REPORT OF THE IMPLEMENTATION PANEL ON THE CCCC PROGRAM

The Executive Committee of the Climate Change and Carrying Capacity Program Implementation Panel (CCCC-IP/EC) met from 18:30-21:00 hours on October 12 and from 13:20-14:30 on October 14, 2003, in Seoul, Korea. The meeting was chaired by Drs. Harold P. Batchelder and Makoto Kashiwai. Dr. Batchelder thanked Dr. Kashiwai for his service as CCCC-IP Co-Chairman, during which he effectively pushed the CCCC Program toward the implementation and synthesis phase. Dr. Batchelder also noted that one of the agenda items that would be addressed during this meeting was the election of a new CCCC-IP Co-Chairman to replace Dr. Kashiwai. He welcomed attendees, and after brief introductions of those present (*CCCC-IP Endnote 1*), reviewed the agenda. The agenda was adopted with slight modifications (*CCCC-IP Endnote 2*).

Review of procedures for Best Presentation Awards and Closing Ceremony

Dr. Batchelder reported on the results of the discussion of this item at the first Science Board session. The procedure of nomination/selection for the CCCC Best Presentation Award by a young scientist was determined. It was difficult to know which papers were eligible for this award, since no information on the age of the presenter was available from the submitted abstracts. It was recommended that Science Board request the PICES Secretariat to ask authors submitting abstracts in future years to indicate whether they are eligible for consideration of Best Presentation Awards by including a checkbox on the abstract submission form for scientists who are less than 35 years old.

Dr. Rolf Ream (National Marine Mammal Laboratory, Alaska Fisheries Science Center, U.S.A.) won the CCCC Best Presentation Award for his paper entitled "Oceanographic influences on northern fur seal migratory movements" (co-authored by J. Sterling and T. Loughlin).

Documentation of PICES XII Sessions (Agenda Item 4)

CCCC-IP/EC discussed responsibilities for documenting CCCC-sponsored scientific sessions at PICES XII. It was agreed that convenors of the REX (Dr. William T. Peterson) and MODEL (Dr. Bernard A. Megrey) Topic Sessions and BASS Workshop (Dr. Gordon A. MacFarlane) would provide session summaries by the end of Thursday, October 16, to Dr. Batchelder, who will direct those summaries to the PICES Secretariat.

Progress reports of Task Team activities (Agenda Item 5)

CCCC-IP/EC received overviews of CCCC Task Team activities from the BASS, REX, MONITOR and MODEL Task Team Co-Chairmen. On October 16, all Task Teams provided final reports that included a summary on progress in 2003 and recommendations and planned activities for 2004, and even some for 2005. These reports appear elsewhere in this Annual Report.

Changes in CCCC-IP/EC membership (Agenda Items 6 and 7)

The Executive Committee recommends that:

- Dr. Kashiwai (Japan), who has completed his term of office as CCCC-IP Co-Chairman, be heartily thanked for his efforts on behalf of the CCCC Program;
- Dr. Suam Kim (Korea) be appointed as new Asian Co-Chairman of CCCC-IP for a term extending from October 2003 to October 2006 (conclusion of PICES XV).

CCCC-IP/EC approves:

- BASS' request to replace Dr. Gordon A. McFarlane (Canada) by Dr. Kerim Aydin (U.S.A.) as BASS Co-Chairman;
- MONITOR's request to replace Dr. David L. Mackas (Canada) by Dr. Phillip R. Mundy (U.S.A.) as MONITOR Co-Chairman;
- REX's request to replace Dr. William T. Peterson (U.S.A.) with Dr. Douglas E. Hay (Canada) as REX Co-Chairman.

Due to the changes in Task Team Chairmen above, CCCC-IP/EC requests that the new Co-Chairmen be added to, and that vacating Co-Chairmen be removed from, the Executive Committee.

Proposals for new subsidiary bodies (Agenda Item 8)

The Executive committee did not receive any proposals for new subsidiary bodies.

Topic Session and Workshop proposals for PICES XIII (Agenda Item 9)

The following Topic Sessions and Workshops are proposed to be convened:

- a ½-day MODEL Topic Session on "Modeling approaches that integrate multiple spatial scales and trophic levels between shelf and open oceans" (*MODEL Endnote 3*);
- a 1.5-day CCCC Topic Session on "CCCC, GLOBEC, and GLOBEC-like results: First steps toward a synthesis of the impacts of large-scale climate change on North Pacific marine ecosystems" (*CCCC Endnote 3*);
- a 2-day BASS/REX/MODEL Workshop on "Linking open ocean and coastal systems II" (*BASS Endnote 4*);
- a 1-day MODEL Workshop to prepare a strategy and products for the future NEMURO and NEMURO.FISH training sessions;
- a 1-day REX Workshop on "The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim" (*REX Endnote 3*);
- a 1-day MONITOR/POC Workshop on "North Pacific GOOS: Needs and activities".

