ICES WGPBI REPORT 2005

ICES OCEANOGRAPHY COMMITTEE
ICES CM 2005/C:04

REPORT OF THE WORKING GROUP ON MODELLING PHYSICAL/BIOLOGICAL INTERACTONS (WGPBI)

7–8 APRIL 2005

HAMBURG, GERMANY

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

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:
ICES. 2005. Report of the Working Group on Modelling Physical/Biological Interactons (WGPBI), 7–8 April 2005, Hamburg, Germany. ICES CM 2005/C:04. 440 pp.

Contents

1 Executive Summary

- Simulations of nutrient load reductions in the North Sea and Baltic show that the effects are strongest in coastal areas near the major rivers, which are the sources of the anthropogenic nutrients. Overall a 50% reduction in nutrients yields about a 10% reduction in primary production.
- The large interannual variability in phytoplankton biomass means that detecting a response to the changes in anthropogenic nutrient loads will require monitoring over many years.
- The Baltic Sea will take decades to adjust to reductions in anthropogenic nutrient inputs because the accumulated phosphorus must be removed by internal ecosystem dynamics rather than flushed out by physical transport due to the limited exchange with the North Sea. Nitrogen levels reduced to a new level in much shorter time (5–7 years) because denitrification is an effective sink.
- In the Baltic Sea there is excess phosphorous relative to nitrogen when measured against the ratio that plankton tend to consume them (the Redfield ratio, 16N: 1P). The imbalance of response times for N and P will further increase the excess phosphorous in case of a simultaneous reduction. As a result, a reduction in nutrient input will likely increase the magnitude of cyanobacteria blooms as cyanobacteria get their nitrogen from the atmosphere.
- Simulations of nutrient load reductions show that the North Sea reaches a steady state after 3 to 4 years because it is a relatively open system and there is substantial exchange with the deep ocean.
- A review of the three dimensional (3D) ecosystem models of the North Sea reveals that several of the models were able to reproduce observations of the state variables correctly in the order of magnitude and range of observed variability. Most of the models were able to reproduce the horizontal gradients in the mean seasonal distribution for the nutrients and phytoplankton. Strangely, none of the models provided a good estimate of the mean chlorophyll distribution in spring. The simulation of the temporal variability was less successful as none of the models could accurately simulate the climatological monthly means for all simulated state variables in all seasons. Overall the discrepancies relative to the data grew with the trophic level;
- Three dimensional ecosystem models of the North Sea do not provide robust simulations of the interannual variability. The differences between models are closely related to differences in the physical simulations. Therefore robust simulations of the interannual variability in the ecosystem require improved simulations of the physical environment.
- Modelling zooplankton will be a major issue over the next decade. Improved simulation of zooplankton is required as a closure term on phytoplankton models and as the link between primary production and larval fish. These are both areas of active research in the international community.
- The next generation of ecosystem models will make greater use of the concept of ‘non-mass’ state variables. Mass state variables are quantities such as the concentration of nitrate and the biomass of diatoms. Non-mass state variables are quantities such as the biomass size spectrum and the diatom to dinoflaggelate ratio. The goal is to avoid the need for a state variable for every species of plankton in the ocean. The drawback is that equations for non-mass state variables are necessarily ad-hoc.
- WGPBI is making progress towards a community approach to modelling with the creation of 1D workbenches for model development and testing, and our support for open-source code.

2 Welcome and opening of the meeting

The meeting of the ICES Working Group on Modelling Physical-Biological Interactions was held at the Institut für Meereskunde, Universitaet Hamburg in Hamburg Germany from 7–8 April 2006. This meeting was co-sponsored by the EU 6th Framework Network of Excellence EUR-OCEANS which provided funding for PI's and associates to attend and contribute to the WG. The goals of EUR-OCEANS are to develop models for assessing and forecasting the impacts of climate and anthropogenic forcing on foodweb dynamics (structure, functioning, diversity and stability) of pelagic ecosystems in the open ocean. Given the closely related goals of the two groups collaboration would be advantageous. Our local hosts were Andreas Moll and Mike St. John. The Working Group continues to grow and the meeting was well attended (Annex 1).

The Terms of Reference for the meeting were as follows.

The Working Group on Modelling Physical/Biological Interactions [WGPBI] (Chair: C. Hannah, Canada) will meet in Hamburg, Germany, from 7–8 April 2005 to:

a) Present and discuss new results related to developments and validation in modelling PBI;
b) Create a WGPBI website for information exchange;
c) Discuss draft review, prepared intersessionally, on nutrient load reduction;
d) Prepare a review of the state of the art in larval fish modelling;
e) Receive report from the Numerical Experiment subgroup;
f) Cooperate with SGBEM to explore ecosystem models;
g) Collaborate with WGRP to enhance the use of physical-biological models for prediction of fisheries recruitment.

WGPBI will report by 9 May 2005 for the attention of the Oceanography Committee.

3 Present and discuss new results (ToR a)

The presentation and discussion of new results is a key part of the meeting. Ten presentations were made during the meeting and are briefly summarized here. Abstracts for the talks are given in Annex 7. The talks by Moll and Skogen tackled the issues of model validation and model comparison for 3D ecosystem models, two key issues for WGPBI. The results from these talks form the basis for several of the conclusions reported in Section 2 of this report.

Elizabeth North talked about whether her particle tracking model was correctly capturing the sub-grid scale turbulent processes within Chesapeake Bay. She showed that the random displacement model based on Visser (1997) gives good results compared to a simulated dye patch. She also discussed the horizontal mixing of the particles compared the simulated dispersal with the Oceanic Diffusion Diagram of Okubo (1971). These results are more difficult to interpret and Andy Visser had some interesting suggestions.

Andreas Moll presented the results of an extensive review of published model-data comparison of eleven ecosystem models of the greater North Sea. The results are fascinating and provide a basis for understanding where the models need improvement. The results were summarized under 'Regional Distribution', 'Annual Cycle', 'Long Term Development', 'Events', and 'Model Complexity.'

Regional distribution:

- reproduction of horizontal gradients in the mean seasonal distributions can be simulated in coincidence with climatological observations for many state variables;
- phosphorus and silicate distributions were simulated best;
- less well for nitrate (and ammonia);
- no model provided a good chlorophyll distribution in spring.

Annual cycle:

- nearly all models have been tested with climatological monthly mean data, representing the annual cycle;
- phosphorus and silicate were simulated best;
- nitrate or nitrogen nutrients with less success;
- chlorophyll was simulated in the order of magnitude, sometime overestimated, sometimes underestimated;
- the phasing of nutrients and chlorophyll showed differences in times of intense regeneration of nutrients (shallow water);
- discrepancies relative to observed (*in situ*) data grew with the trophic level;
- there was no one model that coincided with climatological monthly means for all simulated state variables in all seasons.

Long-term development

- only a few documented long-term simulations exist;
- state variables coincide with the observations within an order of magnitude and reproduce the overall development of eutrophication of the continental coastal North Sea;
- interannual variability in the observed data was not reproduced; simulated cycles are more uniform and/or with systematic shifts;
- local peculiarities at some stations will continue to be problematic as long as horizontal resolution is 10–50 km in the models.

Model complexity

- there are still problems in determining the necessary complexity;
- large differences in complexity may permit very similar results;
- very similar complexity may result in great differences.

Overall summary

1) Several of the models were able to reproduce observations of the state variables correctly in the order of magnitude and range of observed variability;
2) More complexity in the model does not necessarily improve the simulations;
3) ERSEM is the best validated model, followed by NORWECOM and ECOHAM;
4) Most of the models have not been evaluated sufficiently for judging their predictive potential;
5) Very rarely was one model tested with more than one data set;
6) A closer look at the behaviour of ecological models should investigate both the features which the models did reproduce and those which were not reproduced.

Andreas also pointed out that the validation of the physical models has now been published (Delhez *et al.*, 2004).

Delhez, E.J.M., Damm, P., de Goede, E., de Kok, J.M., Dumas, F., Gerritsen, H., Jones, J.E., Ozer, J., Pohlmann, T., Rasch, P.S., Skogen, M. and Proctor, R., 2004. Variability of

shelf-seas hydrodynamic models: lessons from the NOMADS2 Project. Journal of Marine Systems, 45: 39–53.

Alain Vezina discussed simulations of the Scotian Shelf using GOTM as a 1D model to investigate plankton dynamics with a variable-complexity physical-biological model. He showed that the simulations of the winter nutrient levels were improved by including estimates of the vertical velocities and that using a sophisticated, but empirical, zooplankton grazing function improved the simulations of nutrients and phytoplankton biomass and reduced the model sensitivity to the details of the physics.

Morten Skogen reported on a collaborative work with Andreas Moll, showing the difference in the interannual variability in the biological variables between their two models (NORWECOM and ECOHAM) was due to differences in the physical simulations. When they put the ECOHAM biological model into the NORWECOM model they obtained almost the same interannual variability in the biological variables as with the NORWECOM biological model. This adds to the result of Andreas Moll's presentation that showed that the ecosystem models showed no skill in the simulation of interannual variability. The clear conclusion is that more work is required on the physical simulations before robust simulations of the interannual variability in the biological state variables can be expected. Skogen and Moll have submitted this work for publication (Skogen and Moll. Importance of ocean circulation in ecological modelling: An example from the North Sea. Submitted to Journal of Marine Systems).

Alexander Trofimov showed a nice set of 3D diagnostic simulations of the Barents Sea and showed reasonable agreement between simulated circulation and the observed currents. He then used the currents to simulate the transport of larval cod for two years with very different circulation.

Kai Wirtz discussed ideas for a new generation of ecosystem models. One important idea is that the most of the rate parameters in the current generation of models are not constants; they adapt to the environment. The second idea was the systematic introduction of non-mass state variables as an alternative to introducing a large number of state variables to explicitly account for all of the different species of plankton.

Charles Hannah presented a novel approach to benthic habitat mapping of the continental shelf. He and colleagues followed the Southwood model (1977) that assumes that habitat can be characterized along two axes: 'scope for growth' and 'physical disturbance'. Using this as a framework, high-resolution maps of the physical environment, such as temperature, bottom depth and grain size, can be transformed into a map of potential habitat. An example for the Scotian Shelf on the east coast of Canada was presented.

Matteo Sinerchia discussed progress towards using VEW3 to predict squid recruitment near the Falkland Islands. VEW3 is based on the Lagrangian Ensemble metamodel, which treats plankton as individuals obeying phenotypic equations for behaviour and physiology. The model is being used to test Cushing's match-mismatch theory and other hypotheses about the relationship between recruitment and exogenous factors like the weather.

Jan Backhaus presented observations from the N. Atlantic that indicated that the biomasses in winter and summer have equal order of magnitude but the winter-biomass is diluted over much larger volume resulting in low concentrations. He then presented some modelling results to support the idea that the orbital motions of convection support photosynthesis, because plankton from all depths within the convective mixed layer (hundreds of meters) have the same chance for a return to the euphotic zone. The cycling time due to convection is estimated to be about 24 hours, independent of the depth of convection. The result is slow production.

