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3–5 March 2010

Aberdeen, United Kingdom

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Contents

Executive summary

Meeting: ICES WGPME annual meeting was held at the Marine Scotland Marine Laboratory in Aberdeen, Scotland, UK from 3 to 5 March 2010.

Participants: The meeting was co-chaired by William K.W. Li (Canada) and Xosé Anxelu G. Morán (Spain) with 24 scientists representing 11 countries in attendance.

Mandate and Objectives: This meeting was the first to be held since the expert group was established by resolution at the 2009 ICES meeting in Berlin, Germany. The mandate of the group is to provide a primary focus for phytoplankton and other microbes (bacteria, archaea, protists, viruses) within the ICES Science Plan. The objectives of the meeting were to address ToRs adopted at the statutory meeting, with particular attention directed to the conceptual and operational foundations for undertaking a comparative analysis of multiyear time series data of phytoplankton and microbes in support of various elements in the ICES Science Plan.

Approach: The meeting was held over a two and a half day period during which each ToR was addressed in sequence. Eleven participants made presentations of research and monitoring activities conducted at their home institute, and these presentations catalysed the discussion on how the work of WGPME could best proceed. The meeting was conducted in an informal atmosphere with open discussions and ample opportunity for all to contribute.

Structure of the report: This report is organized by the ToRs in sequential order and concludes with a summary and future plans. Documentary details are provided in Annexes.

Main message: A rational, pragmatic, cooperative and incremental approach was developed towards a comparative analysis of multiyear microbial variability and trends using outputs from fixed-site observatories and monitoring programs around the North Atlantic. This analysis is intended to establish a rational basis for prediction, forecast, projection, and scenario building as lower trophic levels respond in the coming years to natural and anthropogenic forcings. Using the successful WGZE template of data analysis and visualisation, WGPME will build a platform of phytoplankton and microbial information using pragmatic considerations that respect diversity of data availability and accessibility, fostering cooperation between contributing members, and proceeding in an incremental fashion by steps rather than by punctuated milestones. The assembly of this information will start with common variables such as chlorophyll a concentration, phytoplankton abundance, bacterioplankton abundance, inorganic nutrients; the assembly will proceed along appropriate lines of taxonomic and ataxonomic differentiation; and will strive towards aggregate or emergent characteristics that inform the ecological, biogeochemical and ecosystem service roles of North Atlantic microbial communities. A website has been organised (WGPME.net) to promote public awareness of group activities and to facilitate the work of group members.

Recommendations: Theme session for 2011 ASC (SCICOM) and ToRs for 2011 annual meeting in Galway, Ireland (WGPME).

Opening of the meeting

The ICES Working Group on Phytoplankton and Microbial Ecology (WGPME) met for the first time at the Marine Scotland Marine Laboratory in Aberdeen, Scotland, UK from 3 to 5 March 2010 at the kind invitation of Eileen Bresnan. The meeting was attended by 24 scientists representing 11 countries (Annex 1).

On behalf of the host institution, the Director, Colin Moffat opened the meeting and welcomed the participants. This was followed by a round of introductions and comments on the logistical arrangements from Eileen Bresnan, our local host. The chronology of earlier events leading to the formation of WGPME by the ICES governing body in 2009 was presented by Bill Li. He thanked the chairs of the previous planning group (PGPYME) John Steele, Franciscus Colijn, and Ted Smayda for establishing the foundation of this new expert group.

1 Adoption of the agenda

The group reviewed the agenda, which had been circulated prior to the meeting, and this was adopted without any change. Some last minute adjustments took place on Friday morning session (see ToR G).

2 Terms of Reference

At the 97th Statutory Meeting (2009), Berlin, Germany, the Council approved the WGPME Terms of Reference as follows:

a) Develop an action plan to provide a primary focus for phytoplankton and other unicellular microbes within the ICES Science Plan;

b) Establish the conceptual and operational foundations for undertaking a comparative analysis of multiyear time series data of phytoplankton and microbial plankton;

c) Report to SSICC on the outcomes of the ASC 2009 Theme Session ("Trends in chlorophyll and primary production in a warmer North Atlantic");

d) Explore possible linkage to other related working groups within ICES (e.g. WGZE) and to those in other bodies (e.g. SCOR);

e) Prepare for a Theme Session at ICES ASC 2010 ("Ecological response of microbial plankton to global change processes in ocean basins, shelf seas and coastal zones");

f) Report by 15 March on potential contributions to the high priority topics of ICES Science Plan by completing the document named "SSGEF_workplan.doc" on the SharePoint site. Consider your current expertise and rank the contributions by High, Low or Medium importance;

g) Prepare contributions for the 2010 SSGEF session during the ASC on the topic areas of the Science Plan which cover: Individual, population and community level growth, feeding and reproduction; The quality of habitats and the threats to them; Indicators of ecosystem health.

3 Term of Reference A

Develop an action plan to provide a primary focus for phytoplankton and other unicellular microbes within the ICES Science Plan

Moderator: Bill Li, Rapporteur: Emilio Marañón

3.1 Main focus of the WGPME

It is acknowledged that the main focus of the WG is the study of temporal variability (at various time scales including interannual) in the abundance, distribution, diversity and functioning of phytoplankton and other planktonic microbes. A working definition of a time series study would be: any repeated sampling (at least annual) of one or more sites that uses consistent methodology to provide information on any of the following properties of phytoplankton and/or other planktonic microbes: abundance, biomass, diversity, community structure, metabolic rates.

Most on-going surveys are based on the sampling of one or a few fixed stations. However, programs exist that include measurements taken over basin-scales, e.g. the Continuous Plankton Recorder (CPR) survey and the Atlantic Meridional Transect (AMT). By combining all sampling programs (those maintained by members of the WG, plus those that have been identified) all relevant spatial scales are covered: local, regional, basin (North Atlantic). Temporal scales covered range from annual (1–2 surveys per year) to weekly (52 samples per year).

It is discussed to which extent the data collected by CPR are useful in the context of the WG, given that some variables are semi-quantitative (e.g. a colour index rather than an actual chl *a* concentration). Given that CPR data are self-consistent, even if absolute numbers are not accurate, it is concluded that the data are useful to detect temporal trends and distribution changes. It is hoped that CPR scientists will get involved in the WGPME.

It is suggested that focusing on particular events (e.g. extremely cold winters) is useful to evaluate impacts on the ecosystem and link small to large scale variability. However, sustained, long time-series are key to describe background conditions and identify regime shifts.

The suggestion is made that special attention should be given to certain species, for instance those with a cosmopolitan distribution such as *Skeletonema costatum*. However, there are risks in targeting single species, since communities are complex.

There is general agreement that focusing on phytoplankton and other planktonic microbes is a natural grouping. Even if the methods used are different (e.g. more presence of 'traditional' techniques in phytoplankton research, whereas molecular biology is key in the study of bacteria and archaea), the common ground is given by the functioning of the microbial community. Although the main focus of ICES is upper trophic levels and fisheries, our WG must highlight the role of planktonic microbes as i) a functional link between climate variability and fisheries dynamics and ii) major drivers of biogeochemical cycles, thus with an impact on key ecosystem services such as the regulation of ocean-atmosphere exchange of radiatively active gases.