MODEL has a proposal titled "International workshop on climate interactions and marine ecosystems: Effects of climate on the structure and function of marine food webs and implications for marine fish production in the North Pacific Ocean and marginal seas" pending with the Asian Pacific Network (APN). If successful (should be known in April 2004), a 4-day workshop for about 15 participants is proposed for the week preceding PICES XIII. In the event that this proposal is successful, it is anticipated that this workshop will be held prior to the BASS/REX/MODEL Workshop and will incorporate the MODEL Workshop on preparing training sessions. PICES has committed funding for two Canadian scientists to attend the APN workshop.

Theme proposals for future Annual Meetings (Agenda Item 10)

CCCC-IP/EC suggests that the theme for the PICES XIV Science Board Symposium (October 2005, Vladivostok, Russia) be related to "Progress in prediction" (*e.g.*, "Progress in prediction: What can we predict, what do we think we can predict, and what isn't predictable?").

CCCC-IP/EC also suggests that the theme for the PICES XV Science Board Symposium (October 2006, Japan) be related to the North Pacific Ecosystem Status Report. This Symposium would be the opportunity to obtain feedback on the NPESR (about 2.5 years after initial publication; and perhaps 6 months prior to publication of the "2nd Edition"). Also, this theme would provide for an evaluation of the usefulness, value, and impact of the NPESR within the North Pacific, as well as an evaluation of its impacts more globally.

Discussion of CCCC integration and NEXT report (Agenda Item 11)

There was only limited discussion of the report produced by the **N**emuro **Ex**perimental **P**lanning

Team (NEXT) at the various Task Team meetings because of a lack of time. CCCC-IP/EC members were asked to communicate additional comments (if any) on the NEXT report to Dr. Batchelder by November 20, 2003. The final report is included as *CCCC Endnote 4*.

Specific discussion occurred within the CCCC Task Team business meetings or in the EC meeting on four issues that relate to the NEXT report. These are:

- merging BASS and REX into a new Task Team that will better achieve the synthesis of CCCC objectives;
- having an inter-sessional scientific symposium (proposed for April 2006) to provide an international forum for the presentation of CCCC synthesis findings from national programs, and to foster multinational synthesis;
- model-data comparisons that are a high priority for evaluating the CCCC products, and will be crucial to CCCC synthesis; and
- substantial capacity building that is required before model-data comparisons can be accomplished.

Some of these discussions produced specific recommendations that are listed below (Agenda Item 19).

CCCC activities and travel support requests (Agenda Item 12)

The following meetings are to be convened inter-sessionally (between October 2003 and October 2004):

- MONITOR will hold a 3-day workshop on "Development of pilot coastal monitoring program(s) in the NE Pacific" (November 20-22, 2003, in Victoria, Canada) to consider PICES' role in coordinated monitoring efforts in the Northeast Pacific. Funding for the workshop is provided by the Pacific Coastal Observing System (PaCOS) and the Gulf Ecosystem Monitoring Program (EVOS-GEM).
- MODEL will hold a workshop in December 2003 in Yokohama, Japan, to further manuscript development for a special issue of *Ecological Modeling* devoted to NEMURO and NEMURO.FISH. This workshop is funded by the Fisheries Research Agency of Japan, and no funding is requested from PICES.
- MODEL will hold a small (4-6 attendees) workshop in August 2004, in Seattle, U.S.A., to 1) document and disseminate various NEMURO model codes, and 2) conduct editorial functions for the *Ecological Modelling* manuscripts. A major product of the MODEL Task Team is the NEMURO code and its various successors NEMURO.FISH, etc. However, to date this code has been developed (and implemented) by a rather small core team. In order to broaden the availability and value of this model development, two actions must occur. The first is that the scientific contribution and value of these codes must be demonstrated and documented by publications in the peer-reviewed literature. MODEL has developed a plan for this. The second step that is needed is to better document and disseminate the NEMURO and NEMURO.FISH codes. This will involve substantial time to improve the legibility/structuring of the code, and a concerted effort in capacity building. The NEXT report (see *CCCC Endnote 4*) recommends holding training sessions, which would bring together modelers and observationists to provide the needed expertise to accomplish basin-wide comparisons of model output with existing datasets. The proposed workshop will address these two crucial actions. Financial support is requested for travel of 2 scientists; it is currently anticipated that one scientist will be from Japan, and the second from the US east coast. It is possible that APN funds may be awarded to this pending project to support one of these travelers, but that is not yet known (should be known by April 2004).

