

# **The North Pacific Ecosystem Status Report**

## **Some thoughts on facilitating comparative studies**

**A report to the North Pacific Marine Science Organization (PICES) from the GLOBEC regional program Ecosystem Studies of Sub-Arctic Seas (ESSAS) based on discussions at the 2006 St. Petersburg ESSAS Workshop**

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In 2005, PICES published the first edition of its report on the Marine Ecosystems of the North Pacific, also known as the North Pacific Ecosystem Status Report (NPESR). This exciting new effort provides a wealth of information on the individual ecosystems of the North Pacific, on selected species of commercial and conservation interest, and a synthesis of how these ecosystems have been changing in recent years. The purpose of this report, according to the foreword, is to:

- 1) “describe the present state of the marine ecosystems of the North Pacific Ocean (status), in the context of their recent (past five years) and longer variability (trends);”
- 2) “summarize these regional assessments into a broad basin-wide synthesis;”
- 3) “identify critical factors that cause changes in these ecosystems; and to”
- 4) “identify key questions and critical data gaps that inhibit understanding of these marine ecosystems.”

The foreword goes on to say that the intended audience for the report is a combination of “... scientists working on or interested in the climate and marine systems of the North Pacific Ocean, governments who deal with issues of understanding, use, and management of North Pacific marine systems, and the general public.” This is a challenging set of goals, particularly in regard to the communication of material to a very diverse audience. In anticipation of the next edition of the NPESR, it was suggested that the 2006 workshop of the GLOBEC regional program, Ecosystem Studies of Sub-Arctic Seas (ESSAS), examine features that might be incorporated in the NPESR that would facilitate its use by scientists interested in understanding the effects of climate variability on the sub-arctic seas. This report is a beginning of a dialogue that ESSAS hopes will be on-going as both PICES and ESSAS develop their approaches to regional comparisons of marine ecosystems.

A major goal of ESSAS is to predict the potential impacts of climate variability on the sustainable use of the sub-arctic seas. A basic tenet of the ESSAS approach to achieving this goal is that it is essential to identify and understand the processes that determine the amount and fate of primary production. This requires not only the examination of those bottom-up processes that determine the amount of primary production, but also an understanding of the processes that determine how the assimilated energy moves through the ecosystem. How do the timing of blooms and

the environmental conditions during these blooms (e.g., water temperature) influence the partitioning of production along pelagic or benthic pathways? How does timing affect the match or mis-match between trophic levels, and what is the role of the life-histories of organisms? What is the largely heretofore overlooked role of micro-plankton in these systems? And, finally, how do top-down effects, especially the effects of fisheries removals, interact with these bottom-up effects?

To address these questions, ESSAS has elected to employ a comparative approach, investigating in each of the sub-arctic seas which processes seem to be particularly vulnerable to the effects of climate variability. By using information garnered from more than one system, responses to similar impacts can be compared across systems to obtain a clearer picture of the range of responses to a particular climate variable. To be effective, the approach taken by ESSAS will require comparable data on the responses of a particular aspect of an ecosystem to changes in features, such as wind mixing, stratification, water temperature and sea ice cover, across many ecosystems. Where organisms are concerned, it will be important to know the species and its life history traits so that true comparability can be accomplished.

In June 2006, ESSAS held a workshop in St. Petersburg, Russia, to develop the foundations of comparative studies of the sub-arctic seas, and to attempt initial comparisons of four sub-arctic ecosystems. PICES agreed to co-sponsor the workshop, and it was suggested that the workshop participants should examine the NPESR and provide suggestions for changes that might be incorporated in subsequent editions. The workshop participants approached their initial look at the NPESR as scientists engaged in comparative studies of the sub-arctic seas. The workshop participants could see that the NPESR might either be used as a source of information about aspects of North Pacific marine ecosystems that are changing and for which an understanding of the underlying processes is sought, or alternatively, the NPESR could be a source of information about data sets essential to comparative studies, such as those at the core of ESSAS. In this initial examination of the NPESR, workshop participants focused on the comparative aspects of the NPESR and did not try to address the complete set of challenges embodied in the NPESR goals set out above.

