carbon/nitrogen). There are additional biochemical approaches that include organic constituents that can be measured on bulk samples e.g. protein, lipids, carbohydrates, ATP, and chitin, as well as elements besides carbon and nitrogen e.g., hydrogen, phosphate. Total biomass depends on the compositional taxon makeup of the samples. But also season strongly affects biochemical makeup. The zooplankton methodology manual provides several taxon and region specific factors for biomass conversion from different sources (Postel *et al.*, 2000, Table 4). In addition, to total biomass, the same approaches may be used to provide taxon specific biomass determinations. Caution is advised in how zooplankton biomass data are obtained. The different approaches provide different quality levels of the data.

A second level of quantitative analysis involves counting / identification to determine the abundance per taxon or species/stage. With the bulk dry mass measure and the total counts of the zooplankton in the sample, the biomass concentration divided by the abundance provides an average individual specific dry mass, which may be sufficient for the first order estimation of physiological rates. Often length and width measurements are made during the counting/identification process. With such measurements, allometric methods have been developed that enable the computation of wet mass, dry mass, or carbon mass. Mauchline (1998) has summarized a long list of conversion equations to interchange between morphometric and biomass measures for calanoid copepods. Fewer conversion factors are available for other zooplankton taxa. Individual specific size allows other computations to be made of physiological rates based on body size. Examples included Banse and Mosher's (1980) conversion of body size to productivity, Hirst and Bunker (2003) conversion of body size to species productivity, and Ikeda's (1985, 2001) conversion of body size and temperature to respiration and excretion.

An example of the generation of individual specific length to carbon relationships was given from the Baltic Sea region. The determination of individual specific biomass was done by measuring the length of a specimen and then the organic carbon of the same specimen. It was performed at Leibniz Institute for Baltic Sea Research (IOW) by using a computer aided digital measuring system and the micro-carbon analyzer of Salonen (1978). This provided stage specific length to carbon mass relationships and factors for given species of the open Baltic Sea (Postel *et al.*, 2007).

To speed-up the use the species and stage specific allometric relationships for a large number of species a semi-automatic system "easy measure" system (from INTEQ GmbH Berlin, Germany) has been used for the analysis of zooplankton samples at IOW. It involves using a Digital camera with calibrations to account for microscope magnifications; identification by "hand" on a screen; count and digital length measurement on the screen by choosing (clicking) a taxa from the list, clicking on an organism to measure it according the standards; automatic registration of the measurement in the list; calculation of abundance, counting error, and carbon mass per m^3 using IOW equations and carbon factors (separately for taxa and for the total) once the analysis is complete; generation of a report; and export of the data to IOW data base. A very similar system "The WHOI Silhouette DIGITIZER" is described by Little and Copley, 2003).

A number of other programs are now available that enhance the analysis of plankton samples including equipment to measure the equivalent spherical diameter (ESD) i.e. Coulter/ particle counter/ FlowCytometer and other optical techniques i.e. a Laser based optical plankton counter (University of Rhode Island, USA), the Video Plank-

ton recorder (VPR) (Woods Hole Oceanographic Institution, USA); Zoo Scan (HYDROPTIC, France); Flow Cam (Fluid imaging Edgecomb, Maine, USA) and Light frame On-sight key species investigation LOKI (AWI, Germany), and others.

In summary, in spite of the technology improvements and the advantages of the use of individual specific biomass determinations, the development of the tools and techniques are still not adequately developed or used. Regional and seasonal individual specific differences may be minimized by morphometric tools (in contrast to bulk methods, like dry mass determination etc.). Semi- or automatic analytical procedures require precise individual specific factors and morphometric results (e.g. length to carbon relationships), and other than copepods, most taxonomic groups of zooplankton are not adequately characterized. A global compilation of the allometric algorithms presently being used around the world by zooplankton biologists need to be aggregated, listed, and their efficacy inter-compared, in order to make them available to the experts.

In the discussion, a point was made that there are groups making comparison of the allometric equations and that some significant differences were being observed. It was noted that it was especially important to do the work on species level. However, it was also pointed out that the objectives of the sample analysis should determine the level of taxonomic breakdown. In the case of providing ground-truth for acoustic measurements, taxonomic levels above the species level was sufficient. To look at seasonality, additional information beyond the species level is needed, for example the determination of the seasonality of lipid levels. This kind of information requires additional measurements on individuals, such as the length and width of the oil sac in copepods.

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6 ToR c - Update and discuss expanded content for the 2012 Zooplankton Status Report and consider areas where the Phytoplankton and Zooplankton Status Reports could be hamonized

Lead: Todd O'Brien; Rapporteur: Alexanda Kraberg

The session started with an overview of the database and project architecture being used to store the hundreds of zooplankton and phytoplankton time series variables and hydrographic data now assembled for the status reports being done by each of the plankton working groups. Taxonomic and data handling were accomplished by using components of NOAA's Coastal & Oceanic Plankton Ecology, Production, & Observations Database (COPEPOD), while time series analysis and visualization graphics were generated using COPEPOD's Interactive Time-series Explorer (COPEPODITE) toolkit.

The session continued with a brief history of the zooplankton status report and how it initially started out with only 10 sites and had no standardization of figures or analysis. This year the zooplankton group has started working on the 9th edition of its report series, which will feature over 50 sites, along with 40 CPR standard areas, and will include a variety of multi-variable intercomparisons and visualizations.

A progress summary of the phytoplankton and microbial plankton working group's first status report was presented. This new report series will use most of the same analysis and standard figures as the zooplankton report. The site-wide target variables of "zooplankton biomass" and/or "total copepods" will be replace with "total diatoms", "total dinoflagellates", and/or "total bacteria". The first report will start out strong, featuring an already assembled collection of over 80 sites.

Todd then gave an overview of the standard figures and text content that would be used in the plankton status reports. During this discussion, possible uses and examples for each of the figure and analysis types were given. Some new visualization techniques were shown for ratios and relative compositions (e.g., "diatoms-to-dinoflagellates", "group % of total zooplankton"). It was noted that a large variety of visualization and analysis options were offered because options that worked for one site may show nothing at another site, and vice versa.

During discussions, a variety of statistical treatments and tests were suggested by Dominique Soudant (France). The strongest suggestion was to switching to a non parametric Spearman rank correlation when comparing variables and/or indices.

Harmonization between the two working groups

During the group-wide data calls, it was noted that the inter-communication of the two working groups has already been beneficial. Through their phytoplankton counterparts, many of the zooplankton sites now have full in situ hydrographic and nutrient data. Likewise, new contacts and professional networking have added many new sites to both groups that were previously unknown.

Harmonization between the two reports is already partially inherent as they both are using the same analysis toolkit and many of the same standard figures. Including similar regional and cross-basin analyses and figures of key zooplankton and/or phytoplankton/microbial plankton variables would further harmonize the report contents.

A number of sites were also identified as having "everything" (microbial plankton, phytoplankton, microzooplankton, and zooplankton data) available at one site.

These sites were noted as a possible future meeting topic or special sessions by the WGZE and WGPME groups.

Peter Wiebe pointed out that there is a need for a synthesis chapter describing changes seen over the last 1–2 years in the different regions - this could be a peer-reviewed paper.

Carola Wagner draw attention to the fact that the way data are presented now makes comparisons of different time series difficult. This should be taken into account and possibly a tool for the analysis of multiple time series could be provided.

Peter Wiebe asked if it is possible to make those data public. Todd replied that US data are public but in other countries there are different regulations which meant that data could not be published automatically, but only after consultation with the data providers in every case.

7 ToR d - Identify analytical approaches and the potential for publications arising from more advanced analysis of existing time-series data on phytoplankton, zooplankton, hydrography and climate

Lead: Todd O'Brien; Rapporteurs: P. León, S. Putzeys, and A. Da Cruz

The ToR d) discussion was started with a single question: "We have assembled the largest collection of plankton time series available anywhere in the world … now what do we do with it?" This question was aimed both at acknowledging the success of both groups while also reminding them that the data itself was heterogeneous and varied from site to site in length of sampling years, available biological and hydrographic variables, and even in baseline environmental conditions (e.g. from Atlantic shelf waters to semi-enclosed seas to bays and estuaries).

For the purpose of pursuing multi-site, regional, and trans-Atlantic comparisons, each working group has identified common target variables for use in their initial studies. For WGZE, these target variables are "Total Biomass" and "Total Copepods". For WGPME, these variables are currently "Total Diatoms", "Total Dinoflagellates", and "Total (heterotrophic) Bacteria". These variables were selected because they already existed at many sites and/or could easily be calculated from the data pieces present within the sites (i.e. "total diatoms", if not already calculated, can be calculated through the summation of all individual diatom taxa present in that site).

The idea of comparing time series using a common time span (year span) was discussed. An example of using a common time span would be comparing sites using only data from 2000–2010 (ten years), excluding any data from years outside of this box. Using a shorter time span will allow more sites to be included in the comparisons (especially the newer/shorter sites), while longer time spans may be better suited for examinations of longer term variability and trends (based on studies by the SCOR global zooplankton time series working group (WG125) and other studies which found 28–30 years to be the ideal minimum time span when looking at climate and other long term trends within the data). The group agreed that some initial studies using a 20 year and 30 year time span should be pursued. It was also suggested that we could also look for the existence of common inflexion points in any sub-trends found within each time series (e.g. the general year in which a time series switches from an increasing trend to a decreasing trend) to see in this minimum ideal time span varies across regions or hydrographic realms.

While the WGZE analysis has historically only looked at annual anomalies in the reports, it was discussed that annual anomalies may not show trends happening within

the seasons or at a monthly time span. Todd display examples of a new "MonAnom" analysis and plot, which displays a given variable as twelve monthly anomaly plots, in addition to four seasonal plots and the standard annual anomaly plot. Multiple examples were show where strong and clear (statistically significant) monthly trends were present but never seen in the annual anomalies. In some examples, this was due to strong but opposite winter and summer (or fall and spring) trends that cancelled each other out. It was suggested that rather than comparing annual anomalies across sites, it may be better to compare anomalies based on "seasons" or months across the sites.

Additional discussion topics and suggestions included the addition of running means, cumulative frequencies, and performing a meta-analysis. It was suggested that additional analysis ideas and results could be pursued during the "between status report" years, with intent of adding new results to the next report.

