

REPORT OF MODEL TASK TEAM



The meeting of the MODEL Task Team (hereafter MODEL) was held from 09:00–12:30 hours on October 28, 2007. The Co-Chairman, Dr. Thomas C. Wainwright, called the meeting to order and welcomed the participants (*MODEL Endnote 1*). The other Co-Chairman of MODEL, Dr. Wei Hao (China), was unable to attend the meeting. The draft agenda was reviewed and adopted without changes (*MODEL Endnote 2*).

MODEL accomplishments after PICES XV (Agenda Item 3)

Dr. Shin-ichi Ito reported on the Fisheries Research Agency (FRA) international workshop on “*Collaborative studies for ecosystem variation and climate change in the North Pacific*” held October 21–23, 2006, at the National Research Institute of Fisheries Science in Yokohama, Japan. The workshop was convened by Drs. Hiroya Sugisaki (FRA), Tsuneo Ono (FRA) and Ralf Georricke (Scripps Institution of Oceanography, U.S.A.), and a number of MODEL members and associates participated. The goals of the workshop were to:

- Compare long-term variation of CalCOFI/CCE-LTER and A-line/ODATE data;
- Identify a set of “seeds” for collaborative studies between A-line/ODATE programs and CalCOFI/CCE-LTER programs;
- Examine the meaning of temporal variations apparent in temporally and regionally restricted time-series observation data, with inputs from basin-scale and/or high-resolution model studies;
- Elucidate potential biases in the data and, if possible, make a list of contrivances to compensate for such biases in the data analysis.

Follow-up plans from the workshop include continued efforts to compare data sets from the two areas, and the development of a hypothesized scenario which is able to explain lower trophic level production in the Pacific Basin.

Dr. Michio Kishi informed the participants that the NEMURO and NEMURO.FISH models are now documented on the EUR-OCEANS Model Shopping Tool web site (www.eur-oceans.eu).

Mr. Jake Schweigert reported on the Tri-national Sardine Forum held in November 2006, in Vancouver, Canada. This was the first time that Canada has hosted the meeting, which included representatives from Canada, Mexico and the United States. The meeting was composed of two focus sessions, one on a coast-wide survey design, and a second on the role of sardines in the ecosystem, which relates to MODEL work on incorporating sardine and anchovy into the NEMURO model suite.

Dr. Wainwright presented an update on the continuing project “*Software framework for integrating marine ecosystem models*” which was funded by NOAA in 2005 and is expected to be completed in the spring of 2008. The project is embedding NEMURO code within the Earth Systems Modeling Framework (ESMF) which will make this code easier to integrate into other U.S. Climate Change research efforts. To date, investigators have completed the development of an independent set of computer codes that replicates the published NEMURO model, created an ODE Solver module that provides four distinct solution methods, completed construction and testing of an Ocean Physics gridded component module for station A7 within ESMF, and are currently embedding the NEMURO model into the ESMF superstructure.

Dr. Yasuhiro Yamanaka reported on recent progress with NEMURO applications in Japan. As part of a 5-year CREST (Core Research for Evolutional Science and Technology) project, coupled COCO-NEMURO applications with high spatial resolution ($1/4 \times 1/6$ degree) were developed for two domains: western North Pacific (led by Dr. Taketo Hashioka) and global (led by Dr. Hiroshi Sumata). These projects will

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utilize a number of plankton models, including NEMURO, eNEMURO, NEMURO(+Fe), NPZD, and PlankTOM5. These applications are currently in the testing stage, with complete analysis to be finished by 2011. In association with this project, Dr. Takeshi Okunishi is beginning to develop a sardine life-history and migration model using NEMURO.SAN. Work is also being conducted on a number of extensions to NEMURO. Dr. Naoki Yoshie is continuing to develop eNEMURO. Dr. Maki N. Aita is introducing iron cycles into NEMURO, and so far the results of this model match Southern Ocean observations much better than the original NEMURO. Dr. S. Lan Smith has introduced new multi-nutrient optimal kinetics into NEMURO for cell quota model (QeNEMURO).

