Developing new scientific programs in PICES

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Dr. Makoto Kashiwai recently retired from the Fisheries Agency of Japan and is now a guest researcher at the Hokkaido National Fisheries Research Institute. For over a decade Makoto has been a key PICES Builder from Japan. He was the first Co-Chairman of the PICES-GLOBEC Program Scientific Steering Committee, then Chairman of the Science Board, Japanese Delegate on the Governing Council, and is currently Co-Chairman of the Implementation Panel of the PICES Climate Change and Carrying Capacity Program. But on top of everything, he is best remembered as the legend behind PICES III (Nemuro, Japan, 1994), pulling off the Annual Meeting together after a devastating earthquake damaged the meeting venue a week before the opening day (see Dr. Kashiwai's biography in PICES Press at http://www.pices.int/Library/PicesPress/Jan01/Makoto_Kashiwai.pdf.

This article was written as background for discussion at the joint meeting of the PICES Science Board and Governing Council in April 2003, in Victoria, Canada. As the PICES CCCC Program (Climate Change and Carrying Capacity) is in its mid-life, it is time to consider what, how and when, to establish a new program or programs within PICES. Many lessons have been learned through the act of implementing the first program and perhaps it is time to reflect on this history while thinking about the future. This article includes some of Dr. Kashiwai's thoughts on this topic.
Editor

Process

Before considering the process of identifying the Scientific Program(s) to follow the CCCC Program, the Organization needs to agree on a design policy that includes the following issues:

- Will it be a 2nd phase of the existing CCCC Program or an entirely new program?
- Will it consist of a single program (with multiple umbrellas), or multiple programs (each with single umbrella)?
- Will it be planned with or without special research funds or as response to a formal Request for Advice with cost sharing among the PICES member countries?
- Will it consider the output from CCCC Synthesis?

Governing Council must consider these elements of a design policy for the next PICES major scientific program.

A starting point of discussion on the procedure for development of a new PICES scientific program can be found in the *PICES Handbook for Chairmen and Convenors*, (Chapter A. Guidelines for Chairmen, Section VI. Scientific Programs), which states:

> PICES has the responsibility to identify research priorities and problems pertaining to the area of interest, as well as appropriate methods for their solution. Coordinated research programs and related activities of common interest shall be undertaken through national efforts of the Contracting Parties. The following processes should be undertaken when developing a joint research project:
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> 1. A Workshop should be undertaken to develop a Science Plan based on identified key scientific questions.
> 2. A Workshop should be undertaken to develop an Implementation Plan based on a scientific strategy that includes program management and a schedule for the program.

The agenda and participants of each workshop must be determined based on the requirements of each plan.

Science Plan

The scientific questions that form the Science Plan are critical for the success of the research program.

> *In the world, there are many things not elucidated, or yet to be elucidated. However, for many people, it is not clear what are unknown matters. If one can clearly point out what is not known, we can say that research has already started. Furthermore, when the unknown matter is captured clearly in the form of a problem, we can see that the way to the solution is already open. Questions that already take the form of problems can, in*

most cases, be solved. But, when we solve a problem on one subject, it does not always deepen our understanding on that subject. It is up to methodology to formulate the problem such that solution results in real deepening of our understandings. (Translation from Kenichi Shiragami, 1972)

Therefore, the Science Plan cannot be an assortment of unrelated scientific questions raised by individuals seeking a funding opportunity. The answer to these questions must give the best available scientific foundation for the decisions of member countries on urgent matters of marine policy for preventing global warming or for mediating resultant disaster caused by it. The Science Plan of a major research program of a science organization must give an updated reason of existence for the organization.

Science Board should have a set of criteria for prioritizing scientific plans, *e.g.*:

- Meet needs of member countries;
- Increase value of PICES activities in support of research;
- Strengthen support of cooperative programs of PICES;
- Provide opportunity for PICES initiatives;
- Attract the interest of excellent scientists;
- Contribute to better participation in PICES activities.

These criteria should be considered during the identification of scientific questions and the development of a scientific strategy.

The national interests of PICES member countries in marine sciences of the North Pacific are not identical because of their geographical position in the North Pacific, the relation to downstream/upstream influences of the major oceanographic features of the North Pacific, and the differences in marine policy of their governments. It is therefore natural and necessary for PICES, as an intergovernmental scientific organization, that major scientific programs planned and implemented by PICES, should meet the needs of its members. To ensure that this is achieved, at least three options can be considered:

- Approval by Governing Council of the Science Plan developed through a workshop under the initiative of Science Board;
- Composition of planning workshops based on national reports of requirements of the new scientific program from member countries;
- Development of the Science Plan based on the questions posed by member countries in the form of formal written requests for scientific advice.