Morten Skogen presented the results of simulation of Chattonella blooms in the Skaggerak and the southeastern North Sea. They had good data on the growth-related parameters and

found that the quality of the simulations was limited by the parameterizations of the mortality rates. Observations seem to suggest that Chattonella blooms are terminated by wind events but the mechanisms are unclear.

4 Create a WGPBI website for information exchange (ToR b)

The WGPBI website (www.icm.csic.es/bio/wgpbi) was created by Cesc Peters and it is being hosted by Institut de Ciències del Mar (CSIC). The site presently has information about the group and its activities (including all of the reports) and a list of interesting meetings. The chair has found it useful for introducing people to the group. The site will be modified and enhanced over the coming year. Members are encouraged to contribute content to Cesc Peters.

Tapani Stipa has provided access to a document sharing facility at the Finnish Institute of Marine Research. The site offers the ability to post documents and then keep track of review comments and document revisions. WGPBI has not taken advantage of this yet as we did not have a compelling use for it this year.

5 Review experimental simulations on nutrient load reduction (ToR c)

The issue of how an ecosystem will respond to nutrient load reductions is of wide interest and members of WGPBI have been involved in three different studies to investigate the responsiveness of ecological models to changes in anthropogenic loads in the North Sea and Baltic Sea. Morten Skogen presented a review done with Thomas Neumann of the six papers listed below. Two of the studies considered anthropogenic sources of nitrogen and phosphorus delivered by major rivers, while the third study also considered atmospheric sources and added estimates of point sources and diffusive sources to the river loads.

The robust conclusions are:

- The effects are strongest in coastal areas near the major rivers, which are the sources of the anthropogenic nutrients.
- 50% reduction in nutrients yields about a 10% reduction in primary production.
- The large interannual variability in phytoplankton biomass means that detecting a response to the changes in anthropogenic nutrient loads will require monitoring over many years.
- Simulations of the North Sea reach a steady state after 3 to 4 years because it is a relatively open system and there is substantial exchange with the deep ocean.
- Simulations of the Baltic Sea suggest that the system will take decades to adjust to the changes because the accumulated phosphorus must be removed by internal ecosystem dynamics rather than flushed out by physical transport due to the limited exchange with the North Sea. Nitrogen reduced to a new level in much shorter time (5–7 years) because denitrification is an effective sink.
- In the Baltic Sea there is excess phosphorous relative to nitrogen when measured against the ratio that plankton tend to consume them (the Redfield ratio, 16N: 1P). The imbalance of response times for N and P will further increase the excess phosphorous in case of a simultaneous reduction. As a result a reduction in nutrient input tends to increase the magnitude of cyanobacteria blooms as cyanobacteria get their nitrogen from the atmosphere.

The conclusions are primarily qualitative in nature. The differences between different models used to simulate the same area preclude robust quantitative conclusions. We believe that the primary limitation in the simulations is still the physical component (see presentation by Skogen and Moll in Section 3), and further improvement is necessary before robust quantitative measures can be given. However long term simulations of shelf seas also require improved

representations of the benthos, as this is where nutrients get stored at annual and longer time scales. Thus the benthic modules will have a major impact on the time scales at which the Baltic Sea responds to nutrient load reductions.

Nevertheless, in spite of their limitations the models give new insight in the effect of changes in anthropogenic forcing, and are used by, and are useful to, management. However, a closer dialogue between management and scientists is essential when further improvement in the models and their applications are undertaken.

Skogen and Neumann concluded that this review does not merit publication. This work item is deemed complete.

References

Neumann, T., Fennel, W., and Kremp, C. 2002. Experimental simulations with an ecosystem model of the Baltic Sea: A nutrient load reduction experiment, Global Biogeochem. Cycles, 16, 1033, doi:10.1029/2001GB001450.

Neumann, T., and Schernwski, G. 2004. An ecological model evaluation of two nutrient abatement strategies for the Baltic Sea, Journal of Marine Systems, in press

Neumann, T., and Schernewski, G. 2001. Cost-effective versus proportional nutrient load reductions to the Baltic Sea: Spatial impact analysis with a 3D-ecosystem model, Water Pollution VI, editor: C.A. Brebbia, WITPRESS Southampton, Boston.

Schernewski, G., and Neumann, T. 2005. The trophic state of the Baltic Sea a century ago? A model simulation study. J. Mar.Systems, 53: 109–124, doi:10.1016/j.jmarsys.2004.03.007 .

Skogen, M.D., Søiland, H., an dSvendsen, E. 2004. Effects of changing nutrient loads to the North Sea. J.of Mar.Systems, 46: 23–38. doi:10.1016/j.jmarsys.2003.11.013 .

Stipa, T., Skogen, M.D., Hansen, I.S., Eriksen, A., Hense, I., Kiiltomaki, A., Søiland, H., and Westerlund, A. 2003. Short-term effects of nutrient reductions in the North Sea and the Baltic Sea as seen by an ensemble of numerical models. MERI, Report series of the Finnish Inst.of Mar.Res., 49: 43–70. A version of the report is available from http://www.imr.no/~morten/nocomments/.

6 Prepare a review of the state of the art in larval fish modelling (ToR d)

This section deals with the report of the Fish Recruitment Processes Sub-Group which includes the ToR and much more. The group met on 6 April 2005 to review progress over the last year.

The group is continuing to make progress on its project called ‘Towards the development of best practices for the modelling of early life history of fish.’ The three major items were: 1) a review paper on larval fish modelling; 2) a theme session on larval fish modelling at the 2005 ASC; and 3) a workshop on larval fish modelling in 2006.

1. Update of Literature Review

Thomas Miller, co-Chair of WGRP, has conducted a literature review of modelling the early life history of fish. It is nearing completion and will be presented at the American Fisheries Society Larval Fish Conference in July 2005 in Barcelona, Spain. We decided that it would be unproductive to duplicate Dr. Miller’s efforts. He agreed to let us use his literature review as a background document for the workshop.

2. Update on 2005 ASC Theme Session.

The theme session that we proposed was merged with another session. The new session is entitled "Connecting Physical-Biological Interactions to Recruitment Variability, Ecosystem Dynamics, and the Management of Exploited Stocks" and is chaired by E. North, M. St. John, and A. Gallego. A list of names of people encouraged to submit abstracts was developed.

3. Discuss plans, agenda, and funding sources for 2006 Workshop.

Fish sub-group members are planning a workshop in 2006 entitled "Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions. It will be chaired by A. Gallego, E. North, and P. Petitgas (local host) and jointly sponsored by WGPBI and WGRP. The workshop will be hosted by P. Petitgas at IFREMER in Nantes, France, and will occur between mid-March and mid-April in 2006.

The **goals** of the workshop are to:

- assess the current state of the art in modelling physical-biological interactions in fish early-life;
- review important technical/methodological issues (including model sensitivity and validation), prioritize important processes to be included in the models, and identify knowledge gaps;
- develop a manual of recommended practices and list of future research directions as a peer-reviewed proceedings from the workshop;
- ensure broad participation of scientists within and outside the ICES community (i.e., AFS, PICES);
- promote the teaching and training of graduate students and early-career scientists.

The **products** of the workshop will include:

- a report on the workshop will be presented to the ICES Oceanography Committee (May 15, 2006) and posted on the workshop web page;
- a peer-reviewed publication entitled "Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions" that will include manuscripts from talks and posters;
- collaborative proposals in response to identified research recommendations;
- a webpage for disseminating workshop findings.

4. Discuss SGRESP proposed workshop.

ICES SGRESP (Study Group on Regional Scale Ecology of Small Pelagics) chaired by Pierre Petitgas, is proposing a workshop to extract meso-scale physical structures from hydrodynamic model outputs to construct long-term series of meso-scale features. Pierre and Benjamin Planque (likely co-convener) requested feedback on this idea from WGPBI and asked if we would like to co-organize the workshop. Fish sub-group members supported the workshop and brought it forward for discussion to WGPBI members. WGPBI members supported the workshop and agreed to co-sponsor it. WG members recommended that the workshop should not be limited to just focusing on small pelagic fish and on using hydrodynamic model output (i.e., retention areas can be important for gadoid fish, and satellite maps may aide in meso-scale feature identification). Corinna Schrum agreed to lead WGPBI's involvement in this effort.

5. Discuss plans for 2007 and beyond.

Fish sub-group members discussed long-term plans for sub-group activities. Our ideas included:

- Publish and disseminate workshop publication
- Develop course that incorporates workshop findings and 'hands-on' experience with models and sensitivity analyses
- Promote open-source model development and dissemination
- Continue working on model validation and pulling together data sets (e.g., LarvalBase)
- Think about 'closing the life cycle' (linking early-life models and adult dynamics)

7 Receive report from the Numerical Experimentation subgroup (ToR e)

The first meeting of the Numerical Experimentation subgroup was held on 6 March 2005 in Hamburg. The highlights of the meeting were:

1) Initial development of the 1D workbench based on General Ocean Turbulence Model with embedded biological modules (GOTM-BIO) is complete and paper submitted to our JMS special issue.

2) The GOTM team will release GOTM-BIO by end of 2005 (Hans Burchard, Karsten Bolding).

3) The initial development of VEW3, the 1D workbench based on the Lagrangian Ensemble Method has been completed. In particular the GUI for specifying the biological model and the scenario is complete.

4) The group agreed to pursue collation of 5 or 6 well known data sets and assembled the forcing data for use in model testing. The data sets include FLEX, Helgoland, Gotland Basin, Halifax, and possibly BATS. This work item is a WGPBI ToR for next year.

5) Once the data sets are in hand, the group probably needs a hands-on workshop in which simulations are run and the results discussed and evaluated on the spot.

6) Discussion of model complexity and the relative strengths/weaknesses of lots of simple state variables versus fewer state variables with more sophisticated interpretation of the contents. Several members will pursue this further perhaps in the context of grazing models.

The complete meeting report is given in Annex 6.

8 Cooperate with SGBEM to explore Baltic ecosystem models (ToR f)

SGBEM met at the Sea Fisheries Institute, Gdynia 14–16 February 2005 (Chair: Wolfgang Fennel).

The meeting brought together modellers working on biogeochemical models and stock assessment fish and fishery models (i.e., at different trophic levels of the marine food web) to discuss their approaches. Two types of models were considered: (1) Coupled physical-chemical-biological models, which provide consistent descriptions of bottom up effects and included nutrient and oxygen dynamics, but which see the action of fish in terms of prescribed mortality rates. (2) Fish stock models without spatial resolution that see lower trophic levels in terms of prescribed prey biomass, or implicitly through data from surveys or landing reports.

The development of model systems which cover the food web (nutrients to fish) is a grand challenge but seems feasible in the coming years. The SG discussed theoretical difficulties associated with the problem of incorporating fish within spatially-resolved model systems. Although such models become rather complex, they can be considered as a theoretical pillar for ecosystem-based advice.

There are requirements for further theoretical research towards new generations of models, but also an urgent need for better data sets, in particular with respect to the spatial distribution patterns of the key species of fish, and a better understanding of the driving mechanisms that control the changes of the patterns.