The WG is made up of scientists with expertise in phytoplankton, heterotrophic bacteria, or both. A strength of the group is that most of us study both autotrophic and heterotrophic microbes, or at least study processes that are driven by broadly different taxonomical groups. It must be taken into account that natural abundances are always the result of the balance between growth and loss processes. Since a major loss process for both phytoplankton and heterotrophic bacteria is grazing, the role of heterotrophic protists must be considered. In this regard, the WG is perhaps lacking in experts in the field of the diversity and functional role of heterotrophic protists.

Global change in the marine environment (including climate change but also other processes such as acidification, eutrophication, man-made transfer of species, removal of upper trophic level biomass, etc.) can impact the ecosystem at three levels, causing change in i) distribution of species and composition of communities, ii) biomass, primary production, bacterial production, respiration, and other metabolic processes and iii) biogeochemical cycling of elements. One of the most important goals of our research is to link ecosystem structure and function, and to do this we need to combine diversity- and process-oriented studies, conducting concurrent and coordinated measurements of community structure, productivity and environmental factors.

3.2 Potential contributions of the WGPME and actions arising from this Discussion

The WG activities can include data analysis, organization of workshops, unification of methodologies, providing expert advice, etc. One objective of the group could be to establish methods that are consistent or comparable (intercalibration exercises), in order to make different time series comparable.

A first action is to identify which time series studies are on-going and describe their main features: spatial and temporal resolution, variables measured, status and availability of data, etc. To initiate the process, some of the data more readily available can be submitted for inclusion in the group's web (www.wgmpe.net), using the data processing and visualizations tools already in use in ICES zooplankton group.

A good way for the group to gain visibility is to propose a theme section for a future ICES conference.

Another action needed is to contact individual scientists and/or consortia which may complement and expand the expertise already represented in the group. These include i) the AMT programme (e.g. Glen Tarran), ii) the CPR programme (SAHFOS), and iii) experts in the study of the diversity and functional role of heterotrophic protists.

3.3 Participants science contributions related to ToR A

3.3.1 Long-term observations on phytoplankton and microbial diversity in the western English Channel

Claudia Halsband-Lenk, Claire Widdicombe and Jack Gilbert

Plymouth Marine Laboratory, UK

Over a 15-year period (1992–2007), weekly water samples were collected from the L4 time-series station in the western English Channel and analysed for phytoplankton community structure and abundance. The data produced have been analysed to identify seasonal patterns, inter-annual variability and long-term trends in the composition of the seven main functional phytoplankton groups. Phyto-flagellates numerically dominated accounting for on average ca. 87% of the phytoplankton abundance while diatoms, *Phaeocystis*, coccolithophorids, dinoflagellates and ciliates contributed 13% of abundance. Distinct seasonal and inter-annual changes in the abundance and floristic composition of the functional groups were observed. Significant long-term changes in abundance showed that, over the study period, diatoms and *Phaeocystis* decreased while coccolithophorids, the dinoflagellate *Prorocentrum minimum* and some heterotrophic dinoflagellate and ciliates increased in abundance. These changes highlight the importance of long-term observations for the understanding of natural temporal variability in plankton communities. Such shifts in the community composition at L4 could have important consequences for ecosystem function. Comparison of this data to a 7-year time series of pyrosequenced bacterial diversity (>1 million 16S rDNA V6 tags) and the Western Channel Observatory (http://www.westernchannelobservatory.org.uk/) dataset of environmental parameters lends itself to the potential for ecological modeling. When provided with a small set of environmental conditions, e.g. temperature, phosphorus concentration and water density, it is now potentially possible to predict the community structure, including diversity and function, of a time-point in the 100 year history of the WCO. This highlights the considerable importance of collecting metadata and applying long-term monitoring programs for a wide-range of marine ecosystems.

3.3.2 Changes in the phytoplankton community in the North East of Scotland: observations since 1997

E. Bresnan, S. L. Hughes, S. Fraser, A. L. Amorim, K. Smith, M. Rose, G. Slesser, S. Hay, J. Rasmussen and M.R. Heath

Marine Scotland Marine Laboratory, Aberdeen, UK

A long term coastal ecosystem station, 5 km offshore of Stonehaven in the North East of Scotland (56º 57.8′ N, 02 º 06.2′ W), is monitored weekly for temperature, salinity, nutrients, phytoplankton and zooplankton. A number of changes in the phytoplankton community have been observed since the time series began in 1997. A four year period was identified from 2001 to 2004 where mid month chlorophyll values during the spring bloom were reduced. Dinoflagellate genera such as *Ceratium* show a decreasing trend in common with shorter time series from other Scottish coastal sites. During the early part of the time series the spring bloom was dominated by *Chaetoceros* species however since 2002, dense blooms of this genus are no longer observed and *Skeletonema* has become more abundant. This change in spring bloom composition is coincident with the end of a period of negative temperature and salinity anomalies observed from 1998 to 2002. Changes in zooplankton composition and predation pressure have also been observed since monitoring commenced.

3.3.3 Different approaches to characterize the phytoplankton community for water quality assessment and more

Véronique Créach, Rodney Forster, Naomi Greenwood, Dave Sivyer, David Mills

Cefas Laboratory, Suffolk, UK

The UK Centre for Environment, Fisheries and Aquaculture Science (Cefas) has invested in the development of Marine Observations Systems (http://www.cefas.co.uk/products-and-services/environmental-monitoring-equipment.aspx) that consist of automated platforms recording multiple-parameters and water samplers moored in UK coastal waters. Alongside this, other techniques such as flow cytometry are being used to characterise the quality of the water bodies based on the composition of the phytoplankton. 2-D cytogram libraries and classification routines have been developed to identify individual particles in natural, mixed samples into phytoplankton functional types. The portable Cytosense flow cytometer is used in this process and has the advantage of being able to analyse fresh samples on board the institute's research vessel. A flow-through water quality system consisting of a standard FerryBox plus additional PAM- and FRRF-type fluorometers for the continuous along-track measurement of algal photosynthetic activity has also been developed. Different waters bodies have been already studied such as the East Coast of UK, the North Sea and the Irish Sea. With this work, we are demonstrating that an automated, operational approach is feasible for studying the diversity of the phytoplankton community. This combines traditional and more recent technologies, and could be used in monitoring programmes for the European Marine Strategy Directive, could provide ground truth for predictive phytoplankton functional type models such as ERSEM and generates maps for the European Marine Ecosystem Observatory (EMECO).