The ESSAS workshop participants agreed that the PICES NPESR provides a good start on comparing how climate variability at various time scales is affecting the marine ecosystems of the North Pacific. However, these ecosystems are very diverse, ranging from the sub-tropical Gulf of California, to the seasonally ice-covered Bering and Okhotsk seas. Grouping the PICES regions in the synthesis chapter by aspects held in common might facilitate the understanding of climate impacts on these systems. Thus, it might be profitable to group comparisons of the PICES areas into those with exposure to seasonal sea ice cover and which are dominated by gadids such as pollock (e.g., the Bering Sea, Sea of Okhotsk, Oyashio Current System, and possibly the Gulf of Alaska), and those with more temperate or sub-tropical affinities that are dominated by small pelagics (e.g., California Current System, Gulf of California, Kuroshio Current, Japan/East Sea, Yellow Sea & East China Sea). This would facilitate east-west comparisons, and comparisons with similar systems elsewhere. It could also be

profitable to compare latitudinal gradients along a given coast, with the assumption that, as warming continues, some of the northern ecosystems will come to look more like their neighbors to the south. One could then explore the likelihood of such climate-driven change given the physical and biological structure of the region.

One approach taken by the ESSAS workshop participants to the challenge of building comparisons was to construct a series of tables that laid out what are believed to be the most critical species supporting each of several commercially important top predators in each of the systems examined. Although far from easy to fill out and not universally popular with the workshop participants, these tables brought into strong relief the similarities and differences in the food chains (webs) thought to be of greatest importance to commercial species as well as gaps in information. A second set of tables addressed the mechanisms by which climate variability might be expected to impact the transfer of energy from one trophic level to the next. The magnitude of these impacts would be expected to be very sensitive to the life histories of the species involved. These discussions were followed by evaluation of modeling strategies that could be employed to elucidate how climate variability may impact these marine ecosystems.

The workshop participants liked the fact that the individual chapters on each of the PICES regions had a similar structure (listing of topics), though they noted that coverage of these topics varied considerably from one region to another. If the coverage could be standardized, at least to the point that a minimum set of tables and graphs could be presented, it would greatly facilitate the use of the report for comparative studies. Likewise, within the synthesis chapter, having a set of figures or tables that compared all or sub-sets of the PICES regions in terms of physical and chemical characteristics, biological rates, and trends in populations would highlight the similarities and differences among PICES regions. On-line sources of the data used for the summary tabulations and figures would be of great help to others wishing to explore the data in alternate ways.

The workshop participants felt strongly that it would be useful for ESSAS to systematically investigate the major mechanisms by which climate change might be expected to affect the sub-arctic seas. To this end, it was proposed that ESSAS hold a series of annual workshops, each of which would be focused on a different aspect or mechanism by which climate would be expected to influence the sub-arctic seas. Initial topics for these proposed workshops included the role of sea ice, the importance of advection and its sources, and the determinants of stratification, among others. Emphasis would be on developing papers, to be published in a refereed journal, that compare all or as many of the ESSAS areas as possible.

The workshop participants also agreed that ESSAS could offer to contribute directly to the next edition of the NPESR, perhaps by providing summaries of the proposed workshop series on the effects of climate variability on the critical mechanisms controlling energy flow in sub-arctic marine ecosystems. There would be a natural fit between the aims of PICES and those of ESSAS as regards the “northern

tier” of the PICES regions, but how ESSAS might incorporate information about the PICES regions at lower latitudes is less clear. ESSAS could take the stand that what happens in lower latitudes foreshadows events at higher latitudes, but so far ESSAS has tried to maintain a focus on those marine ecosystems that are affected by seasonal sea ice cover and that are dominated by gadids.

It was hoped that PICES would wish to be involved with the sponsorship and organization of the ESSAS workshop series. The ESSAS workshops could gain the support of a strong international organization that shared ESSAS interests in climate impacts on marine ecosystems and the effects of these impacts on the sustainability of sub-arctic marine fisheries. The connection with PICES would strengthen ESSAS's position in the North Pacific, and would facilitate the ability of ESSAS to develop comparative studies there. In return, it was seen that ESSAS could provide PICES with a strong connection to the North Atlantic marine community, provide an entry to IPY activities through the lead role played by ESSAS in ESSAR (Ecosystem Studies of Sub-arctic and Arctic Regions), and could complement the activities of the PICES CCCC program and potentially that of the new Integrative Science Program to be undertaken by PICES. Thus, it was hoped that PICES would wish to continue its active interest in, and strong support of ESSAS activities. This support has included hosting the initial ESSAS GLOBEC symposium, *Climate Variability and Sub-arctic Marine Ecosystems*, held in Victoria in May 2005 and providing travel support for several of the speakers. PICES also helped to organize the St. Petersburg ESSAS Workshop on *Developing Comparative Studies of Sub-Arctic Seas*, and provided travel support for Russian Scientists to participate in the workshop.

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