

# ICES WGZE Report 2006

ICES Oceanography Committee

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## Report of the Working Group on Zooplankton Ecology (WGZE)

27–30 March 2006

Villefranche, France



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

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## Executive summary

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The ICES Working Group on Zooplankton Ecology (WGZE) met at Laboratoire d'Océanographie, Villefranche, France from 27–30 March 2006. 24 scientist from 13 countries participated. The main conclusions are summarised below.

- WGZE strongly supports zooplankton inclusion in QA regulatory frameworks (ToR f), noting that it is not effectively implemented in many European monitoring activities (e.g. EU-Water Framework Directive, OSPAR), and suggests that the Zooplankton Methodology Manual be used as a basis for setting standards (ToR g). An *ad hoc* subgroup of three WG members was created with the task of responding quickly to data management demands from the ICES Data Centre and others (ToR i-viii).
- In reviewing the North Sea ecosystem assessment undertaken by REGNS (ToR h) it was felt that zooplankton experts should be more involved in the process. It was felt that inclusion of other zooplankton data sets besides the CPR data could be useful in complementing the present results. Further, it was felt that gelatinous zooplankton should be added to the analysis, and since winter temperatures control the seasonality of zooplankton, phenology should also be included in the REGNS study.
- The ICES Plankton Status Report identified various plankton trends and changes (ToRs a and b). For instance the variability span of most time-series correlated nicely with their location latitude (temperature). Further, sea surface temperatures and phytoplankton seem to be increasing in many regions of the North Atlantic while total copepods are decreasing. Important additions and improvements to the report are planned.
- WGZE noted several examples of introduced species by natural processes (e.g. *Muggiaea atlantica* (Siphonophora) in German Bight, *Temora stylifera* (Copepoda) off the Spanish coast, *Neocalanus cristatus* (Copepoda) in the North Sea) and ballast water (*Acartia omorii* (Copepoda) in European waters) (ToR d). In the cold East Icelandic Current, to the north of the Faroes, a reduction in the abundance of the cold water copepod *C. hyperboreus* and shift in the timing of reproduction of *C. finmarchicus* has been observed.
- The unofficial WGZE website already summarizes and supports several products and activities of the group (e.g. ICES Zooplankton Identification Leaflets, the ICES Zooplankton Methodology Manual), but it was decided to expand it to include lists of publications relevant to the group, WGZE membership listing, along with a news and events section, and an interactive version of the group's main product, the Annual Zooplankton Status Report (ToR e).
- In order to create and foster expert networks, harmonise methods and to compare the ecology of the North Atlantic and the Mediterranean, the group decided to propose a joint meeting of WGZE and CIESM scientists in October 2008 (ToR c).
- WGZE appreciated the conclusions and recommendations of the Workshop on the Impact of Zooplankton on Cod Abundance and Production (WKIZC, ToR i-i). It was stressed that the timing of production of copepod nauplii in relation to first feeding of larvae is decisive for larval survival, and that data on occurrence of fish larvae from zooplankton monitoring stations can be used to determine seasonality in reproduction of fish species.
- A literature review workshop on the use of biochemical methods to measure rate processes in zooplankton will be held in the Canary Islands in October or November 2006, probably followed by a practical workshop in 2007 (ToR i-ii).
- WGZE appreciates the effort of the SCOR WG 125 in carrying out a global analysis of zooplankton decadal variability in the world oceans. WGZE notes that there are gaps in the data sets acquired by SCOR in the North Atlantic and the Indian Ocean, and that the CPR data will therefore be very important in the former region (ToR i-iii).

- Arrangements of the ICES/PICES/GLOBEC 4th International Zooplankton Production Symposium to be held in Hiroshima in 2007 are progressing well (ToR i-iv). WGZE proposes that a workshop on phenology be organised in connection with the symposium.
- WGZE strongly supports the new research initiative RAPID (Research on Automated Plankton Identification), developed as a spin-off from the recently held “ZooImage” workshop, recognising that there is a clear need for developing and advancing automatic imaging processing systems (ToR i-v).
- The Zooplankton Taxonomic Workshop conducted under the auspices of WGZE and supported by ICES and MARBEF will be held in Plymouth 20–23 June 2006 (ToR i-vi). The possibility of organizing a further taxonomic workshop on gelatinous zooplankton in 2007 is being investigated.
- WGZE reviewed three other international projects that are of relevance to the group: EUR-OCEANS, BASIN and MARBEF (ToR i-vii). As to the last named project, WGZE concluded that a letter be sent to MARBEF, informing about the activities of the group in order to initiate information exchange and to avoid overlapping in the future.

WGZE proposes to meet again from 26–29 March at the University of Latvia, Riga, Latvia.

A summary of the Terms of Reference for the 2006 meeting is given in Section 2 of the Report. All ToRs were met. However, the group felt that ToR d) needed more discussion and therefore a similar ToR is suggested for next meeting. ToR a) is related to the Plankton Status Report and thus a continuing task of the group.

## 1 Opening of the meeting

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The ICES Working Group on Zooplankton Ecology (WGZE) met at Laboratoire d'Océanographie, Villefranche, France from 27–30 March 2006 at the kind invitation of Gabriel Gorsky. The meeting was attended by 24 scientist representing 13 countries (Annex 1).

The meeting opened at 12:00 on the first day with a short history of WGZE from Astthor Gislason (Chair), followed by a round of introductions and a welcome and comments on the housekeeping arrangements from Gabriel Gorsky, the host.

Astthor Gislason then drew the attention of the group to an e-mail from Einar Svendsen, Chair of the Oceanography Committee (OCC), asking WG members to keep in mind that ecosystem approach to the management of marine ecosystems is becoming increasingly important within the ICES community and elsewhere, and that one way of motivating for that kind of work is to identify highlights and unusual events related to the work. The Chair encouraged the WG members to keep this in mind during the meeting and try to identify highlights related to the ToRs dealt with.

## 2 Adoption of the agenda

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The agenda for the WGZE meeting (Annex 2) followed the Terms of Reference adopted as a resolution by the ICES 2005 Annual Science Conference and Statutory Meeting and was adopted. WGZE will report by 1 May for the attention of the Oceanography Committee, ACE and ACME. The Terms of Reference for this meeting are to:

- a) Update the ICES Plankton Status Report; consider progress towards consolidation, interpretation with appropriate statistical methods and recommended monitoring standards;
- b) Plan and prepare for additional analyses and products utilising the Plankton Status Report Time-series;
- c) Plan and consider an agenda for a joint meeting with CIESM plankton scientists;
- d) Review the causation and impacts of introduced or disappearing plankton species, particularly from regions in the ICES and CIESM areas;
- e) Consider and consolidate the use of web site and virtual resources for support of WGZE endeavours;
- f) Review and comment on the draft text on the application of AQC Criteria (Annex 8, SGQAE 2004). (The answer to this TOR demands intersessional work by WGZE);
- g) Provide expert knowledge and guidance to ICES Data Centre (possibly via sub-group) on a continuous basis;
- h) Review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant;
- i) Review achievements, progress and prospects for:
  - i) Workshop on the Impact of Zooplankton on Cod Abundance and Production [WKIZC];
  - ii) Workshop on enzymatic and other biochemical and molecular methods to measure rate process in zooplankton;
  - iii) SCOR Working Group, Global Comparisons of Zooplankton Time-series.
  - iv) ICES/PICES/GLOBEC International Zooplankton Production Symposium in Japan 2007;

- v) GLOBEC/ SPACC workshop “Image analysis to count and identify zooplankton” (ZooImage), San Sebastian 2005;
- vi) A taxonomic workshop to advance the Fiches plankton ID sheets, also to encourage the training and retention of plankton taxonomic skills;
- vii) Plans and progress in relevant national and international projects relating to plankton studies (e.g., MARBEF, BASIN and others);
- viii) Data management issues at ICES and elsewhere, including expert knowledge and guidance to the Data Centre.

### **3 Status of WGZE within ICES**

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Before opening for the discussion on the Terms of Reference, the Chair draw the attention of the group to the fact that ICES has set up a special Workshop on Review of the ICES Committee and Expert Group Performance (WKREP). This group met in Copenhagen on 15 March 2006, and was attended by several Expert Group and Committee Chairs. Before going to this meeting, the Chair of the Oceanography Committee, Einar Svendsen, sent an e-mail to the group explaining that he would advice ICES to close down the WGPE due to the low interest of its members (only three members had confirmed attendance to their annual meeting this year). In his e-mail, Einar asked us to consider the option of establishing a new group with a broader view: WG on Plankton Ecology, essentially combining what was left of WGPE with our group. On 7 March 2006 the Chair responded with an e-mail to Einar Svendsen outlining our arguments that WGZE should continue to exist (Annex 3). Our arguments were well taken by Einar Svendsen and he replied that he would propose “to keep WGZE as it is and just close the WGPE some time (with the aim of rebuilding it from scratch)”. Astthor Gislason said that this was not the first time that we were asked by ICES to consider our position. For instance in 2000, Harald Loeng, at that time the Chair of the Oceanography Committee, asked us to consider our standing within ICES and the rationale for our existence. Our answer was then, as now, that the group was very important and should definitely continue to exist (ICES, 2000, 2001). Astthor Gislason said that restructuring of ICES seems to be more or less a continuing process and that it is important that we use every opportunity to argue for that we continue to exist. Nobody else would do this for us. In this context he outlined the evolution of the group by looking at some milestones and deliverables achieved by the group since it was established as a Study Group by the ICES Council in 1990 (Council Resolution 1990/2:45) (Annex 5).

During the meeting Luis Valdés gave a brief account of the WKREP meeting (Workshop on Review of the ICES Committee and Expert Group Performance) held in Copenhagen 15 March that he had attended. The main purpose of this meeting was to consider ways of improving the structures for the science work within ICES.

The main conclusions of the meeting relevant to the Expert Groups are:

- Terms of Reference: the list of terms of reference is usually too large to be addressed in a three-day meeting. So be cautious when producing the ToRs. The number of ToRs should probably not exceed six.
- Include in the EG report an extended Executive Summary (short and complete), highlighting the main points treated and conclusions reached at the EG meeting.
- Expert Group Chairs should attend the Committee meeting at the ASC

The most important points for the Science Committees:

- The Committees are encouraged to discuss on scientific issues and invest less time on reviewing the terms of reference of the EG.
- The number of Scientific Committees (eight) exceeds the capacity of the ASC for parallel meetings of the Committees and Theme Sessions. So it was proposed to reduce the number of Science Committees to three, mirroring the Assessment



Committees; each of them will have a chair and a vice-chair and both will be members of the ConC. This was just a proposal and needs a larger discussion.

In the ensuing discussion Wulf Greve made the comment that reducing the number of Science Committees from eight to three may be taken as an indication of an increased emphasis on ecology within ICES (provided that the Oceanography Committee would be maintained).

## **4 Data quality control and data management**

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(Lead Steve Hay, Rapporteur Angel Lopez-Urrutia)

### **ToR f) Review and comment on the draft text on the application of AQC Criteria (Annex 8, SGQAE 2004). (The answer to this TOR demands intersessional work by WGZE)**

The discussion opened with remarks from the Chair explaining that the task is to review and comment on a draft text on the application of AQC-criteria (Analytical Quality Control-criteria) for evaluating the acceptability of biological data in monitoring programmes (Annex 8, SGQAE 2004, ICES 2004). As the group was asked by ICES to respond before the deadline of 14 February 2006, the Chair sent a letter to Dr Jon Davies, the Chair of SGQAE on 12 February 2006 outlining the position of the group. WG members Roger Harris, Luis Valdés, Steve Hay and Wulf Greve made important contributions in the drafting of this letter. The letter is enclosed as Annex 5.

The proceedings then proceeded with an introductory presentation by Steve Hay on data quality control and management and on the application of AQC Criteria. It was noted that zooplankton has only recently and briefly been mentioned in OSPAR guidelines, EcoQOs, EU Marine Directive proposal, etc. but there are encouraging moves to include it (Anonymous, 2005). Previous meetings (for instance in 2000 and 2002) discussed QA issues and WGZE strongly support zooplankton inclusion in regulatory frameworks alongside physics, chemistry, phytoplankton, benthos and the fish and higher predators. WGZE recommends inclusion of measurements of abundance and biomass with taxonomic ID and species diversity.

Phenology represents a powerful tool to understand timing and changes in seasonal patterns of species life cycles and production in relation to environmental changes through climate or perturbation. A recommendation was made for the Zooplankton Methodology Manual to be used as basis for setting standards and WGZE noted the importance to QA issues in defining aims, timing and scales in sampling, and in considering the appropriateness of methods, survey planning and data analysis/interpretation. The inclusion of zooplankton in monitoring regulations is considered to be essential because WGZE and many published papers have repeatedly shown that zooplankton can be useful indicators. Also because the regulatory framework provides scientists with policy justifications for funding for research and to maintain ongoing monitoring programmes. The exclusion of zooplankton leads to an uneven research effort. Most of the monitoring QA described refers to benthic survey work and little is directed to zooplankton, nevertheless the headings for data quality and management are always relevant: ring tests, suitability of gears, flagging of doubtful or inconsistent data, metadata standardization, responsibility of data and accountability, etc. WGZE stressed the importance of metadata and need for the data managers and data users to be able to collaborate and verify data with the data originators.

In relation to the ICES/OSPAR/HELCOM Steering Group on Quality Assurance of Biological Measurements (STGQAB) a brief summary of their last report was considered and the STGQAB concern that zooplankton monitoring is not included under WFD ecosystem assessment scheme and their appeal and recommendation that countries continue existing monitoring schemes. The new EU Marine strategy has included rate measurements for secondary production in the proposed directive's assessment scheme, so there is a hope that

these measurements too will be further coordinated on an international level. Previous work by WGZE and the planned biochemical methods workshop are relevant here.

A discussion was initiated on possible indices that could be provided like species list or biomass data. It was suggested that optical systems and size spectra could be a valid approach, although it was also argued these may have biases due to animals having a variety of orientations which may make it difficult to obtain consistent measures. It was noted that ICES Data Centre is now accepting biological data whatever the format, and that they will do the translation as long as they can understand the data, this is good news because for previous years this was not possible and this now greatly facilitates the task of data incorporation into ICES datasets. WGZE considered the problem in adopting a reliable and international species code that lacks the problems presented by current ITIS coding. The MARBEF and ERMS initiatives should solve these difficulties in consultation with ITIS and ICES as soon as possible.

Regarding the EU marine strategy initiative, seasonal and regional information is required and WGZE agreed the need to aim our monitoring efforts to monitor for the seasonal and regional changes that might occur. The difficulties of achieving this without close temporal sampling was discussed and considered, noting that many monitoring programs do not sample with sufficient resolution to achieve this aim. A combined approach using weekly or monthly sampling at easily accessible coastal sites with less frequent offshore sampling is best. Difficulties in accessing and using data were discussed where the data is not really available. WGZE noted that there must be proper ways established to cite and acknowledge the data collectors work. It was also felt that where a dataset is used or incorporated into a data base the originator should be informed and perhaps should be given opportunity to correct any errors and misconceptions. The ecological status report that SAHFOS makes can be cited so it is a way to cite and reference data even if it has not yet been fully published. It was mentioned that some workers consider that data collection paid by government should be available for use by others, to encourage the best data use and discussion of the data. It was also noted that data is hard to generate but just as hard to exploit and analyse. It can be hard to find where some datasets are and details of collection etc and this is the reason for lots of data being out there but not fully exploited. John Steele said that in his long experience of gathering datasets, usually acknowledgement of data sources is an absolute requirement. This is because the data has so many intricate clues and factors related to its collection and analysis that only the collector knows about. It was mentioned that it is often very difficult to publish all the data you collect, and that lots of data are not even digitized. Techniques and methods of data analysis change considerably, while the data remains often the same; and new analyses can be very revealing and productive. WGZE raised the question about the time lag for free use of data sets to allow the originators time to analyse and publish. Most data centres let one flag the data so it cannot be used until a given period has elapsed. However for time-series where a long time may be needed to generate an appropriate series for analysis, and when often slow taxonomic analyses are required, such a lag flag can be in place for perhaps several years. This ties up data and a better approach could be to open the data but insist on originators inclusion in collaborative write up and analyses for a given period.