3.3.4 Phytoplankton trends in the Baltic Sea

Norbert Wasmund[a], Jarno Tuimala[b], Leen Vandepitte[c] and Alexandra Kraberg[d]

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It has been known for decades that the marine environment is degrading, most likely by anthropogenic impacts. In order to survey the long-term changes in the Baltic Sea, the Helsinki Commission (HELCOM),founded in 1974, established an international monitoring programme. The resulting data were evaluated in different trend studies. The latest of these assessments on trends in phytoplankton was performed as part of the Responsive Mode Project LargeNet (Large-scale and long-term networking of observations of global change and its impact on marine biodiversity), undertaken within the European Network of Excellence "Marine Biodiversity and Ecosystem Functioning" (MarBEF). The phytoplankton data considered in this presentation were contributed by Denmark, Estonia, Finland, Germany, Lithuania, Poland and Sweden. The data cover the Baltic Proper and the Belt Sea area, from 1979 to 2005. The non-parametric Mann-Kendall test was used for detecting linear trends of phytoplankton biomass. If trend breaks occurred, the data series before and after this break-point were analysed for linear trends. The analyses were performed for stations, seasons and phytoplankton taxa separately. The results of this excercise are compiled in a tabular matrix. They show an increase in phytoplankton biomass in spring in the Baltic Proper, which is primarily due to an increase in dinoflagellates and autotrophic ciliates. In contrast, some diatom taxa revealed decreasing trends. In summer, total phytoplankton biomass and that of the cyanobacteria, dinophyceae, euglenophyceae and prasinophyceae decreased in the southern Baltic proper, whereas diatoms showed no general trend and autotrophic ciliates increased. In autumn, the biomass increased in the Gotland Sea and Kiel Bight, related to an increase in diatoms. Our detailed analyses have revealed a very complex picture with respect to the phytoplankton community in different parts of the Baltic stressing the need for continued monitoring at a regional level.

3.3.5 Regular online archival of images as metadata for plankton time series: some food for thought

Alexandra C. Kraberg and Karen H. Wiltshire

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For many decades the composition of phytoplankton communities has been recorded as part of the long-term monitoring efforts of institutes around the globe. However, the resulting long-term data sets are often extremely noisy. This is due to underlying ecological factors, such as several, cyclical drivers (e.g. climate related) at different temporal scales, with individual species responding in different ways to different drivers. This often makes plankton data very difficult to interpret. However an additional problem that is particularly pronounced in plankton data sets is related to taxonomy and the taxonomic skills of the plankton analysts. Particularly the phytoplankton is extremely species rich with many taxon groups containing several species which are hardly distinguishable by light microscopy alone. This can result in three problems: 1) The data series is 'over identified' with several species names used for the same taxon; 2) The data series contains many taxon groups such as Protoperidinium sp. in which individual species are lumped together, losing taxonomic resolution and therefore a reduction in the explanatory power of the data set; 3) A bias towards certain taxon groups with which a given analyst is most familiar. Most data managers of data series will have conventions as to how to record taxa, but these are not necessarily the same for different time series, making comparisons between data sets difficult without a time consuming and therefore costly post hoc quality control exercise. We argue that these problems could be avoided if, at least with difficult taxa, images of the organisms were to be included as part of the normal data archival process. This would also avoid problems inherent to individual data sets e.g. as the result of a change in analyst. With the increasing use of molecular tools in phytoplankton monitoring images of different cultured clones would also be beneficial. In this presentation we will discuss possible mechanisms and protocols for archiving image material alongside presenting the archival mechanisms for and image material in the PLANKTON*NET online database (http://planktonnet.awi.de) and options for links to the underlying numerical data in the Pangaea database, using data from the Helgoland Roads long-term data series as an example.

3.3.6 Seasonal patterns of microbial dynamics in cold oceans. Comparison of polar and subpolar ecosystems

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Ecosystem processes, which both control biogeochemical cycles and are influenced by climate forcings, are profoundly influenced by the activity and dynamics of the microbial heterotrophs. Marine heterotrophic microbes (i.e. prokaryotic bacteria and eukaryotic protozoa) dominate the fluxes of organic carbon in the upper ocean, where they typically remineralize >75% of primary production back to CO_2. Although these small organisms and their interactions are well studied in low latitudes, there is far less known about their distributions, community structure, activity and food web interactions, and their impact on upper open biogeochemistry in high latitudes and in cold oceans. Despite the low temperatures, microbial processes are highly active and the rates of growth and elemental transformations can be similar to those in lower latitudes. Here we compare the seasonal patterns of microbial activity in two distinct cold ocean regions; a polar site, i.e. Baffin Bay, Canadian Arctic, and a subpolar site, i.e. Logy Bay, Newfoundland, Eastern Canada. Although these sites exhibit a number of contrasting environmental characteristic (e.g., temperature range, duration of ice cover, day-length) and , their temperature minima are the same, are the patterns and magnitudes of bacterial biomass, production and growth as well as their mortality due to protistan grazing.

3.3.7 Spatial and temporal trends in phytoplankton from long-term monitoring in the Bay of Fundy, eastern Canada

Jennifer L. Martin, Murielle M. LeGresley and Alex Hanke

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Phytoplankton abundance and a number of physical and chemical variables have been monitored at four locations in the Bay of Fundy, eastern Canada, at varying weekly to monthly intervals since 1987. Parameters measured include plant nutrients (ammonia, nitrate, phosphate and silicate), Secchi depth, and depth profiles for fluorescence, temperature and salinity. Since the programme was initiated, twenty-seven new species have been observed suggesting the introduction of new species. Phytoplankton abundance from the study sites is compared between years and sites to physical and chemical properties of seawater using principle component analyses (PCA) to identify factors showing the greatest amount of variance in temporal and spatial distribution patterns. Analysis of abundance of most species from the 21 yr period 1987-2009 indicates that cell abundance from one year does not reflect the following year and for one particular species, *Alexandrium fundyense*, nitrate values and cell densities appear to have a negative relationship when concentrations of *A. fundyense* exceed 7.5 $\times 10^4$ cells L^{-1}. Preliminary analyses indicate that phytoplankton abundance and intensity appears to be more climate related than nutrient flux related. Various analytical approaches to examine relationships between cell density, nutrients and environmental variables as well as trends from the Bay of Fundy will be presented.

3.3.8 Flow cytometric monitoring of microbial patterns during a 10 year study in Boothbay Harbor, Maine

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The ability to identify environmental or climatic changes requires monitoring programs that measure well-defined variables for sustained periods of time. In order to understand differences or anomalies on annual to decadal scales, especially those caused by anthropogenic sources, a large number of observations are required for statistical significance. Over the past 10 years (2001 to 2010), weekly observations at high tide of phytoplankton, bacterioplankton and eukaryotic heterotrophs were made using flow cytometry at a single location in Boothbay Harbor, Maine. Temperature, salinity and chlorophyll a were also determined. Flow cytometric ataxonomic groups were defined and enumerated (*Synechococcus*, cryptophytes, total phytoplankton, small eukaryotic phytoplankton (<2 μm - picoeukaryotes), and large eukaryotic phytoplankton (2-20 μm)). Bacterioplankton were detected and enumerated using the DNA stain PicoGreen (Invitrogen). Heterotrophic eukaryotes (microflagellates and small ciliates) were detected using the food vacuole stain Lysotracker Green (Invitrogen). The site experiences a strong seasonal cycle in temperature, ranging from about 1 to 20°C. Distinct annual and seasonal patterns emerge in both the flow cytometric data and chlorophyll a that correlate with changes in temperature and the onset of both the spring and fall phytoplankton blooms. On an annual basis, cryptophytes and *Synechococcus* bloom within a very defined period of time, usually July and September, respectively. Bacterioplankton initially increase following the spring bloom and increase again as temperature increases and remain high until the temperature and concentration of phototrophs begin to decrease. The overall changes and observations in plankton and marine microbes here in Boothbay Harbor add to the increasing number of long-term flow cytometric data sets. This ten-year data set is the beginning of a potentially larger data set in future years and can also be used a model for other long-term monitoring sites.