Dr. Francisco E. Werner provided information on the integration of NEMURO into the Regional Ocean Model System (ROMS) model suite. The code is still being tested, but seems to be working properly. The code is available as part of the current ROMS code download package (<http://www.ocean-modeling.org>).

At PICES XVI, MODEL was involved with three events (details can be found in the *Session Summaries* chapter of this Annual Report):

- A 1-day CCCC/FIS Topic Session (S3) on “*Towards ecosystem-based management: Recent developments and successes in multi-species modeling*”;
- A 1-day POC/CCCC/MONITOR Topic Session (S9) on “*Operational forecasts of oceans and ecosystems*”; and
- a 1½-day POC/CCCC Workshop (W6) on “*Climate scenarios for ecosystem modeling*”.

Discussion of FUTURE (Agenda Item 4)

MODEL reviewed the latest available version (version 4.2) of a Science Plan for a new PICES scientific program, FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Ecosystems). Comments from MODEL are related more to implementation than to the plan itself. Beyond continuing the current MODEL Task Team

work, the following ideas have to be considered for FUTURE:

- There should be clear linkages between lower trophic modeling work and climate-related analyses (such as those of WG 20). There is a need to develop unified physics–biochemical–ecosystem models.
- For developing modeling approaches in FUTURE, there is a need to look at forecasting uncertainty as part of a more diverse/flexible modeling approach that is able to respond to “surprises” (unexpected results or events that do not fit into existing modeling approaches) and that can identify emergent behaviors of the modeled system. “Thinking outside the box”, important to recognize when moving to new approaches, is required.
- There is a need to make management a part of modeling by including bio-economic models and fish stock dynamics models in the FUTURE tool suite.
- The goal should be to move toward fully-integrated (end-to-end) Earth Systems models. This will require experts in areas not presently represented among the PICES modeling community, and who should be invited to participate in the coming activities.

Planning for 2008 and beyond (Agenda Item 5)

Inter-sessional workshops

No inter-sessional workshops are planned for 2008.

Topic Sessions at PICES XVII

Dr. Wainwright presented a proposal for a 1-day workshop on “*Assessing and expressing uncertainty in marine ecosystem forecasts: Moving models forward to the FUTURE*” to take place at PICES XVII in Dalian. However, the Task Team felt that a broader scientific session would be more useful for the transition from the CCCC Program to FUTURE and recommended convening a 1-day joint CCCC/POC Topic Session with co-convenors from all PICES countries to encourage wide participation. The proposed session is described in *MODEL Endnote 3*.

Proposed future scientific work

A number of suggestions for future modeling work within PICES were discussed. These will not be pursued under the CCCC Program, but could become part of FUTURE. Dr. Kishi noted the importance of modeling sea ice dynamics and its effects on Arctic ecosystems. With the apparent sudden disappearance of Arctic Ocean sea-ice, PICES should be prepared for such an effort. He also suggested a project on “*Bottom-up ecosystem-based management modeling using NEMURO and NEMURO.SAN (BUMBAM.NEMURO)*”. This project would transition existing PICES models into management analysis, and would link the NEMURO suite of models with management-oriented models such as Ecopath with Ecosim. Such work should be a high priority.

Dr. Werner described opportunities for collaborative work under U.S. GLOBEC’s pan-regional synthesis phase and the upcoming U.S. CAMEO (Comparative Analysis of Marine Ecosystem Organization) program. Both efforts are focused on cross-system ecosystem comparisons. U.S. GLOBEC pan-regional synthesis projects can compare any of the U.S. GLOBEC study areas with other world ecosystems. Proposals are due in January 2008, and total funding for the program is expected to be about \$2 million per year for 3 years. CAMEO has an explicit management focus, but a higher overall budget (about \$10 million per year for 5 years). It is expected that the focus will be on supporting a few large sustained 5-year projects rather than a large number of small projects. The call for proposals may be issued near the end of 2007, with proposals due in the spring of 2008.