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

WGZE has not been approached this year with any specific requests but given the large number of WG members it was suggested setting up a subgroup of people who could respond quickly to this kind of demand. Volunteers were asked for and so provisionally: Todd O'Brien agreed to ask his institute for permission. Peter Wiebe has great experience and has been involved in ICES and many other data management initiatives. He will be approached by the WGZE Chair to request his participation in the sub group. Steve Hay also agreed to take part.

- Action: A sub-group will be formed with the task of responding quickly to demands from ICES data centre and others to management of zooplankton data. The group will consist of the following WG members: Peter Wiebe, Steve Hay and Todd O'Brien.

**ToR i-viii) Review achievements, progress and prospects for data management issues at ICES and elsewhere, including expert knowledge and guidance to the Data Centre**

This follows and overlaps from the previously discussed ToR. It was noted that there is still no plankton data available at ICES except through HELCOM and via the Plankton Status Report.

WGZE should consider regional species lists and sampling metadata summaries for what is available in the way of data from as many regions as possible. This would at least provide an overview and direction with contact details for the data holders.

If ICES plans to make demands for provision of data, like regional species list or sample metadata, a prepared summary to of what we collect and can provide would be good. It was agreed to get everybody to look at the status report and to think about relevant and important measurements made at these and any other issues. The ICES Plankton Status Report is a brief summary of the data by site; it is only a fraction of what data is actually available. WGZE felt it would be good to start linking zooplankton and phytoplankton, as there are lots of sites where both are measured and many data that could be included. A workshop was suggested to keep up the momentum on the Plankton Status Report initiative and to develop techniques for collaborative means to analyse the data.

John Steel raised the important issue that micro-zooplankton is missing from almost all plankton monitoring and many surveys. Much new work indicates that micro-zooplankton could very often be more important to the ecosystem dynamics than the meso-zooplankton, as routinely collected by the 200-250micron meshes in standard nets. WGZE agreed that we should concentrate more on the microbial food webs. Maria Grazia Mazzocchi mentioned that in their time-series in Naples the micro-zooplankton is included in weekly monitoring.

In relation to the problem of counting samples, one way to standardise might be to consider using centres for taxonomic analysis. Examples were discussed such as sending samples east to Russia, where taxonomy is still strong. An example was given of samples sent to Poland for analyses; first results were not too good but later greatly improved. It has to be noted that sending samples away introduces often difficult quality control issues. This reinforces the growing need for regional emphasis on taxonomic training and for inter-regional workshops and QA ring trials.

## **5 The North Sea ecosystem**

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**ToR h) Review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant**

(Lead Wulf Greve, Rapporteur: Sophie Pitois)

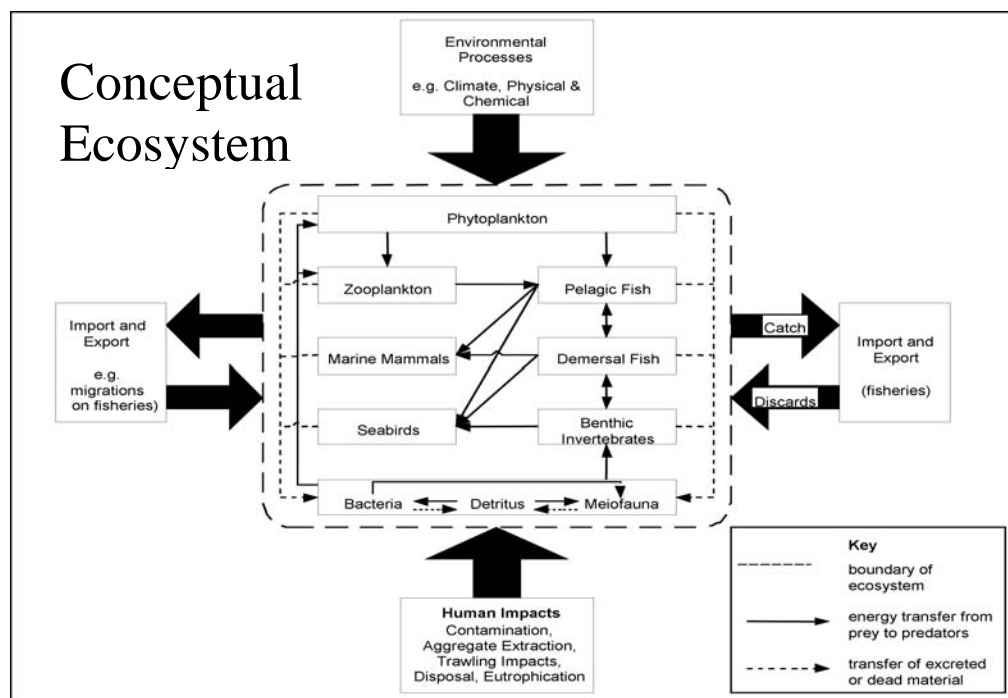
Discussion opened with a reminder from the Chair that the Regional Study Group for the North Sea (REGNS) is presently carrying out an ecosystem assessment of the North Sea. Now REGNS is in the process of collecting data from different compartments of the ecosystem. Zooplankton data are important, and our task would be to identify what zooplankton data are available and to elaborate on how these could be made available to REGNS. The REGNS group will have their next meeting in Copenhagen (15–19 May 2006). According to Andrew

Kenny (Chair of REGNS) it is not necessary to complete this task during the meeting; there is opportunity to continue the assessment at the REGNS workshop in May.

Wulf Greve continued the session with an overview of the Regional Ecosystem Study Group of the North Sea (REGNS). REGNS is an ICES ongoing pilot scheme and preliminary analysis results can be accessed from the REGNS web-database at <https://marsgeo.jrs.it/phppgadmin/>, the username is REGNSUSER and the password is ECOSYSTEM, although this does not seem to be working at the moment. The group is chaired by Andy Kenny from CEFAS, UK ([a.j.kenny@cefas.co.uk](mailto:a.j.kenny@cefas.co.uk)).

The first objective of the group is to deliver an Integrated Assessment of the North Sea by September 2006, and the second objective is to investigate ways in which the existing ICES structure of Working Groups can input into the periodic production of future North Sea Assessments. By Integrated Assessment (i.e. IA), it is meant an Integrated Analysis of data from all sources (R&D and routine monitoring programmes) on Drivers, Pressures, State and Impact in order to help us understand the links between pressures and changes in state, and to contribute to the scientific evidence base upon which Integrated Advice is formulated. An Integrated Assessment is therefore neither status reporting or restricted to assessing a single (or few) pressure and state changes, but is holistic in its approach.

Figure 5.1 highlights the need to have contributions to the assessment at all trophic levels and pressures. Such a diagram can help to identify separate themes that play their own role within the North Sea ecosystem. Each theme still undergoes an integrated assessment of its own data that is to be coordinated by Theme Facilitators from REGNS. An example of such themes is *Eutrophication*, with source ICES working groups WGPE, WGHABD, WGZE, and coordinated by Hein Rune Skjoldal as facilitator. Other themes are *Conservation of Habitats and Species*, *Chemical Pollution*, *Fisheries*, *Climate and Natural Variations*, and of course *Zooplankton*. In total 19 working groups have been identified. A key question of each working group involved is how the relevant data can be integrated with this overview assessment.



**Figure 5.1.** A conceptual description of a marine ecosystem highlighting the biological components and their trophic relationships and the external pressures (both environmental and human) acting upon them. The diagram serves to highlight those areas in which ICES has strong representation (pelagic and benthic macro-organisms) whereas other areas notably at the bottom of the food web are poorly considered (ICES, 2003).

The approach taken by REGNS consists of two steps; firstly we need to identify all relevant sources of data (mainly obtained from non-R&D programs) and to generate metadata tables. A matrix of data is then constructed consisting of long time-series covering the entire North Sea. Analysis of these time-series is carried out in order to identify regime shifts and their possible causes; and spatial analysis is undertaken to identify significant sub-regional areas in the North Sea which have consistent characteristics over time. The second step involves undertaking the sub-regional analysis to observe how regions have changed over time and has yet to be undertaken, but is hoped that this will be carried out by the REGNS intercessional correspondence group prior to the workshop where it will be presented. There is still the need to look at ways in which the discontinuous data in space and time generated by the supporting working groups can be integrated into the sub-regional data sets for assessment purposes.

For example, plankton and chlorophyll data covering the period 1948-2003 are from the CPR and provided by SAHFOS. Other biotic data include fish landings by species, sea birds etc. Abiotic data include salinity, sea surface temperature, bottom temperature, oxygen, tides, nutrients, frontal circulation and so on. Overall, a huge dataset has been compiled, consisting of 126 parameters gridded over 200 statistical squares (i.e. ICES rectangle squares) and spread over 12 years each containing 12 months, which gives a total of 16.5 million raw data values. These 126 parameters comprise 47 species of plankton over the period 1950–2004, 49 species of sea birds over the period 1980–2004, nine species of fish and four fish assessment metrics over the period 1965–2004 and 17 physical oceanographic parameters covering the period 1973–2004.

#### *Analysis of time-series identified a few important features*

Through Principal Component Analysis on abiotic data (i.e. 13 parameters) centred and standardized over the period 1973–2003, two principal states in the average North Sea physical conditions were identified: the period 1980 to 1989 and the period 1990–2002. Besides, plots of average North Sea temperatures show a sudden increase of both surface and bottom temperatures and a decrease of their relative difference in 1989. It would therefore appear that a significant component of the PCA ordination relates to this shift in temperature in 1989.

Analysis of Detrended Correspondence Analysis on square root transformed on biological data (fish landings, fish lengths, exotic fish species and abundance of plankton species) identified three areas which represent abrupt changes from the main trends; these are the periods 1965 to 1973, 1978 to 1981, and 1989 to 1997. Furthermore an examination of the demersal and pelagic fish length data reveals some trends over time which appear to correspond with the changes in state and pressures seen in this analysis; i.e. the mid-1960s, late 1970s to early 1980s and late 1980s–1990s are periods during which the relative difference between the pelagic and demersal fish lengths is relatively large compared. Whether this response is due to fishing or environmental pressures is a key question. Even more compelling is the examination of the relative densities of *Calanus finmarchicus* and *Calanus helgolandicus* since 1958; *Calanus finmarchicus* was relatively dominant compared to *Calanus helgolandicus* during the periods 1963–1967 and 1979–1981, however in 1989 a reversal of the dominance occurred and *Calanus helgolandicus* has remained dominant since.

An examination of the NOWECOM model sea water flux data for the northern North Sea also reveals three significant periods which again coincide with the shifts in state described above; these are low levels of negative flux in 1967 and 1979 followed by a relatively large increase in negative flux in 1988. Whilst this does not prove conclusively the link between ocean climate forcing pressures and change in state, it is nevertheless quite compelling. There is a definite need to develop other tests and analyses to help understand the relationships between natural pressures and fishing pressures on the marine ecosystem using the data available to REGNS.

*Turning our attention to the spatial analysis, using hierarchical cluster analysis*

Applying Euclidean Distance metric to the abiotic data reveals a chaining effect with clusters of statistical squares becoming increasingly dissimilar from cluster 1 through to clusters 3 and 4. This is typical of pelagic environmental data which do not show clear spatial boundaries from one state to the other. This translates into a gradient in dominance for a number of the parameters from cluster 1 through to cluster 4. For example Surface Nitrite increases from cluster 1 which is in the northern North Sea through to cluster 4 in the southern North Sea. The same strong North-South gradient is seen when looking at bottom temperature and surface chlorophyll, reflecting the higher level of primary production in the southern North Sea compared to the northern areas.

Applying hierarchical cluster analysis on the biological data does not reveal any chaining effect which suggests that discrete biological state communities exist, and these are contiguous. In fact, results show that the squares assigned the same cluster are all lying to each other in an ordered way that is too good to be true. Is this an artefact of the method of analysis and type of data used? Or does it represent some real differences in pressure/state which we can use to subdivide the North Sea into eco-regions with characteristics that are proper to each of them?

*Conclusions*

- The assessment of the North Sea ecosystem is ongoing and there is still a lot of work to be done.
- So far, clear gradients in space and time as well as state changes in 1965, 1979 and 1988 have been identified.
- The causes of such changes appear to be related to Sea Water Flux into the North Sea area.
- The weight given to the parameters needs investigating, not all parameters are of equal ecological significance and there is a need for more expert input.
- It is possible to define sub-regions and undertake thematic assessments.

The presentation opened a discussion about the quality of the zooplankton data used by the REGNS study group so far and the direction that could be undertaken in order to make the study more complete regarding the North Sea ecosystem.

The general view was that zooplankton experts should be more involved and Priscillia Licandro felt that although REGNS makes use of the CPR data, there was a lack of direct interaction between REGNS and SAHFOS members, there will however be a SAHFOS representative at the next REGNS meeting in May 2006. She also pointed out that the numerical analysis used could be strengthened by using more advanced statistical analysis methods. Steve Hay stressed the fact that WZGE could be more involved within REGNS because there are other zooplankton time-series that could be useful in complementing the present results because the CPR can only provide surface data and it is therefore doubtful to rely solely on such results. However Sophie Pitois mentioned that REGNS chose to use data from the CPR because this is the only dataset that provides coverage for the entire North Sea. Xabier pointed out that only details contributing to the whole picture should be included.

A general view was that REGNS is missing on key elements within their study such as how climate change affects the North Sea ecosystem. Wulf Greve stressed the fact that REGNS does not take into account any phenology at present in their results; he said that because winter temperature control the seasonality of zooplankton, phenology is very important and should be included within REGNS study. The issue of gelatinous zooplankton was also mentioned; these organisms seem to become more and more abundant and should be included in the data used by REGNS, this is not currently the case.

Steve Hay also suggested that a list of relevant publications be included in the REGNS report.

## 6 ICES Plankton Status Report

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**ToR a) Update the ICES Plankton Status Report; consider progress towards consolidation and interpretation with appropriate statistical methods and recommended monitoring standards**

**ToR b) Plan and prepare for additional analyses and products utilising the Plankton Status Report time-series**

(Lead: Luis Valdés, Rapporteur : Michel Harvey)

This session started with the presentation by Luis Valdés of the fifth Annual ICES Plankton Status Report (2003–2004), prepared by the Working Group on Zooplankton Ecology (WGZE) and edited by Luis Valdés, Todd O'Brien and Angle Lopez-Urruita. This report was the first one to be published as an *ICES Cooperative Research Report*, reflecting its increasing complexity. The WG agreed that the *ICES Cooperative Research Report* is a good medium for annual publication of the Status Report, making it more accessible to the scientific community than if it was only an Annex to the WGZE report and/or a web product.

Luis Valdés briefly described the history of the report (Annex 6). The report was first published in 2001, and then as an Annex to the WGZE report. In the first report there were data from ten transects/locations contributed by six countries. Number of locations has gradually increased and now the report contains data from 23 locations sampled by ten countries distributed around the ICES area on both sides of the North Atlantic Ocean. Moreover, the last report included 8 time-series of data on phytoplankton biomass (Chl a) and surface temperature. Perhaps most significantly the report now contains a Discussion part where an attempt is made to put the long-term zooplankton series in an environmental context. Thus the last report contained a discussion on the general overview of the North Atlantic and the latitudinal patterns of zooplankton biomass and its relationship with temperature.