The first option is a standard procedure for decision-making by PICES. However, when considering that the existing scientific questions of the CCCC Program can also be found among the discussion papers that led to the establishment of PICES, the identification of scientific questions to be addressed in the next major program should proceed on broadly based intra-national discussion among marine scientists in each member country. This first option does not necessarily lead to the successful implementation of the program.

The second option outlines the minimum requirement for better participation from all member countries in a new major PICES scientific program. If it can be assumed that the major research efforts in a new program are to be covered by the activities of the national programs funded by member countries, the existence of contributing national programs is a crucial pre-condition for establishing a new major PICES scientific program. Therefore, national reports from member countries describing their requirements for a new major scientific program of PICES are required to establish and fund the component national programs.

The third option is a very strong challenge for PICES because answering such scientific questions cannot be undertaken by scratching through existing information, but requires the creative scientific production with authorship of scientists or sponsorship of the organization. Thus, even if PICES does not evolve into a science funding organization, the Organization still needs its own research money to conduct its own research program. Raising funds from outside sources for its research program may result in the implementation of scientific programs that are also of interest to outside sponsors, as in the case of the North Pacific Ecosystem Status Report.

The most appropriate way for PICES to have funds for its own research programs is via this third option. This must be considered and challenged with perspective to develop the advisory function of the Organization.

The scientific questions must be prioritized so as to increase the value of PICES activities in support of marine research. Valuable characteristics of PICES activities in support of marine research can include:

- A multi-disciplinary approach in marine science;
- Basin-scale research coordination in northern North Pacific;
- Fisheries-oriented marine science integration;
- Membership of almost all the northern North Pacific rim countries;
- 10-years experience in the study of ecosystem dynamics,
- On-going long-term ecosystem monitoring stations (more than 5),
- Well-established cooperative relations with other international fisheries organizations in the area concerned; etc.

The Science Plan of a major research program must draw on the best use of these characteristics of the Organization and make best use of, and strengthen the support of, on-

going and planned cooperative programs of the Organization, which include:

- Data exchange;
- CPR survey;
- PICES GOOS Programs;
- Iron Fertilizing Experiments;
- North Pacific Ecosystem Status Report; and
- Capacity Building Program.

The scientific scope of a new scientific program must reflect the scientific strategy of PICES, appearing in the Strategic Plan of Science Board, that can provide opportunity for PICES initiatives, which may include:

- Human dimensions;
- Ecosystem approach in resources management; and
- Marine birds and mammals.

In principle, a scientific organization consists of scientists who are led by excellent scientists. Therefore, it is crucially important for the success of a Program to keep attracting excellent scientists and to have their commitment as leaders. This situation cannot be realized without a formulated set of excellent scientific questions addressed by the Program. For the Program to be able to contribute to better participation, the scientific questions addressed by the Program need to include leading questions within the scientific scope of Scientific Committees.

We can receive potential key scientific questions with description of background, needs and seeds, from the following sources:

- PICES National Delegates with national scientific interests, concerning what scientists are requested to answer by taxpayers and decision-makers;
- Scientific Committees and their substructures;
- Remaining or new questions arising from CCCC Program synthesis
- Presentations by individual scientists at scientific sessions and workshops during the Annual Meeting, or recommendations arising from Symposia or Topic Sessions.

The structuring and prioritizing of scientific questions is the most important component of a Science Plan that can be identified as a part of the Scientific Strategy. It is tightly connected with the sub-structuring of the Program Implementation Panel. Thus, when selecting categorical items for the structuring of scientific questions, we need to select categories that are also appropriate for establishing the sub-structure of the Program Implementation Panel. In CCCC these were grouped as:

- Development of methods (*e.g.* MODEL Task Team);
- Comparative studies among national/local programs (*e.g*. REX Task Team);
- Multi-national collaboration on specific fields (*e.g.* BASS Task Team);

Others include:

- Scientific initiatives on frontier area (*e.g.* human dimension-oriented);
- Specific umbrella program-oriented (*e.g.* atmospheric transport of iron dust);
- Specific disciplinary-oriented (*e.g.* sub-arctic/sub-tropic gyre interaction); etc.

The role of model development in the CCCC Program is not only for hypotheses testing but also for sensitivity studies to identify important ecosystem processes. The most important ecosystem process is the eco-physiological response of key species to the full range of environmental variability that they will experience in the future. It means that intense laboratory rearing studies and/or special field incubation experiments are needed, as are currently being performed by China GLOBEC. These process studies are key to constructing a Mechanistic Model, by which the CCCC Program is intending to overcome the limitations of superficial empirical correlation, and to obtain predictive power beyond regime shifts.