CCCC-IP requests support for the following travel:

- 1 CCCC scientist to attend the PICES co-sponsored international symposium on "Quantitative ecosystems indicators in

fisheries management" in April 2004, in Paris, France;

- 1 CCCC scientist to attend the ICES symposium on "The influence of climate change on North Atlantic fish stocks" in May 2004, in Bergen, Norway;
- CCCC Co-Chairmen to participate in the 2004 interim Science Board Meeting;
- 2 invited speakers to attend the CCCC Topic Session on "The impacts of large-scale climate change on North Pacific marine ecosystems" at PICES XIII;
- 2 invited speakers to attend the joint BASS/REX/MODEL workshop on "Linking open ocean and coastal ecosystems II" at PICES XIII; one scientist will be an expert on sardines (perhaps from the Atlantic) and the second scientist will represent individual-based modeling approaches to fish growth;
- 1 invited speaker for the MODEL Topic Session on "Modeling approaches that integrate multiple spatial scales and trophic levels between shelf and open oceans" at PICES XIII;
- 2 scientists to attend an inter-sessional MODEL Workshop to be held in August 2004, in Seattle, U.S.A.;
- 2 invited speakers to attend the REX workshop on "The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim" at PICES XIII;
- 2 invited scientists to attend the MONITOR workshop on "North Pacific GOOS: Needs and activities" at PICES XIII;
- 1 MONITOR representative to attend the ICES-IOC Steering Group on GOOS meeting to be held in April 2004, in Spain;
- 1 MONITOR representative to participate in NEAR-GOOS activities in conjunction with the 6th WESTPAC Symposium in April 2004, in Hangzhou, People's Republic of China.

Discussion of the North Pacific Ecosystem Status Report (Agenda Item 13)

On October 10-11, 2003, just prior to the PICES Twelfth Annual Meeting, the MONITOR Task Team held a 2-day workshop to "Examine and critique a North Pacific Ecosystem Status Report". The workshop included invited presentations, synopsis of the draft NPESR, regional summaries and discussions of the approaches and hypotheses. Extensive plenary discussion occurred on how to produce future editions of the NPESR, ensure quality control, peer review of the document, and mechanisms of outreach and feedback. A brief summary of the workshop is included elsewhere in this Annual Report. Specific recommendations will be forthcoming in the MONITOR Scientific Report of the workshop. Additional comments from CCCC-IP/EC members on the NPESR should be communicated to Drs. Skip McKinnell and Ian Perry by November 20, 2003.

CCCC-IP/EC would like to applaud the efforts of the authors of the individual regional summaries and all the other contributors to the NPESR, and Drs. McKinnell and Perry for accomplishing this important task of PICES.

Discussion of report from Study Group on *PICES Capacity Building* (Agenda Item 14)

Most, if not all, CCCC Task Teams discussed the report produced by the Study Group on *PICES Capacity Building*. All recognized that there exist among the PICES nations disparate levels of scientific expertise in important aspects, such as modeling, data management, analysis skills, etc., which are of concern to CCCC-IP. All Task Teams acknowledged that effective capacity building will require a sustained effort, and will have associated real costs - and probably not insignificant costs. It was the opinion of some within CCCC-IP that Science Board and Governing Council need to evaluate the priority of capacity building, in relation to resources available. CCCC-IP/EC suggests that Science Board forward a request to Governing Council for increased annual dues by the contracting parties, with the increased dues earmarked for PICES capacity building.

The Executive Committee is pleased with the comments of the capacity building report that scientific participation in PICES needs to be broadened. There is a perception that PICES is of greater interest to government-supported

scientists and that academic scientists frequently must find their own travel funds to be able to attend PICES meetings and workshops. It is important that efforts be made to encourage broader participation in PICES activities by junior scientists, senior scientists (who often have connections to national funding bases), and program managers from relevant research funding organizations.

In addition to the excellent capacity building mechanisms suggested for training and education in the Study Group report, it is proposed that training and education could be implemented effectively through (1) extended visits to host countries by scientists bringing expertise in specialized areas of research, and (2) regular yearly "summer courses" (perhaps 1 month in duration every summer) on focus-topics that would provide immersion of graduate students, post-docs, and young scientists. Funding for these approaches would need to be identified by PICES. Possibilities are additional funds from PICES member countries as well as government agencies and private foundations. An example of an extramural funding effort that includes both scientific advancement and capacity building is being pursued by the CCCC MODEL Task Team. MODEL members, Drs. Megrey and Werner, have a proposal pending with the Asia Pacific Network (APN), which includes an education and capacity building component for the training of two visiting scholars (one each from China and Russia).

Additional comments on the report should be communicated before November 20, 2003, to Dr. Batchelder, who then will forward these comments to the Science Board Chairman.

Discussion of report from Study Group on *PICES Strategic Issues* (Agenda Item 15)

The PICES Strategic Plan (Vision Statement) was discussed in each CCCC Task Team's business meeting - more so in some than in others. It was also discussed in the CCCC-IP/EC meeting. Generally, in the CCCC-IP/EC meeting there was a consensus that this Statement was a good start, especially in that it presents a framework for PICES to eventually provide scientific leadership and guidance for wise use of the resources of the North Pacific, and thus putting relevance to PICES role in North Pacific marine science. It was also recognized that the PICES Vision Statement was likely to be revised as needed over the next year or so, and that the future Strategic Plan should again be evaluated by the scientific committees and programs of PICES.