Luis Valdés said that the Status Report should cover two main objectives, 1) To provide ICES with an overview of the zooplankton status in the North Atlantic, and 2) offer an interesting scientific product. The second point is very important; otherwise the Status report will appear as a repetition of the same data every year. So it was important to focus the Discussion part of the report on topics that appeal to the reader, some of which should be different between years. L. Valdés also asked the question if the time-series and the spatial variability of the plankton were scientifically relevant in itself. He answered yes, with reference to Table 6.1 that appeared in a recent publication by PICES, illustrating how little is known about spatial and interannual variability of zooplankton in the Pacific (Perry and McKinnell, 2005). In the North-Atlantic, the situation is not any better.

L. Valdés noted that ten ICES Member Countries have as yet not contributed data to the report and thus there are many new opportunities for the growth of the report.

The WG greatly appreciated this presentation and several suggestions were made to continue the improvement of this report. The backbone of the status report will continue to be the time-

**Table 6.1. The known and the unknown of biological oceanography in the North Pacific Ocean (from Perry and McKinnell, 2005).**

	BACTERIO- PLANKTON	PHYTO- PLANKTON	ZOO- PLANKTON	BENTHIC INVERTS	FISH	SEABIRDS/ MAMMALS
Taxonomy						
Distribution						
Abundance						
Life history						
Productivity						
Seasonal variability						
Spatial variability						
Interannual variability						

	<b>Poor data availability, major unknowns.</b>
	<b>Limited information, some aspects or information from some regions unknown.</b>
	<b>Available information is largely adequate, no major unknowns.</b>

series of zooplankton abundance and/or biomass in the ICES area. There was a discussion on improvements to the existing Status Report. It was felt that examples of good improvements could be:

- Include new zooplankton time-series;
- Include phytoplankton and temperature in all series;
- Update the map of currents;
- Add a map with average temperature fields;
- Add time-series of selected species (warm water/cold water?);
- Appearance or disappearance of species;
- Other unusual events (e.g., blooms of gelatinous species, meroplankton appearance);
- Phenology (length of seasons, shifts in life-history events);
- Include SeaWiFS data;
- Annual anomalies of different variables (Score card);
- Improvements on the time-series variability span approach using CPR data, annual maximum;
- Table with the ten top species.

The second part of the session started with a presentation by Todd O'Brien, who first presented the long-term inter-annual values from 1946–2002 of total copepod abundance (copepods <2 mm), phytoplankton colour, and sea-surface temperature (SST) in standard CPR areas in the North Atlantic. Secondly, he presented the latitudinal patterns of the zooplankton biomass and its relationship with temperature. To examine this quantitatively, a “variability span” was calculated for each time-series by subtracting the minimum yearly anomaly value from the maximum. Plotting these span values against the latitudes of the time-series sites, it was found that the variability span of most time-series correlated nicely with their location latitude. In general, the relative year-to-year variability in zooplankton biomass or abundance decreases with increasing mean water temperature. Following this presentation, the WG suggested continuing this analysis using the log-transformed data at different seasons and also using the CPR data.



Todd O'Brien introduced a discussion on the use of anomalies to present the time-series and so avoid the units problem (abundance, biomass). This point was also raised in the SCOR Working Group 125 on Comparison of Zooplankton Time-series (see "10.3 Global Comparisons of Zooplankton Time-series"). The question was raised if the arithmetic mean or the geometric mean is the most appropriate to use as baseline of the time-series in order to calculate the deviations. Todd indicated, by showing some examples, that the geometric mean reduces the weight of extreme years that otherwise enlarge the span of the series. In the ensuing discussion, it was decided to use the geometric mean in the future Status reports.

The last status report included an overview of the North Atlantic using data on temperature (SST; HadISST Version 1.1 from Hadley Centre, UK Met Office) and SAHFOS data on phytoplankton colour index (PCI) and total copepods (copepods <2mm) abundance. In many regions the sea surface temperature is increasing as well as the phytoplankton colour index, whereas total copepods seem to decrease. The question is then why total copepods are decreasing? We do not know the answer yet. On the other hand and according with the hypothesis of a reinforcement of the stratified upper layer, the phytoplankton should decrease instead of increase.

In an attempt of resolving the long-term trend in phytoplankton, Angel Lopez-Urrutia did a comparison among the SAHFOS phytoplankton colour data in the different Atlantic squares (or SAHFOS divisions) and the chlorophyll data from SeaWiFS in the last decade. A previous study already demonstrated a significant correlation between PCI and SeaWiFS Chl-a in the Central Northeast Atlantic and North Sea between 1997 and 2002 (Raitos *et al.*, 2005). Although the CPR has recorded that current phytoplankton colour index levels over the NE North Atlantic are significantly higher than those reported before the 1980s, there has been a relative decrease in both CPR PCI and chlorophyll concentrations recorded by SeaWiFS during the last decade.

A discussion took place as to if to enlarge the area covered by the Status Report to the Western Mediterranean. This will mean that three new series and a new region with entity in itself (an ecoregion) will be added to the Report. There was consensus in the group to include the series from Naples, Villefranche and Balears in the report that will be published in 2007. This was very welcome from our CIESM colleagues and will represent a good link of collaboration between ICES and CIESM, which is also a strategic objective from the ICES perspective.

The following actions are needed in relation to future reports.

- 1) Inclusion of metadata for Greenland, Poland, Portugal, France, Scotland, Dove, Hudson Bay, Hudson Strait, Stn 27 (Canada), and Mediterranean time-series (Luis Valdés, Todd O'Brien and Angel Lopez-Urrutia will work on this intersessionally);
- 2) A Russian researcher will be contacted to see if there is some possibility to include one of their long time-series of data in the ICES Plankton Status Report 2005–2006 (Astthor Gislason);
- 3) Inclusion of SeaWiFS data (Angel Lopez-Urrutia);
- 4) Inclusion of phenology data (Wulf Greve, Steve Hay);
- 5) Improvements on the time-series variability span approach using CPR data, annual maximum (Todd O'Brien, Priscilla Licandro, Angel Lopez-Urrutia);
- 6) Tables with the ten top species at sites where this information is available (perhaps both the ten top species for a year and the ten top species over all time-series), (Luis Valdés, Astthor Gislason).

As to the last point, the group agrees that a study on the ten top species from each area will be included in this year's report. This will also allow us to make some comments on the importance of the surveillance of rare species and changes in the most important ones.

The ICES Publications Committee has invited WGZE to publish the next Plankton Status Report as an *ICES Cooperative Research Report* (resolution 2005/1/OCC04 of the Publications Committee). Accordingly the next report will not be published as an annex to the WGZE report.

## 7 Introduced or disappearing species

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### ToR d) Review the causation and impacts of introduced or disappearing plankton species, particularly from regions in the ICES and CIESM areas

(Lead: Wulf Greve, Rapporteur: Eilif Gaard)

Wulf Greve introduced this ToR by attesting that many examples are known of new or disappearing species in ICES and CIESM areas. These may be introduced by e.g. natural processes, ballast water or aquaculture.

In several areas introduction of new species most likely is due to temperature changes or changes in current patterns, in some cases with severe ecological impacts. One example is *Muggiaea atlantica* (Siphonophora) invasion in the German Bight. This seems to cause depression of small copepods and thus changes in community structure. The species also has a strong negative effect on the aquaculture by causing damage to fish farms.

During the mid-late 1990s the abundance of the copepod *Temora stylifera* off the Spanish coast increased markedly. It is now considered as a new species in the area and may possible spread northwards in the future.

Zooplankton monitoring at the oil platform 'Stonehaven' in the Northern North Sea has revealed a new copepod species (*Neocalanus cristatus*) in the area.

In the ensuing discussion it was noted that also in northern areas copepod changes have been observed. For instance, in the cold East Icelandic Current Water, to the north of the Faroes, changes have been observed at copepod community level. During the last three years a marked reduction has been observed in abundance of the cold water copepod *Calanus hyperboreus*. Furthermore the reproduction of the dominant copepod species *Calanus finmarchicus* has started earlier in spring (earlier appearance of G1) in the last years, compared to previous years. Both changes may be due to hydrographic changes in the area.

It was noted that in recent years a significant warming of the waters to the north of Iceland has been observed. At present there is an ongoing project to examine possible ecological effects.

In some cases introduction of new species may be through ballast water. An example of a species introduced in this way may be the copepod *Acartia omorii* that has recently been discovered in European waters.

It is usually difficult to actually track potential intruders back to ballast water. In some cases, intruded species may meet favourable conditions and may explode in abundance, either due to better feeding conditions than in their original environment or due to lack of predators.

At the end of the session, Michel Harvey gave an interesting talk about the invasion of the arctic hyperiid amphipod *Themisto libellula* into the Lower Estuary and the Gulf of St Lawrence during the 1990s and how this may be related to climate change. A review of the literature going back to the beginning of 1900s and a reanalysis of several zooplankton samples collected during the 1980s in different areas of the Lower St. Lawrence Estuary (LSLE) and the Gulf of St. Lawrence (GSL) have shown that *T. libellula* was virtually absent from the waters of the LSLE and the GSL before the early 1990s. Since the early 1990s, the abundance of this species varied from 0.17 to 16 ind. m<sup>-2</sup> in the LSLE and the GSL. It is hypothesized that the interannual variations of the mean abundance of *T. libellula* observed in

the LSLE and the NW GSL was associated with the amount of cold water penetrating into the GSL from the Labrador Shelf during winter. This hypothesis was supported by the finding of a significant positively relationship ( $R^2 = 0.66$ ) between the abundance of *T. libellula* and the volume of the Labrador Shelf water advected in the GSL via the strait of Belle Isle during winter (Galbraith, 2006). This does not mean that cold water from Labrador did not enter the St. Lawrence before the early 1990s: several studies have demonstrated just the opposite (see Petrie *et al.*, 1988). Nevertheless, a recent study comparing the stomach contents of Arctic charr on the Labrador Shelf over an 18-year period from 1982 to 1999 showed that *T. libellula* was four times more abundant during the 1990s than during the 1980s (Dempson *et al.*, 2002 and B. Dempson, personal comm.). This suggests that *T. libellula* was more abundant in the Labrador Sea during the last decade than during the 1980s. This could be the result of a large-scale change in the circulation of the Arctic waters associated with the global warming (Morison *et al.*, 2000).

## 8 Use of the web and virtual resources for WGZE work

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### ToR e) Consider and consolidate the use of web site and virtual resources for support of WGZE endeavours

(Lead: Todd O'Brien, Rapporteur: Xabier Irigoien)

Todd O'Brien presented the current contents of the official and "unofficial" WGZE websites. The official website, maintained and hosted by ICES, only contains the annual working group reports and provides no obvious information on the group's activities or goals. The unofficial working website (<http://www.wgze.net>) features multiple sections which summarize and support the working group's products and activities. For example, links are provided to the ICES zooplankton identification leaflets, the ICES Zooplankton Methodology Manual, and to a blog site for intra-group discussions. Todd suggested that this website should be both a tool for the group and a resource for the outside zooplankton community. Todd proposed that this website could be expanded to include lists of publications relevant to the group. During the discussion, it was suggested that a WGZE membership listing with names and contact information should be added, along with a news and events section that highlighted new publications or results and upcoming conferences. It was suggested that an e-mail or on-line newsletter could be sent out to the group members semi-annually asking for any news or new contents for the site. For instance an e-mail after the ICES ASC with highlights to appear in the website.

- Action: After the ICES ASC, the Chair will send out an electronic newsletter to the WGZE members with highlights from the Conference.

Todd continued with a discussion on how to better present the group's main product, the Annual Zooplankton Status Report. While this product was available online as a PDF, this medium was not interactive and somewhat invisible to search engines (i.e. Google). Todd then presented a prototype of an online, interactive version of the same work. Starting with a map of the North Atlantic, a user can click on the map to select any one of the eighteen WGZE zooplankton monitoring sites to get a detailed summary of that site. The prototype featured a description of the station as well as the plots and anomaly figures found in the annual status report, and any relevant references or publication citations. This summary also listed a contact person and links to related websites. Todd then asked for ideas on improving this prototype. A number of improvements were suggested by the group: 1) In addition to the contact person, all other participating scientists and/or institutions should be listed; 2) It would be nice to provide a list of plankton species present (or monitored) at each site. The group was very supportive to the new web interface, but asked about the added effort required in building and maintaining this site. Todd offered to maintain this new section, noting that much of the content for this site was already created during the preparation of the Annual Zooplankton Status Report, and

that the complex web pages were created by scripts and control forms (i.e., easy to maintain and update).

There was a general recognition by the group of the excellent work carried out as well as of the effort dedicated to this site by Todd O'Brien.

At the end of the session Delphine Bonnet gave a brief talk about *Calanus helgolandicus* phylogenetic in European coastal waters. The aim of the study is to investigate if intra-specific genetic variation in *Calanus helgolandicus* European populations is associated with latitudinal and environmental differences. The study seeks to investigate if populations are genetically different between locations in the North Sea, the English Channel, the Bay of Biscay and the Mediterranean, with the ultimate goal of linking the variability to climatic changes. Preliminary results indicate significant differences between locations, especially between north and south. The study is ongoing and the results will be presented at the 38th International Liege Colloquium on Ocean Dynamics (8–12 May 2006).

## 9 Joint meeting with the Mediterranean Marine Research Network (CIESM)

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### ToR c) Plan and consider an agenda for a joint meeting with CIESM plankton scientists

(Lead: Astthor Gislason and Gabriel Gorsky, Rapporteur: M<sup>a</sup>Luz Fernandez de Puelles)

This session was opened with an introduction by the Chair to the background of a call for a Joint meeting of WZGE and CIESM scientists. The idea was proposed on the last annual WGZE meeting in Lisbon 2004. It was felt that such a meeting was important because:

- A comparison of zooplankton ecology in the two areas is important. What is causing the difference between the two ecosystems, some species are common to both systems and it would be interesting to compare their ecology between the two regions.
- There are links between plankton in North Atlantic and Mediterranean, the two areas are influencing each other and it is of interest to elucidate these (e.g. *Calanus helgolandicus*, *Temora stylifera*).
- There is a need for coordination of approach to plankton monitoring (overview of metadata, harmonization of sampling and sampling processing).

WGZE has previously met with PICES on Hawaii (2000) and WGPE in Bergen (2001). On the former meeting an “ICES/PICES mini-symposium on Zooplankton Ecology” with emphasis on comparison between the Zooplankton Ecology of the North Atlantic and North Pacific, was linked to the annual WGZE meeting. That was a very good and successful meeting. The proposed WGZE/CIESM joint meeting could possibly be designed along similar lines.

The Director of The Laboratoire d’Océanographie de Villefranche (LOV), Dr Louis Legendre then gave a kind welcome to the ICES/CIESM participants telling about the history of Villefranche since it was founded 700 year ago. The name of the city of Villefranche, which means literally “free town”, was intended to attract tax exilers during the middle ages. The city grew up simultaneously with the Marine Station and was built to avoid the pirates who were creating difficulties for the commercial navigation. Due to the beauty and high biodiversity of the marine area, famous Russian researchers settled in the area and dedicated their lives to improve the knowledge of the marine species found here. They decided to stay and after some negotiation with the French Minister, the station definitively belongs to the Paris University starting the long time-series of Villefranche Oceanography Laboratory. The Laboratory is ideally placed with easy access to very deep waters (a depth of 2000 m may be found within 10 nautical miles from the station).

Gaby Gorsky made a presentation about zooplankton studies and zooplankton time-series in the Mediterranean. G. Gorsky is involved in the MedZoo project, which is an association of scientists willing to collaborate on the harmonisation of methods for study of the evolution of Mediterranean zooplankton in time and space. It was created during the 37th CIESM congress in Barcelona in June 2004 and is functioning through the CIESM program on Zooplankton Indicators (<http://www.ciesm.org/marine/programs/zooplankton.htm>).

The main aim of MedZoo is to develop and provide data on zooplankton as environmental indicator, in order to assess and forecast ecosystem changes in the Mediterranean and Black Seas. Comparisons of bio-geographical variations across the sea basins will be conducted through the international co-operation and through the constitution of networks of institutes and experts. Coordinated monitoring programs, spatial surveys and re-processing of older archived samples will be organized and linked to data on climate change. Harmonization of sampling methods, treatment of the samples and treatment of the data will be achieved through workshops and collaborations.