There have been many activities of PICES Scientific Committees in support of the CCCC Program implementation. The activity and results of the Working Group on *Marine Birds and Mammals* is one of the examples. CCCC/IP needs to make an effort to incorporate marine birds and mammals into North Pacific ecosystem models, and to identify hypotheses relating to the role of marine birds and mammals in the response of North Pacific ecosystem to climate change. CCCC/IP should encourage scientists on marine birds and mammals to identify key questions and to join in the practical program implementation.

Comparative study is an efficient approach to identify the specific characteristics of the object concerned. Thus, comparative studies are listed as an important task in many international or inter-program coordinating plans. In the CCCC Program, the REX Task Team is responsible for the comparative studies among North Pacific ecosystems. However, a comparative study cannot be performed by mere exchange and comparison of outputs from separate research projects on the subjects to be compared. It needs specific scientific questions, data from common tools and protocols, common base models, and common methods of analyses.

One of the key words for the next generation of the CCCC Program may be human dimensions. The Earth system is characterized as **the Planet of Water** among the other planets of the solar system, and the existence of the human race, that has been causing the change in greenhouse gases and global warming. Thus, it is reasonable that, for the study of global climate change, we need to include human dimensions into the Earth system. What does it mean to incorporate human dimensions into the CCCC Program? In the case of science in general, to incorporate human

dimensions may mean the amalgamation of natural sciences and social sciences.

Bearing in mind the distance between, for example, biological oceanography and chemical oceanography, the distance between marine sciences and social sciences seems far beyond feasible amalgamation. Thus, at present, for PICES as a marine science organization, to incorporate social sciences will be far beyond its scientific scope. Furthermore, we cannot see the effort of constructing a human society model, while we are struggling to construct a North Pacific marine ecosystem model. A possible challenge can be the incorporation of fisheries as a component into ecosystem models.

The first challenge, associated with incorporating fisheries into an ecosystem model, is to have a system composed of components each having its own goal function to be optimized, *i.e.* shift from a mechanistic model, like an automated factory system, to an animistic model, composed of relatively independent elements with capricious interactions among them. The second challenge is to compose an ecosystem model from components having inner system dynamics that exhibit plasticity in the life cycle. Intensive biology-oriented process studies will be needed for this approach.

For the successful implementation of the next generation CCCC Program, the enhancement of scientific creativity of PICES has crucial importance. Difficulties experienced in the CCCC Program implementation, that limited scientific creativity and efficient program progress, are:

- National scientific programs do not necessarily include scientific questions on basin-scales or questions requiring comparative studies, and therefore have no funding for them;
- The CCCC Program lacks dedicated research funds except for workshops or symposia, and national programs or member countries have no funds that can be transferred to the CCCC Program;
- The contribution by scientists to the CCCC Program is, in many cases, neither authorized nor encouraged by their employer.
- PICES is an inter-governmental organization that focuses on equality among member countries rather than on performance or scientific excellence, and thus the chairmanship of the implementation structure is limited to three-year terms and leaders are not eligible for re-election. This makes it difficult to keep excellent leading scientists in key posts of the Program.

In order to overcome these difficulties, it is necessary to have strong support for the next generation CCCC Program from member countries, including high priority for the funding of CCCC contributing programs, promotion of the program by allocating transferable funds, or catering to member countries' request of advice on a specific scientific question to be addressed to the Program. At the same time, PICES needs to change its calling card from "*Inexpensive Organization*" to "*Creative Organization*" instead, and to change operational practices to fit it.

Implementation Plan

The major components of the Implementation Plan, and thus the agenda of the workshop to develop the Implementation Plan, will be:

- Establishment of an Implementation Panel;
- Action plan as an organized set of workplans for sub-structure of the Implementation Panel;
- Cooperation with other international Programs;
- Relation to international umbrella Programs; and
- Time schedule that recognizes program phases.

In the first stages of the CCCC Program, the sub-structure of the Implementation Panel was established as Task Teams, after developing an Implementation Plan, and along with separately determined terms of reference for each Task Team. Thus, the first stages of the CCCC Program lacked an organized workplan among the Task Teams, and the Implementation Plan lacked an organized research plan. Therefore, any workshop to develop an Implementation Plan must deal first with the establishment of sub-structures of its Implementation Panel. The core of the Implementation Plan must be a set of research plans to answer scientific questions given to the sub-structure of the Implementation Panel, and thus becomes the major agenda of the workshop to develop the Implementation Plan.

The CCCC Program is using models as a tool of program integration. The MODEL Task Team found it necessary to create a basic model for comparative studies and hypotheses testing, and has developed a basic lower trophic level ecosystem model, NEMURO, through a series of intensive practical workshops. The program code, parameter values and forcing factor dataset for typical stations, are open for use by the scientific community on the NEMURO Website.