9 Cooperate with WGRP to enhance the use of physical-biological models for prediction of fisheries recruitment. (ToR g)

WGPBI is cooperating with WGRP on a Theme Session at the ICES ASC 2005 and on a workshop in 2006. See Section 7 (ToR d).

WGPBI is also cooperating with ICES SGRESP (Study Group on Regional Scale Ecology of Small Pelagics) on a proposed workshop to extract meso-scale physical structures from hydrodynamic model outputs to construct long-term series of meso-scale features.

10 New business

Phytoplankton growth

The group had a lively discussion about temperature dependent growth rates in phytoplankton. Everyone recognizes that individual species have temperature-dependent maximum growth rates. The question is 'Does temperature limit the maximum growth rate of the community?' or 'Is there always a species that can grow rapidly at the given temperature so that community primary production is roughly independent of temperature?' This has important implications for modelling and our current techniques for assessing the response of an ecosystem to temperature changes. An action item and a ToR were generated in response to this discussion.

Zooplankton

Problems related to modelling zooplankton were a recurring theme in the meeting. The discussion focussed on two primary applications: zooplankton as a closure term on phytoplankton models and zooplankton as the link between primary production and larval fish. These are both areas of active research in the international community. Two action items were generated as a result of this discussion.

Appropriate level of complexity

The topics of model complexity and methods for determining the appropriate level of complexity for a particular application have been discussed at each working group meeting and they are discussed in the WGPBI strategy document (Hannah 2003). The basic problem is that defining the appropriate level of complexity for a model and this is a nontrivial exercise as there is no general answer. The correct answer depends on the application, the available modelling resources and the amount of available knowledge about the ecosystem and species of interest.

The topic came up again in several interesting ways at this meeting. Vezina showed that using a sophisticated, but empirical zooplankton grazing function in his NZP model improved the simulations of nutrients and phytoplankton biomass and reduced the model sensitivity to the details of the physics. Wirtz discussed a systemic approach to introducing non-mass state vari-

ables and deriving time evolution equations for them. At the NESG meeting, Bruggeman discussed some ideas about how to have single phytoplankton state variable (biomass) but be able to partition that variable into light harvesting and nutrient harvesting biomass.

Hannah, C.G. 2003. Strategy for Modelling Physical-Biological Interactions**.** ICES CM 2003/P:04.

Integrated ecosystem assessment

Integrated assessment is going to be a big issue for ICES over the next decade. Regional Study Group for the North Sea, is starting an Integrated Assessment of the North Sea Ecosystem. They are looking for support on

- scoping the work;
- defining methods;
- interpreting the results.

The first meeting is 9–11 May 2005 in Copenhagen.

REGNS may follow the lead of Frank, Choi and others (see below) from the Bedford Institute of Oceanography who performed an integrated analysis of time series of 55 biotic, abiotic and human variables over a 43-year period. They were able to demonstrate the devolution, or reverse evolution, of the Scotian Shelf ecosystem: change from long-lived demersal fish (ground fish) to invertebrates and pelagics. They have also been able to demonstrate a trophic cascade.

If REGNS follows this model, the results will be interesting and compelling. They will also have important management implications. I encourage people to participate if they are interested. Those of you working in the North Sea should give this serious consideration. However WGPBI will not offer an official response because this work is outside the mandate of this group.

Choi, J.S., K.T. Frank, W.C. Leggett, and K. Drinkwater. 2004. Transition to an alternate state in a continental shelf ecosystem. Can. J. Fish. Aquat. Sci., 61: 505–510.

Choi, J.S., K.T. Frank, B. Petrie, and W.C. Leggett. In press. Integrated assessment of a large marine ecosystem: a case study of the devolution of the Scotian Shelf, Canada. *Oceanogr*. Mar. Biol. Ann. Rev. Vol. 43.

Frank, K.T., B. Petrie, J.S. Choi and W.C. Leggett. In press. Trophic cascades in marine ecosystems: an example drawn from a formerly cod-dominated ecosystem. Science.

Other

The chair thinks that ‘Identify emergent physical-biological interaction issues’ should be a permanent ToR. Perhaps it should be added to ToR a).

11 Concluding business

The key concluding items are the location of the next meeting, the resolution for the next meeting and succession:

- Pierre Petitgas will host the 2006 meeting in Nantes, France in conjunction with the larval fish modelling workshop.
- The resolution for the 2006 meeting is in the next section.

At the close of the meeting the chair brought up the issue of succession and the next chair. The next meeting will be the third meeting and WGPBI will need to nominate a chair. The chair reminded the group that when accepting a position in a volunteer organization, ones first job is

to identify a successor. The chair invited anyone who was interested in learning more about being the job to contact him.

The Chair also noted that the large number of new people volunteering to accomplish action items and terms of reference bodes well for the future of the group.

The Chair thanks Andreas Moll and Mike St. John for hosting the meeting.

12 Actions, recommendations and draft resolutions

Action Item 1: Osborn will co-convene a theme session in 2005 on 'Recent advances in our understanding of marine turbulence.' (joint with WGOH).

Action Item 2: North, St. John and Gallego will convene a theme session in 2005 on 'Connecting Physical-Biological Interactions to Recruitment Variability, Ecosystem Dynamics, and the Management of Exploited Stocks' (Joint with WGRP).

Action Item 3: Peters and Hannah will complete the special issue of the J. of Marine Systems based on the WKFDPBI.

Action Item 4: North, Gallego, and Petitgas will host a workshop on 'Advancements in modelling physical-biological interactions in the early-life history of fish: recommended practices and future directions larval fish modelling.'

Action Item 5: Stipa will co-convene a theme session at the ICES ASC in 2006 on 'Harmful Algae Bloom Dynamics; Validation of model predictions (possibilities and limitations) and status on coupled physical-biological process knowledge' (Joint with WGHABD).

Action Item 6: Svendsen and Han will write a resolution for a theme session at the ICES ASC 2006 on 'Operational Oceanography.'

Action Item 7: Schrum will collaborate with Planque and Petitgas of SGRESP (Study Group on Regional Scale Ecology of Small Pelagics) on a workshop to to construct long term series of meso-scale features from hydrodynamic model outputs.

Action Item 8: St. John will review and report on the temperature-dependence of maximum growth rates for phytoplankton and report at the WGPBI 2006.

Action Item 9: Neumann and Moll will draft a synthesis of progress on zooplankton modelling in German GLOBEC and report at the WGPBI 2006.

Action Item 10: Skogen will invite Geir Huse (Norway, and a member of WGPBI) to give talk at WGPBI 2006 on zooplankton IBMs.

Action Item 11: Members of the Numerical Experimentation Subgroup will complete the compilation of data sets suitable for testing 1D ecosystem models. Further information is in Annex 6.

Action Item 12: Skogen, North, Dick and Amundrud will investigate current pre-operational applications of PBI models and report at the WGPBI 2006.

Action Item 13: Svendsen, Han, Amundrud and Dick will identify good ideas for embedding PBI in operational models (e.g., MERSEA) to generate the first generation of products and report at the WGPBI 2006.

Action Item 14: Skogen will continue to encourage members of WGPBI to learn to tell jokes.

Action Item 15: Skogen and Moll will submit for publication their model comparison and Moll will submit for publication the comparison of the 3D ecosystem models of the North Sea (co-authored with G. Radach).

Action Item 16: Hannah to ask Vezina to give a talk on applications of macroecology to testing models.

Action Item 17: St. John and Hannah will work towards a joint EuroOceans and ICES workshop on parameterizing ecosystem models that could take place immediately before WGPBI 2007. This workshop has been moved for early 2006 because of EuroOceans constraints. It will not be an official ICES event.

Action Item 18: Vezina, Hannah, and St. John will write a short project description related to zooplankton grazing models. This could be the basis for PhD project under EuroOceans.

Action Item 19: Hannah will invite Marjorie Friedrichs (US JGOFS Regional Ecosystem Modelling Testbed Project) to the next NESG meeting.

Resolution 1

The Working Group on Modelling Physical/Biological Interactions [WGPBI] (Chair: C. Hannah, Canada) will meet in Nantes, France from 6–7 April 2006 to:

a) Present and discuss new results related to developments and validation in modelling PBI;

b) Plan and execute the workshop on 'Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions' and report on conclusions;

c) Identify good ideas for embedding PBI in operational models (e.g., MERSEA) to generate the first generation of products;

d) Investigate current pre-operational applications of PBI models;

e) Complete the compilation of data sets suitable for testing 1D ecosystem models;

f) Review maximum phytoplankton growth rates as function of temperature as the first in understanding whether temperature regulates total production when integrated across the entire phytoplankton community;

g) Cooperate with SGBEM to explore ecosystem models;

h) Collaborate with WGRP to enhance the use of physical-biological models for prediction of fisheries recruitment.

WGPBI will report by X May 2006 for the attention of the Oceanography Committee.

Supporting Information

Priority:	The WG should be given high priority, since it is concerned with the evaluation and development of the modelling tools used to increase the understanding of the interaction between the living resources in the sea and its ambient physical and abiotic environment. This understanding is essential to the successful development of predictive capability of the state and evolution of the ecosystem for issues such as harmful algal booms, eutrophication, marine protected areas, fish recruitment, and global change. This contributes directly to fulfilling the vision of ICES, "to improve the scientific capacity to give advice on the human impact on, and impacted by, marine ecosystems."
Scientific Justification and relation to action plan	The work of WGPBI contributes to the following ICES Activities: Action Plan no. 1.5 (modelling biological-physical interactions in the sea), Action Plan no 1.1 (provide feedback about research needs), Action Plan no 1.2 (increase knowledge with respect to functioning of the ecosystem). Contributions towards other Activities are noted in the justification below. Providing a forum for the presentation and discussion of new results is an important component of the Group's mandate. The field of modelling physical-biological interactions in fish early-life history is rapidly advancing. Physical-biological interactions are an integral part of understanding fish early-life history and the processes that affect interannual variability in fish recruitment. It is time to review modelling strategies and underlying processes, with the goal of developing a synthesis of recommended practices and identifying knowledge gaps to guide future developments in the field. The proposed workshop will focus on technical and methodological issues, important physical and biological processes, and on future research needs. In addition to providing valuable guidance for the field of physical-biological interactions, this workshop will foster information exchange between international organizations such as ICES, PICES and AFS. The workshop, and the international collaborative research programs that result from it, will advance application of cutting-edge modelling approaches to issues that are critical for fisheries management such as understanding fish recruitment variability, identifying marine protected areas, and implementing ecosystem-based management. Several operational agencies are today running 3D numerical ocean circulation models, with some already coupled with primary production and particle tracking modules. In addition EU has a major integrated project (MERSEA-IP) on developing global to regional operational oceanography, and there are plans for a similar project on regional to coastal operational oceanography. ICES may take

