Theme 1

Ecosystem-Based Fisheries Management and Sustainable Use

The activities of three PICES working groups [WG16 on "Climate change, shifts in fish production, and fisheries management", WG18 on "Mariculture in the 21st century – The intersection between ecology, socio-economics and production" and WG19 on "Ecosystem-based management science and its application to the North Pacific"] will provide information according to their terms of reference, but their activities are potentially very important elements of a new science plan for PICES. WG16 has hypothesized mechanisms linking ocean/climate variability to changes in commercial species population dynamics and ecosystem structure. WG19 is reviewing existing information and models that predict human and environmental influences on marine ecosystems, and is expected to provide further information on issues and activities that address the achievement of ecosystem-based management in the Pacific. These issues and activities could be part of a new science plan. WG18 will report on current and emerging issues of mariculture, with respect to environmental and ecosystem function, sustainability of production, and socio-economics. Scientific issues of mariculture may also be part of a new science plan. Based on the interrelated activities of these working groups, "Ecosystem-based fisheries management and sustainable use including mariculture" is an important theme for a new PICES science plan.

Theme 2

North Pacific Marine Ecosystem Response to the Global Change

During the decade of the PICES Climate Change and Carrying Capacity Programme, knowledge of the relationship between climate variability and ecosystem response was advanced. The CCCC Programme also identified some impacts of anthropogenic activity. Human society receives valuable ecosystem services from marine ecosystems (e.g., fisheries production, nutrient cycling, climate regulation, etc.). The potential degradation of the marine ecosystem by anthropogenic forcing (i.e., increased CO_2 emissions, changes in physical forcing and temperature, changes in nutrient concentrations particularly in coastal waters, pollution by toxic matter, increasing fisheries activities, etc.) is a significant concern. However, we do not fully understand what impact anthropogenic forcing has on marine ecosystems and how anthropogenic forcing coupled with natural forcing (i.e., climate oscillations) will change or degrade marine ecosystems. One reason for the uncertainty is the complex relationship between marine ecosystems and abiotic forcing. For sustainable use of marine services, it is essential to understand the

ecosystem components, their functional roles in end-to-end food-web dynamics and biogeochemical cycles, and their responses to natural and anthropogenic forcings. The overall objective of a new science plan focused on marine ecosystem response to global change is to understand marine food web structure and dynamics from end to end, their biogeochemical cycles and interactions, and their responses to the natural and anthropogenic forcings for the sustainable use of marine ecosystems.

Theme 3

A New Integrative Scientific Program Built upon the Foundations of CCCC

PICES has made great advances in understanding some of the potential impacts of climate change on the North Pacific through its first major interdisciplinary initiative, the Climate Change and Carrying Capacity (CCCC) Program. The goal of CCCC was to forecast the consequences of climate variability on the ecosystems of the subarctic Pacific. Recently CCCC consolidated its efforts around two activities: (1) modeling, and (2) understanding climate forcing of marine ecosystems. Modeling will advance the development of conceptual, theoretical and modeling studies needed for both regional and basin-scale components of CCCC; the climate forcing group will synthesize regional and basin-wide studies and provide a forum for the integration of climate-related hypotheses and data.

The existing CCCC efforts should continue by evolving from a goal of “gaining a better understanding” to a program with more distinct and measurable products and progress. That is, we must move to a program with these foci: (1) clear exposition and testing of mechanisms whereby physical forcing is translated into a biological response, including development and testing of ecosystem indicators, (2) development of regional climate change scenarios with quantitative estimates of uncertainty, and (3) increased outreach whereby CCCC establishes a new human dimensions program that would facilitate translation of our understanding of mechanisms, ecosystem indicators and scenarios into a language understandable to those setting policy, to the media, and to the general public. An emphasis on mechanisms, indicators and scenarios coupled with a stronger human dimensions and outreach program would allow PICES to better predict and communicate the outcome of various climate change ecosystem response scenarios and their uncertainties so that scientists can better explain the options and consequences of various policy choices to society.