8 ToR e - Summarize the status of blooms by gelatinous zooplankton in coastal and shelf ecosystems

Leads: Sophie Pitois, Tone Falkenhaug, and Priscilla Licandro; Rapporteur: Robbert Jak

There were three presentations on this subject, followed by a group discussion.

Sophie Pitois presented on-going work on the ecology, modelling and observations of *Mneniopsis leidyi*. The research project Memo is an Interreg-IVa funded project, focusing on the most southern part of the North sea and the English Channel, and including research parties from Belgium, UK, France, and the Netherlands. See also http://www/ilvo.vlaanderen.be/memo. The project includes monitoring to assess the spatio-temporal distribution, experimental studies on its biology, physiology and feeding behaviour, and on the (potential) ecological, industrial and economic impacts and their mitigation. The group discussed procedures for sampling and preservation. Careful handling is needed. Mainly 1 m ø nylon ring nets with 1 mm or 200 μm mesh size are used, so far. For genetic analyses, specimen are dried on paper before further treatment.

Tone Falkenhaug presented an overview of blooms by gelatinous zooplankton; status, monitoring and research as performed by IMR (NO). Several monitoring and project activities are going on around Norwegian waters (Barents Sea, Norwegian Sea, North Sea, Skagerrak, Atlantic fjords), Each area has its own species of interest, including ctenophores and scyphozoans. The success or failure of these species was discussed in relation to physical conditions (e.g. (low) salinity, transport, light attenuation). Blooms in this region are also related to the introduction of alien speices, i.e. *Mnemiopsis leidyi* to the Baltic/North Sea.

Results from a 3 year research project on gelatinous zooplankton in the Baltic (Bazooca) was also presented. After the completion of this project in 2011, the activity on gelatinous zooplankton in the Baltic is limited. However, a few monitoring stations in the southern Baltic and Kattegat are still running.

Priscilla Licandro presented work of SAHFOS for several locations around the UK. Time-series raise the question whether jellyfish are really increasing, or that it is just a consequence of increased monitoring effort. Moreover, there seems to be a lack of knowledge about the blooming taxa and the understanding of their ecology/biology to predict the consequences of their increase.

The general group discussion tackled several issues, such as the extent of bloom of gelatinous zooplankton (global, local), and publics' perception of blooms. Taxonomy and observations were also considered important in further research. It was suggested that miscellaneous information, e.g. from the public; tourists, hospitals, divers, ferries and aircrafts could increase information on blooms. Hydro-acoustics does seem to work well for all species. The ecological implications of blooming species is also not unravelled.

The group agreed that for next year, information should be updated on blooms of gelatinous zooplankton. Issues should include both trigger factors for the start of bloom forming, and the factors that trigger the end of a bloom. Several steering factors were suggested including climatic factors, global warming, fish removal, eutrophication, availability of substrate (polyp phase), food depletion, and predation. There are a number of activities on gelatinous zooplankton in the ICES area (ongoing or historical), but no comprehensive overview of available datasets. A first step towards better knowledge on the status, consequences and causes behind blooms of gelatinous zooplankton would be to gather available datasets. The group agreed to propose a new ToR on gelatinous zooplankton for the next meeting. This ToR should aim to compile metadata on available dataset on gelatinous zooplankton.

9 ToR f - Summarize regional examples of understudied zooplankton that may be ecologically important but which are not currently monitored

Lead: Peter Wiebe; Rapporteur: Elaine Fileman

There are certain groups of zooplankton that are not currently monitored because of difficulties in finding proper sampling techniques and adequate taxonomic expertise. The absence of such taxa will bias ecosystem models due to missing links in the trophic webs in terms of carbon and energy flow. These unmonitored groups of zooplankton, which are relevant to SciCom codes (152, 162, 121), were summarized.

The main question arising from ToR f was: Which species are currently monitored and where are they being monitored? Do we have lists and can we summarise them? The WGZE Zooplankton Status report should cover some of this, but so far reports do not include all species monitoring. The questions was raised "Of the 40 zooplankton monitoring stations currently summarized in the status report, what's not being monitored?".

Priscilla Licandro pointed out the importance of intercalibration of methods, this is an important issue when comparing different sites.

The presentation focussed primarily on three groups: euphausiids, mysids, and meroplankton and sampling options for these groups were discussed.

Euphausiids: Effective sampling of euphausiids can be achieved using net systems such as MOCNESS tow equipped with a strobe light, which acts to eliminate net avoidance. Net catches combined with multi-frequency acoustic data has been demonstrated to provide a more quantitative way to estimate krill abundance, and if applied to monitoring , could improve the abundance estimates.

Mark Benfield- suggested that it could be interesting to apply this techniques to other animals e.g. mysids.

Padmini Dalpadado mentioned that long term data are available from MOCNESS tows in the Barents Sea.

Erica Head pointed out that sampling euphausiids with a MOCNESS tow could be problematic for small sampling boats.

Mysids: These are mostly epibenthic not holoplanktonic. There are few data to show net avoidance. Their distribution is less well known particularly how far they move off the bottom at night. Priscilla Licandro noted that the CPR survey picks them up near the coast. Epibenthic sledges are typically used to catch bottom dwelling organisms and standard nets can catch those that migrate upwards during the night.

Angus Atkinson suggested that mysids could be surveyed by using a camera on an AOV.

Meroplankton: Some plankton groups already monitor meroplankton e.g. Plymouth L4, Helgoland Roads. Some of the nets used may be too coarse to catch some meroplankton as there are many species covering a wide range of sizes. Elaine Fileman pointed out that fine meshed nets <100μm are more suited for collection of bivalve larvae. Antonina Dos Santos pointed out that some meroplankton species are released only at particular times throughout the year therefore timing of sampling is important. Identification of meroplankton can be time-consuming. New technologies – molecular techniques are now being used to identify species.

What is the need to monitor these groups? Is it science led or Government led? Antonina Dos Santos stated that it important to monitor meroplankton at certain times of year, particularly with respect to commercially important species that can often be site specific. There is Government interest in this in Portugal particularly regarding recruitment.

Therefore, of the sites we monitor at which do we need to have meroplankton monitored or where do we need a higher level of resolution? Coastal areas are prime candidates for such monitoring.

To complement the information presented in Tor B, Peter Wiebe introduced some digitising software- WHOI-DIGITIZER, which uses standard length measurements from the CalCOFI atlas Number 10 to estimate length/weight conversion formulae for meroplankton species. It was noted that IMR length measurements are not necessarily congruent with standard measurements above. Therefore it is critical to standardise methods or at least document what methods have been used.

As a starting point for discussion, the question was raised "what are the candidate taxa that need surveying across the whole of the North Atlantic Ocean? Suggestions from the group: amphipods, krill, fish larvae, abundant copepods such as *Centropages hamatus*.

Priscilla Licandro asked whether it is the case that some species are not adequately sampled or that they are not adequately identified?

Irina Prokopchuk - in the Barents Sea monitoring of euphausiids has been carried out.

Before we can make any further progress with this ToR we need to know what we are monitoring at any given site. The suggestion is to produce a table with the help of Todd O'Brien that will summarise what is being monitored at each site. This would be a major product from the group and would be of relevance to other ToRs e.g. ToR b) and ToR e) and would be a very useful resource for future ToRs and discussions.

10 ToR g - Review the content of the summary of zooplankton sorting centres produced in the past year

Leads: Jasmin Renz & Piotr Margonski; Rapporteur: Solvita Strake

Piotr Margonski summarised shortly his last year presentation of the Plankton Sorting and Identification Centre in Szczecin that is affiliated to the National Marine Fisheries Research Institute (Poland).

This was followed by the Jasmin Renz presentation of two German centres: the 'Materialhof' in Kiel and 'Aquaecology' in Oldenburg.

'Materialhof' is a church related institution which employs and integrates handicapped and disabled people. Next to many different workgroups there is a marine biology centre.

Lab analysis include the taxonomic sorting and classification of meiofauna , mesozooplankton, and macrozoobenthos (marine and limnic), the measurement of organisms by size and weight (including wet- and dry weight), statistical analysis of results and the determination of food composition of fish larvae (stomach content analysis). So far, the focus and expertise of analysis was North- and Baltic Sea plankton. Information on quality assurance has yet to be enquired. Previous clients include exclusively German universities and scientific research institutes. The cost of sample analyses varies depending on volume of samples, number of organisms sorted, analysis and categorization of organisms by development stages, organism measurement requirements and type of data documentation.

The sorting centre 'AquaEcology' offers analyses of plankton (phytoplankton, zooplankton, bacterioplankton) as well as of benthic organisms (phytobenthos, macrophytes, macrozoobenthos) and fishes. The work includes quantitative and differentiated (down to the species level) determination of the whole spectrum of aquatic organisms and all respective quality assurance measures. Analysis of zooplankton (marine, estuarine and fresh water) can include qualitative analysis of species, quantitative analysis of abundances, analysis of size classes, biomass and respiration measurements, data management and evaluation. Water samples or net catches are analysed and listed for zooplankton of all taxonomic groups, using the updated nomenclature. On demand, also other groups (e.g. insects, birds) living around aquatic habitats (riverbanks, floodplains) can be analysed. Furthermore, chemical analysis are provided.

'AquaEcology' works in accordance with current national and international standards (DIN, CEN) and procedures, and provides the customer with all necessary information on the used methods and on the quality assurance measures for the analytical systems.

The focus and expertise so far includes zooplankton of the Antarctics, the outer Ems (German river) and the North Sea (Helgoland Roads time series). The cost of sample analyses varies depending on volume of samples, number of organisms sorted, analysis and categorization of organisms by development stages, organism measurement requirements and type of data documentation.

The following discussion concentrated on different aspects of quality control performed by any kind of sorting centres. This might be solved by workshops, trainings, and inter-comparisons as well as by the system of the internal protocols. The broad taxonomic expertise is required. Information how each of the sorting centres is ensuring the quality control has to be provided.

The other issue is a list of taxonomic experts willing to share their knowledge and provide help with identification of the certain groups. Piotr Margonski summarised his efforts - he contacted Dr. Alexandra Gubanova from the Plankton Department at the Institute of Biology of the Southern Seas, National Academy of Sciences of Ukraine. This group is willing to provide taxonomical identification of external samples (mainly copepods and ostracods, tintinnids). It is known that the group analysed samples from Mediterranean Sea as well. A broad taxonomic expertise exists at the P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences in Moscow. Many of their experts are providing such an external services but most of them are fully booked for the next months or even years. The Polar Research Institute of marine Fisheries and Oceanography (PINRO) is analysing zooplankton samples from the Barents Sea (during the period 1959-1993 between 300 and 500 samples were analysed each year). Canadian Huntsman Atlantic Reference Centre (ARC) is providing the plankton sorting services.