Gabriel Gorsky is also involved in ZooPNEC, created in 2005, which is a French funded pilot study on intercomparison of sampling methods and data treatment. The objectives of ZooPNEC are to introduce new instruments and approaches for the acquisition and treatment of data related to the zooplankton population dynamics and their environment.

In order to further zooplankton work in the area, a Mediterranean workshop was held in October 2005 in Villefranche with 20 countries represented (Albania, Algeria, Belgium, Bulgaria, Croatia, Egypt, France, Greece, Israel, Italy, Lebanon, Morocco, Portugal, Romania, Russia, Slovenia, Spain, Tunisia, Turkey, Ukraine)

The Laboratoire d'Océanographie de Villefranche (LOV), lead by Prof. Louis Legendre, is very active in zooplankton research, with a zooplankton group of about 20 scientists and students. The activity ranges from the construction of new instrumentation (ZOOSCAN, Underwater Video Profiler [www.zooscan.com](http://www.zooscan.com), [www.obs-vlfr.fr/LOV/ZooPart/UVP](http://www.obs-vlfr.fr/LOV/ZooPart/UVP)) through ecophysiology and population dynamics modelling to the treatment of long term series.

Future interests include the determination of the inflowing and outflowing populations through Gibraltar straits, the importance of Mediterranean species as indicators of Mediterranean input into the Atlantic and vice versa, mesopelagic and deep water processes and pelagic-benthic coupling processes.

It is hoped that the interactions between the CIESM and ICES communities will mutually enrich the research activity on the marine zooplankton.

In summary, the main objectives of the zooplankton group at LOV are:

- To complete and determine relevant information on composition-resolved time-series the zooplankton composition;
- To built the metadata, identify existing zooplankton collections;
- To develop the bilateral and cluster collaboration;
- Interconnection with no Mediterranean groups (ICES, SCOR);
- Harmonization of the sampling To built capacities for expertise and a experts' network Strategy;
- To raise awareness on the benefits of routine zooplankton observations. And other trophic levels (micro, macro....);
- Interaction with predictive modelling efforts (i.e. MFSTEPS).

After the presentation of G. Gorsky other visiting representatives of CIESM presented their projects.

M<sup>a</sup> Luz Fernandez de Puelles spoke about the Balearic sea time-series (1994–2004) as an example of a boundary area, very sensitive to environmental changes between northern Mediterranean and the recent Atlantic waters southward.

M<sup>a</sup> Grazia Mazzocchi spoke about the zooplankton time-series at Stn MC in the Gulf of Naples. The main patterns of seasonal and interannual variability were outlined for total zooplankton, copepods, and key copepod species in the period 1984–2004.

Lars Stemman's presentation was about basin and mesoscale distribution of gelatinous macroplankton in relation to water masses. The study is part of the MAR-ECO project, with sampling being carried out on 38 stations along the mid-Atlantic Ridge from Iceland to the Azores. The plankton data were classed according to water masses (three primary and two modified water masses). In his presentation, L. Stemman described the impact of gelatinous predators on copepods and the impact of filter feeders on the size spectra of aggregates and vertical flux.

After the coffee break, the discussion continued with a reminder from the Chair that the group should consider an agenda for a future joint meeting of the two groups (WGZE and CIESM). The issue of where and when such a meeting should be held should also be discussed. The following topics for an agenda were initially suggested:

- Comparison of zooplankton of the Mediterranean and the North Atlantic;
- Overview of ongoing time-series programmes;
- Harmonization of methods;
- Appearance or disappearance of species.

These topics were quite briefly discussed, although throughout prior discussions in this session the area had received considerable debate. The group recognized that all of these topics were important. The group expressed its satisfaction for the proposed joint meeting between WGZE and CIESM which is welcome and timely. Many of the issues which WGZE is dealing with will benefit from a wider, collaborative approach. A joint meeting is an excellent opportunity to develop working links between both groups. After the discussion the final formulation of the topics was as follows:

- Comparison of zooplankton ecology of the Mediterranean and the north Atlantic, with emphasis on common species and size structure using common numerical methods;
- Overview of on-going time-series programmes;
- Harmonization of methods, overview of experimental work;
- Appearance or disappearance of species vs. global warming;
- Autecology of key species.

The group then went on to consider the question where and when to hold such a meeting. At the last WGZE meeting in Lisbon, the possibility of holding a joint meeting in Hiroshima, either just before or after the fourth ICES/PICES Zooplankton Production Symposium (May/June 2007) was discussed. In theory this appears very convenient. However, as the Symposium is taking place in such a remote area, there may be several that will not be able to attend because of lack of funding. There is also the option of having a meeting in connection with the 38th Congress of the CIESM in Istanbul in mid April 2007. There was concern that the year 2007 may not be the best, as the upcoming ICES/PICES Zooplankton Production Symposium is keeping many scientists busy. Thus it may be better to aim for a joint meeting in 2008. It was further felt that in order to make the joint meeting more incisive it should be separated from the annual meetings of WGZE. After a further discussion, in which the desirability of the options was considered, it was decided to aim for a specific joint workshop

in October 2008. While no firm decision was made as to where the meeting should take place, it was felt that this should preferably be in a country bordering the Mediterranean.

To contribute to a satisfying outcome of such a meeting, it was felt desirable that the proceedings from the meeting would be published in the *ICES Cooperative Research Report* series.

- Action: The Chair will propose to ICES that a Joint Workshop of WGZE and CIESM scientists be held in a place yet to be determined in October 2008, and that the proceedings be published in the *ICES Cooperative Research Report* series.

## 10 Other relevant national and international projects

### 10.1 Workshop on the Impact of Zooplankton on Cod Abundance and Production (WKIZC)

**ToR i-i) Review achievements, progress and prospects for Workshop on the Impact of Zooplankton on Cod Abundance and Production (WKIZC)**

(Lead: Eilif Gaard, Rapporteur: Webjørn Melle)

Eilif Gaard opened the session by giving an overview of the major conclusions of the workshop that took place in Copenhagen 7–9 June 2005. It was a joint workshop by GLOBEC and ICES, chaired by Øyvind Fiksen, Norway, Jeff Runge, USA, and Christian Möllmann, Denmark. The terms of reference were:

- a) To determine the zooplankton species in the diets of cod, their temporal and spatial changes;
- b) To determine the variability in zooplankton populations and their relationships to cod;
- c) To examine the vital rates (growth, reproduction, mortality, recruitment) of zooplankton which are relevant to cod life histories (“stock assessment” of zooplankton);
- d) To determine how the timing of zooplankton production and spatial dynamics (including patchiness) of nauplii relates to spawning, distribution, and survival of early stages of cod;
- e) To establish the links between zooplankton and later stages of cod.

Several working documents were presented at the workshop, grouped under three topics: 1) Zooplankton dynamics in relation to fish. 2) Larval cod feeding processes, diets and prey selection. 3) Modelling the zooplankton-larval cod linkage.

The conclusions of WKIZC with regard to ToRs were as follows:

- ToR a) to determine the zooplankton species in the diets of cod, their temporal and spatial changes.
  - Detail regional information presented.
  - Regional differences, opportunistic, size selective.
- ToR b) determine the variability in zooplankton populations and their relationships to cod.
  - Detailed information presented.
  - One of the main difficulties in coupled biophysical models is to include realistic prey-fields, both on the larger, regional scale, and also on the sub-grid scale.

- Our knowledge about zooplankton as predators on larval cod is very limited
  - although variations in predatory invertebrates do have potential to affect recruitment success.
- ToR c) to examine the vital rates (growth, reproduction, mortality, recruitment) of zooplankton which are relevant to cod life histories (“stock assessment” of zooplankton).
  - Very little info on zooplankton life histories and population dynamics was presented at the workshop, but it is an underlying component of many of the regional studies.
- ToR d) to determine how the timing of zooplankton production and spatial dynamics (including patchiness) of nauplii relates to the spawning, distribution and survival of early stages of cod.
  - Overlaps mainly in fronts or other areas with above-average conditions for plankton production. May be aggregated in particular oceanographic regions.
  - Spatial overlap varies between years.
  - In some areas (such as Georges Bank and the Barents Sea) the advection of prey into spawning- and nursery grounds appear to be quite variable. This suggests a connection between large scale oceanography, zooplankton distribution, and cod recruitment.
- ToR e) to establish the links between zooplankton and later stages of cod.
  - A number of interactions between larval cod and particular species of zooplankton were identified
  - Some links between zooplankton and later stages of cod appear to be indirect, through planktivorous food for demersal cod.

WKIZC stressed a number of future monitoring needs to facilitate an effective analysis of long-term co-variability of zooplankton and fish populations:

- Monitoring the changes in population dynamics in relation to environmental fluctuation is a fundamental issue in the provision of advice in an ecosystem based approach to management.
- Effective multidisciplinary monitoring programs over a broad spatial scale, combined with frequent samplings at fixed stations.
  - Hydrographic variables (e.g. temp. sal., density).
  - Chemical variables (e.g. nutrients, oxygen).
  - Biological (e.g. phytoplankton, Chl., zooplankton).
- Establishment of new CPR transects in the Northeast Atlantic.
  - Re-open the transect to and from OWS M.
  - Possibly also the supply route between Tromsø and Longyearbyen.

WKIZC recommended and strongly supported:

- a) Two theme sessions for the ICES ASC 2006 suggested by WGZE: 1) “What zooplankton are fish really eating?” 2) “Biogeographical changes in zooplankton communities: consequences for marine ecosystems”.
- b) Initiatives by WGZE to maintain existing monitoring activities for zooplankton and to plan new ones.
- c) The publication of the report from the meeting in the *ICES Cooperative Research Report* series.

WGZE appreciated the conclusions and recommendations from the WKIZC. In the ensuing discussion it was stressed that the timing of production of copepod nauplii in relation to first feeding of larvae is decisive for larval survival, and that data on occurrence of fish larvae from zooplankton monitoring stations can be used to determine seasonality in reproduction of fish species. It was also argued that targeted sampling at fish spawning sites is crucial to reveal



production of early life history stages of fish species with geographically restricted spawning sites in relation to zooplankton production cycles.

## **10.2 Workshop on enzymatic and other biochemical and molecular methods to measure rate process in zooplankton**

### **ToR i-ii) Review achievements, progress and prospects for workshop on enzymatic and other biochemical and molecular methods to measure rate process in zooplankton**

(Lead: Astthor Gislason/Lutz Postel by submission, Rapporteur: Delphine Bonnet)

Astthor Gislason gave the background saying that the idea of a workshop on enzymatic and other biochemical and molecular methods to measure rate process in zooplankton was first suggested on the 2002 WGZE meeting in Aberdeen by Santiago Hernández-Léon. The more traditional approaches to measuring zooplankton feeding and growth rates are hampered with weaknesses (e.g. gut fluorescence, egg production). An approach based on biochemical and molecular methods hold real prospects for assessing rates and processes. However, there are still problems in interpreting and calibrating the data for most of these innovative methods. The idea of organizing a workshop of this kind is therefore very important.

The workshop idea was discussed further at subsequent WGZE meetings, without being pushed to conclusion. At the meeting in 2004, important input to the idea was made by Rob Campbell and Lutz Postel. Originally the idea was quite ambitious with proposals for several separate workshops (seagoing, data processing and writing up of results). These ambitious plans may have been unrealistic and thus a part of the reason that progress was so slow. A factor in the slow progress may also be the fact that the originators of the idea have only attended the WGZE meetings irregularly.

In 2006, things seem to be moving forward and Lutz Postel, Santiago Hernández-Léon and Rob Campbell have sent a letter to the chair proposing a workshop in the Canary Islands in October or November 2006 (Annex 7).

The objective of the workshop will be to review the current knowledge and discuss and compile advantages and disadvantages of different biochemical methods with emphasis on growth and reproduction.

The agenda for the planned workshop is as follows (Annex 7):

- Review biochemical and radiochemical methods (feeding, growth, reproduction)
- Review potentials and problems of growth and reproduction measurements with:
  - Biochemical methods
  - Radiochemical methods
- Problem of reference values in order to get “real” growth rates

The deliverables from the workshop would be a manuscript on a critical overview of biochemical and radiochemical methods for a scientific journal

Luis Valdés said that the workshop cannot be endorsed by ICES as the Oceanography Committee meets in November only and it will be too late for this year. Steve Hay said that this should not stop the workshop happening, as if it is a review exercise they do not need to be endorsed/ supported by ICES. Luis Valdés suggests that the workshop could be endorsed by another project like EUROCEANS for example.

In the following discussion the point was made that if the practical workshop was held in 2007, it could be supported by ICES, but the literature review workshop (Annex 7) could nevertheless go ahead as planned in November this year. Roger Harris mentioned that organising a practical workshop needs a lot of facilities, and external money would be needed

in order to fund this exercise in terms of consumables for example. It was felt that Santiago should be asked how he is thinking on organising things. He needs to explore the feasibility in funding to organise a practical workshop.

- Action: The Chair will write to Lutz Postel, Santiago Hernández-Léon and Rob Campbell and ask them to write a proposal justifying how and why they want to organise a practical workshop on biochemical methods for measuring zooplankton growth and reproduction; if they provide a plan in time (before November 2006), a proposal could be submitted to ICES for a practical workshop in 2007.

### 10.3 Global Comparisons of Zooplankton Time-series

#### **ToR i-iii) Review achievements, progress and prospects for SCOR Working Group, Global Comparisons of Zooplankton Time-series**

(Lead: Webjørn Melle and Todd O'Brien, Rapporteur: Mark Benfield)

Webjørn Melle presented an overview of relevant activities undertaken by the SCOR WG125. This working group was established in 2004. Their working site is <http://www.wg125.net>. Webjørn and Todd O'Brien are both on the working group, which is co-chaired by David Mackas and Hans Verheye. Our group is represented by associate members: Luis Valdez, Angel Lopez, Webjørn Melle, and Todd O'Brien. The group met in November 2005 in Silver Springs, MD and presented data on available time-series. These include: the Northeast Atlantic Time-series: Iceland (since 1960: north of Iceland, since 1971: South of Iceland), Faroe Islands (Standard sections since 1990), Norway (Standard sections since 1985 in Barents Sea and 1991 in Norwegian Sea), Russia (Standard Sections since 1973 in the Barents and 1954 in the Norwegian Sea). They are also in the process of collecting additional time-series that may be available. At the WG meeting, Luis Valdez presented the ICES Plankton Status Report and discussed the time-series that have been collected in that document. Interest was expressed in other time-series including the Baltic and Mediterranean.

The way this SCOR WG operates is that time-series are collected on a joint (closed) database. Contributors of data are invited to get involved in the analysis and publication of data. It's a good opportunity to present and have your data analyzed. The length of time-series is suggested to be longer than ten years but that is not rigorously enforced. Todd is meeting with their statistician (Andy Solow) in May and will report back to our groups. Luis added that the most interesting series for the SCOR group are the Helgoland and Plymouth series. SCOR would like to know if Roger Harris and Wulf Greve are willing to contribute their data to the group for analysis. Roger mentioned that the Plymouth data is currently being updated so the most recent data may not yet be available. Astthor Gislason asked whether it matters if countries with data are not members of SCOR. This was not thought to be an issue.

The current focus for SCOR is to obtain some of the big datasets so that the analysis can be started. These include: Benguela (S. Atlantic), Peru (S. Pacific), Japan (N. Pacific), Korea (N. Pacific), California (N. Pacific) but there's a gap in the North Atlantic and Indian Ocean. Consequently, the CPR data will be very important in the North Atlantic. Steve Hay pointed out that the fact that SCOR is doing this on a global scale is going to provide a great background for tying in other datasets into a global pattern.