Dr. Bernard A. Megrey described the Ecosystem Studies of Sub-Arctic Seas (ESSAS), which is now a new regional program under GLOBEC. The program has three Working Groups (climate change, biophysical coupling, and ecosystem modeling) with substantial PICES member involvement. This is a possible source for collaboration with MODEL.

Dr. Megrey also requested MODEL support for the creation of a new PICES project on “*Marine ecosystem model inter-comparisons*” (MODEL Endnote 4). This was originally written as a working group proposal, but was modified to a PICES project on advice from the Secretariat. MODEL strongly endorsed the proposed work as necessary for the implementation of FUTURE, and supports creating an independent project so that work can proceed before FUTURE is fully in place. MODEL suggested a 3-year time frame which would be sufficient to accomplish the initial project goals, but will still allow the work to be integrated into FUTURE when that program is operational. It was further suggested that a small planning group be formed immediately to prepare for an initial workshop, co-sponsored by PICES and ESSAS, to be held at PICES XVII (MODEL Endnote 5).

Other planned meetings/workshops

Dr. Kishi is the lead organizer of the second CREAMS/PICES Summer School to be held in August 2008, in Hakodate, Japan. The theme of the school is biomass-based management, and lectures will focus on calculation of the “ecological footprint” and how to design an ecosystem management program (BIO Endnote 7).

Requests for travel (Agenda Item 6)

Travel support is requested for:

- 1 invited speaker for the CCCC/POC Topic Session on “*Marine system forecast models: Moving forward to the FUTURE*” (tentative title) at PICES XVII;
- 1 invited speaker for the CCCC/ESSAS workshop on “*Marine model inter-comparison project*” at PICES XVII.

Rotation of membership (Agenda Item 8)

It was noted that MODEL lacks members from Canada and Russia, and that some members from other countries are not regular attendees at the meetings. Given that MODEL will be reorganized with the closing of the CCCC Program next year, there is no urgency to request new members at this time.

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MODEL Endnote 1

Participation list

Members

Shin-ichi Ito (Japan)
Michio J. Kishi (Japan)
Bernard A. Megrey (U.S.A.)
Goh Onitsuka (Japan)
Jake Schweigert (Canada)
Thomas C. Wainwright (U.S.A., Co-Chairman)
Francisco E. Werner (U.S.A.)
Yury I. Zuenko (Russia)

Observers

Vera Agostini (U.S.A.)
Fei Chai (U.S.A.)
Taketo Hashioka (Japan)
Yasuhiro Yamanaka (Japan)

MODEL Endnote 2

MODEL meeting agenda

1. Welcome and introduction
 2. Adoption of agenda
 3. Review of MODEL accomplishments after PICES XV:
 - a. FRA international workshop on “*Collaborative studies for ecosystem variation and climate change in the North Pacific*” (November 2006, Yokohama, Japan)
 - b. NEMURO model information included in EUR-OCEANS project
 - c. Tri-national Sardine Forum (November 2006, Vancouver, Canada)
 - d. Status of NOAA project “*Software framework for integrating marine ecosystem models*”
 - e. Progress in coupling NEMURO and NEMURO.FISH models with higher resolution ocean circulation models
 4. Discussion of FUTURE
 5. Planning for 2008 and beyond
 - a. Inter-sessional workshops
 - b. PICES XVII (October 2008, Dalian, China) – proposals for Topic Sessions and workshops.
 - c. Proposals for future scientific work
 - d. 2008 CREAMS/PICES Summer School
 - e. PICES XVIII (October 2009, Korea)
 6. Requests for travel to future meetings
 7. Other new business
 8. Rotation of membership
 9. Announcements
 10. Adjournment
- under CREST program (Y. Yamanaka) and within ROMS
- f. Brief discussion/review/preview of workshops and scientific sessions at PICES XVI

MODEL Endnote 3

Proposal for a 1-day CCCC/POC Topic Session at PICES XVII on “*Marine system forecast models: Moving forward to the FUTURE*”