It was decided to prepare the list of all known sorting centres to be presented at the WGZE website. However, the additional list of taxonomic experts has to be treated with caution as we have to be absolutely sure that the relevant permission to present those names is granted in each case.

11 ToR h - Identify relevant zooplankton indicators with utility for assessment of ecosystem quality

Leads: Robbert Jak & Lidia Yebra; Rapporteur: Maiju Lehtiniemi

Robbert Jak had a presentation on the Marine Strategy Framework Directive (MSDF) and the indicators at development, which are related to zooplankton and the pelagic environment. The MSFD aims to achieve and maintain 'good environmental status' (GES) in the marine environment in 2020. In order to use seas sustainably one should apply an 'ecosystem-based approach' to the management of resources.

Time schedule for the implementation of the MSDF:

- 2007 initiated
- 2008–2012 preparation
- 2012 initial assessment
- 2014 monitoring program
- 2015/2016 program of measures
- 2020 good ecological status achieved

There are 11 descriptors to describe the environmental status. Most relevant ones to the pelagic ecosystem are descriptors 1 'biodiversity' and 4 'food webs'.

Other ones that are related as well are 2 'Non-indigenous species', 5 'eutrophication' and 6 'seafloor integrity'.

Managers questions in relation to 'indicators' are:

- Does it respond to a particular human pressure? (Is it not a natural variability?)
- Response linked to a human activity? (What can I do about it?)
- Easily measured? (What does it cost me?)
- Acts as early-warning signal? (Can I use it?)
- Do I and the public understand it? (How do I communicate on it?)

- Existing information on trends?
- Does it record changes with regards to background noise? (Is it really telling me what I expect?)
- Error rate? (How sure are we about it?)

Robbert explained that these questions show how difficult it is to include zooplankton indicators. They don't easily give answers to these questions. Every descriptor is divided to many criteria, which all have several indicators. There are indicators describing the state of the sea and pressures affecting the sea.

Robbert also informed about an OSPAR workshop last year, where pelagic habitats were discussed as well. The workshop participants were of the opinion that there is little consistency in the proposed indicators and that there are no suggestions for pressure indicators. There were several indicators proposed for both phyto- and zooplankton in the workshop e.g. species composition, species richness and representativity, spatial distribution, phytoplankton biomass, also expressed as chlorophyll *a*, timing of the spring bloom, abundance of valuable and vulnerable species, phytoplankton abundance as number of cells l^{-1}.

The following indicators were also suggested: plankton functional types index; large copepods & small copepods; copepod grazers & non-copepod grazers; condition and abundance of typical species/communities; biomass of copepods; biomass of microphagous mesozooplankton; change of plankton functional types (life form) index; ratio between: gelatinous zooplankton & fish larvae, copepods & phytoplankton; holoplankton & meroplankton; change of plankton functional types (life form) index, ratio between: diatoms & dinoflagellates; ciliates & microflagellates; *Pseudonitzchia spp*. & Other toxin producing dinoflagellates.

The group discussed issues concerning indicator development. Peter Wiebe asked what is meant by the human activity in relation to proposed indicators. Robbert Jak said that managers want that pressures affecting the status of the sea are manageable, and that management efforts can be seen via the indicators. Peter Wiebe stressed the importance of monitoring in order to get data for MSFD indicators. Erica Head asked if all countries can choose their own indicators. Piotr Margonski said that at least in the Baltic Sea the process of indicators selection is coordinated by HELCOM but member states are free to submit to EC their own list of indicators considering the regional and sub-regional peculiarities.

Lidia Yebra informed that the national reports are now being prepared, including the long list of suggested indicators, which EU checks through and may ask to change during the first round. Countries can suggest which indicators to use for e.g. descriptor 4 (food webs), but zooplankton is not especially mentioned. Lidia Yebra informed about discussion in Spain if food web descriptor could be covered by the abundance of whales and tuna only and that now experts are trying to convince the managers that food webs cannot work properly without lower trophic levels, and thus they should be included in the indicator lists as well.

It was underlined that the governments will have to pay for the selected monitoring activities, thus plans are being less and less ambitious recently.

Lidia Yebra continued by presenting what has been done at IEO concerning MSFD indicators. She said that Zooplankton Status Reports could be used in initial assessments for descriptors 1, 2, 4. The IEO time series examples include:

- zooplankton data on: abundance, biomass, taxonomic composition;

- data on distribution at: inter-annual scale, seasonal scale, spatial scale.

She informed that the 2012 initial assessment i.e. description of the current status of the sea is now being prepared. The final goal of MSFD is to achieve Good Environmental Status (GES) by 2020. In order to define GES we need to assess the ecosystem quality, and first we need to characterize the ecosystem. There is a lot of variation between sites/areas during different seasons (e.g. zooplankton total biomass or abundance). There is an idea to show trends in different sites including:

- Key species: recurrence in >75% of the samples (based on abundance);
- Key species (abundance) seasonal variations also presented;
- Functional groups abundance over seasons, e.g. salps, cladocerans, siphonophores, copepods;
- Examples of WGPME-WGZE: diatoms, dinoflagellates, diatoms/dinoflagellates ratio, copepods, chordata (filter feeders)/gelatinous species (predators) ratio.

The initial assessment report is now ready in Spain but it might be changed after the public consultation.

Solvita Strake showed the work of the Baltic zooplankton indicator group, which was presented in the HELCOM CORESET meeting held in March 2012. In addition to already submitted "biomass of copepods" and "biomass of microphageous zooplankton", zooplankton experts suggested the new one: "MS-TS" (mean size vs. total stock) which combines the total abundance (or biomass) of zooplankton and the mean size of the zooplankters.

Solvita Strake explained that this indicator is shown in 4 panel graph where the worst situation would be when eutrophication has caused the number of small sized plankters (poor quality food for fish) to increase. The best situation would be when large copepods, which are good quality food for fish, have increased in abundance due to less eutrophic conditions. GES boundaries are determined based on reference periods, which correspond to the times when fish growth has been good and/or when chlorophyll values have been low.

12 ToR i - Review the progress of the SGIMT

Leads: Ann Bucklin; Rapporteur: Piotr Margonski

At first, Ann Bucklin reviewed the rationale for the creation of the Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT):

- In many ICES nations, traditional taxonomy has been poorly conserved, funded and developed over recent decades;
- The internet and digital communications have changed taxonomy development and many new initiatives are pursued, often beyond ICES general purview;
- New biochemical and molecular genetics methods and developments have radically altered research approaches and opportunities in taxonomy and almost all related areas in marine biology and ecology;
- There is a need for greater integration of effort and information between morphological taxonomy and molecular biology/genetics, and indeed with the wider community of ecologists, physiologists and applied biologists.

Then she briefly summarized the history of SGIMT, which started in 2009 as an initiative of WGZE members. Chaired by Steve Hay (UK) the group was preparing the work plan by correspondence. Informal discussions continued in 2010, but there was a limited progress regarding the ToRs. In 2011 ICES approved the second 3-years term for the group chaired by Ann Bucklin.

Then Ann presented response to the SGIMT 2010 Questionnaire. The main message was that:

- New policy is increasing demand for taxonomic expertise and expanding diversity of species to be surveyed/studied;
- Data integrity is at risk if standards of taxonomic identification and nomenclature are not set and maintained;
- Nomenclature standards and taxonomic resources such as species keys and ID guides are not ready available to all, and/or they do not cover the extended regions and ranges of species that modern surveys and research require. Descriptions of less common species and developmental stages are often lacking or unavailable, at times impossible without molecular genetics;
- Molecular methods are developing fast and widely appreciated as key to solving problems in species ID and to providing many new insights into such dynamics as trophic interactions, speciation and meta-populations, also in understanding of species relationships with their environments and reactions to stresses. However many molecular scientists and many field ecologists have difficulties in establishing collaborative studies. Cost is an issue as is consistency over time in the rapidly advancing molecular methods and approaches;
- Training and knowledge transfer are seen as key to expanding taxonomic expertise, resources and availability. True taxonomists are very scarce. Most ecologists and technicians that are actually identifying species and counting samples have little or no depth to their knowledge of taxonomy, beyond that required to ID and count organisms in those samples. Even these skills are often scarce, hard to learn and undervalued, requiring access to appropriate identification guides and keys, expert mentoring and considerable practical experience.

Based on that, the Terms of References for the 2011 were prepared to identify resources, current gaps, and important issues in taxonomic research:

a) Expand membership; ensure balance of expertise, morphological/molecular approaches, across taxonomic groups;

b) Develop a web platform for promotion and exchange of information;

c) Initiate and support provision of standards, training materials, and taxonomy workshops;

d) Assist in the revision / development of species identification keys;

e) Develop continuing integration of molecular/morphological taxonomy;

f) Advise on implications of developments for science / management.

The group decided to continue with the same ToRs in 2012. Ann Bucklin invited WGZE members as guests at the SGIMT meeting on Friday (30 March) in Palacio Hotel, Malaga. The meeting goals are: review the group's previous ToRs, reports and recommendations; consider guidelines and suggestions from WGZE, as well as sug-

gestions and presentations of SGIMT members; and prioritize future ToRs in relation to the expertise of SGIMT members.

During the following discussion, various WGZE members expressed their support and interest in SGIMT work: e.g. lots of SAHFOS activities are very relevant. Antonina dos Santos from IPIMAR mentioned her contribution to the ICES Identification Leaflets for Plankton. It was also stressed that Steve Hay is still considered by ICES as an editor of this series and SGIMT should suggest another candidate. Priscilla Licandro called attention to ZIMNES, Steve Hay's online key for crustacean identification that was hosted by SAHFOS for many years. The ZIMNES keys, morphological features and pictures should be reconsidered and may be useful for SGIMT.

Silke Laakmann informed the group that the German Centre for Marine Biodiversity Research (DZMB), so far mostly interested in fish larvae and eggs identification, has recently expanded their focus to include zooplankton (including larval stages). The group is currently searching for useful and relatively inexpensive methods of species identification.

Several participants expressed their interest in creation of the taxonomic experts list, which could be developed as a joint task for WGZE and SGIMT.