3.3.9 Multiscale analysis of the nitrate-chlorophyll relationship in Bedford Basin, Canada

William K.W. Li[a], Marlon R. Lewis[b] and W. Glen Harrison[a]

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The relationship between nitrogen (N) and phytoplankton chlorophyll a (Chl) establishes a basis for understanding eutrophication in coastal marine ecosystems. A substantial literature exists on the spatial relationship based on cross-ecosystem analysis, but there is little information across temporal scales. A collection of observational records in Bedford Basin (Canada) was used to construct the N-Chl relationship at 4 time scales: intra-day, intra annual, interannual, and interdecadal. In Bedford Basin, N statistically predicts Chl at time scales that are short (intra-day, intra-annual) and long (interdecadal) but not intermediate (interannual). There is an apparent stoichiometric regularity in the dependence of Chl on N that crosses time scales. This study clearly demonstrates a general tenet of ecology: at low levels of organisation, organismal biology and population ecology are not complicated too much by particular circumstances of time; at intermediate levels, community ecology is overwhelmingly complicated by contingency; but at high levels, macroecology displays a statistical order that emerges from detail-free patterns.

3.3.10 Towards an integrative approach in phytoplankton and microbial ecology

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Current marine monitoring programmes provide valuable plankton data that depict long-term trends in abundance and reveal changes in community structure, but extrapolations in space and time of these trends remain critical. On the other hand, credible predictions are crucial to unambiguously promote mitigation strategies. The meaning of plankton community structure for the functioning of the marine foodweb is hardly understood. With our presentation we therefore wish to encourage an integration of diverse and highly specialized research activities. We propose to put more emphasis on causal links between reactivity of organic matter, metabolic activities, and interactions between heterotrophic- and photoautotrophic microorganisms of the marine pelagial. In this spirit, we will briefly outline some advanced methods that may complement bulk measurements at monitoring sites. The following topics will be put up for discussion (ToR A and ToR B): 1) A better understanding of the reactivity of organic matter can be derived from molecular compound analysis. Although the majority of dissolved organic matter escapes chemical characterization, the major biochemicals involved in microbial cycling (i.e. carbohydrates, proteins, and lipids) can now be determined with high precision. This links resource quality to microbial activity. 2) The analysis of the structure, dynamic and activity (function) of bacterial populations provides either direct or indirect proxies for environmental changes. Recently developed molecular techniques enable high throughput analyses of the bacterial community, as needed for time series samples. 3) Recent innovations in measuring the molecular diversity of marine microplankton have the potential to facilitate and refine monitoring programmes. In order to consolidate new approaches, a state-of-the-art survey and intercomparisons are required. 4) Advanced methods, like Principal Component Analysis or Bayesian Statistics that are based on probability theory, facilitate the identification of trends in observations or in subsets of time-series data. Subsets of data that show similar variations in time can be further tested for the probability of coherent step functions, explaining changes in community structure. 5) Given the taxonomic complexity of existing data, the tolerable level of data aggregation for modelling purposes must be discussed (e.g. when mapping species into functional groups). Recent model developments include plankton size as generalized trait. Possibilities to monitor plankton size should also be addressed. In summary, an integrative approach helps to better resolve biochemical and ecological details that help to improve our understanding of ecosystem function. These details are crucial for constraining model solutions. Thus, individual, highly specialized research activities may take advantage of monitoring programmes and vice versa.

3.3.11 Phenological shifts of three interacting zooplankton groups in relation to climate change

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An advanced statistical method is outlined, in support of identifying biogeochemial and physical details in bulk measurements at monitoring sites. The method helps to improve our understanding of ecosystem function. Using long-term abundance data of ctenophores (*Pleurobrachia pileus* and *Beroe gracilis*) and that of their prey (copepods), the response of these organisms to climate warming was investigated. The data used is part of the time series in the German Bight at Helgoland Roads, which yields an extraordinary high temporal resolution. Based on Bayesian statistical considerations it was concluded that the phenology of the two ctenophores shifted in a steplike mode in the year 1987/1988 to permanent earlier appearances. The seasonal change in the population blooms of *Pleurobrachia pileus* and *Beroe gracilis* correlated best with a step-like increase in winter and spring sea surface temperatures of the southern North Sea. Interannual variations in ctenophores abundances were linked to changes in spring temperatures, although the impact of temperature on *Beroe gracilis* was less pronounced. Changes in copepods abundance were not in accordance with variations seen in abundance of ctenophores. *Pleurobrachia pileus* showed longer periods of high abundance after the permanent seasonal advancement. The longer periods were correlated with a decline in the average autumn abundance of copepods. The extended annual presence of *Pleurobrachia pileus* might have influenced fish stock decreases observed in the region during the same time period.

3.4 Round table wrap-up discussion ToR A

Moderator: Xelu Morán, Rapporteur: Melanie Sapp

Most of the wrap-up discussion following the participants' oral contributions dealt with the available time-series datasets. It was first agreed that there is a need for pragmatism in the consideration of datasets; in other words, valuable information can in principle be extracted from both high and low frequency sampling programs.

A first step would be to identify commonalities in datasets. The cyanobacterium *Synechococcus* was offered as an example of an organism showing a distinct seasonal cycle in several available datasets. A discussion followed on *Synechococcus* serving as a possible key "species " and its possible use for ecosystem monitoring, especially because of its clear signature in epifluorescence microscopy and flow cytometry as picoplankton-sized orange-fluorescing cells. After acknowledging the importance of unicellular cyanobacteria for primary production, it was remarked that in some cases, the seasonal pattern of *Synechococcus* can be a strong reflection of hydrography changes, as in the Thau lagoon in southern France, where the environmental influence on *Synechococcus* is very clear when triggered by a sharp temperature change. Yet it was argued that *Synechococcus* could not easily be used as an indicator species, as it cannot be directly linked to any single causative pressure.

Nucleic acid based molecular methods provide important phylogenetic information on microbes but few observatories or ecosystem monitoring programs include these as elements in core reports. A serious gap in available datasets for grazers was also identified, as well as a lack of a clear understanding of the scale dependence of bottom-up and top-down controls for microbial organisms.

We asked ourselves the question of which variables would be valuable for modelling purposes: species, functional groups, size classes, etc.? Biovolume would certainly be important, but not many datasets give this information and in most models abundance is probably more important. Although the use of flow cytometry techniques are becoming widespread, its applicability for long (>10 years) time series is still very limited. The choice of factors to feed in models depends on the question addressed, and a good example is the long ecological debate on species vs. biomass/energy flows. Using solely species abundance can be misleading for biogeochemical purposes and it was stressed that biomass matters for phytoplankton. The Bedford Basin data presentation (3.3.9) seemed to provide a good example on how to address this problem.

Next it was argued whether bacterial community structure or functional groups were important for monitoring purposes. Although the response was affirmative, it is far from easy to embed this type of data in long time series as information on function is largely unknown. Bulk bacterial carbon cycling, i.e. production plus respiration of assimilated dissolved organic matter, is important to be considered in the WGPME future work.