Specific comments by CCCC-IP EC members should be communicated by November 20, 2003, to Dr. Batchelder, who will then direct these comments on to the Science Board Chairman.

Relations with other organizations and programs/projects (Agenda Item 16)

CCCC-IP identified linkages with ICES, GLOBEC, NPRB and the EVOS Gulf Ecosystem Monitoring (GEM) initiatives as high priorities for the coming year. Also, there are several regional coastal observing programs in the Northeast Pacific (PaCOS, PNW-IOOS, AOOS), as well as numerous programs in the Northwest Pacific (CREAMS, NEAR-GOOS, others), that CCCC-IP should maintain close relations with. The continued development of closer links with GOOS and the Sloan Foundation's Census of Marine Life initiative are also viewed as promising areas to support. Finally, CCCC-IP must interact closely with NPAFC to address salmon issues of interest to the CCCC Program in the North Pacific.

Request for scientific advice from the United States (Agenda Item 18)

CCCC-IP/EC discussed the request from the United States for PICES' scientific advice on 1998-1999 regime changes in conditions in the North Pacific and their implications for fisheries, and potential PICES response. Consensus is that an active and positive response by PICES is both an obligation and an important opportunity.

The US request is a clear recognition of PICES' expertise and scientific leadership on the topic of ecosystem regime shifts. Collectively, PICES scientists can provide a comprehensive and up-

to-date assessment of what is known. Equally important, we can provide a realistic assessment of what is "unknown" or (at least for now) "unknowable", and the best strategies for reducing or working around these areas of uncertainty.

The request for advice is also a clear evidence that governments are open to strong (and independent) scientific input regarding ecosystem variability, and the development of robust management strategies. Effective response by PICES will help build our case for continuing and expanding support from member nations.

Recommendations to Science Board (Agenda Item 19)

- CCCC-IP ***recommends*** that Science Board support the request of interest and participation of PICES for the proposed 2005 workshop to conduct global comparisons and identify global synchrony in fluctuations of zooplankton populations (*SB Endnote 11*). It is anticipated that this workshop will be supported also by other organizations, including ICES and GLOBEC International.
- CCCC-IP ***recommends*** that PICES serve as prime sponsor of a 2-3-day symposium on CCCC synthesis in April 2006 (probably in Honolulu).
- CCCC-IP ***recommends*** the approval of changes in CCCC-IP/EC membership requested under Agenda Items 6 & 7 above. However, see also next recommendation regarding the future status of BASS and REX.
- BASS and REX believe that the goals of the CCCC Program during the synthesis phase will be best achieved by merging these two Task Teams. The division of effort between the deep ocean (BASS) and coastal regions (REX) is artificial (and often blurred), and understanding large-scale forcing effects on important coastal marine resources and ecosystems requires the larger scale view that a merged Task Team will provide. Thus, CCCC-IP supports the BASS and REX proposal, and ***recommends*** that the BASS and REX Task Teams be dissolved, and that a new CCCC Task Team, titled **CFAME** for **C**limate **F**orcing and **M**arine **E**cosystem Response be created. Terms of Reference, suggested Co-Chairmen (several names have been nominated already), and membership of CFAME will be developed in the next several months by an interim committee that includes the existing members of both REX and BASS, with leadership by the current REX and BASS Co-Chairmen, and will be recommended to Science Board at the interim Science Board meeting in spring 2004.
- MONITOR considered its future role within PICES. The function of MONITOR needs to extend beyond the duration of the CCCC Program. MONITOR has assumed the primary responsibility for the evaluation (and perhaps future versions) of the NPESR, as well as providing guidance for present and future monitoring programs in the North Pacific. Since these goals go far beyond those originally anticipated as part of the CCCC Program, CCCC-IP ***recommends*** to Science Board that the existing MONITOR Task Team be moved outside of CCCC—*e.g.*, MONITOR should become a Technical Committee, much like TCODE. Should this recommendation be approved it is suggested that each Scientific Committee, each Technical Committee and each scientific program designate one official representative to the new MONITOR Technical Committee. This change would suggest also that the Chairman of MONITOR be added as a member of Science Board.
- CCCC-IP ***recommends*** that the membership for each CCCC Task Team be reviewed, in order to evaluate participation, and to ensure that each country is represented by active members to the greatest extent possible. As in prior years, participation by some nations in particular Task Team workshops and/or business meetings was lacking. This is a recurring problem that is best addressed by ensuring that 1) activities of the CCCC Task Teams are of relevance to all member nations, and 2) the most appropriate and

interested scientists from each nation are on the Task Teams.

- CCCC-IP ***recommends*** that PICES accept the task of providing guidance/advice regarding the nature and duration of the recent regime shift and its impact on the coastal ocean and marine fisheries, which was recently requested by the United States.

Other business (Agenda Item 20)

Request for CCCC information from GLOBEC
At the request of the Executive Director of GLOBEC International, CCCC-IP Co-Chairmen will provide information for a 1-page flyer on GLOBEC regional programs.