13 ToR j - Review the outcomes of theme sessions J and K from the 2011 Annual Science Conference

Lead: Piotr Margonski and Mark Benfield; Rapporteur: Tone Falkenhaug

Piotr Margonski started with the short summary of the Theme Session K - Integrating micro- and meso-zooplankton in marine food web research. It was convened by James J. Pierson (USA) and Sigrún Jónasdóttir (Denmark). Both conveners expressed their deepest gratitude to Steve Hay (UK) for his support and assistance with the preliminary work setting session up, and more importantly his many years of hard work with the WGZE and ICES.

Scope of this session was described as it follows:

- Zooplankton in energy and material transfer and cycling through marine food webs;
- Modeling studies;
- Field observations;
- Laboratory experiments;
- Direct and indirect interactions between and among zooplankton species within the pelagic ecosystem;
- Comparative analysis of food web organization or connectivity particularly including both micro- and meso- zooplankton groups.

In total, there were 9 oral presentations and 7 posters. Response to the session and from audience members was strongly positive. Results varied from lab experiments with individual copepods to global syntheses of zooplankton productivity. Session was very much dominated by the Baltic Sea studies but there was also one presentation from Papua New Guinea.

In a few talks, the effect of environmental stressors on zooplankton populations, including increasing atmospheric CO_2 concentrations, was presented. Stable isotopes and fatty acid signatures were used as tracers in food web studies.

There were no major overarching conclusions formed from the session, however it was well attended and a number of good questions were drawn from the audience.

Convenors underlined that in future much of the microzooplankton work within ICES will be included within WGPME, and further sessions or programs exploring links between meso- and micro- zooplankton might benefit from jointly held meetings or session between the WGZE and WGPME.

Subsequently Mark Benfield presented the outcomes of the Theme Session J - Climate and Fishery-Related Influences on Marine Ecosystems at Regional and Basin Scales. Originally, it should be co-convened by Webjorn Melle (Norway) and Erica Head (Canada) but Erica could not attend and Mark Benfield (USA) replaced her.

Session was extremely well attended with over 100 people present during presentations. There were 10 oral presentations and 4 posters. Speakers provided examples from the Central and Sothern Baltic, NE and NW Atlantic, the Barents and Norwegian Seas. Presentation illustrated changes in the biological-, fisheries- and climatic-forcing on zooplankton (copepods, chaetognaths, euphausiids) and fishes (sprat, capelin, sardines, herring, cod and others).

Presentations on climate-induced changes prevailed with fewer fisheries induced examples. The general difficulty in disentangling fisheries impacts from those of climate was recognized. The challenge for the future is to develop integrated analysis that look at both fisheries and climatic influences. It was pointed out that in many cases, the lengths of the fisheries time-series are shorter than those of climate time-series.

14 ToR k - Review and report on existing indicators of biodiversity that are linked to predictable changes in ecosystem function and/or to develop, assess and report on the feasibility and performance of such indicators

Lead: Antonina dos Santos and Piotr Margonski; Rapporteur: Kathryn Cook

Piotr Margonski explained that this ToR came from SCICOM out of an ICES Workshop on Marine Biodiversity (WKMARBIO) held in February 2011 (ICES 2011). Antonina dos Santos was participating at that workshop and she was asked to present the ToR and lead the discussion.

Antonina dos Santos referred to the morning discussion on bioindicators (ToR h) which made this topic much easier and explained that the WKMARBIO workshop was convened so that ICES could be prepared to give advice on biodiversity indicators. The workshop included country representatives and invited experts. Attendees were divided into 3 groups each discussing one topic: data and assessment, the use of indicators and reference levels, and science priorities. At the end of the day, participants got together to discuss the outcomes.

Biodiversity studies are supported by the policy: e.g. Convention on Biological Diversity and Marine Strategy Framework Directive descriptors (D1 - biological diversity, D2 - non-indigenous species, D3 - commercially exploited fish and shellfish, D4 - marine food webs, D6 - sea-floor integrity).

Biodiversity may be analysed at different levels: **species level** (distribution area, range and pattern; population dimension (abundance and/or biomass); population condition (e.g. sex-ratio, fecundity rate, mortality/survival rate, etc.); and population genetic structure); **habitat level** (habitat condition (distribution range and extension);

habitat extent (area); and community condition (species composition, population abundance, biomass); as well as **ecosystem level** (ecosystem structure (composition and relative proportions of all components)).

During the workshop participants were preparing and discussing the list of indicators which are being used to describe: state/structure, state/function, and pressure.

The goal was to decide what indicators would be useful and produce good information and reference levels. ICES started discussion on identification of a group of indicators for each ecosystem component. From that perspective WGZE is asked to provide a list of indicators, with explanations, useful for assessing zooplankton.

The subsequent discussion concentrated on difficulties of using the traditional indices of biodiversity, data availability, problems with taxonomic expertise and impact of sampling gear change.

Piotr Margonski reminded Robbert Jak, Lidia Yebra and Solvita Strake presented sets of indicators this morning (ToR h) but, e.g. those suggested for the Baltic Sea are more useful for MSFD Descriptor 4 than Descriptor 1.

There are already traditional diversity indices such as Shannon, species richness, Pielou's evenness etc. The question is why they are not suggested by experts of HELCOM or OSPAR. One of the explanations is that traditional diversity indices are not useful when data are not all analysed to the same taxonomic level, have different sampling periods etc. and taxonomy expertise varies with sites and time. But what seems to be the most important they are not providing information how pressures affects those indices. MSFD needs biodiversity at different levels - species, habitat, ecosystem - and information on how pressures are acting on them so it needs indicators that assess pressures. Pressures are defined as those arising from human activity but not climate, e.g. for non-indigenous species it would include those arriving via human activities but not by range expansion.

Jeff Runge mentioned a 2011 paper by Catherine Johnson *et al*. published in PLoS ONE as a successful example of using the traditional indices for zooplankton studies. Analyses were done in the Gulf of Maine using CPR data and other samples. Authors used species richness with rarefaction and the evenness index. Spatial and temporal patterns were identified. Species richness for CPR data was always very low in the Gulf of Maine but differences could be seen, but we don't know what it means for ecosystem health.

As indicated by Angus Atkinson, evenness and diversity indices were used in Antarctica with data from the 20s and recent data. Diversity increased but this was due to warming and therefore we have to be cautious as index change could mean different things in different areas. In addition, the idea that high diversity is good comes from terrestrial literature where increases in farming is reducing natural diversity.

Erica Head stressed that in northern regions an increase in diversity would be caused by a loss of the dominant species, and in this case an increase in diversity would be bad for ecosystem structure. **This message (that an increase in diversity is not necessarily good for ecosystem structure) should be explicit in our report.**

Peter Wiebe reminded that an extensive reviewed of existing indicators was presented at the WGZE meeting last year (ToR f of the WGZE 2011 report) and that there are probably more than 60 diversity indices in the literature. Also the Zooplankton Methodology Manual, Chapter 4.5 deals with Analysis of Community Structure.

Following discussion focused on the need of the caution application of indices to different spatial and temporal scales as well as considering the knowledge on the ecosystem change at the regional scale (including possible 'regime shifts').

Finally it was concluded that the first step for this ToR needs to be a list of taxonomic categories available for all sites included in the Zooplankton Status Report. This is fundamental information needed in order to recommend indices and how to apply them. We should use the metrics we understand, but with a description of context so that non-specialists can also understand them.

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15 ToR I - Identify and report on functional characteristics that could lead to species being defined as 'keystone'

Lead: Antonina dos Santos; Rapporteur: Angus Atkinson

The Workshop on Marine Biodiversity (WKMARBIO, ICES 2011) was an ICES initiative to build on existing capacity to further develop the profile, relevance, influence and use of biodiversity science and advice. During the WKMARBIO, discussion was divided into 3 topics: data and assessment; use of indicators and reference levels; and science priorities. This latter group identified the need to evaluate the role of key species or functional groups in ecosystem functions. The aim was to move towards defining the roles that these key species/functional groups play in delivering ecosystem services such as productivity, nutrient cycling, carbon sequestration, resistance to diseases, pollution mediation, providing habitat complexity, etc. Again with the aim of providing simplification and tractability of approach, there is a need to be able to apply proxies for these functions that can be widely applied.

For the group discussion Antonina dos Santos presented the following functional characteristics which could lead to a species/group being defined as keystone:

1) Particularly sensitive to a certain parameter (e.g. pteropods and pCO_2)

2) Represents an important functional group (e.g. according to feeding mode)

3) Important in the food web (e.g. as food/predator)

4) Characteristic of a specific habitat (e.g. of upwelling systems, endemic)

The discussion group noted that Paine's (1969) original definition of a keystone species was "one which had an impact on the system that was disproportional to its abundance, and whose removal caused major structural alteration of the ecosystem". The following discussion used the more common pelagic interpretation of a species/functional group as being "key" in the sense of being highly/critically important or characteristic in a food web, or otherwise meritorious of directed study as a "target species". It was pointed out that Chapter 4 in the book "Marine Ecosystems and Global Change" (Gifford *et al.* 2010) was devoted to the justification of the "target species" approach to making systems more tractable to study during GLOBEC, and for the criteria by which they are selected.

Point 3 above was agreed as the typical definition of a "key" species, but the information on whether it is key or not is not binary. It was suggested that a species is key if removing it would have a major effect. If the lack of one small calanoid results in it simply being replaced by another small and functionally similar calanoid, then it is not key. However the functional group ("small calanoid copepods") may well be. However key species, according to any of the 4 definitions above, tend naturally to attract research attention for specific autecological study.

Key species should be thought of affecting the system in possibly adverse ways as well as contributing to the "good" ecosystem services listed in the context section above. This can include, for example, outbreaks of harmful jellies or toxic blooms.

Key species can also be unusual specialists, such as some of the *Gymnosome pteropods* that are specialist predators of *Thecosome pteropods*.

The group agreed that recognition of key species for targeted study was not an excuse to ignore all the others, and could lead to major problems for example in representing wider food web processes in conceptual and numerical models. This is a major impediment in linking the GLOBEC (key target species) approach with more biogeochemically-focussed approaches that are based on whole functional groups such as microzooplankton or mesozooplankton as input terms for models and budgets.

There was universal agreement that the species composition of ecosystems varies intensely in time as well as space. Species may thus make an ephemeral presence to act briefly as critical/key species. Species or groups may thus be key at different times/places and identifying them requires specialist knowledge.