As marine system models mature, they are increasingly used to forecast future conditions, both for understanding potential effects of climate change and for projecting system responses to management activities. In particular, the PICES FUTURE Program is focused on forecasting and understanding the responses of North Pacific marine systems to

climate change and human activities. This work will reach beyond the models currently used by the PICES community to include models that provide system forecasts, assess uncertainty, and link together multiple levels of system organization. Achieving meaningful forecasts that are useful for management of marine resources will require cross-disciplinary

approaches that link processes ranging from atmospheric and ocean physics, through biology to socio-economic systems. This session will focus on multidisciplinary coupled models designed to forecast marine systems in the PICES region, including both strategic (long-term) and tactical (short-term) forecasts linking

across two or more disciplines (such as physical oceanography, climate, ecosystem dynamics, marine resource management, or socio-economic systems). Presentations describing approaches to assessing and communicating the reliability (or uncertainty) of coupled marine system forecasts are particularly encouraged.

MODEL Endnote 4

Proposal for a PICES project on “*Marine ecosystem model inter-comparisons*”

Rational and justification

Past PICES modeling activity has concentrated on the development of the NEMURO family of models. The strategy of NEMURO was to develop and apply the same model to multiple locations in order to remove the “model” confounding effect and isolate localized or species effects. This process is moving forward and applications of the NEMURO family of models are progressing in several ecosystems in the North Atlantic as well as in the North Pacific (NEMURO special volume in *Ecological Modelling*, Vol. 202, ICES Annual Science Meeting, 2007).

Alternatively, when a single “correct” model cannot be identified *a priori*, a suite of models can be applied to the same system to determine not only which models are appropriate, but also the range of outcomes that may be expected. This is similar to the IPCC procedure for evaluating alternative climate models, a process that has been widely accepted. We propose to implement the same model evaluation process, except that we plan to use marine ecosystem models instead of climate prediction models. Thus, the idea behind the proposed project is to apply multiple ecosystem models to the same location/species and to use an ensemble model forecast to identify and compare predicted and observed responses of marine ecosystem types to global changes. To our knowledge this exercise has not been carried out with marine ecosystem models although other recent model comparison exercises have been undertaken using NPZ models (Friedrichs 2001; Friedrichs *et al.* 2007; Friedrichs and Hofmann 2001; Friedrichs *et al.* 2006; Hood *et al.* 2006) and

Ecopath models (Taylor and Wolff 2007). Also Plagányi (2007) recently conducted an in depth qualitative analysis of the characteristics, data requirements and outputs of a large number of models appropriate for addressing management of fisheries in an ecosystem context.

Modeling is a central approach for comparative analyses of ecosystems, *i.e.* concerning the structures, functioning and impact responses of marine ecosystems. It is important for process and modeling studies to identify if inter-relationships amongst physical and biological variables are the same in different locations or whether certain relationships vary geographically, or if the conclusions are dependent on the particular applied modeling tool.

The ability to evaluate the range of ecosystem response from different modeling approaches will produce valuable outcomes. Through this process, we hope to be able to identify and characterize components of the major marine ecosystems which are likely to be affected at an early stage by global changes, to understand the responses to global change of each component of the ecosystem, focusing primarily on zooplankton which provide the prey base for upper trophic level fish species, and to use ecosystem models to pinpoint and compare predicted and observed responses of marine ecosystem types to global changes. We will also be able to detect which of the candidate models are the most successful at hind-casting in each of the ecosystems chosen for study.

A key outcome of these comparisons will be to identify “early-warning” indicators of large-scale ecosystem changes, and to learn the extent

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to which these indicators are similar among a variety of ecosystems when multiple systems are analyzed. Early identification of potential indicators will provide opportunities for monitoring and assessment through planned field and modeling activities.

Comparative analysis is a valuable scientific activity since the size and complexity of marine ecosystems precludes conducting controlled *in situ* experiments. Comparative analysis is also a powerful procedure to underscore important similarities and differences between and among ecosystems.