Theme 4

North Pacific Ocean Sustainability

Objectives: Broadly stated, this program would undertake a widespread examination of human use of the North Pacific Ocean, assessing the degree to which the activities are sustainable (in the sense of continued harvest, impacts to ecological services, or productivity); PICES would bring its collective scientific expertise to bear on addressing these issues.

Issue: The concept of ocean sustainability is clearly integrative and has the capability to bring together many PICES programs to examine these questions from a multidisciplinary approach. A key question, however, is whether it can be developed as a program with sufficient focus to prevent it from including everything that PICES does. This will require a clear definition of "sustainability" and statement of the program's objectives. This program would have broader applicability to human activities than the current Climate Change and Carrying Capacity Program, recognizing that climate change is but one aspect of global change.

Sustainability is widely used as an objective in ocean programs worldwide. It is a "guiding principle" in the report of the U.S. Commission on Ocean Policy, for example, which defines sustainability as "meeting the needs of the present generation without compromising the ability of future generations to meet their needs." Other, more detailed definitions exist, but the general sense is one of assuring long-term production or ecological function. Diverse scientific expertise is needed to address these questions to support policy requirements of PICES member nations.

Theme 5

Coastal Ocean Ecosystems – The Human Dimension and Climate

Coastal ecosystems are influenced by both the deep ocean and by freshwater ecosystems. The coastal marine environment is affected by climate change and variability, fishing, altered freshwater inflows that affect sediment, water properties, nutrients, and toxic chemicals. Introductions of non-native species affect diversity and physical changes to habitat (e.g., filling, dredging, and diking) affect the biological productivity of nearshore coastal ecosystems. Many of these ecosystems are critical to a species' survival. We should not think of marine and freshwater ecosystems as separate entities but as two tightly coupled systems. There is a need for a new understanding of the critical coupling of resource pathways

and food webs between freshwater and marine environments.

A focus on coastal ecosystems will build on the strong foundation of the Climate Change and Carrying Capacity Program and bring the human dimension explicitly into the science program of PICES. Such a program would support and enhance our nascent efforts to develop the science needed for ecosystem-based management. A related issue is the need to assess the status and trends in biodiversity.

Objectives:

1) the development of ecosystem indicators that are mechanistically linked to biological responses from physical forcing and from human-induced impacts;
2) the development of scenarios for response to climate change and human activities, including modeling to confirm mechanistic relationships and the ability to predict impacts, and
3) the reporting of results to PICES member countries and the broader public.

Theme 6

Status and Trends in Marine Biodiversity

The resolutions adopted at the World Summit on Sustainable Development (2002) and the Convention on Biological Diversity represent a commitment by governments to "*achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth*".

National governments and international agencies are attaching increasing priority to evaluating progress towards that objective, and the reporting in 2010 is likely to have high profile nationally, regionally, and globally. Measuring progress on that commitment poses special challenges in the marine environment. Although the Convention on Biodiversity has some suggested indicators of biodiversity overall, the science community has not agreed on appropriate ways to quantify marine biodiversity, and the strengths and applications. Moreover, the information on marine biodiversity is scattered and incomplete, even for most knowledge gaps, but Census of Marine Life itself is not designed to respond to the 2010 biodiversity commitments. Significant efforts will be needed to consolidate the scattered, but growing body of information, from both research and fishery sources, in ways that make it possible to report on status and trends in marine and coastal biodiversity.

PICES has a unique opportunity to take global leadership into an emerging priority area of marine science.

The pooled scientific expertise of PICES would be able to evaluate alternative ways to measure and report on status and trends in marine biodiversity, and provide expert guidance on approaches that would be feasible, scientifically sound, and suitable for different marine situations. PICES would be able to coordinate the consolidation of data and information from the North Pacific, ensuring meaningful comparability across national reports, and possibly supporting analyses of status and trends in biodiversity at large spatial scale appropriate for many marine systems. This work would be the scientific basis for informed scientific (and public) dialogue on the crucial issue of the conservation of marine biodiversity.