## 10.4 ICES/PICES/GLOBEC 4th International Zooplankton Production Symposium

### ToR i-iv) Review achievements, progress and prospects for ICES/PICES/GLOBEC International Zooplankton Production Symposium in Japan 2007

(Lead: Roger Harris, Rapporteur: Priscilla Licandro)

Roger Harris introduced the discussion on this topic by reporting the background and current status in local organization. The ICES/PICES/GLOBEC 4<sup>th</sup> International Zooplankton Production Symposium titled *Human and climate forcing of zooplankton populations*, will be held in the International Conference Centre, Hiroshima, Japan, 28 May–1 June 2007. Convenors are S. Uye, L. Valdez (Spain/ICES), M. J. Dagg (USA/PICES) and R. Harris (UK/GLOBEC). The symposium is co-sponsored by ICES, PICES and GLOBEC and with the additional support of Plankton Society of Japan and Japanese Society of Fisheries Oceanography. The PICES website ([www.pices.int](http://www.pices.int)) contains the most current information on the conference.

Roger Harris presented the scientific programme. On the first day there will be workshops on current research on zooplankton production in Asian countries and welcome reception. The 2nd day there will be an opening ceremony, plenary, theme sessions and poster sessions. On days 3-5 there will be parallel scientific sessions, with a closing ceremony in the afternoon on the last day (1. June)

The Scientific programme will include theme sessions on: 1) Global comparison of zooplankton time-series (Conveners: D. Mackas, & L. Valdés); 2) Importance and activity of zooplankton biochemical fluxes and cycles (Conv.: Saito); 3) The role of zooplankton in food web, changes related to climate variability and human perturbation; 4) Mortality impact of the ontogeny and productivity of zooplankton (Conv.: S. Poulet); 5) Zooplankton functional groups in the ecosystem (Conv.: Sun Song); 6) Microbial loop vs classical short food chains: implications for appraisal of food webs efficiency and productivity (Conv.: U. Båmstedt); 7) Environmental and other constraints on zooplankton behaviours, life histories and demography (Conv.: C. Miller); 9) Zooplankton critical rates and limits: adaptation to climate forcing; 10) Advance in image technologies and the application of image analysis to count and identify plankton; 11) Modelling zooplankton in aquatic ecosystems.

As seen from the above list conveners are still to be confirmed for several of the themes. Roger Harris asked for suggestions on conveners and keynote speakers, as well as ideas on two additional workshops. He noted that USA's community is not well represented in theme session conveners. Mark Ohman and Cabell S. Davis were suggested as conveners on themes number 4 and 10, respectively.

Wulf Greve and Roger Harris made the suggestion that a workshop on phenology be organized in connection with the Symposium. It was suggested that Roger Harris ask an Asiatic scientist to join Wulf in organising it.

At the end of the session Piotr Margoński introduced the group to the zooplankton and ichthyoplankton activities of the GEF Baltic Sea Regional Project. Activities on zooplankton and ichthyoplankton comprise: intercalibration of sampling and analytical methods, zooplankton taxonomy training, procurement of necessary monitoring equipment, increasing participation and contribution to the ICES Working Group on Zooplankton Ecology (WGZE), establishing contacts and cooperation with other Baltic Sea research projects studying the role of zooplankton, and proposing zooplankton indicators for ecosystem based management of the Baltic Sea. A range of different approaches to produce plankton indicators was presented, showing the long history of ecosystem approach to management within the Baltic scientific community. A new CPR line between Gdynia and Karlskrona in Sweden with a finer mesh

size (nylon 100  $\mu\text{m}$ ) and battery driven sampling in periods representing 5–10 nautical miles is going to be established. Calibration of the CPR against the WP2 will be carried out during 2006.

A further presentation was given by Piotr Margoński on zooplankton indicators in the Gulf of Riga. This is a collaborative study with Solvita Strake and Georgs Kornilovs. The aim of the study is to analyse long term changes in zooplankton abundance in relation to environmental factors, and linking this in turn to the variability in herring recruitment. Multi Dimensional Scaling (MDS) demonstrated strong seasonal differences between spring and summer for eight key zooplankters. Long-term changes of the same eight key species were analysed separately for May and August, with some species showing apparent shifts in abundance (i.e. *Acartia* and *Eurytemora* in May), while the results for other species were less conclusive. BIOENV analysis indicated that the Gulf of Riga zooplankton community changes were significantly correlated with changes in herring abundance and recruitment.

The session ended with a short presentation by Arno Pollumae on long-term zooplankton studies in the Gulf of Finland. The zooplankton sampling extends back to the 1960s with 3 transects across the Gulf of Finland. A. Pollumae showed interesting examples of species that have showed significant long-term changes in abundance. Multivariate statistics (BIOENV and BVSTEP) were used in order to explore the relationships between environmental factors and abundance and composition of zooplankton. Preliminary results indicate that nitrogen concentrations are important in explaining zooplankton composition.

## **10.5 Workshop on image analysis to count and identify zooplankton**

### **ToR i-v) Review achievements, progress and prospects for GLOBEC/ SPACC workshop "Image analysis to count and identify zooplankton" (ZooImage), San Sebastian 2005**

(Lead: Xabier Irigoien, Rapporteur: Cabell S. Davis)

Before commencing the discussion on this ToR, Delphine Bonnet gave a short description of a project entitled "Seasonal changes of the condition factor, egg production and hatching success of several copepod species in the Western English Channel". The aim of the study is to determine how strongly the food environmental conditions influence the population dynamics of the copepods *Calanus helgolandicus*, *Centropages hamatus*, *Acartia clausii* and *Temora longicornis* by monitoring the condition factor of the females for each of these copepod species for a year. Preliminary results indicate that temperature and phytoplankton biomass is having a significant effect on the condition of these copepods. D. Bonnet has started a literature review for length and weight of the copepods and advertised for additional unpublished data on length and weights from different areas.

The results of the GLOBEC/SPACC workshop and follow-on image analysis work were given as two presentations made in this session, one by Xabier Irigoien, and the other by Mark Benfield.

The general purpose of the GLOBEC/SPACC workshop, held in San Sebastian, 1–3 November 2005, was to bring together zooplankton biologists (who are the end users) with researchers who specialize in image analysis and automatic identification methods. The practical goal was to determine the need and criteria for common software platforms. Having such commonality would allow a network of users to share common tools, thus fostering development and use of these approaches.

Workshop objectives specifically were:

- To sit together people developing image recognition systems and people counting plankton samples so that end-users can learn and evaluate the new systems and developers can obtain feedback about real applications of their systems and improve them consequently;
- To explore the possibility of developing common software platforms and tools in order to maximize the effort of different teams;
- To explore the possibility of developing a network of users to share tools, images and to produce information on plankton distribution on a global scale;

The workshop had 61 participants representing 21 countries. There was a good mix of end users and algorithm developers. The workshop had three main groups of talks: 1) Image Analysis, 2) Imaging Systems, and 3) Algorithms. ZooImage was presented as a candidate for the common tool at the workshop. The consensus of these software developers, imaging hardware designers, and active or potential end-users was the need to develop a common framework for software development.

Xabier then presented the ZooImage graphical user interface to WGZE. The ZooImage website is: <http://sciviews.org/zooimage>. A manual for ZooImage will be available on the website.

Xabier said that the objectives of the GLOBEC/ SPACC workshop were met. The report of the workshop is on the ZooImage website.

Xabier said a new research initiative was being proposed called RAPID: Research on Automated Plankton IDentification. This program, which has broad support from the plankton research community, is designed to extend and adapt the capabilities of ZooImage to the point that it becomes a freely-available, highly flexible, and powerful system to process and classify planktonic image datasets. In parallel with this initiative will be research on classification algorithms, ways to quantify and reduce sources of error by humans and machines, development of high-quality distributed training datasets, and exploration of taxonomic features based on intrinsic image properties.

After discussing the results of the workshop, Xabier presented data from grid of net tow stations in the Bay of Biscay that were analyzed using ZooImage from scanned images of the samples. He also showed data processed manually from a Flowcam images of bottle samples.

Mark Benfield gave the second presentation, focusing on the status of image processing in zooplankton and the RAPID initiative (Research on Automated Plankton Identification).

He described the need for automated methods for real time data collections. Because of the long lag time between sample collection and analysis, samples are almost never processed at sea, and important biological features in the ocean can be missed. Other problems with manual sample collection and analysis include need of expert time for sampling and the fact that samples can be destroyed and samples are often never analyzed and remain on shelves in archives.

There are many sophisticated imaging systems have been developed and are available for use. Examples include the analog and digital VPRs, ZOOVIS, HAB Bouy, UVP, LOPC, SIPPER, ZOOVIS-SC, HOLOCAM, E-HOLOCAM, LAPIS, FLOWCAM, DHI, and ISIIS.

The advent of these new imaging systems means that we have become swamped with images. It is beyond human capacity to analyze this massive volume of image data. Additionally, automated methods for imaging preserved samples have generated large volumes of image data, the volume of which is beyond our human ability to analyze. Thus, there is a clear need for automatic processing of both in situ and lab-based imaging systems.

There is a large potential user base for these new imaging systems. There is a reluctance to adopt them, however, due to their high cost, technical complexity, and lack of quality imaging processing software. The cost could be brought down if there were more users, so that there is an economy of scale.

The solution to this problem is to develop image analysis software. This software involves detection of in-focus objects in the images, thresholding, segmentation, image measurement (=feature extraction), and image classification based on a training data set. There are many kinds of features and classifiers that can be used and it is presently feasible to obtain 70-80% correct classification.

The literature on automatic identification has rapidly increased in recent years (Hu and Davis, 2005, 2006; Davis *et al.*, 2004; Blaschko *et al.*, 2005; Culverhouse *et al.*, 1996; Grosjean *et al.*, 2004; Lisin *et al.*, 2005; Luo *et al.*, 2003; Tang *et al.*, 1998; Nebrensky *et al.*, 2002). The list of papers reflects the diversity of methods now available. Both the community of end users and developers needs to become more united to move toward a common effort for automatic identification of zooplankton.

The criteria for common software include open source, flexibility, and the capability for post-processing and real time analysis. The ZooImage software, developed by Philippe Grosjean *et al.* (2004) meets many of the common needs and is a suitable core package. It is built using R and Java languages and allows for image acquisition, extraction, training sets, and classification.

As a result of the workshop, a new research initiative called RAPID: Research on Automated Plankton IDentification has been proposed. Thus far it has received broad support from the plankton research community. A goal of RAPID is to extend and adapt the capabilities of ZooImage to the point that it becomes a freely-available, highly flexible, and powerful system to process and classify planktonic image datasets.

In parallel with the RAPID initiative will be research on classification algorithms, ways to quantify and reduce sources of error by humans and machines, development of high-quality distributed training datasets, and exploration of taxonomic features based on intrinsic image properties.

Additional events related to zooplankton image analysis include the release of ZooImage Version 0.3-1 Beta (available online), the agreement by the NSF Funded Image Classification Project (UMass/Bigelow/LSU) to develop modules for ZooImage, and preparation of a White paper on RAPID. Future activities in this area include preparation of a scientific Op-Ed article, a workshop at the 2007 Zooplankton Production meeting in Japan, establishment of linkages with other groups who build classifiers, write software, design instruments, and the pursuit of new funding opportunities for this work.

The comments after Mark's talk included a caution by Steve Hay that developers have to be careful not to hack proprietary software. Cabell Davis agreed and said that the freeware program, Visual Plankton (the VPR's realtime plankton identification and visualization software), was written in house using Matlab m-files, but it requires a Matlab license (which most researchers have anyway). Astthor Gislason asked about the issue of handling different incoming image resolutions and formats. Xabier said ZooImage would have modules specific for different incoming images. Gabriel Gorsky noted that the classifiers are rapidly evolving, and we need to be open to incorporation of these new methods. Benfield said these new methods can be put into ZooImage as algorithms. It was less clear how ZooImage could handle large volumes of real-time imagery needed for producing real-time plots at sea. Currently the VPR with Visual Plankton program is the only system with this capability. Davis agreed to explore with Xabier the possibility of coupling components of Visual

Plankton with ZooImage and has given all the source m-files for Visual Plankton to the ZooImage group.

## 10.6 Taxonomic workshop

### **ToR i-vi) Review achievements, progress and prospects for a taxonomic workshop to advance the Fiches plankton ID sheets, also to encourage the training and retention of plankton taxonomic skills**

(Lead: Steve Hay, Rapporteur: Arno Pollumae)

The session opened with an introduction to the background of a call for a workshop from the chair. WGZE has previously organised two taxonomic workshops. The first one was held in Terramare Germany, 14–17 May 2000, and focused on the Calanoida. It was organized by Heino Fock, Steve Hay and Luis Valdés. The second workshop was held at SAFHOS in Plymouth in June 2003. It was organized by Alistair Lindley and focused on the Calanoida, but included also a consideration of novel techniques (image analysis and genetics. Thus the workshop discussed here will be the third one.

Steve Hay continued the session with a short description of the taxonomic workshop scheduled for 20–23 June 2006 in Plymouth and supported by ICES and MARBEF. The aim of the workshop will be to improve and calibrate the present taxonomic knowledge among scientists working on zooplankton in the North Atlantic and European shelf seas. The workshop will focus on Crustacean zooplankton and is aimed primarily at scientists and technicians involved in regular analysis of zooplankton samples (parataxonomists) and researchers in plankton ecology who are not primarily taxonomists. Website: [http://www.sahfos.org/Event\\_taxonomic\\_wkshp\\_index.htm](http://www.sahfos.org/Event_taxonomic_wkshp_index.htm)

The workshop will last for four days, provisionally including presentations and laboratory practical sessions on:

- Copepod morphology & general characteristics of developmental stages. Dr Geoff Boxshall;
- Classification of copepods (emphasis on non-calanoids). Dr Geoff Boxshall;
- Use of confocal microscopy in zooplankton studies. Dr Isabella Buttino;
- Identification of developmental stages of copepods. Dr DVP Conway;
- Genetic analysis of formalin preserved plankton. Dr R.R. Kirby;
- Distinguishing mysids, euphausiids, and pelagic stages of decapods and stomatopods. Identification of larval stages of major groups within Decapoda. Dr J.A. Lindley;
- Identification of *Paracalanus* spp. and *Clausocalanus* spp. (Copepoda: Calanoida). Prof. Tecla Sertorio Zunini.

Cabell S. Davis asked if geneticists are involved in this workshop and Priscilla Licandro answered that they were.

It was pointed out that such workshops in future may provide good opportunity to collect genetic material for DNA analysis for the Census of Marine Life Programme, as the samples will be carefully identified by several taxonomists. Participants of the workshop should bring some of their own samples fixed in ways suitable for genetic analyses. In this context, C.S. Davis mentioned that certain food conservatives are now being considered as sample fixatives.

The workshop is already over-subscribed and there is clearly a need for organizing more workshops in the future. Gabriel Gorsky will look into the possibilities of arranging the next taxonomic workshop in 2007 in Villefranche focusing on gelatinous plankton.

- Action: WGZE will work towards a further taxonomic workshop, preferably focusing on gelationus zooplankton.

Fiches plankton ID sheets were not mentioned during Steve's presentation, but the subject came up during final discussion. The need for new simple identification keys is obvious. Ideally they will be web based and not copyrighted. It was suggested that the group should address the topic on the next meeting with a specific ToR: How to create taxonomic training using the web?

The report of the ICES/MARBEF Crustacean Zooplankton Taxonomic Workshop was included in this report after it was finalised. See Annex 12.

## **10.7 Other relevant national and international projects relating to plankton studies**

**ToR i-vii) Review achievements, progress and prospects for plans and progress in relevant national and international projects relating to plankton studies (e.g., MARBEF, BASIN and others)**

(Lead: Roger Harris, Rapporteur: Piotr Margonski)

Roger Harris provided an overview of the EUR-OCEANS, BASIN, and MARBEF projects.