References

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16 ToR m - Exploratory assessment of *Calanus finmarchicus*

Lead: Jeff Runge; Rapporteur: Roger Harris

In introducing the discussion, it was noted that this topic had been assigned to the WGZE at very short notice. It was not one of the formal ToRs for the meeting and for this reason little preparatory work had been possible. Fortunately, members of the group had already been involved in an independent *Calanus* synthesis activity and this on-going work provided some basis for discussion.

Piotr Margonski began by informing the group of the background. ICES had received a request from the Director General of the Norwegian Royal Ministry of Fisheries and Coastal Affairs requesting an exploratory assessment of *Calanus finmarchicus* in the Norwegian Sea. It was noted that *C.finmarchicus* is abundant in all parts of the Norwegian Sea, and is one of the most abundant zooplankton species of the North Atlantic. It is the major herbivore of the Norwegian Sea ecosystem, and the main food of important pelagic fish stocks, for example, herring, mackerel, 0- and 1-group blue whiting and a crucial first food of cod and herring larvae. The role of *C. finmarchicus* for fish productivity in the large marine ecosystem of the Norwegian Sea and the

Norwegian coast, calls for a better understanding of the stock dynamics. For this reason, the Ministry requested ICES to conduct an exploratory assessment of *C. finmarchicus* in the Norwegian Sea.

The main elements of the Norwegian request to ICES, referred to the WGZE, were:

- To evaluate the data sources and methodology for an exploratory assessment of *C. finmarchicus* in the Norwegian Sea during 2012;
- To make an exploratory assessment of the abundance and production of *C. finmarchicus* based on available data and methodology;
- To evaluate quantitatively the ecosystem effect of the harvesting of *C. finmarchicus;*
- To evaluate the potential need for future annual assessment of the stock; in order to improve the understanding of the function of the ecosystem and to consider possible catches of *C. finmarchicus;*
- Provide advice on improved data collection for the development of future assessments of *C. finmarchicus.*

A Norwegian exploratory fishery on this species is already in place along the Norwegian coast at a low level. Annual catch is less than 1000 tonnes.

Jeff Runge then initiated the discussion by presenting a summary of "Basin scale distribution of key zooplankton species and aspects of the life history of *Calanus finmarchicus* in the North Atlantic Ocean". This is a BASIN synthesis activity led by Webjoern Melle with a particular relevance to the request from ICES. Most of the writing work has been completed and the intention is to submit to Progress in Oceanography. In addition to Webjoern and Jeff other co-authors from the WGZE are Erica Head, and Priscilla Licandro and contributors from the WGZE, past and present, include Tone Falkenhaug, Eilif Gaard, Astthor Gislason, Kurt Tande and Peter Wiebe.

Jeff started by summarizing the main elements of the synthesis:

- A discussion of some of the key zooplankton species in the North Atlantic Ocean in relation to oceanographic features.
- Then focus on the most studied of these species, *Calanus finmarchicus*, in order to investigate how detailed knowledge of species life history can provide insight to understanding abundance and distribution patterns across its range.
- Compile and compare for first time demographic and life history data across range of *C finmarchicus*.
- Identify similarities and differences in regional life histories.
- Prescribe directions for further synthesis efforts that will lead to predictive understanding of responses of *Calanus* to scenarios of change in the North Atlantic.
- With an ultimate goal that this exercise will provide insight into approaches for understanding responses of other key species.

Initial consideration has been given to North Atlantic habitat and distributions of key zooplankton species/taxa. These are *C. finmarchicus*, *C. helgolandicus*, *C. hyperboreus*, *Pseudocalanus spp*., and *Oithona spp*., Thecosomata, Euphausida and Cnidaria.

The main elements of the synthesis, with lead authors are:

- Demographic patterns (Webjoern Melle *et al.*);
- Dormancy (Jamie Pierson, Catherine Johnson);
- Egg production rates (Erica Head, Sigrun Jonasdottir);
- Mortality rates (Stéphane Plourde);
- Basin-shelf exchange processes (Jeff Runge).

The working hypothesis is, "there are (are not) basin scale differences in life history traits, functional and population responses in relation to environmental variables".

The writing group has accumulated an extensive collection of information on *C. finmarchicus* over the whole of the North Atlantic basin. On the basis of their analysis of this unique compilation of data-sets the trans-Atlantic patterns that emerge include:

- There are differences between the NW Atlantic and NE Atlantic in surface layer temperature, chlorophyll standing stock and day length.
- Highest abundances are in deep basins in the NE Atlantic and Labrador Sea, but western coastal shelves and seas also have very abundant *C. finmarchicus* populations.
- Variable phenology. There is a similar start in late winter to the active period; generally later start to dormancy in the NW Atlantic.
- There are differences in egg production rate variables: smaller clutch size, lower critical concentration, less relationship with chlorophyll in the NE Atlantic.
- CV mortality is higher inshore than offshore; egg-C1 mortality is lower on the NW Atlantic shelf and higher in the presence of *Calanus* congeners.
- Generally transport is from south to north in NE Atlantic, and from north to south in the NW Atlantic: there are implications for population responses to warming.
- The important role of marginal shelf seas and local production in the NW Atlantic, relative to direct basin-shelf exchange on the Norwegian Shelf.

Jeff Runge concluded his introductory presentation by considering the next steps for analysis of population abundance/distribution under scenarios of environmental (and mortality) change. These were summarized as:

- Comparative analysis: body size; C/N relationships
- Model parameterization:
    - Development time-temperature relationship for the NE Atlantic
    - Upper temperature constraints on reproduction
    - Ocean acidification effects(?)
    - Relationships of growth and reproduction to food
- Coupled physical biological models including diapause strategy

Informed by Jeff's presentation of the BASIN synthesis paper, but focused on the Norwegian request to ICES, a wide-ranging discussion of whether exploitation of *Calanus* might affect other fisheries then followed. It was agreed that the data assembled as part of the synthesis paper project would help towards an exploratory assessment. However, to fully evaluate the ecosystem effects of any proposed harvesting there would be a need for appropriate ecosystem models; modelling would be essential. Additionally, in discussion, the possible need for future annual

assessments was raised. This would have implications for improved data collection for future assessments of *Calanus finmarchicus*.

The question of how big would be any proposed expansion of fishery was raised and also where in the region are concentrations high enough to make exploitation viable. It was suggested that the aim might be to target dormancy stocks. Past initiatives to exploit plankton were mentioned in discussion. Wiborg (1976) published a paper in the ICES Journal on, "Fishery and commercial exploitation of *Calanus finmarchicus* in Norway". The Calanus was stored deep-frozen and used as supplementary food in culture of salmonids and as pet fish food. Experiments were made on products for human consumption. The conclusion was that, "The potential of the fishery is thought to be large, and the yield may be increased according to demand". It was mentioned that there had also been an evaluation of a possible *Calanus* and krill fishery in Gulf of St Lawrence, but it had been decided not to go ahead with this. There was also thought to possibly be a krill fishery on the western Canadian coast. The need to investigate what is going on globally was raised and in the context reference was made to the review by Omori (1978) in Marine Biology, "Zooplankton Fisheries of the World: a review". This survey showed that, at the time, about 20 species of zooplankton (copepods, mysids, euphausiids, sergestids, and Scyphomedusae) were being commercially fished and utilized as food or feed. The annual world catch of crustacean zooplankton was probably just below 210 000 tons and represented 11% of the total world crustacean catch. The status of plankton harvesting in various parts of the world was described and problems in development of plankton fisheries were discussed. Finally, mention was made of the FAO review by Nicol and Endo on "Krill Fisheries of the World" (1997). The conclusion of the discussion was that, while much was known about *Calanus finmarchicus* as a target species in the North Atlantic there remained significant unknowns, particularly in relation to any proposed fishery. While the group were aware of some previous plankton exploitation initiatives (mentioned above) more work would need to be done to provide a balanced assessment of any ecosystem effects.

It was agreed that the WGZE should support the idea of a focussed workshop on "Exploratory assessment of *Calanus finmarchicus*" to explore further the issues and unknowns raised in the previous discussion, summarized above. Once again it was noted that there had been little advanced warning of the need for discussion and hence good preparatory work had not been possible. However, it was felt that the group had an adequate response to the ICES request through the work done on the BASIN synthesis paper.

It was understood that a workshop was already planned under the leadership of Webjoern Melle and with Bergen as the proposed venue. The WGZE proposed that Jeff Runge should be a co-convener and other members were willing to participate if appropriate.

A summary of suggested topics for inclusion at the proposed workshop included:

- The need for a strong ecosystem modelling component to address ecosystem effects of possible harvesting.
- The need to consider other dependent species – birds/whales etc.
- A consideration of the potential by-catch effects of such a fishery.
- Evaluation of whether *Calanus finmarchicus* populations are being measured effectively.
- Huge data gaps spatially – areas of range that are not covered.

- A consideration of new technology which might be used for expanded surveys.

17 Progress Reports: Climate effects on the Barents Sea ecosystem dynamics

Padmini Dalpadado, Randi B. Ingvaldsen, Leif Christian Stige , Bjarte Bogstad, Tor Knutsen, Geir Ottersen and Bjørnar Ellertsen (presented by: Padmini Dalpadado)

Effects of climate variability and change on sea temperature, currents and water mass distribution are likely to affect the productivity and structure of high latitude ecosystems. This work focuses on the Barents Sea, a productive arcto-boreal shelf ecosystem sustaining several ecologically and economically important fish species. The water masses in the region are classified as Atlantic, Arctic and mixed, each having a distinct ecological signature. The pronounced increase in temperature and reduction in the area covered by Arctic Water that has taken place during the last decade has imposed ecological alterations on the region. An increase in biomass of lipid-rich euphausiids in recent years, possibly linked to the temperature increase, has apparently provided good feeding and growth conditions for several species, including capelin and young cod. The observed reduction in Arctic zooplankton may on the other hand have negative implications for polar cod and other zooplankton predators linked to the Arctic food web. Despite these changes, the Barents Sea at present seems to maintain stable levels of boreal zooplankton biomass and production, with no significant changes in the abundances of *Calanus finmarchicus* or the episodic immigrant *C. helgolandicus*.

18 Progress Reports: Plankton investigations in Polar Research Institute of Marine Fisheries and Oceanography (PINRO)

Emma Orlova & Irina Prokopchuk (presented by: Irina Prokopchuk)

Russian/soviet plankton investigations had been started in the Barents Sea in 20th of the last century. In 1926–1931 there were conducted 26 expeditions, which resulted in main ideas about inter-annual, spatial and seasonal zooplankton variations, species composition and vertical distribution of copepods.