We propose to use several species of copepods and Pacific krill (*Euphausia pacifica*) as the modeled indicator species. Modeling the lower trophic level with minimally ecologically complex models makes the modeling task easier with respect to parameterizing and configuring multiple models. These candidate species are widely distributed in the North Pacific, are well studied, and have what we believe to be ecological equivalents in the North Atlantic, thus facilitating collaboration with North Atlantic colleagues. For many, there also exist substantial, high quality time series. The final decision of the indicator species on which to focus will be decided by the working group once data sets are assembled and evaluated.

Project activities

- Prepare terms of reference;
- Evaluate and select potential models for comparison and their data needs. The Eur-Oceans Model Shopping Tool (www.eur-oceans.eu/WP3.1/shopping_tool/about.php) provides a large array of documented candidate models to choose from;
- Identify location(s) for comparisons;
- Identify comparison protocols;
- Compare model data needs against location data availability and compatibility;
- Identify the most appropriate indicator species, such as krill, to be used as the “metric” for correct model behavior. Appropriate reasons for selection might include: Pacific basin-wide distribution, well studied-known life history and biology,

abundant data for model validation and calibration;

- Plan “pseudo-controlled” experiment;
- Evaluate results;
- Make recommendations;
- Note implications for resource managers or those studying the impact of climate change on marine ecosystems;
- Report results in PICES scientific reports and peer-reviewed scientific papers.

Participants

This depends partially on the geographic location on which the project is going to focus. We anticipate involvement of a total of 15–20 scientists, with one or two from each PICES member country and other scientists to be selected because of their familiarity with models that have originated outside the PICES region. Additional experts on the data sets available and on the life history of chosen organisms may be invited to participate during the process of selecting model organisms and ecosystem(s) to be modeled.

Sponsorship: ESSAS, PICES

Critical scientific linkages

- ESSAS Working Group on *Modeling Ecosystem Response*,
- PICES MODEL Task Team
- PICES Working Group on *Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim*

References

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- planktonic groups. *Journal of Geophysical Research-Oceans* 112(C8): doi:10.1029/2006JC003852.
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MODEL Endnote 5

Proposal for a 1-day CCCC/ESSAS workshop at PICES XVII on “*Marine ecosystem model inter-comparisons*”

Comparative analysis is a valuable scientific activity because the size and complexity of marine ecosystems precludes conducting controlled *in situ* experiments. It is also a powerful technique for understanding the important similarities and differences between and among ecosystems. Modelling is a central approach to comparative analyses of ecosystem structure, function and responses. It is important to understand whether inter-relationships among physical, chemical and biological variables vary geographically, and the extent to which any particular conclusions depend on the model used to derive them. The model inter-comparison project will use different models to develop forecasts of different ecosystems and will use different models to compare forecasts of the same location/species. The intention of the project is to develop ensemble model forecasts to compare predicted and observed responses of marine ecosystem types to global changes—similar to the widely-accepted approach used by the IPCC (Intergovernmental Panel on Climate Change) to evaluate alternative climate models. The project will implement the same model evaluation process with marine ecosystem models rather than climate prediction models. A

major goal of the workshop is to begin planning the work of the project. Workshop activities will include: (1) nomination and discussion of potential models (and their data needs) to compare (the Eur-Oceans Model Shopping Tool, http://www.eur-oceans.eu/WP3.1/shopping_tool/about.php, provides a large array of documented models from which to choose); (2) nominate location(s) for comparisons; (3) identify comparison protocols to compare model performance, given data needs against location data availability and compatibility; (4) identify the most appropriate indicator species on which to base comparisons, such as krill, as the “metric” for correct model behavior; and (5) plan “pseudo-controlled” experiments. Workshop participants should have at least one of the following characteristics: (1) be familiar with ecosystem models from beyond the PICES region; (2) be knowledgeable about running models; (3) be experts on the life histories of selected organisms and data associated with them; and (4) have a broad perspective on marine ecosystems.

Recommended convenors: Bernard A. Megrey (U.S.A.) and an Asian scientist (TBD).