	advantage on these activities by challenging them to produce useful products for ICES overall goals of an ecosystem approach to marine research and management. In the ICES area many physical, biological, and chemical models are available and used for management purposes. To improve and stimulate future use of operational models, brief reports from selected countries will present overviews of operational or pre-operational model products used by managers, scientists, and other stakeholders. Data sets containing information on nutrients, phytoplankton and the physical forcing are required to create standard test cases for models. The compilation of such data sets is the first step. It is well known that for each species of phytoplankton, the maximum growth rate is a function of temperature. The question is 'Does temperature limit the maximum growth rate of the community?' or 'Is there always a species that can grow rapidly at the given temperature so that primary production is roughly independent of temperature?' This has important implications for modelling and our current techniques for assessing the response of an ecosystem to temperature changes. The Baltic Sea Regional Project is supported by the World Bank and aims at improvement of infrastructure for science driven monitoring. The new ICES Study Group on Baltic Ecosystem Modelling Issues in Support of the BSRP (SGBEM) considers the WGPBI as its parent group, which implies the membership of several scientists in both groups. Action Plan no 1.12 Members of WGPBI and WGRP (Working Group on Recruitment Processes) share the common goal of enhancing, guiding, and promoting use of coupled physical-biological models for prediction of fisheries recruitment. Close coordination between Working Groups is required to prevent duplication of efforts. WGPBI members will invite WGRP involvement in 2005–2007 WGPBI activities, including joint sponsorship of the Theme Session (2005) and Workshop (2006). We will also work to develop a joint task between WGPBI and WGRP in 2007–2009. For example, WG members may focus efforts on building a community approach for using coupled physical-biological models in recruitment prediction.
Resource Requirements:	No specific resource requirements beyond the need for members to prepare for, and participate in the meeting.
Participants:	The Working Group benefits from the participation of those outside of the modelling community. Observational and experimental scientists with an interest in physical-biological interactions are encouraged to attend. The meeting requires at least two Norwegian participants.
Secretariat Facilities:	None
Financial:	None
Linkages To Advisory Committees:	ACFM, ACE
Linkages To other Committees or Groups:	ICES-IOC Working Group on Harmful Algal Bloom Dynamics, WGRED WGZE, WGRP, BSRP, SG on Modelling
Linkages to other Organisations	GEOHAB (IOC/SCOR), GLOBEC (IOC/SCOR), PICES
Secretariat Cost Share	ICES:100%

Resolution 2: A Workshop for 2006

A Workshop entitled "Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions" (WKAMF) with co-chairs A. Gallego (UK), E. W. North (USA) and P. Petitgas (France) will be held on 3–5 April 2006 in Nantes, France, to:

a) summarize current state of the art in modelling physical-biological interactions in fish early-life history;

b) review important technical/methodological issues (including model sensitivity and validation), prioritize important processes to be included in the models, and identify knowledge gaps;

c) develop a manual of recommended practices and list of future research directions as proceedings from the workshop.

The workshop will report by 15 May 2006 for the attention of the Oceanography Committee.

Supporting Information

Priority:	This workshop will provide guidance at critical juncture in the developing field of modelling physical-biological interactions in the early-life history of fish.
Scientific Justification and relation to Action Plan:	The Workshop contributes to ICES Goal 1, in particular Activities 1.2.1, 1.3, and 1.5. The field of modelling physical-biological interactions in fish early-life history is rapidly advancing (Werner *et al.* 2001, ICES 2004). Physical-biological interactions are an integral part of understanding fish early-life history and the processes that affect interannual variability in fish recruitment (Werner *et al.* 1997). It is time to review modelling strategies and underlying processes, with the goal of developing a synthesis of recommended practices and identifying knowledge gaps to guide future developments in the field. The proposed workshop will focus on technical and methodological issues, important physical and biological processes, and on future research needs. In addition to providing valuable guidance for the field of physical-biological interactions, this workshop will foster information exchange between international organizations such as ICES, PICES and AFS. The workshop, and the international collaborative research programs that result from it, will advance application of cutting-edge modelling approaches to issues that are critical for fisheries management such as understanding fish recruitment variability, identifying marine protected areas, and implementing ecosystem-based management. International Council for the Exploration of the Sea (ICES). 2004. Report of the Working Group on Recruitment Processes (WGRP). ICES Oceanography Committee ICES CM 2004/C:09. 5–7 April 2004 Copenhagen, Denmark. Werner, F. E., J. A. Quinlan, B. O. Blanton, R. A. Luettich, Jr. 1997. The role of hydrodynamics in explaining variability in fish populations. Journal of Sea Research 37: 195-212 Werner, F. E., J. A. Quinlan, R. G. Lough, and D. R. Lynch. 2001. Spatially-explicit individual based modelling of marine populations: a review of the advances in the 1990s. Sarsia 86: 411-421.
Resource Requirements:	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.
Participants:	This Workshop should attract 25-40 participants and will include some scientists from outside the regular ICES scientific community. We plan to identify participants during the 2005 ASC Theme Session proposed by WGPBI entitled "Connecting biological-physical interactions to fish recruitment variability". We also will invite participation from ICES groups with an interest in physical-biological interactions and fish recruitment processes (e.g., WGCCC, WGRP, WGZE, WGFE, SGCRAB) and from groups such as GLOBEC and PICES.
Secretariat Facilities:	None
Financial:	No financial implications
Linkages To Advisory	Relevant to the work of the ACFM, ACE

Committees:	
Linkages To other Committees or Groups:	WGCCC, WGRP, WGZE, WGFE, SGCRAB
Linkages to other Organisations:	GLOBEC (IOC/SCOR), PICES, IMBR, GOOS
Secretariat Marginal Cost Share:	

Theme Session proposed for ASC 2006

1) Harmful Algae Bloom Dynamics; Validation of model predictions (possibilities and limitations) and status on coupled physical-biological process knowledge". *Conveners*: Patrick Gentien (France) and Tapani Stipa (Finland).

2) Operational Oceanography (OCC) *Conveners*: Y. Desaubies; Guoqi Han + NN.

Annex 1: List of participants

NAME	ADDRESS	PHONE/FAX	EMAIL
Trisha Amundrud	FRS Marine Laboratory Aberdeen, UK		t.amundrud@marlab.ac.uk
Jan Bachaus	IfM-ZMAW Hamburg, Germany		backhaus@dkrz.de
Jorn Bruggeman	Vrije Universiteit, Amsterdam		Jorn.bruggeman@falw.vu.nl
Rob Campbell	IHF Hamburg, Germany		Rob.Campbell@uni-hamburg.de
Asbjorn Christensen	DIFRES Charlottenlund, Denmark		asc@dfu.min.dk
Stephan Dick	BSH Hamburg, Germany		stephan.dick@bsh.de
Rabea Diekmann	IFH Hamburg, Germany		rdiekmann@ifm-geomar.de
Luis Ferrer	AZTI San Sebastian Spain		lferrer@pas.azti.es
Alejandro Gallego	FRS Marine Laboratory Aberdeen, UK		gallegoa@marlab.ac.uk
Guoqi Han	NWAFC St John's, NL, Canada		HanG@dfo-mpo.gc.ca
Charles Hannah	BIO Dartmouth, NS Canada	Tel: 1-902-426-5961	hannahc@dfo-mpo.gc.ca
Hans-Harald Hinrichsen	IFM-Geomar Kiel, Germany		hhinrichsen@ifm.uni-kiel.de
Ute Hochbaum	IFH Hamburg, Germany		hochbaum@ifm.uni-hamburg.de
Wilfried Kühn	IfM-ZMAW Hamburg, Germany		kuehn@ifm.uni-hamburg.de
Mike St John	IHF Hamburg, Germany		michael.st.john@uni-hamburg.de
Herman-Josef Lenhart	IfM-ZMAW Hamburg, Germany		lenhart@ifm.uni-hamburg.de
Andres Moll	IfM-ZMAW Hamburg, Germany		moll@ifm.uni-hamburg.de
Larissa Mueller	BSH Hamburg, Germany		
Thomas Neumann	IOW Warnemünde, Germany		Thomas.neumann@io-warnemuende.de
Elizabeth North	UMSC Horn Point Laboratory Cambridge, MD USA		enorth@hpl.umces.edu
Myron Peck	IHF Hamburg, Germany		myron.peck@uni-hamburg.de
Corinna Schrum	Schrum and Wehde Ecosystem Modeling GbR Hamburg, Germany		schrum@dkrz.de
Matteo Sinerchia	Imperial College London, United Kingdom		matteo.sinerchia@imperial.ac.uk
Morten Skogen	IMR, Bergen, Norway		morten.skogen@imr.no

Christoph Stegert	ZMAW-IfM Hamburg, Germany		stegert@ifm.uni-hamburg.de
Einar Svendsen	IMR, Bergen, Norway	Tel: +47 55 238458	einar.svendsen@imr.no
Alexander Trofimov	PINRO Murmansk, Russia		trofimov@pinro.ru
Alain Vezina	BIO Dartmouth, NS Canada		vezinaa@dfo-mpo.gc.ca
Andy Visser	DIFRES Charlottenlund, Denmark		awv@dfu.min.dk
Kai Wirtz	GKSS Geesthacht, Germany		wirtz@gkss.de

Annex 2: Draft agenda

Draft Agenda for WGPBI, 7–8 April 2005 University of Hamburg

Thursday morning (10-1)

Welcome, logistics, introductions

Report of the Numerical Experimentation subgroup (ToR e) – Hans Burchard (30 minutes)

Present and discuss new results (7 x 20 minutes) (ToR a)

- Elizabeth North - TBA
- Morten Skogen - Importance of ocean circulation in biogeochemical/ecological modelling: An example from the North Sea
- Uffe Thygesen - Pseudocalanus elongatus use chemical signals during mating
- Andreas Moll - The Status of validation of eleven models of the greater North Sea area
- Tapani Stipa - TBA
- Alain Vezina - Modelling plankton dynamics with a variable-complexity physical-biological model
- Alexander Trofimov - Modelling Barents Sea
- Kai Wirtz - Initiative for a new generation of ecosystem models: facing the dynamics of non-mass variables

Lunch (1-2)

Thursday afternoon (2-6)

Draft review on nutrient load reduction (ToR c) - Morton Skogen (30 minutes)

Report of the Larval Fish subgroup (ToR d,g) Elizabeth North and others (1 hour)

Present and discuss new results (2 x 20 minutes)

- Charles Hannah - Benthic Habitat Classification
- Matteo Sinerchia - VEW3

Short break (15 minutes)

Reports on WGPBI website (ToR b), document sharing site, status of JMS special issue.

Report on SGBEM (ToR f)

Review 5 year plan and action items from 2004.

Friday morning (9-1)

Moving Forward

Events and activities beyond 2006, event for IPY 2007

Breakout groups for discussion

- Small pelagics workshop proposal
- Others?

Short break (20 minutes)

Plenary discussion

Are there any new groups who want to develop a plan for activities?