In spring and summer 1959–1993 PINRO carried our mesoplankton investigations in the course of Ichthyoplankton Survey. The main purpose of those investigations was to evaluate plankton as food for fish larvae on the way of their drift. The main gear used for collection of plankton was Juday net (opening diameter 37 cm, mesh size 180 cm) with towing speed 0.8–0.9 m s^{-1}. This method is used till present days.

The second period of detailed plankton investigation in PINRO was connected with sharp increase of capelin stock and its fisheries in the Barents Sea. In 1982–1993 a complex plankton survey in the central Barents Sea between 74°30′–77°00′N and 30°00′–56°00′E was carried out. The main purpose was to determine quantitative relationship between feeding conditions and capelin growth in its feeding area in the northern part of the Barents Sea. Based on the results of the survey, features of reproduction and development of copepods, formation of their population structure and abundance in years with different temperature conditions were described.

Lange-scale investigations of mesoplankton have been resumed in PINRO in 2000s in the course of Norwegian-Russian Ecosystem Survey of the Barents Sea in August-September. The main aim of this study was widening of the northern area of investigations due to an intensive ice melting and the ice edge retreatment above 82°N.

Changes in species composition, abundance and biomass of copepods in the Barents Sea and the north-western Kara Sea were observed.

Besides mesoplankton investigations, PINRO conducted long-term investigations of macroplankton. Since 1952 and till now PINRO carried out annual monitoring of euphausiid distribution and their abundance dynamics in the Barents Sea in October-December during the Trawl-acoustic Survey of Demersal Fishes. The main gear is a trawl net (opening diameter 50 cm, mesh size 564 μm), which attached to the head-line of a bottom trawl, and macro-plankton was sampled at 4–5 m above the bottom. Indices of euphausiid abundance and features of their distribution are the base for forecasting on feeding conditions for commercial fishes in the Barents Sea.

Since 1954 PINRO also had been carried out regular mesoplankton investigations in the Norwegian Sea. Juday net was used to collect plankton from several layers. General patterns of mesoplankton development and distribution, features of plankton community were revealed, and these knowledge were used to identify the main productive areas for pelagic fish (herring, mackerel and blue whiting), which perform feeding migrations in the Norwegian Sea. Up to the beginning of 1990s plankton investigations in the Norwegian Sea were regular and carried out in different seasons. Later on the number of cruises had been reduced and their duration was limited to June and July. In 2005 the last survey in the Norwegian Sea was conducted.

In August/September 2007 PINRO conducted a complex survey in the Kara Sea. 58 plankton organisms of different taxonomic groups were found, including 24 species of copepods. A wide variety of species was marked at costal area on the southern part of the sea.

19 Progress Reports: Investigating the role of benthic larvae in coastal pelagic systems

Elaine Fileman and Pennie Lindeque (presented by: Elaine Fileman)

During the reproductive season the larvae of benthic organisms may produce large numbers of transient pelagic larvae that feed while in the pelagic system. These meroplanktonic larvae are an important dispersal mechanism for sessile invertebrates such as bivalves and decapods. When in the pelagic system the larvae will compete with other plankton grazers and are a source of prey for fish larvae and other organisms. Food availability plays a critical role in allowing the larvae to gain sufficient energy and nutrients to metamorphose and develop so they can recruit to the sea floor. As part of the western channel observatory time series (www.westernchannelobservatory.org.uk), zooplankton samples, including meroplankton, have been collected and analysed from 20 years of weekly sampling. Meroplankton can account for up to 43% of the total zooplankton community following spawning events linked to phytoplankton blooms. Two dominant meroplankton include bivalve larvae and decapod larvae that may contribute up to 50% of total meroplankton at certain times of the year. In 2009 and 2010 we carried out a study to quantify the impact of bivalve and decapod larvae in the pelagic foodweb of the western English Channel over a seasonal cycle. Our study site was Station L4, part of the western channel observatory situated approximately 10 km off Plymouth. The results generated from our decapod and bivalve larval feeding experiments have given us a better understanding of what the meroplankton are feeding on, indicating that they are omnivorous. Bivalves typically fed on the smaller size prey such as pico- and nano-eukaryotes but also had a trophic impact on small ciliates. Decapods fed upon a wider size range of prey from large diatoms and dinoflagellates to smaller

nano-eukaryotes. Complimentary gut content analysis using molecular techniques was used to firstly increase the resolution of identification of ingested prey and secondly to compare feeding in the experiments and the field. Following the bivalve larvae feeding experiments clone libraries were constructed from amplified fragments of the 18S rRNA gene for each larva cohort. These were used to determine what species of larvae are found at L4 and therefore used in the feeding experiments. The results show that the species composition varies over the year and that larvae that look morphologically identical in fact belong to many different species. Primers have also been designed such that we can determine the prey ingested by the larvae (decapod and bivalve) both following the bottle incubations and also from animals taken directly from the field.

20 Progress Reports: Zooplankton status in 2011, long-term dynamics and interactions among ecosystem components in the Gulf of Riga: LIMOD project results

Presenter: Gunta Rubene

The LIMOD (Development of Gulf of Riga ecosystem functional model for effective national policy to ensure the protection of the Baltic and the promotion of sustainable ecosystem) project is implemented by two institutes form Latvia – Latvian Institute of Aquatic Ecology (LHEI) and Institute of Food Safety, Animal Health and Environment (BIOR). The main objective of the project is to develop a 1D biogeochemical model for the Gulf of Riga ecosystem, which includes planktivorous fish.

The LIMOD structure is formed by four working groups - biochemical group, primary production group, zooplankton and fish group and modelling team, which will develop a model of the Gulf of Riga, including the latest data on phytoplankton, zooplankton and fish.

The geochemical part of the model will focus on the processes that control nitrogen and phosphorus turnover in the bottom sediments. The biological part of the ecosystem model will comprise phytoplankton (including primary production and nitrogen fixation), zooplankton and herring *Clupea harengus*, which is a commercially important fish species and at the same time the main planktivore in the ecosystem.

Zooplankton and fish group use long-term (from 1980) zooplankton data sampled seasonally (May, August and October) in the project activities. Additional data from the LIMOD project activities will include zooplankton data sampled monthly from May to October from 2011 to 2013. The June, July and September zooplankton and fish stomach samples are collected for the first time in the Gulf of Riga.

Monthly plankton collection in 2011 has led to valuable information on zooplankton inter-annual dynamics in the Gulf of Riga. The peak of total zooplankton biomass was reached in June in 2011. The analysis of multi-annual data of May, August and October always shows that the maximum zooplankton biomass is reached in August. Annual dynamics of individual species are reflected more precisely, when the samples were collected monthly. Thus, it can change the interpretation of inter-annual dynamics of zooplankton. The total zooplankton biomass reached the minimum values in August in summer of 2011. The LIMOD results show that numbers of large monocyclic copepod *Limnocalanus macrurus* in May and August in 2011 were above the long-term average level, but was very low in October. No negative connection with climatic factors and *L.macrurus* growth was found. Environmental factors was favourable for the *L.macrurus* growth in 2011 in the Gulf of Riga (lower salinity, cold

winter). It is expected that the inter-annual decrease in numbers of the monocyclic species were caused by predation of herring. Dominant copepod *Eurytemora affinis* show extreme increase of biomass in June in 2011, especially in Daugava river inflow basin. It could be connected with temperature increase in June and also with other factors not yet clarified.

Temperature and the biomass of the copepod *E.affinis* are main factors used in the prediction of herring year-class strength in the Gulf of Riga (ICES 2009). *E. affinis* biomass in spring (May) is used to predict Gulf of Riga herring recruitment. Usually large number of herring Age 1 coincides with high values of *E.affinis* biomass. So *E.affinis* can be defined as an indicator species of herring yield in the Gulf of Riga. The first LIMOD results of fish stomach analyses show that *E.affinis* was dominated pray item of herring in June and July, but *L.macrurus* was the most preferred food of herring in May. *L.macrurus* numbers has increased in May compared to previous years in the Gulf of Riga. It could be the reason of higher numbers of *L.macrurus* in herring stomachs in May 2011.

It can be concluded that for the proper interpretation of the zooplankton dynamics it is necessary to collect samples each month and it is not enough to collect samples in May, August and October to determine the maximum and the minimum values of biomass. Temperature and feeding conditions are the main factors affecting zooplankton production in the spring. Salinity and oxygen regime changes may affect some species during the summer in deeper water layers. Predation by fish (mainly herring, *Clupea harengus*) may influence zooplankton species inter-annual dynamics in the Gulf of Riga.

Reference

ICES 2009. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), ICES CM 2009/ACOM:07

21 Progress Reports: Toward global application of biochemical approaches for estimating secondary production: Cooperation between ICES and PICES

Presenter: Toru Kobari

Zooplankton community has important roles for trophodynamics and material cycles in marine ecosystems. This presentation gave brief reviews and suggestions for the current methodologies to estimate secondary production. While standardized methods with simple and quick protocols have been developed for primary production, various approaches have been applied for secondary production. Unfortunately, some methods are not only laborious and time-consuming but also inapplicable to some taxonomic groups or whole community. Due to the simple and quick protocols, biochemical approaches have been applied for estimating secondary production in the last decade. However, there is little comprehensive information on advantages and disadvantages among the currently available methodologies including the biochemical approaches. The following issues are suggested for more developing the methodologies and understanding secondary production:

1) Guideline of experimental protocols and advantages/disadvantages for the current methods to estimate zooplankton growth rate;

2) Cooperative research program to compare the methodologies for zooplankton production on a cruise or in a marine laboratory;

3) Summer school to distribute the methodologies for secondary production to ICES and PICES members.

These issues will be discussed in the upcoming workshop (Secondary production: measurement methodology and its application on natural zooplankton community) of annual PICES meeting.

22 Information/discussion on the Multi-annual management of SCICOM Expert Groups

Presenter: Piotr Margonski

Piotr Margonski reminded that this issue was discussed earlier among the group participants by correspondence when ICES started consultations prior to the SCICOM 2012 meeting.