Request for CCCC endorsement
The formal request for PICES to support an invitation to participate in a proposal for a workshop to "Identify global synchrony in fluctuations of zooplankton populations" (*SB Endnote 11*) is being made through the BIO Committee, but CCCC-IP wanted Science Board to know that CCCC-IP is very interested in seeing the goals of this effort achieved.

CCCC Endnote 1

Participation List

Members

Harold P. Batchelder (CCCC-IP Co-Chairman)
Shin-ichi Ito (MODEL Co-Chairman)
Makoto Kashiwai (CCCC-IP Co-Chairman)
Gordon A. MacFarlane (BASS Co-Chairman)
David L. Mackas (MONITOR Co-Chairman)
William T. Peterson (REX Co-Chairman)
Sei-ichi Saitoh (MONITOR Co-Chairman)
Francisco E. Werner (MODEL Co-Chairman)
Akihiko Yatsu (BASS Co-Chairman)

Observers

Kerim Aydin (U.S.A.)
Suam Kim (Korea, in-coming CCCC-IP Co-Chairman))
Stewart M. McKinnell (Deputy Exec. Secretary)
R. Ian Perry (Science Board Chairman)
Chang-Ik Zhang (Korea)

CCCC Endnote 2

CCCC-IP/EC Meeting Agenda

1. Welcome and opening remarks
2. Adoption of agenda
3. Business from last year's meeting
4. Review of responsibilities for documenting CCCC scientific sessions
5. Progress reports of Task Teams activities from past year and plans for next two years
6. Review of current CCCC-IP membership; election of new CCCC-IP/EC Co-Chairman
7. Replacements for Task Team Chairmen
8. Proposals for new CCCC subsidiary bodies
9. Topic Session and Workshop proposals for PICES XIII
10. Themes for future PICES Annual Meetings
11. Discussion of CCCC integration and the NEXT report and recommendations
12. Review of planned CCCC activities and travel support requests
13. Discussion of North Pacific Ecosystem Status Report
14. Discussion of report from Study Group on *PICES Capacity Building*
15. Discussion of report from Study Group on *PICES Strategic Issues*
16. Relations with other international programs
17. PICES web site revisions
18. Request for scientific advice from the United States
19. CCCC report and recommendations to Science Board
20. Other business

CCCC Endnote 3

Proposal for a 1.5-day CCCC Topic Session at PICES XIII on "CCCC, GLOBEC, and GLOBEC-like results: First steps toward a synthesis of the impacts of large-scale climate change on North Pacific marine ecosystems"

Session description

Although it is widely known from the fossil record of deep-sea cores that climate changes on the glacial-interglacial scale generate significant impacts on marine ecosystem productivity and structure, it is only in the last ten to fifteen years that marine scientists have begun to document evidence that basin- or large-scale climate changes might be significant forcing for decadal to millennium-scale changes in marine ecosystems. Tidbits of information led to the development of the Global Ocean Ecosystems Dynamics projects of many individual nations, and to several regional scale programs examining the influence of climate change. In 1994, PICES initiated the Climate Change and Carrying Capacity (CCCC) Program to provide an organizational framework for examining climate impacts on marine ecosystems in the North Pacific. During the past decade, the North Pacific experienced the strong 1997 El Niño and 1998 La Niña, as well, as perhaps, a regime shift in the late 1990s. The purpose of this session is to begin a general synthesis of these studies linking climate change to ecosystem productivity and structure in the North Pacific Ocean.

Session rationale

Many national programs examining climate–ecosystem linkages on a regional scale are nearing conclusion and will benefit by the grander scale, basin-wide, synthesis that will be initiated in this session. We believe that this session will bring together scientists from different regions of the Pacific to share their results, and will encourage collaborations for the broader synthesis that will be the topic of an inter-sessional symposium recommended by the **N**emuro **Ex**perimental Planning **T**eam (NEXT).

Session format

We propose a 1.5-day oral scientific session with additional abstract submissions being posters. The huge interest in this scientific topic, with the culmination or near conclusion of many national GLOBEC programs around the Pacific basin suggests to us that this session will be very heavily subscribed. We propose additionally that 1.5 hours of time be reserved at the beginning of the oral session for six 15-minute presentations that will provide summaries on national GLOBEC efforts by each PICES member nation. We tentatively suggest that these speakers would be: David L. Mackas (Canada), Yoshioki Oozeki (Japan), Qisheng Tang (People's Republic of China), Suam Kim (Republic of Korea), Vladimir I. Radchenko (Russia) and Harold P. Batchelder (U.S.A.).