Action Items for 2005

Lunch (1-2)

Friday Afternoon (2-5)

Working Group Report

Action Items and ToRs for 2006

Recommendations and Draft Resolutions

Succession Planning

Annex 3: Calendar of events and activities

YEAR	EVENT
2004	Workshop on '**Future Directions for Modelling Physical Biological Interactions**.' (Barcelona, March 2004) Special Session at ICES ASC on Physical-biological Interactions: Experiments, Models and Observations (September 2004, Vigo Spain) First meeting the Numerical Experimentation Subgroup (Hamburg, 6 April 2005)
2005	Theme Session at ICES ASC on '**Recent advances in our understanding of marine turbulence.**' T. Osborn. Joint with WGOH. Theme Session at ICES ASC on **'Connecting Physical-Biological Interactions to Recruitment Variability, Ecosystem Dynamics, and the Management of Exploited Stocks'** with convenors North, St. John, and Gallego. Joint with WGRP. Special issue of J. Marine Systems from 2004 workshop. Peters and Hannah Draft review of nutrient load reduction experiments. See Section 5 of 2005 Report. Skogen and Moll report on the interannual variability comparison (Skogen and Moll submitted). Draft manuscript of modelling techniques for larval fish. T. Miller Submit North Sea ecosystem model comparison. (Radach and Moll Review of three-dimensional ecological modelling related to the North Sea shelf system: Model validation and data needs)
2006	Workshop on '**Advancements in modelling physical-biological interactions in the early-life history of fish: recommended practices and future directions larval fish modelling**.' 3–5 April 2006 in Nantes France. E. North, A. Gallego, P. Petitgas. Working Group meeting 6–7 April 2006 in Nantes France. NESG meeting on 5 April 2006 in Nantes France. Database on effects of turbulence on planktonic organisms. F. Peters Theme Session at the ICES ASC on '**Harmful Algae Bloom Dynamics; Validation of model predictions (possibilities and limitations) and status on coupled physical-biological process knowledge**'. Joint with WGHABD. Co-convenor T. Stipa Theme session at ICES ASC on '**Operational Oceanography**'– E. Svendsen and G. Han. Needs a resolution. A workshop to extract meso-scale physical structures from hydrodynamic model outputs to construct long term series of meso-scale features. Led by ICES SGRESP (Study Group on Regional Scale Ecology of Small Pelagics). C. Schrum. Review of temperature dependence of maximum growth rates for phytoplankton. M. St. John Synthesis of progress on zooplankton modelling in German GLOBEC. T. Neumann and A. Moll Invite Geir Huse to give talk at WGPBI 2006 on zooplankton IBMs. M. Skogen. EuroOceans workshop on parameterizing ecosystem models. M. St. John
2007	Theme session PBI – C. Hannah Peer reviewed publication from larval fish workshop. E. North *et al.* Good ideas for next generation of zooplankton modules in PBI models. Non-mass state variables and stage resolved, etc. All

Annex 4: Action items from WGPBI 2004

Action Item 1: F. Peters and C. Hannah will act as guest editors for a special issue of the J. of Marine Systems based on the WKFDPBI.

There are 8 papers in review and revision. We hope to wrap this up in the spring.

Action Item 2: F. Peters, C. Hannah and W. Fennel will co-convene the theme session at the 2004 ASC on Physical-Biological Interactions.

The theme session was very successful with 42 presentations (32 talks and 10 posters) and attendance ranging from 60–70 on Friday to 30-40 on Saturday morning.

Action Item 3: F. Peters, T. Stipa and E. North will develop a WGPBI website that will host discussions relevant to physical-biological interactions, and provide a location to archive useful documents and links to other websites. They will work on this during 2004.

See ToR b in this report.

Action Item 4: T. Osborn will co-convene, with Hendrik van Aken of WGOH, a theme session in 2005 on 'Recent advances in our understanding of marine turbulence.'

Abstracts are being accepted

Action Item 5: C. Hannah will revise the draft plan to emphasize the need for modellers to interact with observationalists to design observations that will permit rigorous evaluation of the models and allow the community to select and reject models based on quantitative criteria.

This was done and included as Annex E in 2004 WG report.

Action Item 6: Resolution for larval fish theme session in 2005. North and Gallego. (Resolution 2 in 2004).

The session was merged with another one and renamed 'Connecting Physical-Biological Interactions to Recruitment Variability, Ecosystem Dynamics, and the Management of Exploited Stocks' with convenors North, St. John and Gallego. Abstracts are being accepted

Action Item 7: Resolution for larval fish workshop in 2006. Gallego and North.

Progress on the workshop planning is reported under ToR c (Section 6 in this report).

There may be some bureaucratic hiccups with formal approval but the workshop will happen.

Action Item 8: Resolution for an ICES/GLOBEC/PICES Symposium on Modelling Physical/Biological Interactions in 2008.

Hannah and Werner decided not to proceed.

Action Item 9: Create a Numerical Experimentation Subgroup and convene the initial meeting before the 2005 WGPBI meeting.

The results of the inaugural meeting are reported under ToR e) in this report.

Action Item 10: Respond to WGHABD on a joint Theme Session at the ICES ASC in 2006 with a proposed title 'Harmful Algae Bloom Dynamics; Validation of model predictions (possibilities and limitations) and status on coupled physical-biological process knowledge.'

T. Stipa agreed to co-convene this session.

Annex 5: Report of Larval Fish Subgroup

The Fish Recruitment Processes Sub-Group met on 6 April 2005 at 18:30 to discuss sub-group activities and to plan new ones. The following members were in attendance: T. Amundrud, A. Christensen, R. Diekmann, M. Peck, A. Gallego,. H.-H. Hinrichsen, W. Hochbaum, E. North, C. Schrum, M. St. John, and A. Visser. Charles Hannah and other from NESG were in the close proximity. The following report summarizes fish sub-group activities as well as discussion and recommendations of WGPBI members in response to sub-group report on April 7, 2005.

1. Review our ToR

The Fish Recruitment Modelling group returned with a project called 'Towards the development of best practices for the modelling of early life history of fish.' The three major items were: 1) a review paper on larval fish modelling; 2) a theme session on larval fish modelling at the 2005 ASC; and 3) a workshop on larval fish modelling in 2006. It is expected that members will stay in close communication with members of the Working Group on Recruitment Processes. Alejandro Gallego and Thomas Miller are members of both WGRP and WGPBI and will facilitate this interaction" (2004 WGPBI meeting report).

2. Update on Literature Review

Thomas Miller, co-Chair of WGRP, has conducted a literature review of modelling the early life history of fish. It is nearing completion and will be presented at the American Fisheries Society Larval Fish Conference in July 2005 in Barcelona, Spain. We decided that it would be unproductive to duplicate Dr. Miller's efforts. He agreed to let us use his literature review as a background document for the workshop.

3. Update on 2005 ASC Theme Session.

The theme session that we proposed was merged with another session. The new session is entitled "Connecting Physical-Biological Interactions to Recruitment Variability, Ecosystem Dynamics, and the Management of Exploited Stocks" and is chaired by E. North, M. St. John, and A. Gallego. We will discuss names of people encouraged to submit abstracts (we have already encouraged 116 people). Working group members added additional names to the invitation list.

4. Discuss plans, agenda, and funding sources for 2006 Workshop. Fish sub-group members are planning a workshop in 2006 entitled "Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions. It will be chaired by A. Gallego, E. North, and P. Petitgas (local host) and jointly sponsored by WGPBI and WGRP. Collaborators/advisors include Charles Hannah, Eileen Hofmann, Thomas Miller, Pierre Pepin, Mike St. John, and Francisco Werner. The workshop will be hosted by P. Petitgas at IFREMER in Nantes, France, and will occur between mid-March to mid-April in 2006.

Funding. E. North, with collaboration from A. Gallego and P. Petitgas, submitted a proposal to US National Science Foundation for logistical support for the workshop, publication fees, and travel for US scientists. Workshop co-chairs will continue to pursue EU funding. A. Gallego intends to submit a proposal this fall. WGPBI members suggested that co-Chairs approach EUROCEANS (Philippe Cury, France) and GLOBEC.

The **goals** of the workshop are to:

- assess the current state of the art in modelling physical-biological interactions in fish early-life.
- review important technical/methodological issues (including model sensitivity and validation), prioritize important processes to be included in the models, and identify knowledge gaps.
- develop a manual of recommended practices and list of future research directions as a peer-reviewed proceedings from the workshop.
- ensure broad participation of scientists within and outside the ICES community (i.e., AFS, PICES).
- promote the teaching and training of graduate students and early-career scientists.

Location. Pierre Petitgas has kindly agreed to be local host. The Director of the IFREMER Center in Nantes has agreed to provide the following facilities at no cost for 3 days during mid-March to mid-April 2006:

- one amphitheatre with video projector, computer and loudspeaker
- one separate room
- space for 40 posters and poster easels
- 3 computers with internet access for use by conference participants
- space and a time slot at the on-site cafeteria for lunch for 50 participants
- staff support

Agenda. The workshop will contain 7-core information sessions, a poster session, and structured discussions, including a 'consensus development' discussion at the end of the workshop. Each invited speaker will be asked to submit a paper before the workshop with a list of recommended best practices and research needs. Each core information session will include 3 talks (20 minutes plus 5 minutes discussion) followed by a 25-minute discussion during which workshop participants will be asked to review and discuss the recommendations of the speakers. The following agenda was agreed on by WGPBI members:

Introduction: Workshop goals

Session I: Initial conditions: Egg production, spawning location/time, maternal effects

Session II: Small-scale processes (turbulence, feeding success)

Session III: Mesoscale transport processes I: Physics

Session IV: Mesoscale transport processes II: Larval behavior

Poster session discussion: best practices, current limitations

Session V: Biological processes I: development, growth, and mortality

Session VI: Biological processes II: Juvenile recruitment, metamorphosis, settlement

Session VII: Future Directions: Integration with observing systems, operational models, monitoring programs, and management recommendations

Consensus Development: Recommended Practices and Future Directions

Workshop Wrap Up, Student Poster Award, Acknowledgements

Although not explicitly included in the agenda, WGPBI members recommended that someone with expertise in zooplankton modelling should be invited to the workshop because prediction of larval fish prey is important, and because we could learn from modelling techniques in this

field. Workshop co-Chairs encouraged fish sub-group and WGPBI members to send them names of people who they recommend for invited talks, along with information and a brief explanation of which workshop session they could participate in and why they would enhance the workshop. E. Svendsen suggested that it might be useful to invite someone from MERSEA to discuss, and demonstrate, how operational models might have application for real-time prediction of fish early-life stages.

The **products** of the workshop will include:

- a report on the workshop will be presented to the ICES Oceanography Committee (May 15, 2006) and posted on the workshop web page
- a peer-reviewed publication entitled "Advancements in modelling physical-biological interactions in fish early-life history: recommended practices and future directions" that will include manuscripts from talks and posters
- collaborative proposals in response to identified research recommendations
- a webpage for disseminating workshop findings

WGPBI members indicated that publishing the workshop proceedings in a peer-reviewed journal would be preferable if funds can be raised to support publication costs. Possible journals include Fisheries Oceanography, Journal of Fish Biology, ICES Journal of Marine Science (although most symposium issues are reserved for the next several years), and Journal of Marine Systems. If we do not raise funds to support a journal publications, publishing an ICES Manual, or creating an 'in-house' publication through University of Maryland Center for Environmental Science Integration-Application-Network might another approach. WG members indicated that it will be important to identify a guest editor for the workshop proceedings to establish credibility.