The rationale of the new system was presented by Manuel Barange (Chair of ICES Science Committee) in his letter to EGs chairs: "The multi-annual ToRs proposal will be a substantive change in the management of EGs and the relationship between SCICOM, the SSGs and the Expert Groups. The rationale is explained in the document, but in essence it is an effort to provide a greater opportunity for the expert groups to work on specific aspects of the science plan and to minimise short-term reporting responsibilities. An increased effort is placed in identifying and showcasing outputs and products of EGs, to ensure they are valued, communicated and used to its maximum capacity. There is also a role for self-evaluation and redefinition of the work, either through a renewal of terms or an evolution to a new EG. SCICOM believes this process will modernize the way ICES science operates, with a lighter administrative footprint."

Draft version of the Multi-annual Management of SCICOM Expert Groups: Implementation Report has been uploaded to the WGZE SharePoint.

Piotr Margonski highlighted shortly the main changes introduced by the new rules:

- EGs are appointed for an initial 3-years. They can request renewal at the end of their term.
- ToR for all EGs are approved at the onset for the duration of the EG (3 years for EG), although new ToRs can be considered in response to ad hoc requests.
- WGs will provide interim, reduced, reports at the end of years 1 and 2 of their appointment, and a final, comprehensive report at the end of year 3.
- EGs are self-assessed, through a simple questionnaire that identifies and showcases their achievements against original goals. Renewals for further terms are considered by SCICOM based on justification and self-assessments.

In practise, existing EGs would move to multi-annual ToR as soon as they request this change, or at the end of the term of their current chair.

Subsequently, participants looked through the draft self evaluation questionnaire to identify group's activities which will be scored high. Those are: contribution to Science Plan priorities, contribution to the Advisory needs, and networking with non-ICES organisations. Piotr Margonski stated that those criteria have to be in mind when planning future activities.

Piotr Margonski informed about the WGZE position reported to SCICOM:

1) Self-evaluation is a good idea – and is central to how science works. The success of our group has been based on science outputs and we can document many solid achievements over the last 20 years. In addition, we are pretty convinced that nothing should be forever, therefore, if one day the group "slow down" the new system will enforce necessary changes.

2) We are able to plan our activities for the next three years but our concern is rather about new ToRs which will be sent every year from SCICOM/ACOM which we have no impact on. Therefore, in practice, we will be receiving additional work on the yearly basis anyway, hence, the reduction of routine reporting seems to be a bit problematic...

Finally, participants discussed the idea that the new rules should consider the clause saying EGs will accept new ToRs coming to the group before 1 January only. This would ensure sufficient period of time for preparatory work prior to the meeting.

23 Theme session suggestions for the forthcoming ICES Annual Science Conferences

After a vivid discussion it was decided to support the following three theme session proposals. Two of them for the **2013ASC**:

Application of new genetic techniques to food-web studies [conveners: Ann Bucklin (USA), Janna Peters (Germany), and Penny Lindeque (UK)]

Interactions between micro/mesozooplankton and phytoplankton in controlling primary and secondary production [conveners: Elaine Fileman (UK) and Angus Atkinson (UK) and Claudia Castellani (UK)]

and another one to be submitted for the **2014 ASC**:

The Deepwater Horizon oil spill: what have we learned to understand future environmental impacts relating to pelagic ecology [conveners: Mark Benfield (USA) and Cabell Davis (USA)].

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Annex 2: Agenda

Monday March 26, 2012

Plenary Session

09:00 – 09:30 Meeting Open, Introductions, Logistics, Adopt Agenda (Lidia Yebra and Xosé Anxelu G. Morán, IEO, Spain)

09:30 – 10:00 WGZE-WGPME exchange of information of mutual concern (WGPME ToR a Bill Li, BIO, Canada and Piotr Margonski, MIR, Poland)

10:00 – 10:30 Discussion

10:30 – 11:00 Coffee Break

11:00 – 12:00 Update and discuss expanded content for the 2012 Phytoplankton and Zooplankton Status Report and consider areas where the Phytoplankton and Zooplankton Status Reports could be harmonized (WGZE ToR c) (Todd O'Brien, NOAA-NMFS, USA); Joint session of WGPME and WGZE for exchange of information of mutual concern (WGPME ToR a)

12:00 – 12:30 Discussion

12:30 – 14:00 Lunch

14:00 – 15:00 Identify analytical approaches and the potential for publications arising from more advanced analysis of existing time-series data on phytoplankton, zooplankton, hydrography, and climate (WGZE ToR d) (Todd O'Brien, NOAA-NMFS, USA); Joint session of WGPME and WGZE for exchange of information of mutual concern (WGPME ToR a)

15:00 – 15:30 Discussion

15:30 – 16:00 Coffee Break

16:00 – 17:00 Discussion

Tuesday March 27, 2012

Session 1

09:00 – 10:00 Review videos of zooplankton sampling/processing techniques as part of progress in updating the Zooplankton Methodology Manual (WGZE ToR a) (Mark Benfield, Louisiana State Univ., USA)

10:00 – 10:30 Review allometric relationships relating zooplankton morphology to volume, mass, carbon and identify data needs, utility, and regional applicability of these equations (WGZE ToR b) (Christina Augustin and Lutz Postel by correspondence, IOW, Germany)

10:30 – 11:00 Coffee Break

11:00 – 12:00 Summarize the status of blooms by gelatinous zooplankton in coastal and shelf ecosystems (WGZE ToR e) (Priscilla Licandro, Sophie Pitois, and Tone Falkenhaug)

12:00 – 12:30 Discussion

12:30 – 14:00 Lunch

14:00 – 15:30 Exploratory assessment of *Calanus finmarchicus* (WGZE ToR m) (Jeffrey Runge, Gulf of Maine Research Institute, USA)

15:30 – 16:00 Coffee Break

16:00 – 17:00 Summarize regional examples of understudied zooplankton that may be ecologically important but which are not currently monitored (WGZE ToR f) (Peter Wiebe, WHOI, USA)

Session 2

09:00 – 10:30 Discuss and prepare sections for a Cooperative Research Report on ICES Phytoplankton and Microbial Plankton Status to be completed for June 2012 (WGPME ToR b Bill Li, BIO, Canada)

10:30 – 11:00 Coffee Break

11:00 – 12:30 Discussion and assignments

12:30 – 14:00 Lunch

14:00 – 15:00 Continue to explore additional ecological indicators in phytoplankton and microbial time series; where possible (e.g. CPR), cross-verify molecular and traditional methods of taxonomic identification to recognise commonality and complementarity (WGPME ToR c Rowena Stern, SAHFOS, UK)

15:00 – 15:30 Review and report on existing indicators of biodiversity that are linked to predictable changes in ecosystem function and/or to develop, assess and report on the feasibility and performance of such indicators (WGPME ToR h Norbert Wasmund, Leibniz Institute, Germany)

15:30 – 16:00 Coffee Break

16:00 – 17:00 Discussion

Wednesday Mar 28, 2012

Session 1

09:00 – 10:00 Review the content of the summary of zooplankton sorting centres produced in the past year (WGZE ToR g) (Piotr Margonski, MIR, Poland and Jasmin Renz, German Centre for Marine Biodiversity Research)

10:00 – 10:15 Climate effects on the Barents Sea ecosystem dynamics (Padmini Dalpadado, IMR, Norway)

10:15 – 10:30 Plankton investigations in Polar Research Institute of Marine Fisheries and Oceanography (PINRO) (Irina Prokopchuk, PINRO, Russia)

10:30 – 11:00 Coffee Break

11:00 – 12:30	Identify relevant zooplankton indicators with utility for assessment of ecosystem quality (WGZE ToR h) (Robbert Jak, IMARES, The Netherlands and Lidia Yebra, IEO, Spain)
12:30 – 14:00	Lunch
14:00 – 15:00	Review and report on existing indicators of biodiversity that are linked to predictable changes in ecosystem function and/or to develop, assess and report on the feasibility and performance of such indicators (WGZE ToR k) (Antonina Santos, IPIMAR, Portugal and Piotr Margonski, MIR, Poland)
15:00 – 15:30	Investigating the role of benthic larvae in coastal pelagic systems (Elaine Fileman, PML, UK)
15:30 – 16:00	Coffee Break
16:00 – 16:10	Zooplankton status in 2011, long-term dynamics and interactions among ecosystem components in the Gulf of Riga: LIMOD project results (Gunta Rubene, BIOR, Latvia)
16:10 – 17:10	Identify and report on functional characteristics that could lead to species being defined as 'keystone' (WGZE ToR l) (Antonina Santos, IPIMAR, Portugal)
17:10 – 17:30	Discussion

Session 2

09:00 – 10:30	Discuss cross-ocean basin patterns/trends and regional synchronies in microbial groups with a view towards possible collaborative peer reviewed manuscripts (WGPME ToR d Xosé Anxelu G. Morán, IEO, Spain)
10:30 – 11:00	Coffee Break
11:00 – 12:30	Discussion
12:30 – 14:00	Lunch
14:00 – 15:00	Review the considerations for which good/bad environmental status may be informed by microbial biodiversity and ecological knowledge, such as from key taxa lists, life cycle stages, abundance/biovolume/biomass relationships, assemblage dendograms, phylogenetic trees, and biogeochemical fluxes (WGPME ToR e Eileen Bresnan, Marine Laboratory, Scotland)
15:00 – 15:30	Identify and report on functional characteristics that could lead to species being defined as 'keystone'. (WGPME ToR i Pep Gasol, Institut de Ciències del Mar, Spain)
15:30 – 16:00	Coffee Break
16:00 – 16:30	Discussion
16:30 – 17:00	Continue interactions with and linkages to other working groups such as WGOOFE/WGHABD/WGOH/HELCOM_PEG/SCOR and explore possibilities for future joint meetings with other groups (WGPME ToR f Joe Silke, Marine Institute, Ireland)

Thursday Mar 29, 2012

Session 1

09:00 – 09:50	Review the outcomes of theme sessions J and K from the 2011 Annual Science Meeting (WGZE ToR j) (Mark Benfield, Louisiana State Univ., USA and Piotr Margonski, MIR, Poland
09:50 – 10:10	Information/discussion on the Multi-annual management of SCICOM Expert Groups (Piotr Margonski, MIR, Poland)
10:10 – 10:30	Toward global application of biochemical approaches for estimating secondary production: Cooperation between ICES and PICES (Toru Kobari, Kagoshima University, Japan)
10:30 – 11:00	Coffee Break
11:00 – 12:00	Discussion of ToRs for 2013 and theme session suggestions (Piotr Margonski, MIR, Poland)
12:00 – 12:30	AOB