EUR-OCEANS is the Network of Excellence project and its main objective is to develop models for assessing and forecasting the impacts of climate and anthropogenic forcing on food-web dynamics (structure, functioning, diversity and stability) of pelagic (i.e. open ocean + continental margin) ecosystems in the open ocean. About 160 Principal Investigators (PIs) representing 66 institutes are co-operating within the project. The Joint Programme of Activities covers: Integrating Activities (Networking, Data Integration, and Model Integration); Jointly Executed Research (Ecosystems end-to-end, Biogeochemistry, Ecosystem approach to marine resources, and Within system integration); and Spreading Excellence (Training for researchers, Transfer to socio-economic users, and Public outreach). The project is concentrating on seven sea/ocean systems: Arctic and Nordic Seas, Baltic Sea, Mediterranean Sea, North Atlantic Ocean, North Atlantic Shelves, Southern Ocean, and Eastern Boundary Upwelling Systems. Roger Harris emphasised that there are some activities relevant to ICES WGZE. Of those which might be the most interesting he mentioned Work Package 2.1 "Observing Systems" (however, it deals with open ocean only), METAOCEANS Early Stage Training Network, a survey on "key species: vital rates", and the BASIN project initiative.

BASIN is a co-operative project involving scientists from Europe and North America. Its aim is to understand and simulate the population structure and dynamics of broadly distributed and trophically important plankton and fish species in the North Atlantic Ocean to resolve the impacts of climate variability on marine ecosystems, and thereby contribute to ocean management. EUR-OCEANS and NSF organised the BASIN Workshop which took place in Reykjavik (11–15 March 2005). The following conclusions sum up the Workshop discussion:

- Continental shelf and marginal sea ecosystems are affected by basin-scale forcing on decadal scales and cannot be studied in isolation;
- Advances in modelling marine ecosystems will require coupling numerical formulations across trophic levels that have differing degrees of resolution and embedding these in a basin-scale representation of the physics and biogeochemistry;
- There is no single, fully integrated model that can simulate all possible ocean ecosystem states;
- The key steps in representing extended food webs in complex marine systems are to concentrate the biological resolution, or detail of representation, in the main



target species, and to make increasing simplifications, or decrease the resolution, with distance both up and down the trophic scale from the target species.

As an outcome of the Reykjavik Workshop another meeting took place in Brussels (11 October 2005). Participants decided that a Specific Support Actions proposal would be submitted to 6th FP proposal call by 3 November 2005. The project consortium consists of two partners: University of Hamburg, Institute of Hydrobiology and Fishery Science (Germany) and Plymouth Marine Laboratory (UK). There are affiliated scientists with external funding representing Woods Hole Oceanographic Institution (USA), University of North Carolina at Chapel Hill (USA), and Memorial University (Canada). The principle objective of the BASIN Specific Support Action is to develop a joint EU-North American research plan in the field of ocean ecosystems in support of the Global Earth Observation System of Systems (GEOSS) initiative. Project objective are going to be achieved through the sequence of workshops and meetings: European workshop on the synthesis and integration of pan-Atlantic climate related ecosystem research, North American workshop the synthesis and integration of pan-Atlantic climate-related ecosystem research, Working group meetings on developing implementation plans for joint research Programs, and Working group meetings on producing a joint science plan for pan-Atlantic climate related ecosystem research.

Roger Harris briefly introduced the MARBEF project another of the EU Networks of Excellence. It is a large scale and long term networking project on the observation of Global Change and its impact on Marine Biodiversity. One of the MARBEF initiatives is the LargeNet project in which Friedrich Buchholz (Alfred Wegener Institut für Polar- und Meeresforschung), Stephen Hawkins (Marine Biological Association, Plymouth), and Herman Hummel (NIOO, Yerseke) are Principal Investigators. Project objectives are to establish a large-scale network of research locations/sites along the European coast to assess long term changes in biodiversity and their possible causes taking into account natural and anthropogenic gradients.

It is a common feeling among the scientific community that MARBEF is mostly focused on benthic organisms but this is not a case: e.g. the International Conference on Copepods in Tunisia was co-sponsored by MARBEF. ICES is cooperating with MARBEF, participating in many of their meetings

It was felt that in order to avoid overlapping of activities, and also to promote possible involvement and cooperation in the future, MARBEF should be informed of our activities.

- Action: The ICES WGZE decided that the Chair should send a letter to MARBEF (together with meeting report and Annual Zooplankton Status Report), with a copy to Adi Kellermann ICES Head of Science Programme, presenting the Working Group on Zooplankton Ecology goals and activities to initiate information exchange and to avoid overlapping in future.

## **11 Next meeting (2007)**

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It is proposed to hold the next (2007) meeting of the ICES Working Group on Zooplankton Ecology at the University of Latvia, Riga, Latvia, from 26–29 March kindly hosted by Dr Solvita Strake at the Institute of Aquatic Ecology, University of Latvia.

## **12 Actions, recommendations and draft resolutions**

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### **12.1 Actions**

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

- A sub-group will be formed with the task of responding quickly to demands from the ICES Data Centre and others to management of zooplankton data. The group will consist of the following WG members: Peter Wiebe, Steve Hay and Todd O'Brien.
- Actions in relation to future Plankton Reports:
  - 1) Inclusion of metadata for Greenland, Poland, Portugal, France, Scotland, Dove, Hudson Bay, Hudson Strait, Stn 27 (Canada), and Mediterranean time-series (Luis Valdés, Todd O'Brien and Angel Lopez-Urrutia will work on this intersessionally);
  - 2) A Russian researcher will be contacted to see if there is some possibility to include one of their long time-series of data in the ICES Plankton Status Report 2005-2006 (Astthor Gislason);
  - 3) Inclusion of SeaWiFS data (Angel Lopez-Urrutia);
  - 4) Inclusion of phenology data (Wulf Greve, Steve Hay);
  - 5) Improvements on the time-series variability span approach using CPR data, annual maximum (Todd O'Brien, Priscilla Licandro, Angel Lopez-Urrutia);
  - 6) Tables with the ten top species at sites where this information is available (perhaps both the ten top species for a year and the ten top species over all time-series), (Luis Valdés, Astthor Gislason).
- After the ICES ASC, the Chair will send out an electronic newsletter to the WGZE members with highlights from the Conference.
- The Chair will propose to ICES that a Joint Workshop of WZGE and CIESM scientists be held in October 2008, and that the proceedings be published in the *ICES Cooperative Research Report* series. While no firm decision was made as to where the meeting should take place, it was felt that this should preferably be in a country bordering the Mediterranean.
- The Chair will write to Lutz Postel, Santiago Hernández-Léon and Rob Campbell and ask them to write a proposal justifying how and why they want to organise a practical workshop on biochemical methods for measuring zooplankton growth and reproduction; if they provide a plan in time (before November 2006), a proposal could be submitted to ICES for a practical workshop in 2007.
- WGZE will work towards a further taxonomic workshop, preferably focusing on gelationus zooplankton
- The Chair will send a letter to MARBEF (together with meeting report and Annual Zooplankton Status Report), with a copy to Adi Kellermann, ICES Head of Science Programme, presenting the Working Group on Zooplankton Ecology goals and activities to initiate information exchange and to avoid overlapping in future.

## 12.2 Recommendations

The ICES Working Group on Zooplankton Ecology recommends to the Oceanography Committee the following two Theme Sessions for the 2007 ICES Annual Science Conference. Supporting information is given in Annex 8.

- Zooplankton community structure and biomass in the mesopelagic and deeper layers. Conveners: Gabriel Gorsky and Eilif Gaard.
- Phenology and adaptive capacity: plankton, benthos and fish. Conveners: Wulf Greve and Steve Hay.

## 12.3 Draft resolutions

### **WGZE Terms of Reference proposed for 2007**

After discussion of future ToRs, the following suggestions were made, which cover review of plankton research and methods as well as maintaining and developing collaborative approaches and the useful products of the WGZE, particularly the ICES Plankton Status Report (Annex 9):

- a) update the ICES Plankton Status Report.
- b) review the role of microzooplankton, including metazoans, in marine food web.
- c) compare the zooplankton ecology of the North Atlantic and the Mediterranean;
- d) review the use of numerical methods in exploring and predicting long-term plankton variability;
- e) review and consider the impact on zooplankton communities of introduced or disappearing species.
- f) consider rate process studies and zooplankton phenology in association with time-series monitoring.
- g) consider the development of web-based taxonomic training and the promotion of the ICES WGZE to a wider community.
- h) review and consider species biodiversity in zooplankton from coastal zones to oceanic deep sea: progress and prospects for the European Census of Marine Life Project (EuroCOML)

### **Proposal for publication of Plankton Status Report**

WGZE proposes that the Plankton Status Report be published in the *ICES Cooperative Research Report* series. Supporting information is given in Annex 10.

### **Proposal to hold a joint meeting of WGZE and CIESM scientists**

WGZE propose that ICES sponsor a joint meeting of WZGE and CIESM scientists in a place yet to be determined in October 2008, and that the proceedings from the meeting be published in the *ICES Cooperative Research Report* series. While decision has not been made yet as to where the meeting should take place, this should preferably be in a country bordering the Mediterranean. Further details are given in Annex 11.

## 13 Closure of the meeting

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Astthor Gislason (Chair) thanked all members for their contributions and the stimulating discussions. He also thanked the CIESM colleagues for their contributions and Dr Gabriel Gorsky for his kind hospitality and the excellent organisation. The hospitality of the Director of The Laboratoire d'Océanographie de Villefranche, Dr Louis Legendre, was very much appreciated. Astthor Gislason looked forward to seeing the participants at the meeting next year.

The meeting was closed at 13:00 on 30 March 2006.

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## Annex 1: List of participants

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## **Annex 2: Agenda**

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### **Monday 27 March**

12:00-13:00 OPENING, AGENDA, ANNOUNCEMENTS

13:00-14:00 Lunch

14:00-15:30 DATA QUALITY CONTROL AND DATA MANAGEMENT

(Lead: Steve Hay, Rapporteur: Angel Lopez-Urrutia)

ToR f) Review and comment on the draft text on the application of AQC Criteria (Annex 8, SGQAE 2004). (The answer to this TOR demands intersessional work by WGZE).

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

ToR i-viii) Review achievements, progress and prospects for data management issues at ICES and elsewhere, including expert knowledge and guidance to the Data Centre.

15:30-16:00 Coffee break

16:00-18:00 THE NORTH SEA ECOSYSTEM

(Lead: Wulf Greve, Rapporteur: Sophie Pitois)

ToR h) Review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant.

### **Tuesday 28 March**

9:00-11:00 ICES PLANKTON STATUS REPORT

(Lead: Luis Valdés, Rapporteur: Michael Harvey)

ToR a) Update the ICES Plankton Status Report; consider progress towards consolidation, interpretation with appropriate statistical methods and recommended monitoring standards.

ToR b) Plan and prepare for additional analyses and products utilising the Plankton Status Report Time-series.

11:00-11:30 Coffee break

11:30-13:00 ICES PLANKTON STATUS REPORT (Cont.)

13:00-14:00 Lunch

14:00-15:30 INTRODUCED OR DISAPPEARING SPECIES

(Lead: Wulf Greve, Rapporteur: Eilif Gaard)

ToR d) Review the causation and impacts of introduced or disappearing plankton species, particularly from regions in the ICES and CIEM areas.

15:30-16:00 Coffee break

16:00-18:00 USE OF THE WEB AND VIRTUAL RESOURCES FOR WGZE WORK

(Lead: Todd O'Brien, Rapporteur: Xabier Irigoien)

ToR e) Consider and consolidate the use of web site and virtual resources for support Of WGZE endeavours.



**Wednesday 29 March**

- 9:00-11:00 JOINT MEETING WITH CIESM  
(Lead: Astthor Gislason and Gabriel Gorsky, Rapporteur: Ma Luz Fernandez de Puellas)  
ToR c) Plan and consider an agenda for a joint meeting with CIESM plankton scientists.
- 11:00-11:30 Coffee break
- 11:30-13:00 OTHER RELEVANT NATIONAL AND INTERNATIONAL PROJECTS  
ToR i) Review achievements, progress and prospects for:  
i) Workshop on the Impact of Zooplankton on Cod Abundance and Production (WKIZC).  
(Lead: Eilif Gaard, Rapporteur: Webjørn Melle)  
ii) Workshop on enzymatic and other biochemical and molecular methods to measure rate process in zooplankton.  
(Lead: Astthor Gislason/Lutz Postel by submission, Rapporteur: Delphine Bonnet)
- 13:00-14:00 Lunch
- 14:00-15:30 OTHER RELEVANT NATIONAL AND INTERNATIONAL PROJECTS (CONT.)  
ToR i) Review achievements, progress and prospects for:  
iii) SCOR Working Group, Global Comparisons of Zooplankton Time-series.  
(Lead: Webjørn Melle and Todd O'Brien, Rapporteur: Mark Benfield)  
iv) ICES/PICES/GLOBEC International Zooplankton Production Symposium in Japan 2007.  
(Lead: Roger Harris, Rapporteur: Priscilla Licandro)
- 15:30-16:00 Coffee break
- 16:00- DEMONSTRATION OF THE ACTIVITIES OF OBSERVATOIRE Océanologique (Lead: Gabriel Gorsky)

**Thursday 30 March**

- 9:00-11:00 OTHER RELEVANT NATIONAL AND INTERNATIONAL PROJECTS (CONT.)  
ToR i) Review achievements, progress and prospects for:  
v) GLOBEC/ SPACC workshop "Image analysis to count and identify zooplankton" (ZooImage), San Sebastian 2005  
(Lead: Xabier Irigoien, Rapporteur: Cabell S. Davis)  
vi) A taxonomic workshop to advance the Fiches plankton ID sheets, also to encourage the training and retention of plankton taxonomic skills.  
(Lead: Steve Hay, Rapporteur: Arno Pollumae)  
vii) Plans and progress in relevant national and international projects relating to plankton studies (e.g., MARBEF, BASIN and others).  
(Lead: Roger Harris, Rapporteur: Piotr Margonski)
- 11:00-11:30 Coffee break
- 11:30-13:00 SUMMARY DISCUSSION, FUTURE PLANS (TERMS OF REFERENCE FOR WGZE 2007, THEME SESSIONS, WORKSHOPS)
- 13:00 FINISH

### **Annex 3: E-mail to Einar Svendsen, Chair of OCC**

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Reykjavik, 7 March 2006

Dear Einar

I am very sorry to hear about the problems within the WGPE. As judged by how few people have attended their meetings for several years, they seem to be in serious trouble. So their group may have to be dissolved. However, I fail to understand why this should lead to the closing down of WGZE also. Further, I do not think that the establishment of a new WG for Plankton Ecology will solve anything, and certainly not the problems of WGPE. Below I justify my position.

Given the low interest the WGPE-members seem to have in their own WG - even though it is a disciplinary group especially devoted to their own field of interest - I see no reason why they should rather want to take part in the newly created group, with its broader scope. Conversely, I would argue that they would show less interest. Most likely the active participants in an eventual new group would be recruited from the then phased out WGZE, not from the former WGPE. So what would then be achieved? In addition, and more importantly, given its broader perspective, the new group is not likely to attract as many devoted zooplankton specialists as our current WGZE, and thus the change will ultimately weaken the zooplankton work within ICES also.

So my conclusion is, that if our current WGZE were to be dissolved for a new one with a broader scope, this would ultimately weaken the zooplankton work within ICES. I recognize that WGPE has a problem. However I think the problem lies within the WGPE, and it cannot and should not be solved at the expense of WGZE, which has proven to be a very efficient and meticulous Working Group. For justification of this view see e.g. recent reviews by the Oceanography Committee of the reports of the Working Groups under its auspices. Examples of products by WGZE useful to the ICES community are The Zooplankton Methodology Manual, Taxonomic Workshops, the Plankton Status Report, the ICES Zooplankton Taxonomic Sheets, ICES Zooplankton Production Symposia, to name but a few.