Advertising. The date for the workshop should be determined before July so that the workshop can be announced at the AFS Larval Fish conference in Barcelona, Spain, in July.

Workshop timetable. The following timetable was agreed on by WGPBI members:

Activity	Date
Agenda finalized	April, 2005
Invited speakers list finalized	October, 2005
Abstract submission deadline	October, 2005
Contributed speakers and posters list finalized	Early November, 2005
Workshop	mid-March to mid-April, 2006
Workshop report to ICES Oceanography Committee	May 15, 2006
Peer-review publication	Summer, 2007

5. Discuss SGRESP proposed workshop

ICES SGRESP (Study Group on Regional Scale Ecology of Small Pelagics) chaired by Pierre Petitigas, are proposing a workshop to extract meso-scale physical structures from hydrodynamic model outputs to construct long term series of meso-scale features. Pierre and Benjamin Planque (likely co-convener) would like feedback on this idea from WGPBI and ask if we would like to co-organize the workshop. Fish sub-group members supported the workshop and brought it forward for discussion to WGPBI members. WGPBI members supported the workshop and agreed to co-sponsor it. WG members recommended that the workshop should not

be limited to just focusing on small pelagic fish and on using hydrodynamic model output (i.e., retention areas can be important for gadoid fish, and satellite maps may aide in meso-scale feature identification). Corinna Schrum agreed to lead WGPBI's involvement in this effort.

6. Discuss plans for 2007 and beyond

Fish sub-group members discussed long-term plans for sub-group activities. Our ideas included:

- Publish and disseminate workshop publication
- Develop course that incorporates workshop findings and 'hands-on' experience with models and sensitivity analyses
- Promote open-source model development and dissemination
- Continue working on model validation (pulling together data sets (e.g., Larval-Base)
- Think about 'closing the life cycle' (linking early-life models and adult dynamics)

Annex 6: Report of Numerical Experimentation Subgroup

Meeting on 6 April 2005 at ZMAW in Hamburg

Agenda

1. Opening remarks
2. Who is who?
3. Model system overviews (oral presentations)
   - Virtual Ecology Workbench (VEW) by Matteo Sinerchia
   - GOTM-BIO
   Overview by Hans Burchard
   Computational structure by Karsten Bolding
   Numerical aspects by Jorn Bruggeman
   - Lessons from JGOFS modelling by Iris Kriest
4. What to be achieved until April 2006 ?
   - Formulate sensible questions (e.g., Eulerian versus Lagrangian method, necessary model complexity, data sets for evaluation, ...).
   - List of deliverables.
   - List of responsible persons.
5. Fund raising: EUROCEAN funding might be located to support one Ph.D. student for working on Lagrangian-Eulerian model integration. Further funding to be requested after commitments until April 2006 are fulfilled.

Participants

Karsten Bolding (Asperup, Denmark)
Jorn Bruggeman (Amsterdam, The Netherlands)
Hans Burchard (Warnemünde, Germany)
Asbjorn Christensen (Copenhagen, Denmark)
Stephan Dick (Hamburg, Germany)
Charles Hannah (Halifax, Canada)
Mike St. John (Hamburg, Germany)
Iris Kriest (Kiel, Germany)
Wilfried Kühn (Hamburg, Germany)
Andreas Moll (Hamburg, Germany)
Larissa Mueller (Hamburg, Germany)
Thomas Neumann (Warnemünde, Germany)
Matteo Sinerchia (London, UK)
Alain Vezina (Halifax, Canada)

Commitments

(Responsible persons are given in brackets)

1) Progress with GOTM:

- Initial development of GOTM-BIO is complete and paper submitted to our JMS special issue.
- The GOTM team will release GOTM-BIO by end of 2005 (Hans Burchard, Karsten Bolding).

2) Progress with VEW3:

- The GUI for specifying the biological model and the scenario is complete.
- The initial development of VEW3 is complete.

3) Collection and collation of useful data sets for testing biogeochemical models. These data sets will be prepared for simulation under GOTM (www.gotm.net), where they will be made available to the public.

Iris Kriest will provide a few paragraphs on JGOFS data to Charles Hannah.

The following data sets will be prepared:

- BATS, Hans Burchard and Lisa Weber
- NABE (North Atlantic Bloom Experiment 47 N), JGOFS data CDs needs collation work (no responsible appointed).
- FLEX (Fladenground Experiment 1976, Northern North Sea, 2 months during plankton bloom). (Hans Burchard and Wilfried Kühn). Paper by Burchard *et al.* submitted to JMS special issue for WGPBI workshop in Barcelona (2004).
- Helgoland Reede data – Collate the data and forcing data, daily (Mike St. John). Scenario is well mixed, depth: 8 m. Data will be difficult to be simulated in 1D model, but are still important, since the time series is long and includes algal succession. They may provide good test for size spectrum models.
- Gotland Basin Station 271 (Baltic Sea). Monitoring data exist 5 times per year since 1974. Data from other cruises fill many gaps (Thomas Neumann and Hans Burchard).
- Station 2 off Halifax (bi-weekly sampling; 1999-2002; exists to 2004), including phytoplankton composition (Alain Vezina). When SeaHorse works well, we will get hourly sampling of T,S, fluorescence, and eventually full optical coverage.
- North Sea Project data set (Karsten Bolding in cooperation with CEFAS, UK).

All data should be given in the GOTM data format. Karsten Bolding will write an email explaining this to Charles Hannah to be forwarded to all member of the Working Group and the participants of the Numerical Modelling Subgroup Meeting.

With the two JGOFS data sets BATS and NABE, it needs to be clarified with JGOFS people whether publication is possible (Iris Kriest for NABE and Hans Burchard / Lisa Weber for BATS).

4) The following questions will be put to discussion until next year (Charles Hannah, Alain Vezina, Mike St. John):

- Can we define processes which are difficult to formulate in Eulerian models and that matter? Can we define experiments that could quantify the advantages of the Lagrangian approach?
- Differences between Eulerian and Lagrangian models arise when the history of an organism plays an important role in the results. Under what conditions does it matter whether one formulates photo-adaptation in an Eulerian or Lagrangian framework?
- Given an appropriate phytoplankton growth model, what are the consequences of whether or not plankton undergo mixing over the mixed layer (consequences of variability light levels and changes in respiration). This also related to photo-adaptation.
- We wish to investigate the consequences of increased model complexity. There is a common result that more complex models do not improve the model – data misfit. Can we demonstrate this quantitatively? Can we learn something?
- Is there a question related to the difference between lots of simple state variables and a few state variables with some complex diagnostic measures. Mike and Charles (possibly Jorn) will write a 2 page description of a question and an approach.

5) The US JGOFS Regional Ecosystem Modelling Testbed Project is also working on 1D workbenches for testing ecosystem models. Hannah will invite Marjy Friedrichs to the next meeting. The project web pages www.ccpo.odu.edu/~marjy/Testbed/ has the presentation from their recent workshop (21 - 23 March, 2005).

6) Think like a Lagrangian, model like an Eulerian (Hannah quoting Ralph Cheng, USGS).

(Notes taken by Hans Burchard and Charles Hannah)

Annex 7: Abstracts

An update on modelling dispersal of oyster larvae in Chesapeake Bay

Elizabeth North, Raleigh Hood, Ming Li, Liejun Zhong

University of Maryland Center for Environmental Science, Horn Point Laboratory

and

Tom Gross

Chesapeake Research Consortium, NOAA/NOS/Coast Survey

The overall research objective is to predict population dispersal of native and non-native oysters in Chesapeake Bay using hydrodynamic, particle-tracking, and adult demographic models. The presentation focused an important question for modelling oyster larvae transport:

- Does the particle tracking model capture sub-grid scale turbulent processes correctly?

Two techniques for assessing whether the particle-tracking model captures sub-grid scale process were presented: numerical dye release studies (for vertical turbulence) and comparison with *in situ* dye release experiments (for horizontal turbulence). In the numerical dye release study, particle concentrations were compared to a simulated 'dye' using an Eulerian tracer (Fig. 1). When a random displacement model (Visser 1997) was used to simulate vertical turbulence, particle and 'dye' concentrations compared favorably.

Comparison between *in situ* dye studies and measures of horizontal dispersal of particles were conducting using an 'Ocean Diffusion Diagram' (Okubo 1971). Preliminary results indicate that this technique may be useful for parameterizing horizontal diffusivity in models with vertical and horizontal turbulent particle motion, but that constant values of horizontal diffusivity may overestimate the dispersal of particles in the first 12 hrs after release.

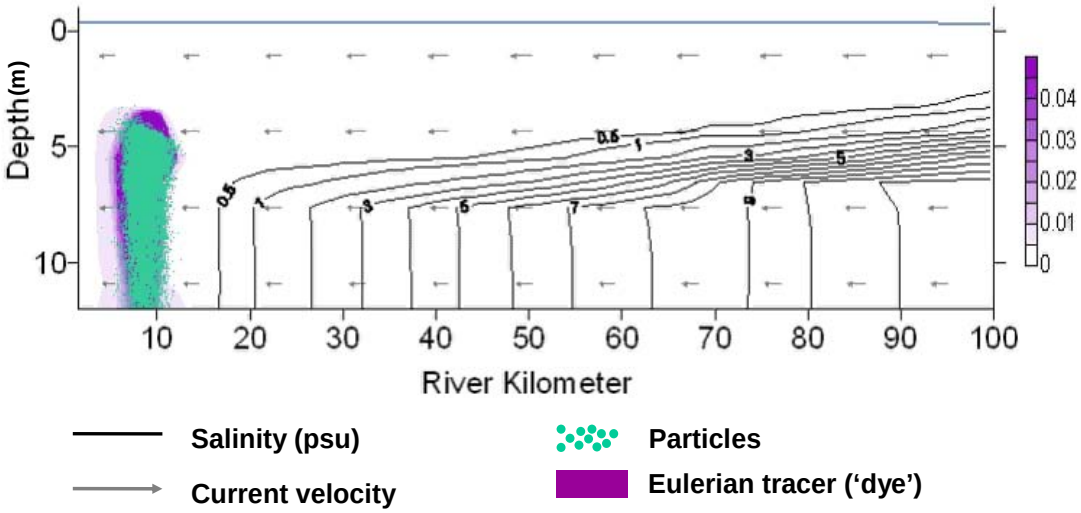

Fig. 1. Distribution of particles (green) and Eulerian tracer (purple) one hour after release from the same location up-estuary of the salt front.

Review of three-dimensional ecological modelling related to the North Sea shelf system: Model validation and data needs

Günther Radach and Andreas Moll

Institut für Meereskunde,
Universität Hamburg, ZMK-ZMAW
Bundesstr. 53, D-20146 Hamburg

corresponding author: moll@ifm.uni-hamburg.de

Status 29.03.2005

(The table of contents for the entire report and abstract are presented.)