Session 2

09:00 – 10:30	Outline a 3-year strategic roadmap for WGPME by assessing the current state of ecological knowledge on marine microbial plankton (e.g. viruses, bacteria, fungi, flagellates, protists) with reference to the indicated areas of WGPME contribution to the ICES Science Plan priorities (WGPME ToR g Xosé Anxelu G. Morán, IEO, Spain)
10:30 – 11:00	Coffee Break
11:00 – 12:30	Discussion
12:30 – 14:00	Lunch

Plenary Sessions

14:00 – 15:00	WGZE-WGPME collaborative plan (Bill Li and Piotr Margonski)
15:00 – 15:30	Discussion
15:30 – 16:00	Coffee Break

Session 1

16:00 – 16:15	Joint session between WGZE and SGIMT (Ann Bucklin, Univ. of Connecticut, USA and Piotr Margonski, MIR, Poland)
16:15 – 17:00	Review the progress and future plans of the Study Group on Integrated Morphological and Molecular Taxonomy (SGIMT) (WGZE ToR i) (Ann Bucklin, Univ. of Connecticut, USA)
17:00 – 17:20	Discussion and Closure

Session 2

16:00 – 17:00	Wrap-up assignments and Closure (WGPME ToR b Bill Li and Xelu Moran)

Annex 3: WGZE draft terms of reference for the next meeting

The **Working Group on Zooplankton Ecology** (WGZE), chaired by Piotr Margonski, Poland, will meet in Lowestoft, UK, 11–14 March 2013 to:

a) Complete the videos production of zooplankton sampling/processing techniques as part of progress in updating the Zooplankton Methodology Manual;

b) Review the regional patterns observed in the changes having taken place in the existing zooplankton time series collected in the Zooplankton Status Report;

c) Production of metadata on ongoing monitoring of gelatinous plankton;

d) Global compilation of existing allometric relationships relating zooplankton morphology to volume, mass, carbon, and nitrogen;

e) Compile the list of taxonomic categories including species and stages which are currently monitored;

f) Update the information on plankton sorting centers and existing taxonomic expertise and posted on the WGZE website;

g) Review the progress of the SGIMT;

h) Review the ICES response to the Norwegian request regarding the *Calanus finmarchicus* exploratory assessment.

WGZE will report by 1 May 2013 (via SSGEF) for the attention of SCICOM and ACOM.

Supporting Information

Priority	The activities of this group are a basic element of the SSGEF, 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	Term of Reference a): SCICOM Science Code: 000 (Capacity Building). Updating the ICES Zooplankton Methodology Manual has been identified as a priority activity by this group. Many techniques mentioned in the manual are most effectively communicated visually. A series of short videos will be produced by teams within the group, leading to production of a video series that compliments concepts in the ICES Zooplankton Methodology Manual. Term of Reference b): SCICOM Codes: 115, 162, 321, 322. The Zooplankton Status Report continues to evolve as a major published output of the WGZE. It covers the zooplankton time-series of 40 sites located in Western North Atlantic, Nordic, Barents, Baltic, North Sea, Northwestern Iberian, and Mediterranean Seas as well as accompanying data series on sea surface temperature, chlorophyll concentration and surface salinity data (Baltic Sea only). It gives a rare opportunity to examine the regional patterns in existing zooplankton time series in response to antropogenic as well as climate forcing.
	Term of Reference c): SCICOM Codes: 161, 162, 321. Recent concerns that jellyfish populations are increasing have stimulated speculation about possible causes including climate change, eutrophication, over fishing and invasions. Their fragile nature often

	means that gelatinous zooplankton are poorly represented in regular monitoring programs, and many time-series are still too short to interpret causality. A first step towards better knowledge on the status, consequences and causes behind blooms of gelatinous zooplankton would be to gather info on available datasets. Term of Reference d): SCICOM Codes: 152, 161. Allometric relationships are commonly used to quickly convert routinely collected monitoring data into estimates of zooplankton standing stock that are requested for the assessment and management of the marine ecosystem.At present a wide variety of allometric relationships are available for many zooplankton taxa in the literature; however, there are many taxa for which, useful allometric equations are lacking. A global compilation of the allometric algorithms presently being used around the world by zooplankton biologists need to be aggregated, listed, and their efficacy inter-compared, in order to make them available to the experts. Term of Reference e): SCICOM Codes: 161, 162, 321. This would be a major product from the group and would be of relevance to various previous and current ToRs: e.g. indicator testing at different spatial and temporal scales or zooplankton taxa which are not monitored sufficiently. Such a list is fundamental information needed in order to recommend indices and how to apply them. Term of Reference f): SCICOM Code: 000 (Capacity Building). Taxonomists are a threatened species and taxonomic skills are vanishing quickly. It is of high importance to know which taxonomic expertise is present, and where it is situated. Therefore it is adequate to list taxonomic centers and even single experts to present their competence, experience and processing abilities on particular groups of zooplankton. In the case of many laboratories there are numerous samples, which have not been analyzed so far. Therefore we should also identify and review the centers capable of helping to solve this problem. Term of Reference g): SCICOM Code: Codes: 121, 122, and 346. This study group is addressing issues of taxonomy that are directly relevant to zooplankton ecology as well as the broader ICES community. Close linkages between the WGZE and the SGIMT will ensure that the latter is successful and will keep members of the former informed about new developments in this area. Term of Reference h): SCICOM Code: Codes: 162,211, and 312. The conclusion of the discussion was that, while much is known about Calanus finmarchicus as a target species in the North Atlantic there remained significant unknowns, particularly in relation to any proposed fishery. More work would need to be done to provide a balanced assessment of any ecosystem effects. Thus, it was agreed that the WGZE should support the idea of a focussed workshop on "Exploratory assessment of Calanus finmarchicus" to explore further the issues and unknowns raised during the 2012 discussions.
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
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	The Group reports to the SSGEF, SCICOM and ACOM. Mainly WGZE provides scientific information on plankton and ecosystems to the SSICC and welcomes input from other committees, working/ study groups etc.
Linkages to other committees or	Any and all working and study groups interested in marine ecosystem monitoring and assessments, modelling and/or plankton studies, including fish

groups	and shellfish life histories and recruitment studies. Strong working links have been developed between WGZE and Mediterranean colleagues (CIESM). WGPME will likely work closely with WGZE on issues of microzooplankton ecology and trophic coupling between phytoplankton and zooplankton.
Linkages to other organizations	Links with the WGPME 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 4: Recommendations

RECOMMENDATION	ADRESSED TO
1. ToRs for the WGZE 2013 meeting (see Annex 3)	WGZE
2. Publication of the Zooplankton Status Report as a CRR	WGZE, PUBCOM
3. Propose Theme Sessions for the 2013 ASC	WGZE, SSGEF
4. Propose a workshop (see Annex 5)	WGZE, WGPME, SSGEF
5. Contribute to the WKCALANUS preparations	WGZE, SSGEF, ACOM

Annex 5: Draft Resolution - ICES Workshop "Synthesis of hydrographic, phytoplankton, microbial plankton and zooplankton time-series in the North Atlantic and adjacent seas" (WKSERIES)

A **Workshop on Synthesis of hydrographic, phytoplankton, microbial plankton and zooplankton time series in the North Atlantic and adjacent seas** (WKSERIES), chaired by Lidia Yebra, Spain (WGZE), and Alexandra Kraberg, Germany (WGPME), will be held at ICES Headquarters, Copenhagen, Denmark, in late 2013 to:

a) Review plankton and hydrographic time series data in ICES and adjacent areas;

b) Define time series analysis techniques;

c) Analyse variability and trends in plankton and hydrographic conditions;

d) Analyse variability and trends in taxa distribution and phenology;

e) Review trophic interactions amongst taxonomic or functional groups within the time-series;

f) Discuss pan-regional trends;

g) Prepare one or more synthesis papers that summarize the state of lower trophic levels and their relationship to hydrography and other environmental properties.

Potential participants: Members of the WGPME and WGZE.

WGZE and WGPME will report by 31 October 2013 (via SSGEF) for the attention of SCICOM.

Supporting information

Priority	The results of the Workshop will provide ICES with synthetic pan-regional view of the relationships between the physical, chemical environment and plankton communities in the context of climate change. The Workshop aims relate to SCICOM Codes 113, 115 and 162. This activity is of high priority and central to ecosytem approaches.
Scientific justification	There is potential for more complex joint analysis of existing time-series data on phytoplankton and other planktonic microbes, zooplankton, hydrography, and climate as summarized in existing ICES Plankton Status Reports time-series data. The Zooplankton and the Phytoplankton and Microbial Plankton Status Reports now cover time-series of 40 and close to 100 sites, respectively, located in Western and Eastern North Atlantic, Nordic, Barents, Baltic, North Sea, Northwestern Iberian, and Mediterranean Seas. Parallel reports on hydrography also exist. Synthesis of these data provides an opportunity to create a more comprehensive examination of long-term plankton community changes, foodweb dynamics/shifts and more precise model parametizations. An example of similar analysis carried out for seven different subregions of the Baltic Sea (ICES CRR 302) gives an example how the understanding of the ecosystem change due to e.g. climate and anthropogenic impact may benefit from the multiple time-series analyses.
Resource requirements	Resource required to undertake the activities of this group is negligible.
Participants	The Workshop will consist of 10-20 participants (WGPME and WGZE members).
Secretariat facilities	Meeting room for Workshop.
Financial	No financial implications.

Linkages to advisory committees	The Groups involved report to the SSGEF, SCICOM and ACOM. Mainly WGZE and WGPME provide scientific information on plankton and ecosystems to the SSICC and welcome input from other committees, working/ study groups etc.
Linkages to other committees or groups	Any and all expert groups interested in marine ecosystem monitoring and assessments (e.g. WGOH, WGNARS), modelling and/or plankton studies, including fish and shellfish life histories and recruitment studies. Strong working links have been developed between WGZE and WGPME, as well as with Mediterranean colleagues (CIESM).
Linkages to other organizations	Links with WGHABD are intended and some contact is maintained. The WGZE input to REGNS is an ongoing effort. The Zooplankton and Phytoplankton and Microbial Plankton Status Reports are of interest and practical use for a wide range of national and international research groups, programs and agencies such as PICES, CIESM, GOOS , and IMBER. 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 and WGPME. Contacts are maintained through networking and collaborative activities.