Recommended convenors: Harold P. Batchelder (U.S.A.), Suam Kim (Korea) and several others (to be named)

CCCC Endnote 4

NEXT - Nemuro EXperimental Planning Team
Strategy for accomplishing PICES CCCC Program synthesis

Introduction

The PICES Climate Change and Carrying Capacity (CCCC) Program was recently summarized in a report by Perry *et al*. (2002). Most of the details, including the history of the CCCC Program, can be found there, and are not repeated here. But, it is worthwhile to re-visit the conceptual foundation of the CCCC Program, before examining how to go about accomplishing the integration and synthesis of PICES member nation activities in the Pacific that contribute to the Program. The overall goal of the CCCC Program is **"to forecast the consequences of climate variability on the ecosystems of the subarctic Pacific"**. More

specifically, the CCCC Program was formed to investigate **"how do inter-annual and decadal variation in ocean conditions affect the species dominance, biomass, and productivity of the key zooplankton and fish species in the ecosystems of the PICES area"**.

The CCCC Program is a core regional program of the IGBP GLOBEC program. Consistent with other regional and national GLOBEC programs, CCCC adopted a diverse strategy that included retrospective analysis, model development, process studies, sustained observational systems and data management, to address the aforementioned goal and question. The CCCC Science Plan identified eight specific scientific questions that mapped onto four core scientific issues, which relate to: 1) Physical Forcing of North Pacific Ecosystems and the responses of 2) Lower Trophic Levels (primary producers and primary consumers), and 3) Higher Trophic Levels (secondary and higher consumers) to that forcing, and 4) Ecosystem Interactions (especially top-down *vs.* bottom-up forcing). Some or all of these issues have been addressed at one or more regional or local sites by each of the PICES member nations (Canada, China, Japan, Korea, Russia and the United States).

The CCCC Program created four Task Teams to assist in implementing coherent and cooperative marine research. These are REX, MODEL, BASS and MONITOR. REX, or the Regional EXperiment Task Team had the responsibility of developing inter-comparisons among regional national (primarily coastal) studies. The MODEL Task Team was charged with developing conceptual and theoretical models of physical circulation, biological populations and the coupling of physics and biology in the North Pacific. BASS, or the BASin Scale Task Team, was charged to develop a basin scale research program in the North Pacific. The MONITOR Task Team was charged to design and assist in the implementation of a monitoring program for detecting climate variability and its impacts on North Pacific ecosystems. Some of these Task Teams have Advisory Panels to provide direction to specific Task Team initiatives, *e.g.*, the *Iron Fertilization Experiment* Advisory Panel of BASS, and the *Continuous Plankton Recorder* Advisory Panel of MONITOR.

To date, each of these CCCC Task Teams has held workshops, sessions at PICES Annual Meetings, and produced useful reports and products, with relatively little input or interaction with the other Task Teams. In recent years this has changed as both REX and BASS have worked closely with MODEL to implement specific models that apply to their specific needs and interests. It is clear that the CCCC Program, with its diverse Task Teams and implemented national programs, has reached the point where it must move forward with integration and synthesis of these diverse activities. It was with this background that the **N**emuro **Ex**perimental Planning **T**eam (NEXT) was formed. Terms of Reference for NEXT and the membership of NEXT are included in *Appendix A* and *Appendix B*, respectively. These Terms of Reference are rather specifically oriented around the use of the NEMURO model developed by MODEL for future synthesis. **NEMURO** is the **N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography. The recommendations below provide some generic guidance for synthesis using NEMURO and its successors, *e.g.*, NEMURO.FISH, NEMURO_SAURY and NEMURO_HERRING, which include links to higher trophic levels. More generally however, the recommendations below provide a "roadmap" for achieving a basin-scale synthesis of the regional and local datasets generated by CCCC projects in the member nations.

Recommendations

1. A major inter-sessional (2-3 days) PICES sponsored symposium should be held in around April 2006, to present CCCC synthesis findings from national programs, and to foster multinational synthesis (a grander understanding) of the connections between climate variability and ecosystem structure and functioning in the North Pacific. A suggested venue for this symposium is Honolulu, Hawaii, U.S.A., because of the desire to enable broad national participation of scientists from PICES member nations from both sides of

the Pacific. We would hope that the papers from this symposium would be published in a special journal issue (*e.g.*, *Progress in Oceanography*).

2. The CCCC Program should conduct detailed model-data comparisons/validation of the NEMURO lower trophic levels model using data from many different coastal regions. (See recommendations 3 and 4 below and *Appendix C*).

3. A two-tiered approach should be used for further development of ecosystem and coupled physical-ecosystem models in the North Pacific. The first tier, which will continue to be led by the MODEL Task Team, will be to further theory and implementation of the basic model frameworks needed to advance our understanding of climate, physics and biology in the PICES region. An example of this would be future incorporation of the role of iron limitation on population dynamics, diversity and ecosystem structure. This might be accomplished through future dedicated workshops, or via "virtual workshops" in which several key investigators work to accomplish a specific model implementation and series of simulations. The second tier, which will require extensive involvement of scientists with time-series or spatially-explicit data sets, will be careful and detailed comparisons of model predictions using NEMURO to field observations of the various state variables in the NEMURO code. To accomplish this latter goal will require substantial capacity building (influx of funds directed toward training workshops).