Abstract: The aim of this review is to provide an overview about the status of validation of eleven models of the greater North Sea area (COHERENS, CSM-NZB, DCM-NZB, DYMONNS, ECOHAM, ELISE, ERSEM, FYFY, GHER, NORWECOM, POLCOMS-ERSEM), of which seven have a three-dimensional space resolution. Two new three-dimensional models are in preparation. The applied validational exercises are sorted from qualitative/subjective to quantitative/objective methods, giving examples.

The validational exercises reported show that several of the models were able to reproduce observations of the state variables correctly in the order of magnitude. The simulated time series fall into the range of observed variability, and the state variables were close to the climatological mean situation concerning annual cycles and decadal changes. For more objective comparison, mostly measures of goodness were used which show the agreement of observations and simulations at a special time instant or for an interval at a certain station or for a box by direct comparison. Statistical measures for the whole region and the whole time interval are not yet common. Comparison of results from different models with common data sets are focussed on and the evaluation of the validity of the model simulations were performed according to the different spatial and temporal scales sorted by: regional distribution, annual cycles, long-term development at stations and events.

For regional distributions the reproduction of horizontal gradients in the mean seasonal distributions for homogeneous and stratified waters can be simulated in coincidence with climatological observations for many state variables, best for the nutrients phosphate and silicate, less well for nitrate and ammonia, and good to reasonable for chlorophyll. Several models failed to meet the regional distribution of concentrations for chlorophyll for the important spring period.

Nearly all three-dimensional models have been tested with climatological monthly mean data, representing the annual cycle. The comparisons showed that mostly the nutrients phosphate and silicate were simulated best, but nitrate or nitrogen nutrients with less success. Chlorophyll was simulated in the order of magnitude, sometimes over-, sometimes underestimated. The phasing of nutrients and chlorophyll showed differences compared to the data mainly in times of intense regeneration of nutrients, which was not satisfactorily modelled so far. The regional differences of the annual cycles of nutrients, chlorophyll and primary production could be reproduced quite well. Large differences of annual chlorophyll cycles occurred, when models were compared to a common data set. The quality of the annual simulations varied with parameter, area and season. There is no one model that coincided with climatological monthly mean annual cycles for all simulated state variables in all seasons.

The few documented and evaluated long-term simulations showed that the state variables coincided in the order of magnitude with the available observations. They were able to reproduce the overall development of the eutrophication of the continental coastal North Sea. In all model cases the interannual variability seen in the observations was not reproduced by the simulations. The simulated annual cycles were much more uniform than the observed ones. The simulated time series showed often systematic time shifts. The stations used for testing the long-term simulation are positioned all together in relatively shallow waters and owe peculiarities which disturb the direct comparison with the simulations. For the event scale by far too little validational work within three-dimensional modelling has been done. Spring phytoplankton blooms can be simulated satisfactorily with respect to the order of magnitude and timing. But only very few detailed comparisons were made in the papers for judging the realism of specific spring blooms and depletion phases.

The review has also shown the apparent deficiencies of the ecosystem modelling. At the present time most models are suited only for investigating a rather restricted scope of process complexes. The discrepancies to data grew with the trophic level. Model comparison studies for the North Sea exist for phytoplankton composition and eutrophication issues and suggest

that there still exist problems in determining the necessary complexity of the model ecosystem, because strong differences in the complexity may permit very similar results and very similar complexity may result in great differences in the simulation outcome. The few examples where the pelagic model was extended by a benthic model showed that the extension did not necessarily improve the model outcome substantially. Special attention should be devoted to the regeneration mechanisms at the bottom, especially in shallow areas, where most of the models seem to have problems in correctly describing the regeneration of nutrients.

Species groups have been simulated so far with rather limited success. Species successions could not really be assessed so far because it is still lacking the scientific basis for being successfully simulated. More complexity in the model does not necessarily improve the simulations. The possible causes of the deficiencies are so manifold in such complex ecosystem models that it is nearly impossible to find the causes, and by fixing them not creating a new deficiency elsewhere in the simulation. The comparisons of simulation results with data have shown that ecological model simulations did not reproduce fully the observed variability. This may have several reasons lying in the model set up or in the available data or both; possible sources of lacking coincidence with observations can originate from the spatial and temporal resolution of the internal dynamics, the trophic resolution, or the resolution of the forcing functions. Clearly the quality of the manifold forcing data for the model simulations play a major role regarding the goodness of the simulation compared to data. For judging the capability of the model to reproduce nature in comparison to the capability of other models the only way seems to consist in calculating statistical measures for coincidence and to compare these numbers for selecting the simulation model of choice.

Most of the models have not been evaluated sufficiently for judging their predictive potential, and they have not yet been tested to a degree which is possible today using the various existing data sets from the northwest European shelf seas (presented in the Appendix). Validational exercises performed so far had to use climatological annual cycles together with the long-term variability on a monthly basis for comparisons. Validation of the ecological models depends on the available data, and significant progress can only be expected in the future if the data base is improved by new field experiments providing the “critical data sets” needed for testing and discriminating of the various complex ecological model systems. Apart from the NERC North Sea Project (NSP) 1988/89 data, no comprehensive data sets exist for testing the models for one single special year. Common data sets for the necessary annual cycles of forcing functions are still needed. Observations during full annual cycles are especially needed for validating sub-modules of benthic and pelagic regeneration mechanisms. For testing more than the general coincidence of simulations within the range of climatological observations, data sets are needed which combine measurements of all relevant state variables on the event scale. A historic example of such a data set was provided by the Fladen Ground Experiment in spring 1976 (FLEX’76). Comparable data sets are needed which are obtained for dynamic developments like spring and fall blooms, regeneration events, storm events and their consequences, overwintering and start of the new production period before the spring blooming. And all in the necessary complexity which renders them suitable for hindcasts because of their completeness.

Modelling plankton dynamics with a variable-complexity physical-biological model

Alain Vézina[1], Markus Pahlow[2], Benoît Casault[1], David Brickman[1] and William K.W. Li[1]

[1]Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, N.S. B2Y 4A2, Canada
[2]Oceanography Department, Dalhousie University, 1355 Oxford Street, Halifax B3H 4J1, Canada.

Plankton ecosystems show strong seasonal, interannual and interdecadal variability on the Scotian Shelf, off Nova Scotia, Canada. A variable-complexity plankton ecosystem model, which can be forced with different physical models, is used to investigate the sources of that variability and its consequences on the structure of plankton ecosystems. The model includes novel parameterizations of phytoplankton growth and grazing dynamics. It also uses the results from broad scale empirical analyses (macroecology) to parameterize the effect of phytoplankton and zooplankton size on ecosystem dynamics. The model is driven by results from GOTM (General Ocean Turbulence Model), a one-dimensional physical model, forced by meteorological data. We compare the model results with general seasonal patterns and with interannual variability in a large independent dataset for the Scotian Shelf region. By varying model complexity and forcing we can pinpoint the significance and effect of individual processes, such as upwelling or phytoplankton temperature acclimation.

Our results indicate that including vertical velocities in the 1D model is essential to capture both the seasonal cycle of phytoplankton biomass and nutrients and the interannual variability over 5 years (from 1999 to 2004). Temperature acclimation, i.e., allowing for time for the phytoplankton assemblage to adapt to changing temperatures, has a positive impact on representing winter dynamics and shaping the timing and magnitude of the spring bloom. The use of different grazing functions also had a substantial impact. We tried 3 functions that vary in complexity from simply dependent on food concentration through dependent on both concentration and food size and finally to dependent on concentration, food size and predator size. The least complex function tended to unrealistically smooth seasonal and interannual variations. The intermediate complexity formulation performs well with the spring bloom but it does not produce a fall bloom as observed. Only the full complexity grazing formulation managed to reproduce the full seasonal cycle; however, its performance in reproducing patterns in interannual variability was mixed. Both the intermediate and full complexity grazing formulations appeared as good candidates for further exploration.

A three dimensional hydrodynamic model of the Barents Sea

by A.G.Trofimov

Polar Research Institute of Marine Fisheries and Oceanography (PINRO),

6 Knipovich St., 183763 Murmansk, Russia, e-mail: *trofimov@pinro.ru*

Studying the water dynamics in the Barents Sea provides an insight into the processes behind formation of climate in the Barents Sea and enables to make a judgment of how the water dynamics impact on the biota in this area, and in particular, on the distribution of eggs and larvae of fish, which is important to know for year class abundance assessment.

This paper offers mathematical and numerical formulations to compute the Barents Sea currents as well as verification of the hydrodynamic model constructed and examples of its application.

For resolving the task of computing currents in this basin we used the spherical coordinate hydrodynamic equations taking account of the Boissinesq and quasi-static approximation (Sarkisyan, 1991). Surface elevation was used as an auxiliary function.

The model equations were approximated by finite difference techniques and solved by a modified method of successive iterations.

Thus a 3D numerical diagnostic model of water circulation, which takes account of the heterogeneity of seawater density, wind stress, non-linearity and lateral exchange effects as well as of a combined baroclinity and bottom topography effect, was developed for the Barents Sea on the basis of approach suggested by A.S.Sarkisyan. In simulations of currents input data used are prescribed seawater density, atmospheric pressure as well as current velocities at the open boundaries computed on the basis of water fluxes through corresponding sections and straits (Loeng, Ozhigin, Adlandsvik, 1997).

For simulating the transport of particles the approach based on a random-walk method was applied (Averkiev, Chantsev, 1995).

The model was verified in two steps. First, a visual comparison of simulated currents with the map of main surface currents in the Barents Sea developed by PINRO was undertaken. Simulations showed good consistency with the existing knowledge of water dynamics in the Barents Sea. Then simulations by the model were compared with current measurements (Loeng, Satre, 2001). It was noted, that simulated and observed currents coincided. However simulated current velocities were on the average 1 cm/s less than observed.

This model allows computing the fields of surface elevation and three components of current velocity at prescribed depths and to calculate separately wind and density driven currents. This makes it possible to simulate the distribution of eggs, larvae and 0-group fish, which can further be used in forecasting the distribution of fish at early life stages.

Averkiev A.S., Chantsev V.Yu. 1995. Simulation of cod eggs distribution in the upper layer at the border between Norwegian and Barents Sea by the hydrodynamic model//Questions of fisheries oceanography of the Northern basin. In: PINRO Collected Scientific Papers, Murmansk, PINRO Press, pp. 131-138 (in Russian)

Loeng H., Ozhigin V., Aadlandsvik B. 1997. Water fluxes through the Barents Sea//ICES J.Mar.Sci., vol.54, pp.310-317

Loeng H., Satre R. 2001. Features of the Barents Sea circulation//Fisken og have. Nr. 1, 40 pp.

Sarkisyan, A.S.1991. Modelling the ocean dynamics. Saint-Petersburg, Gidrometeoizdat Publishing House, 306 p. (in Russian).