On at least two of our earlier meetings (WGZE 2000 and 2001), the question whether or not we should be joined with another working group has been discussed by the request of the Chairman of the Oceanography Committee. The general consensus at these meetings was that merging was not feasible. The meeting in 2001 was held jointly with the WGPE, and from the minutes from that meeting it is clear that merging was in fact opposed by the WGPE members also. The members of WGZE felt that by merging, the focus of WGZE would be less incisive. There was also the important concern that if the working groups were merged they would pursue their more disciplinary oriented interests elsewhere and probably outside the ICES structure and to the detriment of the ICES mission. Generally, it was felt that it was important to preserve the ICES disciplinary groups strong, and that new cross-disciplinary groups - although important by themselves - should not be created at the expense of the existing disciplinary working groups.

Having said this, we realize of course, that there is plenty of scope for collaboration between the working groups. For instance, an obvious area of collaboration between WGZE and WGPE is the Annual Status Report. However, we believe this could better be pursued through cooperative work and joint sessions of the two groups, rather than by merging.

At the end, I would like to inform you that it looks like the next meeting of WGZE will be a very successful one. As always there are many participants - already, there are more than 20

committed attendees. And this time we have more points to discuss than at any of our earlier meetings, a positive endorsement for the continuation of our working group. So we are looking forward to a very fruitful and stimulating meeting.

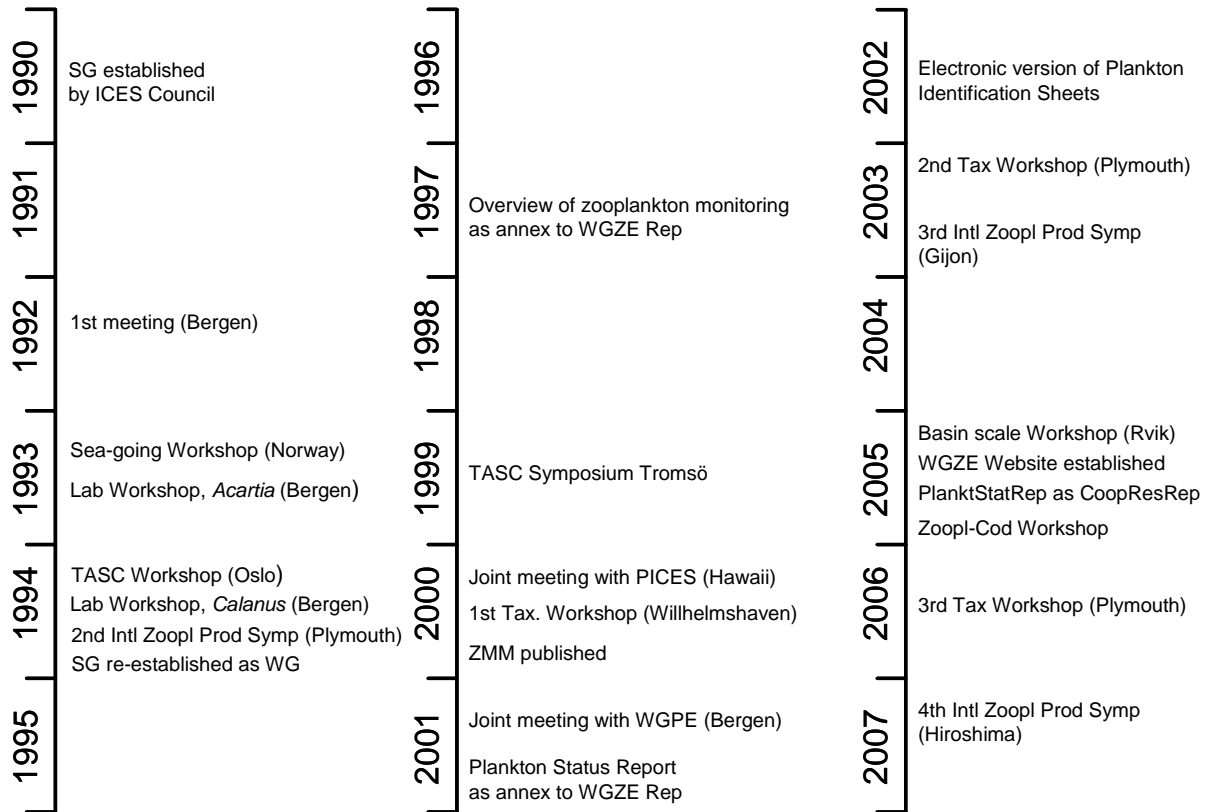
I hope you have a successful meeting in Copenhagen.

Best regards,

Astthor Gislason

(Chair of the ICES WGZE)

## Annex 4: Time-line of WGZE with some major deliverables



## **Annex 5: Letter to Dr John Davies, Chair of SGQAE**

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Dr Jon Davies  
Chair of the ICES SGQAE  
Joint Nature Conservation Committee  
Monkstone House City Road  
Petersborough PE1 1JY  
United Kingdom

Reykjavik, 12.02.2006

Dear Dr Davies

### **SGQAE request for comments on a draft text on the application of AQC Criteria (Annex 8, SGQAE 2004)**

The ICES Working Group of Zooplankton Ecology (WGZE) has received your request to consider a draft text on the application of Analytical Quality Control (AQC) Criteria for evaluating the acceptability of biological data in monitoring programmes. In order to meet the deadline of 10 March, we have dealt with this by correspondence. However, as the issue of quality control of field sampling, sample analysis, data analysis, data storage and reporting etc. is such a complex task, we feel it can hardly be dealt with adequately in this way. At this stage, we therefore only have a few general comments to make.

We note that the scope of including zooplankton in water quality programmes is not mentioned at all in the draft text. Also, that zooplankton are only recently and briefly mentioned in the water or ecosystem monitoring documents and guidelines of OSPAR, HELCOM and the recent EU Marine Strategy draft document. This is unfortunate, given the central ecosystem role of zooplankton and demonstrable links with climate change.

At several previous meetings (see e.g. Reports from the WGZE meetings in 2000 and 2002), we have discussed matters related to QA and the scope of including zooplankton in water quality monitoring programs. The general consensus was that there is a strong scientific support for the inclusion of a measure of zooplankton in ICES/OSPAR monitoring, because of the sensitivity of the organisms to changes in eutrophication status. WGZE therefore recommends that the SGQAE consider the inclusion of zooplankton structural parameters (abundance and biomass), taxonomic identification and diversity indices (very sensitive to environmental perturbations) as routine measurements in eutrophication-related monitoring studies.

We also wish to point out that phenology can provide a powerful tool for understanding the status of species, communities and ecosystems in a changing environment. For example, the timing of spring production and the length of the productive season may change as a consequence of a changing climate. Zooplankton is – for one thing – a very good indicator of phenological change in the sea. Within The Marine Strategy Initiative it has been pointed out that information of the typical phytoplankton and zooplankton communities including the typical species, seasonal and geographic variability and estimates of primary and secondary productivity is needed. The seasonal aspect is covered to a great extent by phenology, a subject of major importance to zooplanktology as cold-blooded organisms in a slowly changing thermal environment respond as highly sensitive to global warming. In the U.S., plans are being made to install a phenological observation network within terrestrial systems (Anonymous, 2005, *Eos*, 86(51): 539-542). The marine system so far has no phenological observation system, but should be initiated.

Regarding the methodology involved, we think that the recently published ICES Zooplankton Methodology Manual offers a good base of discussion (Harris *et al.* (eds), 2000, ICES Zooplankton Methodology Manual, Academic Press, London), but for implementation purposes an agreement on standardisation and guidelines must be provided by the authorised body (OSPAR, JAMP, ICES SGQAE). WGZE recognises that, in addition to considerations of the accuracy and precision of selected method, critical QA aspects include the importance of coupling the process being measured with the timing and spatial scale of sampling effort. Automated measures (e.g. OPC, VPR) used in towed bodies may satisfy issues concerning spatial and temporal scales, but at the expense of sacrificing the taxonomic precision.

We like to point out that it has been a continuing and repeated task of WGZE to consider and review results from national monitoring programmes on zooplankton abundance and productivity. This includes the setting of monitoring standards and recommendations so as to facilitate comparative analysis. Since 2000, WGZE has edited an Annual Report, based on the time-series obtained in these programmes (ICES 2005. Zooplankton monitoring results in the ICES area. Summary Status Report 2003/2004. ICES Cooperative Research Report, No. 276). Temperature and phytoplankton data are only presented for some locations, but the final goal is to produce a Plankton Status Report with environmental variables.

One final item before closing this letter: At our next meeting, we shall review achievements, progress and prospects for organizing a workshop on enzymatic and other biological and molecular methods to measure rate processes in zooplankton. This may be relevant to Quality Assurance of Biological Measurements in the future.

Yours sincerely

Astthor Gislason

(Chair of the ICES WGZE)

**Annex 6: A few facts on the Zooplankton Status Report (ZST)**

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YEAR	ZST YEAR	SITES	COUNTRIES	PAGES	FORMAT	BYTES	SIGNIFICANT ADDITIONS
2001	1999–2000	10	6	18	Annex	0.25	
2002	2000–2001	14	8	21	Annex	1.5	
2003	2001–2002	14	8	21	Annex	1.5	
2004	2002–2003	15	8	26	Annex	8.4	Phytoplankton
2005	2003–2004	23	10	35	CPR	8.8	Phytopl, Temp, Discussion
2006	2005–				CPR		

## **Annex 7: Proposal for a workshop on biochemical methods**

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### **Working document prepared by Santiago Hernandez-Leon, Lutz Postel and Rob Campbell**

During the last year, contacts with several researchers working on biochemical methods to assess the metabolic activity of zooplankton from feeding to growth were made. The objective was to organize a workshop on biochemical methods to compare different methods proposed as proxies of the metabolic rates of zooplankton. Feedback from different authors working on biochemical indices was rather poor. Rob Campbell did a big literature search on enzyme proxies for respiration (Citric acid cycle enzymes and ETS) and excretion (GDH). He found, it's a fairly large literature, with measurements from sediments, through bacteria, to zooplankton. However, it turns out that the majority of those papers either did not do calibration incubations, or the calibration data is not given, just proxy-derived values. Lutz Postel proposed a previous exercise to first review current approaches and to discuss / compile their problems, advantages and disadvantages. The idea will be to have a meeting with different researchers engaged in this topic and try to review the methods and their potentials in getting accurate metabolic rates, following the provisional agenda:

- Short review of biochemical and radiochemical methods from zooplankton feeding to growth and reproduction
- Comprehensive debate on potentials and problems of zooplankton growth and reproduction measurements by
  - Biochemical methods, and
  - Radiochemical methods,
- Considering the problem of reference values in order to get “real” growth rates.

A manuscript of the critical overview to be considered for a journal could be a product of this meeting as well as a detailed outline for a potential practical workshop.

The original idea to have a meeting in the Canary Islands in October or November 2006 is still maintained in order to launch the initiative. Santiago Hernández-León will be in charge of the organization of it supported by Rob Campbell, Lutz Postel (and others).



## **Annex 8: Theme Session Proposals for 2007 ASC**

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The **Working Group of Zooplankton Ecology (WGZE)** proposes the following two Theme Sessions for the ICES 2007 Annual Science Conference:

### **Proposal 1**

#### **Zooplankton community structure and biomass in the mesopelagic and deeper layers**

Theme session conveners: Gabriel Gorsky (France) and Eilif Gaard (Faroe Islands).

#### **Supporting Information**

The deep ocean extends from the edge of the continental shelf to the depths of the deepest trenches, covering approximately two-thirds of the earth's surface. Only a small percentage of this huge portion of the globe has ever been observed or sampled. Some of the critical ecological questions concern the biodiversity, structure and function of the communities of organisms inhabiting this "inner realm". The scarce results show that the upper bathypelagic zone is intimately linked with the twilight zone (200-1000 m). Both are influenced by seasonally changing abiotic parameters, high variability in flux and vertically migrating zooplankton. Net tows which integrate zooplankton over wide depth intervals in the mesopelagic have indicated that mesozooplankton abundance is usually several orders of magnitude less than in the epipelagic. Particle concentration (i.e. potential food for mesozooplankton) is usually displays the same trend, but particles are often aggregated at density discontinuities. Bioenergetic models suggest that mesozooplankton must feed in these layers of enhanced particle concentration if they are to meet their daily metabolic requirements, grow and reproduce. Acoustic and imaging data on zooplankton suggest that layers of zooplankton also exist in the mesopelagic. These and the preliminary data on subduction of surface produced matter in the dynamic frontal zones may be considered as "hot spots/layers" of the food particles. These particles and zooplankton may be tightly coupled in both temporal/spatial scales. As consequence, these hot spots generate spatial heterogeneity of zooplankton and may be important sites of midwater processes that influence the sinking flux of organic material and the aphotic food chain in the ocean. Future studies should focus on zooplankton community structure and processes in the mesopelagic. A variety of new sampling techniques should be employed both to document the distribution of zooplankton on the important time and space scales in the mesopelagic and to create "smart samplers" which detect zooplankton hot spots and collect them for identification and the assessment of the ecosystem's stability and resilience in the ocean's interior.

### **Proposal 2:**

#### **Phenology and adaptive capacity: plankton, benthos and fish**

Theme session conveners: Wulf Greve (Germany) and Steve Hay (UK)

#### **Supporting Information**

Different organisms evolved different life cycle strategies and adaptive capacities to exist and co-exist in the habitats and niches they occupy. Any population's success or failure depends essentially on the changing relationships between organisms and their habitats and on the relative efficiencies of life cycle trajectories and functional abilities within communities. Study of phenology, the timing of life cycles and developmental processes in relation to environments over time and across latitudinal gradients, allows insight into the real expression of species adaptive capacities and ranges and into the factors determining resultant productivity across the food web.

All species adapt to their surroundings, which may involve underlying genetic traits and capacities as well as expression of phenotypic plasticity in relation to environmental trends and pressures. The study of functional relationships in relation to environmental gradients allows insight into the capacity and efficiency of organisms in their adaptations to change. The marine environment is changing, sometimes abruptly, due to habitat changes, climatic factors, anthropogenic pressures or introduced species. Understanding the effects of such changes across the continuum of marine habitats demands a coming together of observations, ideas and research efforts.

We hope in this theme session to bring together field observers of variability in productivity and timing of life cycles, with studies of population dynamics in varied species and environments and with those experimenters determining rates and functional relationships. We hope too that modellers of these processes will communicate the strengths and gaps in current formulations, theories and data. The session aims to span the marine food web, to find synergies and to build towards ecosystem perspectives.

## Annex 9: Proposed Terms of Reference for the 2007 WGZE meeting

The **Working Group on Zooplankton Ecology** [WGZE] (Chair: A. Gislason, Iceland) will meet in Riga, Latvia from 26–29 March 2007 to:

- a) update the ICES Plankton Status Report.
- b) review the role of microzooplankton, including metazoans, in marine food web.
- c) compare the zooplankton ecology of the North Atlantic and the Mediterranean;
- d) review the use of numerical methods in exploring and predicting long-term plankton variability;
- e) review and consider the impact on zooplankton communities of introduced or disappearing species.
- f) consider rate process studies and zooplankton phenology in association with time-series monitoring.
- g) consider the development of web-based taxonomic training and the promotion of the ICES WGZE to a wider community.
- h) review and consider species biodiversity in zooplankton from coastal zones to oceanic deep sea: progress and prospects for the European Census of Marine Life Project (EuroCOML).