With regard to the next steps within the WGPME, the elucidation of the comparability of datasets and their suitability to fit into the ICES Science Plan and ability to answer ICES questions should come first. Specifically, we should process data in a general, common way which includes forming a baseline for metadata and use of common units. It was emphasized the need to incorporate size approaches. A good example for comparability is the seasonality of *Synechococcus*. Finally the use of different methods should be considered, such as flow cytometry vs. light microscopy. We agreed to look carefully at the use of size classes (also in HELCOM, where data on biovolume is accessible).

As the immediate step, a map should be used to identify available time series and each participant will add his/her specifics to a table of available datasets and variables measured. The problem of integrating molecular data into the time-series analysis framework should be addressed as part of a new ToR.

4 Term of Reference B

Establish the conceptual and operational foundations for undertaking a comparative analysis of multiyear time series data of phytoplankton and microbial plankton

Moderator: Xelu Morán, Rapporteur: Alexandra Kraberg

The session started with a request by Todd O'Brien to map information on datasets held by WGPME participants and additional datasets that could be requested from external data providers. The discussion then concentrated on concrete issues of data delivery including a list of desirable data from each data provider. The main discussion point was the set-up (number/type of fields for biotic and abiotic factors) in which data providers could enter their data series. Potential methodological and data management issues that need to be taken into account when delivering data were also discussed.

4.1 Methodological and data management issues

The discussion began with a general question by Yves Collos as to the reliability of the Reynolds sea surface temperature data set mentioned in the talk by O'Brien in his description of the ICES zooplankton working group and its products. O'Brien answered that on the basis of a preliminary inspection of the data and quality-check work done by the Reynolds group itself, the data were deemed reliable. But a switch to a different data set (Hadley) was considered as it was more detailed. Li commented that it was not the responsibility of the WGPME group to engage in extensive validation tasks. Richard Rivkin raised the issue of the possibility of the data being published with a caveat, i.e. including a description of potential problems such as methodology changes and Jennifer Martin suggested a cover section for each data set in which these problems could be described. O'Brien added that a section describing the different methods used and additional metadata for each of the delivered data sets would be important not only for the group members but also for external visitors to the website on which the data are to be published.

Collos noted that methodological problems may be inherent in many long-term chlorophyll datasets, for example when many researchers started using different filters in the 1980s for filtering seawater samples (change from GF/C to GF/F). O'Brien asked whether this was published anywhere and whether it was possible to use correction factors for the differences in retention of these filters. Rivkin answered that the application of a correction factor will not be possible as the error will depend on the size structure of the community, which varies seasonally, geographically, etc.

The discussion then turned in more detail toward the tabulation of a variables and parameters list (both abiotic and biotic) to be filled in by data providers to get an overview of available data. The level of detail in which biotic data were to be provided was discussed. Total diatom and dinoflagellate abundance/biomass were suggested as a minimum requirement by O'Brien. Coccolithophores (suggested by Snejana Moncheva) were added to the list as well as well. A list was produced and provided online (http://www.editgrid.com/user/todd.obrien/wgpme_data). Group members were issued with passwords to access the list. The list is also accessible from the new group website (http://wgpme.net).

Norbert Wasmund commented that one should not be too restrictive about which data to supply in the beginning but collate what is available first and then structure the data later (a similar comment was made later in the discussion by Rivkin). But he also suggested to choose and concentrate on a small number of indicator species that are indicative of certain environmental conditions. Moncheva asked whether the data acquisition should be limited to coastal time series. Li replied that this was not the case. It was emphasized that open ocean time series are also desirable for future work.

As an example of the scope of data that may be considered useful in WGPME, Li presented a description of the Blanes Bay Microbial Observatory (BBMO). The time-series program in Blanes, Catalonia, Spain, is led by Josep M. Gasol, who, though absent at Aberdeen, has indicated a strong interest in active future participation. At BBMO, oceanography and atmosphere are monitored by CTD, oceanographic buoy, weather station, estimates of runoff, river inputs, wave energy inputs, and wet and dry deposition; biogeochemistry is monitored by inorganic nutrients (P, N, Si), organic nutrients (DOC, POC, PON, DON.), primary production, bacterial production, respiration, DMSP/DMS production and consumption, and nitrogen fixation; biotic interactions are monitored by flagellates, microplankton, viruses, mixotrophs, protist diversity, protists grazing rates, and viruses lysis rates.

4.2 Size classes

A short discussion ensued on the value of including different size classes in the data table after a question by Xelu Morán whether only size classes should be reported for flagellates (rather than functional or taxonomic groups). Rivkin stated that some functional groups could be used (bacterivorous flagellates).

Traditional size classes for pico-, nano-, microplankton, etc. are well established but it was mentioned by Markus Schartau that in terms of modelling the interesting fractions seem to be larger and smaller than 5 µm. He also commented that biomass data were difficult to compare unless different researchers used the same conversion factors. Schartau then asked about how biomass measurements for bacterioplankton were carried out. Rivkin answered that there were no reliable direct methods and that all were based on counts and subsequent conversions to biomass.

Several participants asked about the likelihood that established data series contain additional size fractions. Usually the recorded size fractions seem to follow the 'pico-, nanoplankton' tradition or e.g. for chlorophyll only bulk measurements are available.

The conclusion was that this can only be answered once all available data have been collated and the metadata described appropriately. It was suggested that it should be made a ToR for the next meeting to produce the complete list. Alex Kraberg commented that there have already been many such data collection efforts particularly in Europe and North America (MarBef, Obis/Eurobis, Seadatanet). These can be used to speed up the production of a data table.

4.3 Definitions

Rivkin again posed the question of what a time series is. For bacterioplankton for instance few data series are available on the decadal scale. For instance Anetta Ameryk mentioned that her institute had bacterioplankton data for a period of over 10 years, but they were taken at irregular intervals (roughly annually) and not exactly at the same position, but it was agreed that, as such data are very rare, that they should nevertheless be included.

5 Term of Reference C

Report to SSICC on the outcomes of the ASC 2009 Theme Session ("Trends in chlorophyll and primary production in a warmer North Atlantic").

Li and Morán reported that they submitted two written contributions in February 2010 to the ICES White Paper on Climate Change being prepared by SSICC under Luis Valdés. The first contribution on chlorophyll and primary production in the North Atlantic was delivered to the lead of Chapter 6 (Antonio Bode), and the second contribution on the effects of ocean acidification on marine microbes was delivered to the lead of Chapter 5 (Liam Fernand).

6 Term of Reference D

Explore possible linkage to other related working groups within ICES (e.g. WGZE) and to those in other bodies (e.g. SCOR)

Moderators: Representatives of SCOR, WGZE, WGHAB, WGPBI, Rapporteur: Markus Schartau

In the review of possible interactions with other ICES and SCOR working groups we identified specific points of common interests. Also, a series of complementary aspects were noticed that could guide future collaborations and the exchange of information. Our conclusions were inferred from short presentations given by individual members of other ICES working groups (listed below) and from the inspection of those ToRs that were constituted by related working groups embedded in SCOR.