4. Members of the MODEL and BASS Task Teams discussed how various models developed within the CCCC Program could be used to test specific scientific hypotheses related to ecosystem structure in the North Pacific, and how the ecosystem has, or might, respond to climate change and variability. Most of the hypotheses relate to mechanisms that might be responsible for controlling productivity at multiple levels of the ecosystem. The ECOSIM model is most powerful in assessing the effects of large-scale changes in predation and trophic levels (specifically, through top-down processes) as they have, or may, respond to climate variability. Conversely, NEMURO-like models emphasize physical-forcing acting on lowermost trophic levels and impacting higher trophic levels through bottom-up processes. Thus, combined hypothesis testing using both ECOSIM and NEMURO models provides a powerful framework for examining ecosystem changes, and for deciphering the mechanisms that are responsible for those changes. The list of scientific hypotheses for future model experiments is listed in *Appendix D*.

5. Better mechanisms are needed to bring together the expertise of modelers with marine scientists making observations, or to train the observationists to implement and use the models to provide simulations that can be compared to their data sets. This lack of connection between modelers and data collectors has been a severe impediment to the wider application of NEMURO. Two specific suggestions to accomplish this are:

    a. To hold one or more 2-3 day **practical workshop(s)** during which potential users of the NEMURO model code and its derivatives (*e.g.*, NEMURO.FISH, etc.) receive instructions and hands-on training with the model. The goal of this workshop is to encourage the use of the NEMURO model code of LTL, and perhaps HTL, in regional programs, and importantly, to compare the model output with data from several coastal regions. Ideally, attendees from PICES member nations at the first workshop would be able to subsequently transfer their accumulated knowledge to other scientists and research groups in their nation. Regions where extensive and sufficient data sets exist for doing such model-data comparisons are now many, largely as a result of many nationally funded regional observation programs

that have occurred within the CCCC Program for the past 5-10 years, and in some places funded by other sources for much longer times (*e.g.*, CalCOFI). Examples are listed in *Appendix C*. If the first workshop, to be held just prior to the April 2006 CCCC synthesis symposium, is successful, similar workshops could be held in later years to broaden the connections between modelers and data observers even more.

b. **To assure better web page support** by the PICES Secretariat in order to provide better access to code and documentation for the NEMURO model and its successors. At the present time, this support is provided on an *ad hoc* basis by key members of the MODEL Task Team, but this role should be assumed by the PICES Secretariat. It is recommended that an intern position be established that will oversee this, as well as all of the other PICES web based activities (except meeting registrations). A plan for addressing this issue was presented to most CCCC Task Teams at PICES XII by Ms. Julia Yazvenko of the PICES Secretariat.

References

Perry, R. I., A. B. Hollowed, and T. Sugimoto. 2002. The PICES Climate Change and Carrying Capacity Program: Why, how, and what next? PICES Scientific Report, 22, 87-100.

PICES 2000. MODEL Task Team report of the international workshop to develop a prototype lower trophic level ecosystem model for comparison of different marine ecosystems in the North Pacific. PICES Scientific Report, 15, 1-77

Yamanaka, Y. 2001. NEMURO model follow-up. PICES Scientific Report, 17, 37-43.

NEXT Appendix A

NEXT Terms of Reference

1. To help guide and prioritize requests for modifications, future advancements, extensions, validations, and calibrations of the NEMURO model and its successors.
2. To develop a scientific strategy, based on requirements of ecosystem models to be developed, for a series of workshops for testing hypotheses on the following topics of CCCC Integration:
   a. Comparison of coastal ecosystems around the North Pacific Rim (and North Atlantic), using zooplankton and small fish as focal species;
   b. Latitudinal comparison of North Pacific ecosystems, using multiple focal species;
   c. Link basin-scale ecosystem models to coastal ecosystem models in the North Pacific, using salmon and associated species linked trophically to salmon as focal species.
3. To direct the development of advances in NEMURO by considering the scientific importance of the suggestion, the time and resources required to complete the task, and proposed suggestion's relevance to the goals of PICES and the CCCC Program.
4. To develop an outline of hypotheses testing model experiments during the early half of 2003, mainly through "virtual meetings" such as e-mail and other forms of long distance communication, and report to CCCC-IP/EC for consideration.

NEXT Appendix B

NEXT membership

Harold P. Batchelder (Chairman)
Gordon A. McFarlane (BASS)
Akihiko Yatsu (BASS)
Shin-ichi Ito (MODEL)
Bernard A. Megrey (MODEL)
Thomas C. Wainwright (MODEL)
Douglas E. Hay (REX)
William T. Peterson (REX)
Yoshiro Watanabe (REX)
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NEXT Appendix C

Possible locations for future NEMURO model-data comparisons/validation

To date, the NEMURO LTL model has been configured to simulate biological processes and state variables for three regions: Station Papa in the Eastern Subarctic Pacific; Station A7 in the Western Subarctic Pacific; and an Eastern Bering Sea Station (PICES 2000; Yamanaka, 2001). At recent MODEL workshops, it was decided to move forward with publishing some of these simulations and others in a special issue of *Ecological Modelling*. This is a significant milestone in the dissemination of NEMURO to the scientific community.