This model is one of the major achievements of the CCCC Program and is evolving to include higher trophic level models, and to be embedded into a 3-dimensional ocean circulation model. The family of NEMURO models is expected to be the major tool in the CCCC Integration Plan. For this family of NEMURO models to be a community tool for ecosystem studies, there must be consistency among models of different ranks, *i.e*. among box models, 1-D models, 2-D models and 3-D models. This could not be achieved during the first stage of the CCCC Program.

Among marine biologists and even among ecosystem modelers, there is recognition that ecosystem models are special tools for ecosystem modelers only. This is the largest obstacle for models to be the core of program

integration. There must be a protocol for biologists to use a sophisticated ecosystem model as scientific equipment, like a sophisticated chemical analyzer that a biologist cannot construct or repair. This will make it possible for a model-familiar biologist to be a good program synthesizer, while an ecosystem modeler cannot always be a good program coordinator.

Dr. George Hunt (University of California, Irvine) is proposing a Research Plan: *Ecosystem Studies of Sub-Arctic Seas Program*, including the Bering Sea, the Barents Sea, the Newfoundland/Labrador Shelf, the Sea of Okhotsk and the Oyashio shelf region, *i.e.* seasonally ice-covered, sub-arctic seas thought to be sensitive to decadal-scale and secular changes in climate. This proposal includes an important part of the PICES region and also encompasses PICES plans for comparative studies between ICES-CCC and PICES-CCCC Programs. We need to discuss and decide how to consider this proposal.

Judging from the sequence of discussion that led to the foundation of PICES, it is quite natural and reasonable that PICES initiated its first research program as one of the regional programs of GLOBEC. The scientific question on dynamic response of the North Pacific ecosystems to large scale climate variability, is nothing but the scientific concern that pushed member countries to establish PICES, and is also the central question of GLOBEC.

However, GLOBEC is one of the international research programs dealing with the response of the ocean to climate changes. Each of these programs has its own focal questions based upon a specific discipline. Thus the choice of GLOBEC as an umbrella automatically confined the scientific scope of the CCCC Program within that of GLOBEC, which does not necessarily have a direct focus on the response of ocean circulation to climate variability of the atmosphere, or on the response of chemical cycling to the climate variability. Therefore, although the Key Scientific Questions of the CCCC Science Plan can be interpreted as including questions on physical oceanography or chemical oceanography, the CCCC Program has been failing to attract scientists from the Physical Oceanography and Climate Committee and the Marine Environmental Quality Committee.

As a consequence, the CCCC Program lacked scientific questions and hypotheses from the point of view of physical oceanography; *e.g.* "How do the interannual or decadal changes in winter monsoon over the Subarctic Pacific affect the strength and distribution of upwelling velocity?", "How does it change the productivity, geographical extent, and seasonal cycle of subdivisions of Subarctic Pacific ecosystems?", and "How do the interannual or decadal changes in winter monsoon over the North Pacific affect the circulation and inter-gyre water-mass exchange?" We must note that the next stage of the CCCC Program may not need to limit its umbrella only to GLOBEC.

Finally, the Implementation Plan of the first stage of the CCCC Program failed to indicate the total duration of the program and the need for revision of the time schedule. I hope this article can ignite your inspiration for a new PICES scientific program.

(Robert Emmett - *cont. from page 21*)

There has been very little research into the ecology of northern anchovy off the Pacific Northwest, so it is impossible to identify unequivocally what biophysical factors precipitated the large increases in their population. However, there were some obvious major physical and biological changes off the Northwest that appear to be responsible. Most obvious has been the cool oceanic conditions that were initiated by the strong La Niña of 1999. This marked the end of a strong El Niño and a long period of warm ocean conditions that existed during most of the 1980s and 1990s. Starting in 1999, Northwest waters became cooler, sea surface height lower, and southerly current transport larger. These physical factors are indicators of increased nutrients and primary production, which evidently led to a shift in copepod composition and abundance, with subarctic species becoming abundant. At the same time, chinook and coho salmon marine survival increased significantly. Chinook and coho salmon do not feed on copepods, so the copepod species change did not affect salmonids directly. However, copepods are a primary prey for forage fishes such as northern anchovy.

Forage fishes obviously responded to these changes in primary and secondary production (copepod change) by successfully recruiting. Similar fishery recruitment responses to large-scale Pacific Ocean basin wide changes have been observed previously.

Peak Columbia River yearling chinook and coho salmon ocean entry occurs in May. At that time they are very similar in size to adult northern anchovy. Undoubtedly having an abundant "alternative prey" available to piscivorous predators, such as northern anchovy, should enhance salmonid smolt survival and benefit many other marine species such as seabirds and mammals.

Data from these surveys indicates that northern anchovy and other forage fish populations increased dramatically after 1999, and appears to be linked to salmonid marine survival. Ultimately it will only be through long-term studies of the entire California Current pelagic ecosystem will we be able to identify the bio/physical mechanisms that control forage fish abundance and salmonid marine survival.