The working group discussed to which extent collaborations should be initiated at this early stage. WGPME is still in the process of establishing a clear and detailed working focus, which is a prerequisite needed for a formal collaborative engagement with any other working groups. It was agreed that the working group should first prioritize collaborations based upon the possibility of valuable output. Accordingly, it was decided to rank possible linkages to other working groups. The following list reflects the potential for efficient collaborations, starting with those four working groups that provide advantageous input to WGPME or may quickly benefit from the working group's products:

6.1 ICES WGZE (Working Group on Zooplankton Ecology; chaired by Mark Benfield, USA)

O'Brien's (NOAA, USA) presentation pointed towards similarities between the WGPME's initial task to analyse collected time series data and achievements in WGZE. He explained how WGZE agreed on providing observations to a database that has been developed at NOAA - National Marine Fisheries Service, called COPEPOD (Coastal and Oceanic Plankton Ecology, Production and Observation Database). COPEPOD was programmed by O'Brien as a generic tool, which facilitates the intercomparison of time series data between distinct sites. WGZE had already discussed how to normalise their collected data in order to analyse anomalies of selected variables (parameters) in space and time. The WGPME concluded that their data can be treated similarly and that COPEPOD may indeed serve as their database as well. It will allow for a best possible intercomparison with results from WGZE, and will likely be beneficial for both working groups (in terms of a bottom-up versus top-down viewpoint on the plankton community). However, observations of WGPME include bulk variables and many details about the plankton community structure, which makes this particular database more extensive compared to WGZE data. For the future it is expected that COPEPOD will need refinements in order to match specific needs within WGPME, which may be done in consultation with WGZE.

Steve Hay (Marine Laboratory Aberdeen, UK) distributed a questionnaire that addresses the fields of morphological and molecular taxonomy. It was recognized that the WGZE concerns on how to integrate morphological- and molecular taxonomic data is also central to WGPME. In spite of looking at different plankton communities, this field of research can be well explored in close collaboration with WGZE.

6.2 ICES WGOH (Working Group on Oceanic Hydrography; chaired by Glenn Nolan and Hedinn Valdimarsson)

Sarah Hughes (Marine Laboratory Aberdeen, UK) presented a comparison between different optimally interpolated Sea Surface Temperature (SST) datasets, Reynolds/NCEP OISST.v2., Reynolds ERSST.v3, and the Hadley Centre HadISST1 respectively. It was stressed by the WGPME that these investigations are of crucial importance when linking climate patterns to ecosystem response. Apart from gridded SST datasets, WGPME will likely benefit from other findings of the WGOH, such as identifying anomalies in salinity and the detection of changes in large-scale circulation patterns. It was concluded that an exchange of information with WGOH greatly facilitates the process of relating local observations (at the monitoring sites) to larger spatial scales and to constrain direct climatic effects on the phytoplankton and microbial community.

6.3 ICES-IOC WGHABD (Working Group on Harmful Algal Bloom Dynamics; chaired by Joe Silke, Marine Institute, Ireland)

Joe Silke is member of WGPME and he emphasized the obvious linkage to the WGHABD. Part of WGHABD research is to improve the efficiency of monitoring programmes with respect to detecting HABs. Both working groups deal with plankton population dynamics, with some special joint foci on dissolved organic matter cycling (bacterial activity) and heterotrophic activity in general. In this respect, the WGPME may gather expertise that can directly support WGHABD activities. For example, the development of molecular probes for specific target organisms is substantial for detecting harmful algal blooms. This scientific task was recognized to be of common interest for both groups. It was discussed whether a joint meeting should already be initiated. WGPME concluded that a detailed and formal collaboration at this point in time is premature and may not yet lead to expedient advice to ICES. However, WGPME plans to establish such a formal collaborative link in the near future.

6.4 SCOR-WG137 (chaired by Kedong Yin, Australia, and Hans Pearl, USA)

Li made a short presentation of SCOR-WG137 (Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observation), describing its roots (2007 AGU Chapman Conference), its conceptual framework (Ecology Letters 11:1294-1303; Estuaries & Coasts 33: 230-241), its statistical tools ("wq"), and its ToRs. It was recognized that SCOR-WG137 and WGPME have some common interests (i.e. analysis of time series data) so it would benefit both groups to have active engagement. Members of WGPME who are already associated with SCOR WG137 include O'Brien, Moncheva, and Morán. It was clearly identified that WGPME has a greater depth of coverage in the ICES area of focus (North Atlantic), a broader scope of trophic consideration (autotroph, heterotroph, mixotroph, virus), and explicit ecosystem linkages (WGOH, WGZE, WGHABD, etc).

6.5 Other related working groups

The above listed working groups are currently regarded as partners with whom WGPME will possibly consider a more formal collaboration. Other ICES working groups have been recognized to have linkages to WGPME. These are:

6.5.1 ICES WGOOFE (Working group on Oceanographic Products for Fisheries and Environment; chaired by Morten Skogen and Mark Dickey-Collas)

Barbara Berx (Marine Laboratory Aberdeen, UK) presented the objectives of this working group. It was well perceived that WGOOFE could become a platform that either promotes or informs about WGPME results and products. As WGPME is in the phase of consolidation, any input to WGOOFE is not yet formally considered. However, in the process of short-term projections of time series data, WGPME can consider the operational products (forecasts and optimised hindcasts) provided by WGOOFE.

6.5.2 ICES WGPBI (Working group on Modelling Physical-Biological Interactions; chaired by Uffe Thygesen and Elizabeth North)

Alejandro Gallego (Marine Laboratoy Aberdeen, UK) shortly outlined some of their activities. WGPBI had established foci on modelling of harmful algal blooms and the modelling of fish stock recruitment. In their working group they discussed theories to individual based and distribution based modelling. For WGPME, these modelling approaches are not of primary concern, as linkages between dissolved organic matter, bacterial production, photo-autotrophic picoplankton have hardly been addressed within WGPBI. In conclusion, for a meaningful collaboration between WGPBI and WGPME, additional emphasis may need to be put on the modelling of the microbial plankton community and possibly the concomitant variation in stoichiometric elemental ratios (e.g. carbon, nitrogen, and phosphorus).

6.5.3 ICES/IOC/IMO-WGBOSV-WGITMO (Working group on Ballast and Other Ship Vectors; chaired by Tracy McCollin)

Tracy McCollin shortly reported about WGBOSV activities. Investigations on invasive species could relate to WGPME activities. In this context, the bacteria contamination in sediments turned out to be of interest. The brief discussion on a possible linkage between WGBOSV and WGPME did not give rise to an obvious predefined collaboration between the two working groups at this point in time.

Additional SCOR working groups were identified for which possible linkages have to be further explored and perhaps intensified. These are: SCOR WG 130 (Automatic Visual Plankton Identification; co-chaired by Mark Benfield, USA, and Phil Culverhouse, UK), SCOR WG 125 (Global Comparisons of Zooplankton Time Series; co-chaired by David Mackas, Canada, and Hans Verheye, South Africa), SCOR/LOICS WG 132 (Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems; co-chaired by Patricia Glibert, USA, and Lex Bouwmann, Netherlands), SCOR WG 134 (The Microbial Carbon Pump; co-chaired by Nianzhi Jiao, China, and Farooq Azam, USA).