Model-data comparisons should be done for other regions within the North Pacific that have sufficient data sets for (1) forcing (local wind intensity, solar radiation, mixed layer depth, etc.) future region-specific models and (2) biological data (phytoplankton and zooplankton biomass and size composition) for comparing to the resulting simulations. Ideally, sufficient data would be available from a prospective **model-data** comparison to permit comparison of seasonal averages and higher frequency fluctuations. There are only a few locations where the biological (*e.g.*, plankton) data are sufficiently well sampled temporally (minimum of quarterly sampling) to conduct detailed comparisons with model output. These are:

- Newport, OR Line (Peterson)
- Vancouver Island Shelf Stations (Mackas)
- CalCOFI (Bograd/Ohman)
- Coastal Gulf of Alaska off Seward, AK (Coyle, Whitledge) and maybe Prince William Sound, AK (Cooney)
- Jiaozhou Bay, China (Qiao)
- Yellow Sea (Qiao; sampled at *ca*. 70 stations on 6 cruises between spring 1996 and fall 1997)
- Toyama Bay in the Japan/East Sea (Ikeda & colleagues)
- PM line in the Japan/East Sea (Chiba)
- Yellow and Japan/East Sea waters off the Korean Peninsula (Kang)

These, plus the Station P, Station A7 and Station in the Bering Sea, are the key locations for future **model-data** comparisons.

NEXT Appendix D

Hypotheses and scientific questions for future model testing experiments

The two models that have received the most attention within the CCCC Program are the ECOPATH (and ECOPATH with ECOSIM; hereafter referred to as ECOSIM) and the NEMURO model and its various enhancements. NEMURO models are fundamentally bottom-up, physically-forced process models with detailed functional linkages among and between trophic levels for vital rates (consumption, growth, mortality, and reproduction). Conversely, ECOSIM models are often built "middle-out" starting with commercially harvested fish species (*e.g.*, flatfish, pollock, cod, salmon), and with lower trophic levels (phytoplankton, mesozooplankton) and higher trophic levels (predatory fish, birds, mammals)

calibrated from observations of trophic level abundances and consumption pathways. ECOSIM models can be used to address connections between food web components that are not modelled by detailed bottom-up process models like NEMURO. The combined use of bottom-up and top-down forced models is valuable for cross-calibration and for evaluating how climate variability impacts marine ecosystems, and how those impacts are propagated through the food web. It also allows explicit evaluation of the influence of other human (*e.g.*, fisheries) impacts on marine ecosystem structure.

Hypothesis list:

$H1_o$: The role of top predators (large fish, birds and marine mammals) in North Pacific marine food webs has varied over time (*e.g.*, due to climate changes, whaling, fisheries, natural fluctuations).

$H2_o$: North Pacific wide changes in predatory fish populations (flatfish, pollock, cod) reflect common climate forcing as well as local fishing patterns (this hypothesis attempts to understand the role of basin wide, presumably climate variability versus more local, harvest related forcing).

$H3_o$: Climate variability, as quantified by the temporal and spatial pattern of the Pacific Decadal Oscillation (PDO) brings simultaneous changes in both western- and eastern-side populations of small pelagics (sardine and anchovy), but through different mechanisms on opposite sides of the ocean basin (this hypothesis is directed at understanding how populations of small pelagics on opposite sides of the North Pacific appear to be coherently responding to large-scale forcing, when ocean conditions (SST pattern as measured by the PDO) are opposite (colder in east, when warmer in west).

$H4_o$: Sardine and anchovy population fluctuations are controlled by lower trophic level productivity (bottom-up processes) during both the increases and declines in their populations.

$H5_o$: Small but concurrent changes in combined predator population (*e.g.*, fish and birds which feed on a common resource [*e.g.*, euphausiids]) can be used as an indicator for detecting shifts in key unsampled prey populations.

$H6_o$: Overall marine productivity (defined at the broadest level), esp. its magnitude, form (*e.g.*, crustacean *vs* gelatinous zooplankton; or size structure), and seasonality is important in determining survival of commercially important North Pacific species.

- $H6A_o$: The timing and availability of marine production in coastal regions of the North Pacific, and its availability in a proper form for juvenile salmon is key in determining early ocean survival of salmon, and may be particularly impacted by changing climate.
- $H6B_o$: Differences in the vulnerability and timing of production cycles of the zooplankton populations used by sardine, anchovy and saury in the recirculation region of the Kuroshio Extension is responsible for the alternation of dominant species in the western Pacific.

Although not phrased in hypothesis form, another question that is of interest is to determine what upper trophic level biological flows are key in connecting open ocean ecosystems and continental shelf ecosystems in the North Pacific.