The Physical Environment Approach to Benthic Habitat Mapping

Vlad Kostylev and Charles G. Hannah

Bedford Institute of Oceanography, Dartmouth, NS, Canada

We present a novel approach to benthic habitat mapping of the continental shelf. The goal is high-resolution (~1 km) maps of the habitat; a goal that cannot be attained by interpolating between limited numbers of benthic grabs and trawls distributed across the shelf. We follow the Southwood (1977) model and assume that habitat can be characterized along two axes: 'scope for growth' and 'physical disturbance.' This provides a framework for transforming high resolution maps of the physical environment, such as temperature, bottom depth and grain size, into a map of potential habitat. The map becomes a hypothesis that must then be tested against observations. Using the Scotian Shelf on the east coast of Canada as an example, we discuss the input layers, present the map, and touch on validation.

A new biological model for predicting fisheries recruitment

Matteo Sinerchia, John D Woods

Department of Earth Science and Engineering, Imperial College of London, SW7 2AZ.

This new model is designed to predict recruitment in a Virtual Ecosystem based on the Lagrangian Ensemble metamodel, which treats plankton as individuals obeying phenotypic equations for behaviour and physiology. Inter-annual variation in recruitment is related to year-to-year variation in the atmospheric forcing, derived from ERA-40. The model extends the classical food chain. Physical environment is computed by submodels for optics (Liu, 25 spectral bands) and turbulence (WB mixed layer model). Chemical environment includes three nutrients (ammonia, nitrate, silicate) in solution and in Droop pools in each plankter. Diatoms feature Geider photo-adaptation, in which the growth rate and chlorophyll content of a cell vary with ambient irradiance, temperature and nutrient concentration. They over-winter as cysts. Copepods perform diel migration; ingestion is based on gut capacity; the ingested carbon is dynamically allocated to lipid, protein and carapace pools. Growth is staged to allow size specific ingestion by predators. They have an energy cost for each metabolic activity (basal, digestion, swimming). Squid include an explicit embryonic phase (temperature dependent) that determines the size and stoichiometry of the hatchling. They feed visually on the copepods and smaller squid, until they grow too big and switch diet. As in the copepods, respiration is related to activities (basal, new tissue production, swimming, feeding), which vary independently. Squid paralarvae are eaten by top predators with exogenous demography (trophic closure). The model is being used to test Cushing's match-mismatch theory and other hypotheses about the relationship between recruitment and exogenous factors like the weather.

Importance of ocean circulation in biogeochemical/ecological modelling: An example from the North Sea

Morten Skogen

Institute of Marine Research, Bergen Norway

The interannual variability of the North Sea primary production was studied in Skogen and Moll (2000) by comparing outputs from two state of the art ecological models, NORWECOM(Skogen *et al.*, 1995) and ECOHAM1 Moll (1995, 1998); Wei *et al.* (2004). The conclusion was that the two models agreed on an annual mean primary production, its variability and the timing and size of the peak production. Also the integrated influence of the river inputs was equal, even if some spatial differences were apparent. The interannual variability could in both models to a large extent be explained from differences in the physical conditions between the years. On the other hand, the physical process that triggered the differences in the primary production between the years was not the same in the two models. In NORWECOM it was controlled by the inflow of nutrient rich Atlantic water, while in ECOHAM1 stratification was the main mechanism. Also, there was a low (even negative dependent of area) correlation in the production in different years between the two models. From these results it was stated that changes in the physical conditions and forcing resulted in a large variability in the primary production in the North Sea, and that a proper circulation model, including both a realistic horizontal advection, exchange with the Atlantic, and a proper simulation of the vertical density structures was essential for primary production studies in that area.

To try to better understand the observed differences between the two models, the two ecological models have been run in an identical physical setting. This is done by including the biochemical part of ECOHAM1 in the physical setting of NORWECOM, such that the resulting model has two ecological options with the same underlying physical model. With such a setting it should be possible to identify to which order the observed differences in Skogen and Moll (2000) was due to the different physical models, or the differences in the biochemical cycle.

In this new experiment both models have been run for 10 different years (1985-94), with identical ocean physics, river inputs and light. With this new setting, all conclusions from Skogen and Moll (2000) are duplicated (mean production, level of variability, timing and size of peak production). In addition, both models now show the same interannual variability in the production. From having a negative correlation between the mean North Sea production of $r = -0.49$ in Skogen and Moll (2000), this correlations is $r = 0.63$. Dividing the North Sea into the so called ERSEM boxes, the correlation within these boxes using the two ecological options (NORWECOM or ECOHAM1) is up to $r = 0.88$.

From this study it is concluded that the single most important factor for a reliable modelling of phytoplankton and nutrient distributions and transports within the North Sea is a high quality physical model. This is of special importance when models are used for management purposes with changed forcing in scenario simulations.

M.D.Skogen and A.Moll. (Submitted). Importance of ocean circulation in ecological modelling: An example from the North Sea. Journal of Marine Systems

References

Moll, A. 1995. Regionale Differenzierung der Prim¨arproduktion in der Nordsee : Untersuchungen mit einem drei-dimensionale Modell. Tech. rept. 19. Institut f¨ur Meereskunde, Troplowitzstr. 7, D-22529 Hamburg. Berichte aus dem Zentrum f¨ur Meeres- und Klimaforschung- Reihe B.

Moll, A. 1998. Regional distribution of primary production in the North Sea simulated by a three-dimensional model. J.of Marine Systems, 16(1–2): 151–170.

Skogen, M.D., and Moll, A. 2000. Interannual variability of the North Sea primary production: comparison from two model studies. Cont.Shelf Res., 20(2): 129–151.

Skogen, M.D., Svendsen, E., Berntsen, J., Aksnes, D., & Ulvestad, K.B. 1995. Modelling the primary production in the North Sea using a coupled 3 dimensional Physical Chemical Biological Ocean model. Estuarine, Coastal and Shelf Science, 41: 545–565.

Wei, H., Jun, S., Moll, A., and Zhao, L. 2004. Phytoplankton dynamics in the Bohai Sea - observations and modelling. Journal of Marine Systems, 44(3-4): 233–251.

Modelling of harmful algae blooms:

The case of Chattonella spp. in the North Sea and Skagerrak

Morten Skogen

Institute of Marine Research, Bergen Norway

As part of the EU-funded project HABILE http://www.nersc.no/HABILE/ a module for the Harmful Algae Chattonella was included in the ecological model NORWECOM (Skogen *et al.*, 1995; Skogen and Søiland, 1998). Chattonella is believed to have been introduced in the North Sea in the mid-1990s, and has caused fish mortality in fish farms along the southern coast of Norway in 1998 and 2001. Using available information on growth and abundance of Chattonella from the HABILE project, both sensitivity and a realistic simulation for the years 1998-2001 was done with NORWECOM.

The conclusions from this study were that:

- The model was able to reproduce both the large-scale spatial (north eastern North Sea) and temporal (one month duration) blooms of Chattonella
- The model was not able to simulate the right timing of the onset of the blooms
- Calm winds is a necessary, but not sufficient, condition for a Chattonella bloom to occur
- There are evidence that the death rate of Chattonella is turbulence dependent, but further laboratory work is needed to study this
- With a growth rate that is dependent on both temperature and salinity, it seems like there is a relationship between flooding of rivers and the triggering of Chattonella blooms.
- A fine scale model, with a proper resolution (horizontal and vertical) of the salinity profile is necessary for a realistic modelling of the Chattonella.

Skogen, M.D., and Søiland, H. 1998. A User's guide to NORWECOM v2.0. The NORWegian ECOlogical Model system. Tech. rept. Fisken og Havet 18/98. Institute of Marine Research, Pb.1870, N-5024 Bergen. 42 pp.

Skogen, M.D., Svendsen, E., Berntsen, J., Aksnes, D., and Ulvestad, K.B. 1995. Modelling the primary production in the North Sea using a coupled 3 dimensional Physical Chemical Biological Ocean model. Estuarine, Coastal and Shelf Science, 41: 545–565.

Annex 8: Action Plan Progress Review

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	OCC	Oceanography	WGPBI		2005:\C:04	2C04		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfatory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
1.1, 1.2, 1.5	Please see relevant AP items below this table	Present and discuss new results related to developments and validation in modelling PBI.	a)	X			3	
1.1, 1.2, 1.5		Create a WGPBI website for information exchange.	b)	X			4	www.icm.csic.es/bio/wgpbi
1.1, 1.2, 1.5, 1.12, 2.8, 2.9		Discuss draft review, prepared intersessionally, on nutrient load reduction.	c)	X			5	Review and conclusions are in the report. There will not be a separate paper.
1.1, 1.2, 1.5		Prepare a review of the state of the art in larval fish modelling.	d)	X			6	Review is beign done by Tom Miller co-chair of WGRP
1.1, 1.2, 1.5		Receive report from the Numerical Experiment subgroup.	e)	X			7	
1.1, 1.2, 1.5, 1.12		Cooperate with SGBEM to explore ecosystem models.	f)	X			8	
1.1, 1.2, 1.5		Cooperate with WGRP to enhance the use of physical-biological models for prediction of fisheries recruitment.	g)	X			9	A joint theme session for 2005 and a workshop in 2006.

AP items

1.1	Provide feedback to Science Committees about research needs and priorities that are identified in the advisory process. [MCAP/Advisory Committees]
1.2	Increase knowledge with respect to the functioning of marine ecosystems. This will be achieved through continued basic research on the biological, chemical, and physical processes of marine ecosystems and specific activities directed at improved understanding of observed and potential variability in the marine environment due to physical forcing and biological interactions. [MHC/OCC/LRC/RMC/BCC/DFC].* Particular planned activities include the following:
1.2.1	Understand and quantify the biology and life history, stock structure, dynamics, and trophic relationships of commercially and ecologically important species. [LRC/OCC/BCC/MHC/DFC]
1.2.2	Quantify the changes in spatio-temporal distribution of the stocks of important species in relation to environmental change, using survey and commercial data. [OCC/LRC/RMC/BCC/DFC]*
1.5	Develop and apply biophysical modelling, and improve capacity in such modelling to cover biological–physical interactions in the sea. [LRC/OCC/BCC/MHC/DFC]*
1.12	Address the substantial need for improved data and information on components of the marine ecosystem in the Baltic Sea including:
1.12.1	Meteorological and oceanographic conditions (exchange processes, input to the Baltic);
1.12.2	Nutrient productivity and toxic blooms;
1.12.3	Evaluation of the biomass and production of the main prey of intensively exploited fish stocks;
1.12.4	Evaluation of the condition of seabirds and marine mammals
1.12.5	Improved application of technology to surveys and monitoring;
1.12.6	Evaluation of the state of the Baltic Sea ecosystem. [BCC/OCC/LRC/RMC/MHC/FTC/DFC]
2.8	Continue and further improve assessments of the transport, fate, and biological effect of contaminants on the marine ecosystem through sampling, analyses, data collection, and evaluation of sampling, analytical, and data processing techniques. [MHC/OCC/LRC/BCC]
2.9	Determine the biological response to eutrophication taking into account oceanographic conditions. [OCC/MHC/LRC]*