7 Term of Reference E

Prepare for a Theme Session at ICES ASC 2010 ("Ecological response of microbial plankton to global change processes in ocean basins, shelf seas and coastal zones").

Li and Morán reported that the proposal for this theme session was not approved for ASC 2010. WGPME will recommend a resubmission of this proposal for consideration at the 2011 ICES Annual Science Conference.

8 Term of Reference F

Report by 15 March on potential contributions to the high priority topics of ICES Science Plan by completing the document named "SSGEF_workplan.doc" on the SharePoint site. Consider your current expertise and rank the contributions by High, Low or Medium importance

Moderator: Bill Li, Rapporteur: Richard Rivkin

The main activity of this session was to complete the required document. There was some initial discussion about our possible contributions as a WG to the ICES Science Plan and specifically on the balance between providing advice and providing data. This was not clear and was not picked up again after completing the table.

The main question relative to the contributions to the plans is "Do we, as a group, have the expertise to provide advice, or do we rather provide information that can be used by others?". There was significant discussion about what is meant by contributions to the ICES Science Plan. A suggestion was made to discuss priorities of the group before filling in table but it was decided to delay this discussion.

The completed document is available as Annex 3.

9 Term of Reference G

Prepare contributions for the 2010 SSGEF session during the ASC on the topic areas of the Science Plan which cover: Individual, population and community level growth, feeding and reproduction; The quality of habitats and the threats to them; Indicators of ecosystem health"

Given the extended time dedicated to ToR F, this ToR was excluded from the Agenda. Members agreed that the task will be assumed by the co-chairs in the next few weeks following the meeting, with a contribution delivered directly to SSGEF.

10 Summary and Future Plans

10.1 Recommendations

WGPME recommends to the Science Committee the following Theme Session for the 2011 ICES Annual Science Conference: "Ecological response of phytoplankton and other microbes to global change processes in ocean basins, shelf seas and coastal zones". Convenors: William Li (Canada), Xosé Anxelu G. Morán (Spain), Philippe Lebaron (France). Supporting information is given in Annex 4.

10.2 Draft Resolution

a) Identify and assemble proposed and additional datasets of time series of phytoplankton and other unicellular microbes with associated physical and chemical measurements.

b) Initiate the assessment of representative datasets to describe temporal trends and spatial variability; review outputs using the standard WGZE result formatting.

c) Review the information from the time series data to address the topics of anthropogenic and natural forcings on marine biodiversity, ecosystem function and biogeochemical cycling.

d) Review the inclusion of other types of data (e.g. molecular biology / rate processes/ life histories) into time series.

e) Review and finalise the plans for a special theme session on "Ecological responses of phytoplankton and other microbes to global change processes in ocean basins, shelf seas, and coastal zones" for the 2011 ASC.

f) Discuss new findings pertaining to phytoplankton and other microbes.

g) Maintain interactions with other Working Groups such WGPBI / WGHABD / WGOH / WGBOSV / WGZE / SCOR with the possibility of joint meetings in the future.

10.3 WGPME Next Meeting

Two possible venues for the next meeting were graciously offered: one by Alexandra Kraberg (Helgoland) and another by Joe Silke (Galway). By written ballots, Galway was approved by the closest possible margin. The next meeting of WGPME will be held in Galway, Ireland at the The Marine Institute from 21 to 24 March 2011 at the kind invitation of Joe Silke.

Annex 1: List of participants

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Annex 2: Agenda

Wednesday March 3

9:00 – 9:30 Welcome, Logistics, Introductions
(Leads: Xelu Morán, Eileen Bresnan)
9:30 – 10:30 Agenda, ICES Science Plan, ToRs
(Lead: Bill Li)
10:30 – 11:00 Break
11:00 – 12:30 Round Table Initiating Discussion **ToR A**
"Develop an action plan to provide a primary focus for phytoplankton and other unicellular microbes within the ICES Science Plan".
(Moderator: Bill Li, Rapporteur: Emilio Marañón)
12:30 – 13:30 Lunch
13:30 – 16:30 Participant Science Contributions related to **ToR's**
13:30 – 16:30 Oral presentations (submit written abstracts, latest by 31 Jan)
13:30 – 13:45: Claudia Halsband-Lenk (English Channel)
13:45 – 14:00: Eileen Bresnan (Stonehaven, NE Scotland)
14:00 – 14:15: Veronique Creach (UK waters, North Sea, Irish Sea)
14:15 – 14:30: Norbert Wasmund (Baltic Sea)
14:30 – 14:45: Alexandra Kraberg (Helgoland Roads)
14:45 – 15:00: Richard Rivkin (Polar and subpolar waters)
15:00 – 15:30 Break
15:30 – 15:45: Jennifer Martin (Bay of Fundy)
15:45 – 16:00: Nicole Poulton (Boothbay Harbor)
16:00 – 16:15: Bill Li (Bedford Basin)
16:15 – 16:30: Markus Schartau (Integrative approach)
16:30 – 17:00 Round Table Wrap-up Discussion **ToR A**
(Moderator: Xelu Morán , Rapporteur: Melanie Sapp)

Thursday March 4

9:00 – 10:30 Presentation of WGZE model
(Lead: Todd O'Brien)
10:30 – 11:00 Break
11:00 – 12:30 Round Table Discussion **ToR B**
"Establish the conceptual and operational foundations for undertaking a comparative analysis of multiyear time series data of phytoplankton and microbial plankton".
(Moderator: Xelu Morán, Rapporteur: Alexandra Kraberg)
12:30 – 13:30 Lunch
13:30 – 15:00 Practical Session **ToR B**
Practical session with contributed model datasets
(Leads: Todd O'Brien , Xelu Morán)
15:00 – 15:30 Break
15:30 – 17:00 ToR D
"Explore possible linkage to other related working groups within ICES (e.g. WGZE) and to those in other bodies (e.g. SCOR)".
(Leads: Representatives of SCOR, WGZE, WGHAB, WGPBI, Rapporteur: Markus Schartau)

Friday March 5

9:00 – 9:30 Discussion **ToR F**
"Report by 15 March on potential contributions to the high priority topics of ICES Science Plan by completing the document named "SSGEF_workplan.doc" on the SharePoint site. Consider your current expertise and rank the contributions by High, Low or Medium importance".
(Lead: Bill Li, Rapporteur: Richard Rivkin)
9:30 – 10:00 Discussion **ToR G**
"Prepare contributions for the 2010 SSGEF session during the ASC on the topic areas of the Science Plan which cover: Individual, population and community level growth, feeding and reproduction; The quality of habitats and the threats to them; Indicators of ecosystem health".
(Lead: Xelu Morán, Rapporteur: Richard Rivkin)
10:00 – 10:30 Break
10:30 – 12:30 Discussion ToRs for 2010, Recommendations
(Leads: Bill Li, Xelu Morán, Rapporteur: Jennifer Martin)
12:30 Adjourn