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

### Supporting Information

<b>PRIORITY:</b>	The activities of this group are a basic element of the Oceanography Committee, fundamental to understanding the relation between the physical, chemical environment and living marine resources in an ecosystem context. Reflecting the central role of zooplankton in marine ecology, the group members bring a wide range of experienced expertise and enthusiasm to bear on questions central to ICES concerns. Thus the work of this group must be considered of very high priority and central to ecosystem approaches.
<b>SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:</b>	<p>Action Plan No: 1.2 - 1.13; 2.2, 2.9, 2.10; 3.2, 3.3, 3.15; 4.2, 4.10, 4.11, 4.14, 4.15; 5.2 – 5.5, 5.9, 5.10, 5.13 – 5.17; 6.1; 8.1, 8.2, 8.4, 10.1, 10.3</p> <p>a) This is a repeating task established by the Working Group in 2000 to monitor the plankton abundance in the ICES area. The material presented under this item updates and expands the annual Summary Plankton Status Report in the ICES area. Reported results are significant observations and trends based on a wide range of time-series sampling programmes. Efforts are in hand to expand the report, to include phytoplankton and elementary physics and to facilitate comparative analyses and setting monitoring standards and recommendations.</p> <p>b) Microzooplankton constitute a significant component of the plankton community in many marine environments. Owing to their small size they typically have higher weight-specific growth rates than larger metazoans. Hence, they are important phytoplankton grazers in many marine systems, capable of exploiting pico- and nanoplankton. Microzooplankton may in turn be eaten by larger metazoans of the plankton community and thus they form an important link in the “microbial loop” between pico- and nanoplankton and higher trophic levels. Due to lack of proper methodology for collection, preservation and difficulties in identification, their ecology is relatively poorly understood. With all this in mind WGZE members feel it is important to explore and discuss the role of microzooplankton in the marine food web.</p> <p>c) It is recognized that there is a movement towards broader and more global syntheses and comparisons in the research community, particularly being driven by the process and implications of climate change for marine ecology generally. The WGZE members are keen to forge links with their fellow plankton scientists in CIESM as there is much to be learned and gained through exchange and collaboration. There is need for coordinated approaches to plankton monitoring in the two areas (e.g. overview of metadata, harmonization of sampling and sample processing), and comparison of the zooplankton ecology in the two areas. Links between plankton in the North Atlantic and the Mediterranean need to be explored.</p> <p>d) Time-series studies on zooplankton long term-trends and their relationships with</p>

	<p>climate indices (e.g. NAO, Gulf Stream north wall index) and global warming suggest that important changes may occur in zooplankton processes and community structure as a result of climate change. By taking account of advances in statistical and biophysical modelling approaches we seek to elucidate the links between climate change and long term zooplankton variability.</p> <p>e) Appearance of new species or disappearance of established species has been noted in a variety of regions. There is a need to gather examples and examine how they may be related to changes in their environment and what the consequences might be for plankton communities and regional ecology.</p> <p>f) Rate process measurements for estimating zooplankton secondary production of zooplankton have been on our agenda since 2001. Significant progress is now within reach with a sub-group of WGZE members organising a workshop to deal with this issue. The WGZE feels it is important to follow the progress. Phenology can provide a powerful tool for understanding the status of species, communities and ecosystems in a changing environment. For example, the timing of spring production and the length of the productive season may change as a consequence of a changing climate. Zooplankton is – for one thing – a very good indicator of phenological change in the sea. The marine system so far has no phenological observation system, but should be initiated.</p> <p>g) The WGZE has set up a site thanks to the enthusiasm of one member. This welcome initiative we need to foster and capitalise on, therefore we need to review and develop the application of this approach to our endeavours. One application is an interactive web site that may be used to create a virtual taxonomic expertise facility to promote this critical skills base. Also, the development and enhancement of the existing ICES Fiches Plankton ID sheets would be greatly assisted by available interactive web based resources. A poster and/or a PowerPoint presentation should be put together in order to advertise what WGZE does and encourage participation and collaboration by others. The information should be simple: working group name, missions statement, current members, examples of outputs, and contact details.</p> <p>h) The WGZE has been very active in defending taxonomic skills in the ICES region (e.g. promoting taxonomic training courses), producing zooplankton checklists, ecological indices based on zooplankton diversity and collating data of zooplankton abundance at a wide distributed network of sampling sites. All these topics meet in the goals of EuroCoML initiative (i.e. assessing and explaining the diversity, distribution and abundance of marine life in the oceans). The WGZE is willing to collaborate with this important programme, expand partnerships and formulate future contributions with EuroCoML.</p>
<b>RESOURCE REQUIREMENTS:</b>	Resource required to undertake the activities of this group is negligible. However, ICES must be committed to provide some sponsorship and support for workshops, publication costs for the Plankton Status Report, and the 4 <sup>th</sup> Zooplankton Symposium.
<b>PARTICIPANTS:</b>	The group has an enthusiastic core membership, and is successfully making efforts to attract broader participation both across ICES nations and across relevant skills. The Group is normally attended by some 20-25 members and guests.
<b>SECRETARIAT FACILITIES:</b>	None beyond communication support.
<b>FINANCIAL:</b>	Beyond the 10,000DK support for the Symposium in 2007 and publication costs for the Plankton Status Report, no other current financial implications.
<b>LINKAGES TO ADVISORY COMMITTEES:</b>	The Group reports to the Oceanographic Committee, ACE and ACME (information also relevant to some ACFM aims). Mainly WGZE provides scientific information on plankton and ecosystems and welcomes input from other committees, working/ study groups etc.
<b>LINKAGES TO OTHER COMMITTEES OR GROUPS:</b>	Any and all working and study groups interested in marine ecosystem monitoring and assessments, modelling and/or plankton studies, including fish and shellfish life histories and recruitment studies.
<b>LINKAGES TO OTHER ORGANIZATIONS:</b>	Links with the WGMDM, WGRP, WGCCC, WGPE and WGABD 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.
<b>SECRETARIAT MARGINAL COST SHARE:</b>	ICES: 100%.

## Annex 10: Draft resolution for an ICES internal publication

The report **Zooplankton monitoring results in the ICES area: Summary Status Report 2005/2006**, edited by members of WGZE, as reviewed and approved by the Chair of the Oceanography Committee, will be published in the *ICES Cooperative Research Report* series. The estimated number of pages is 30.

The Working Group on Zooplankton Ecology agrees to submit the final draft of the proposed publication by 1 July 2007.

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

### Supporting Information

Priority:	This draft resolution enhances the development of the plankton status report, and makes it an official and citable ICES product.
Scientific Justification:	The Cooperative Research Report series offers a good venue for the annual publication of the Plankton Status Report, making it available to the scientific community as a citable publication. This status report represents an annual assessment which can support the new advice format, providing regionally-based assessments of plankton in the ICES area.
Relation to Strategic Plan:	This resolution will contribute towards Scientific Objectives; 1a (Describe, understand and quantify the state and variability of the marine environment in terms of its physical chemical and biological processes.); 1b (Understand and quantify the role of climate variability and its implications for the dynamics of the marine ecosystems); 5c (Coordinate international, monitoring and data management programmes which underpin ongoing ICES core science.); 4c (To publicise the work of ICES and the contributions that ICES can make for its stakeholders, and for the wider public audience, regarding the understanding and the protection of the marine environment), and Institutional Objective 6 (Make ICES' scientific products more accessible to the public.)
Resource Requirements:	Cost of production and publication of a 15 page CRR
Participants:	
Secretariat Facilities:	Help with document preparation/publication. Final editing.
Financial:	
Linkages To Advisory Committees:	ACE, ACME, ACFM, Publications Committee
Linkages To Committees Groups:	Oceanography Committee, REGNS
Linkages to Organisations	IOC, GLOBEC, OSPAR

## Annex 11: Draft resolution for joint WGZE/CIESM workshop

A Joint Workshop of **Working Group on Zooplankton Ecology** [WGZE] (Chair A. Gislason) and **Mediterranean Marine Research Network** [CIESM] (Chair G. Gorsky) scientists will be held in a place yet to be determined in October 2008 to review and consider:

- a) Comparison of zooplankton ecology of the Mediterranean and the North Atlantic, with emphasis on common species and size structure using common numerical methods;
- b) Overview of on-going time-series programmes;
- c) Harmonization of methods, overview of experimental work;
- d) Appearance or disappearance of species vs. global warming;
- e) Autecology of key species.

### Supporting Information

<b>PRIORITY:</b>	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently these activities are considered to have a very high priority.
<b>SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:</b>	Action Plan No: 8.1, 8.2; 1.2-1.13; 2.2, 2.9, 2.10 A joint meeting is important and timely because: <ol style="list-style-type: none"> <li>a) There is need for coordinated and cooperative approaches to plankton monitoring (overview of metadata, harmonization of sampling and sample processing).</li> <li>b) Comparison of zooplankton ecology in the two areas has great scientific value (what is causing the differences between the two ecosystems, some species are common to both systems and it would be interesting/challenging to compare their ecology between the two areas).</li> <li>c) The two regions/ecosystems may influence each other and it is important to elucidate the links between them.</li> <li>d) Important to mobilize the wider scientific community besides ICES to address issues of common interest.</li> <li>e) Many of the issues which WGZE is dealing with will benefit from a wider collaborative approach.</li> </ol>
<b>RESOURCE REQUIREMENTS:</b>	The research programmes which provide the main input to this group are already underway, and resources already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
<b>PARTICIPANTS:</b>	The Workshop will probably be attended by 30–40 scientists (15-20 from each group).
<b>SECRETARIAT FACILITIES:</b>	None.
<b>FINANCIAL:</b>	There will be no financial costs to ICES.
<b>LINKAGES TO ADVISORY COMMITTEES:</b>	There are no obvious direct linkages with the advisory committees.
<b>LINKAGES TO OTHER COMMITTEES OR GROUPS:</b>	The issues are within the mandate of the WGZE. There is a very close working relationship with all the groups of the Fisheries Technology Committee. It also is of close relevance to the Working Group on Ecosystem Effects of Fisheries.
<b>LINKAGES TO OTHER ORGANIZATIONS:</b>	Linkages to CIESM and the Census of Marine Life Programme.
<b>SECRETARIAT MARGINAL COST SHARE:</b>	ICES:CIESM 50:50.

## **Annex 12: ICES/MARBEF Crustacean Zooplankton Taxonomic Workshop**

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**Host organisation:** Sir Alister Hardy Foundation for Ocean Science

**Location:** Marine Life and Environmental Sciences Resource Centre, The Laboratory, Citadel Hill Plymouth, UK

**Date:** 20–23 June 2006

### **Organising group**

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Dr J. A. Lindley (Chair), C.L. Buckland, A.W. G John, T.D. Jonas, Dr P. Licandro, D.P. Stevens, M. Wootton.

### **Speakers**

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Prof. Geoff Boxshall (Natural History Museum)

Dr Alistair Lindley (SAHFOS)

Dr David Conway (SAHFOS/ Marine Biological Association)

Dr Richard Kirby (University of Plymouth)

Dr Isabella Buttini (Stallion Zoological, Naples)

Prof. Tecla Sertorio Zunini (University of Genoa)

### **Participating Institutes**

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Canada – Bedford Institute of Oceanography

Germany – Alfred Wegener Institut für Polar und Meeresforschung, Bremerhaven

Greece – University of Patras

Italy – University of Lecce, CONSIMA

Japan – Tohoku National Fisheries Research Institute

Norway – Institute of Marine Research, Bergen

Poland – Institute of Oceanology, Polish Academy of Sciences

Spain – Centro Oceanográfico de Gijón

Tunisia – Faculty of Sciences, Bizerta

Turkey – University of Cukurova

UK – CEFAS, University of St Andrews, University of Plymouth

### **Programme**

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#### **Tuesday 20th June.**

0900-0930 Registration

0930-1000 Introduction by Chair. Alistair Lindley.

1000-1100 Introduction to Copepod Morphology. Geoff Boxshall

1100-1130 Coffee/Tea break

1130-1230 Important non-calanoïd families from the Marine zooplankton. Geoff Boxshall

Lunch

1400-1430. Visit to SAHFOS laboratory and workshop.

1430-1700. Practical session (with opportunity for coffee/tea break from 1545)

1800-1930. Ice Breaker (drinks and snacks) at the common room, Citadel Hill Laboratory

**Wednesday 21<sup>st</sup> June**

0900-1000. Identification of developmental stages of copepods – eggs to adults. Dave Conway

1000-1230. Practical session (with opportunity for coffee/tea break from 1045)

Lunch

1400-1500. Use of confocal microscopy in zooplankton studies. Isabella Buttino.

1500-1700. Practical session (with opportunity for coffee/tea break from 1545)

**Thursday 22<sup>nd</sup> June**

0900 -1000. *Clausocalanus* and *Paracalanus*: identification and species distribution in the Mediterranean Sea. Tecla Sertorio Zunini

1000-1230. Practical session (with opportunity for coffee/tea break from 1045).

Lunch

1400-1430. Genetic analysis of CPR samples. Richard Kirby

1430-1545. Practical session

Coffee/Tea

1615-1700. Discussion.

1930. Workshop dinner. Common Room Citadel Hill Laboratory.

**Friday 13<sup>th</sup> June.**

0900-1000. Distinguishing Mysidacea, Euphausiacea, and pelagic stages of Decapoda and Stomatopoda. Identification of larval stages of major groups within Decapoda. Presentation. Alistair Lindley (SAHFOS).

1000-1230. Practical session (with opportunity for coffee/tea break from 1045).

Lunch

1400 -1545. Completion of practical

Coffee/tea

**Report**

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This Workshop was part of a series initiated by the ICES Working Group on Zooplankton Ecology (WGZE) to help to standardise and exchange expertise in identification of zooplankton and also to stimulate interest in and contributions to the *ICES Identification Leaflets for Plankton*. The second such workshop was held in Plymouth and hosted by SAHFOS in June 2003. Due to the limit to the numbers attending, many people who expressed an interest in attending could not be accommodated for that workshop. A workshop of similar content but hopefully improved due to the experience of 2003 was offered on this occasion. An application for support from the MARBEF Training Programme was successful and the MARBEF Taxonomic Clearing Scheme supported the attendance of students from Tunisia and Turkey.

The Workshop commenced with introductory remarks from the Chairman. These included drawing attention to the fact that the *ICES Identification Leaflets for Plankton*, as well as being available in hard copy and on CD, are accessible on-line on the ICES web site (<http://www.ices.dk/products/fiche/Plankton/START.Pdf>). The site now includes the facility to add amendments to existing leaflets. He also drew attention to an example of the ETI CDs that was installed in one of the computers in the resource centre.



The content of the presentations is given on the SAHFOS web site [http://192.171.163.165/Event\\_taxonomic\\_wkshp\\_Talks.htm](http://192.171.163.165/Event_taxonomic_wkshp_Talks.htm) so they will not be described in detail here. Dr Buttino demonstrated the practical use of the confocal microscope to small groups as the equipment could not be transferred from the laboratory in which it was used to the Resource Centre. Apart from this the practical sessions in the laboratory of the resource centre were provided with sorted and unsorted preserved plankton from the Indian Ocean and the Antarctic as well as European waters. Some participants brought interesting material from their own institutions. Also live plankton caught daily off Plymouth. The participants worked in various sized groups with advice and guidance from the speakers, organising group and other SAHFOS staff. A video microscope with large monitor was used to display material of particular interest.

Participation in the Workshop has resulted in new initiatives for future research, for example during her visit Dr Buttino carried out studies on the morphologies of widely distributed copepods from different areas to provide a basis for further research in intra-specific populations or cryptic speciation. Also Dr Kirby has been approached for further information on the analysis of DNA from formalin preserved material.

Feedback forms were distributed to participants. The responses in were generally positive, participants enjoyed the Workshop, were complimentary about SAHFOS and appreciated the organisation. The main critical comment was that some participants would have liked more structure and organisation to the practical sessions.

## **Acknowledgements**

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We thank the University of Plymouth (Dr. Roger Haslam, School of Biological Sciences) and Olympus Optical Co. (U.K.) Ltd., who made microscopes available for the Workshop. Dr Colin Brownlee of the MBA made the confocal microscope available.