Annex 3: Potential contributions of WGPME to the ICES Science Plan

11 Climate change processes and predictions of impacts

111	112	113	114	115
Med	High	High	Med	High

12 Biodiversity and the health of marine ecosystems

121	122	123	124
High	Med	Med	Med

13 The role of coastal zone habitat in population dynamics of exploited species

131	132	133	134
NA	NA	Low	Low

14 Fish life history information in support of EAM

141	142	143	144	145	146	147
NA	NA	NA	NA	NA	NA	NA

15 Sensitive ecosystems (deep-sea, seamounts, arctic) and data-poor species

151	152	153	154	155
Low	High	NA	Med	Med

16 Integration of surveys and observational technologies into operational ecosystem surveys

161	162
High	High

17 Role of top predators (mammals, birds, and large pelagics) in marine ecosystems

171	172	173
NA	NA	NA

21 Impacts of fishing on marine ecosystems

211	212	213	214	215	216
Low	NA	NA	NA	NA	NA

22 Carrying capacity and ecosystem interactions associated with mariculture

221	222	223
Med	Med	NA

23 Influence of development of renewable energy resources (e.g. wind, hydropower, tidal and waves) on marine habitat and biota

231	232	233
Low	Low	NA

24 Population and community level impacts of contaminants, eutrophication, and habitat changes in the coastal zone

241	242	243	244	245
Med	High	Low	High	High

25 Introduced and invasive species, their impacts on ecosystems and interactions with climate change processes

251	252	253	254
NA	Low	NA	Med

31 Marine living resource management tools

311	312	313	314
Med	Low	Low	Low

32 Operational modelling combining oceanography, ecosystem and population processes

321	322	323	324	325	326	327
High	Med	Med	NA	NA	Low	Low

33 Marine spatial planning, effectiveness of management practices (e.g. MPAs), and its role in the conservation of biodiversity

331	332	333	334	335
NA	NA	NA	NA	NA

34 Contributions to socio-economic understanding of ecosystem goods and services, and forecasting of the impact of human activities

341	342	343	344	345	346

NA	NA	Low	NA	Low	Med

Annex 4: Theme Session Proposal for ASC 2011

The **Working Group on Phytoplankton and Microbial Ecology** [WGPME] proposes a Theme Session for the ICES 2011 Annual Science Conference:

Title: Ecological response of phytoplankton and other microbes to global change processes in ocean basins, shelf seas and coastal zones

Conveners: William Li (Canada), Xosé Anxelu G. Morán (Spain), Philippe Lebaron (France)

Description: Microbial plankton, which comprise unicellular algae, bacteria, archaea and protists, are sensitive to climate change, ocean acidification, eutrophication, and other environmental pressures. These systemic pressures act at scales of space and time that are much larger than those relevant to individual unicells. Thus, local and contemporary observations of microbial populations and communities must be made extensive in order to discern ecological response to systemic change. Comparative analysis of long term time series observations across ecosystems lays a strong empirical foundation for understanding patterns of global ecological change.

Across ocean basins, shelf seas and coastal zones, papers are welcome on the following topics:

- Time series observations of prokaryotic and eukaryotic microbial plankton at any level of the genealogical hierarchy (e.g. genes, organisms, species, monophyla) or of the ecological hierarchy (e.g. macromolecules, organisms, populations, functional groups, communities).
- Propagation of ecological signals (abundance, productivity, diversity) through bottom-up forcing of microbes or top-down cascades from higher trophic levels, including abrupt state transitions (regime shifts).
- Conceptual, mathematical, statistical and modelling approaches that serve to elucidate linkages between environmental drivers and microbial responders.

Annex 5: WGPME Terms of Reference for the 2011 meeting

The **Working Group on Phytoplankton and Microbial Ecology** (WGPME), chaired by William K.W. Li, Canada, and X. Anxelu G. Morán, Spain, will meet in Galway, Ireland, 21–24 March 2011 to:

a) Identify and assemble proposed and additional datasets of time series of phytoplankton and other unicellular microbes with associated physical and chemical measurements.

b) Initiate the assessment of representative datasets to describe temporal trends and spatial variability; review outputs using the standard WGZE result formatting.

c) Review the information from the time series data to address the topics of anthropogenic and natural forcings on marine biodiversity, ecosystem function and biogeochemical cycling.

d) Review the inclusion of other types of data (e.g. molecular biology / rate processes / life histories) into time series.

e) Review and finalise the plans for a special theme session on "Ecological responses of phytoplankton and other microbes to global change processes in ocean basins, shelf seas, and coastal zones" for the 2011 ASC.

f) Discuss new findings pertaining to phytoplankton and other microbes.

g) Maintain interactions with other Working Groups such WGPBI/ WGHABD/ WGOH/ WGBOSV/ WGZE/ SCOR with the possibility of a joint meeting in the future.

WGPME will report by 15 May 2011 (via SSGEF) for the attention of SCICOM.

Supporting Information

Priority	The activities of this Group are related to issues of climate change, lower trophic level biodiversity, and ecological dynamics of coastal waters. Consequently, these activities are considered to have a high priority.
Scientific justification	Term of Reference a) There are many datasets of phytoplankton, bacteria, archaea, protists (microzooplankton) and virus in the North Atlantic region but little attempt has been made to assemble them for a synthetic overview. WGPME is well-positioned for undertaking such an exercise because of broad disciplinary expertise and geographic distribution of its members. Such an exercise is needed to formulate a microbial perspective on many elements of the ICES Science Plan. Term of Reference b) For the purpose of examining time series, a standard method of analysis and visualisation of different data types is an essential first step. WGZE has developed a useful operational tool that can be readily customised and implemented for microbial data. Term of Reference c) The topics of anthropogenic and natural forcings on marine biodiversity, ecosystem function and biogeochemical cycling directly address Action Plan 11 Climate change processes and predictions of impacts, 12 Biodiversity and the health of marine ecosystems, and 24 Population and community level impacts of contaminants, eutrophication, and habitat changes in the coastal zone. Term of Reference d) Many microbial measurements are relevant to the Action Plan but do not

	readily fit into an operating framework focused on multiyear time series data. These include, for example, phylogenetic, metagenomic and transcriptomic information on microbial taxonomic units ; growth and loss rates of functional groups such as heterotrophic protists; and life cycle stages of unicellular algae. A discussion is needed on how other relevant microbial knowledge can be used to inform the narratives based on cell abundance and biomass. Term of Reference e) A theme session proposed for 2011 ASC will highlight progress of WGPME to date, and will serve to facilitate linkages to other working groups. Term of Reference f) Reports of developments in observations, methodologies, analyses, syntheses, products, and proposals serve to inform WGPME of new opportunities. Term of Reference g) WGPME is in a very early stage of development and needs to be closely linked to other groups in order to accelerate towards its objectives.
Resource requirements	Resource required to undertake the work of this group is negligible at present.
Participants	The Group is attended by some 20–25 members.
Secretariat facilities	None, beyond communication support.
Financial	No current financial implications.
Linkages to advisory committees	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups	Established interactions with WGZE, WGHABD, and SSICC. Potential interactions with WGOH, WGPBI, and WGBOSV.
Linkages to other organizations	The work of this group is synergistic with that of SCOR WG137.

Annex 6: Recommendations

Recommendation	For follow up by:
1. Theme session for 2011 ASC	SCICOM
2. ToRs for 2011 WGPME annual meeting in Galway, Ireland	WGPME, SCICOM