

PICES report on *Marine Ecosystems of the North Pacific*: Towards ecosystem reporting for the North Pacific basin

R. Ian Perry¹ and Jeffrey M. Napp²

¹ Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, V9T 6N7, Canada
E-mail: perryi@pac.dfo-mpo.gc.ca

² NOAA/Alaska Fisheries Science Center, 7600 Sand Point Way NE, Bldg. 4, Seattle, WA 98115-6349, U.S.A.

In 2004, the North Pacific Marine Science Organization (PICES) published its first report on the marine ecosystems of the North Pacific, which had been in preparation since 2002 (PICES, 2004). The objectives of the report were to:

1. describe the present state of marine ecosystems of the North Pacific Ocean (Status), in the context of their recent (past 5 years) and longer variability;
2. summarise assessments of conditions in the various marine ecosystems and regions of the North Pacific into a broad basin-wide synthesis;
3. identify critical factors causing changes in these ecosystems; and
4. identify key questions and critical data gaps inhibiting understanding of these marine ecosystems.

An important point to note is that the report was not explicitly designed to provide advice for ecosystem-based management, and no explicit management objectives were identified in the report. The report was built around individual chapters on specific themes and geographic regions:

- Large-scale ocean and climate indices,
- Yellow and East China seas,
- Japan/East Sea,
- Okhotsk Sea,
- Oyashio/Kuroshio,
- Western Subarctic Gyre,
- Bering Sea,
- Gulf of Alaska,
- California Current,
- Gulf of California, and
- North Pacific Transition Zone.

It also included chapters on individual species of particular importance and for which international management agencies were responsible, such as Pacific halibut, tuna, and Pacific salmon. Each regional chapter addressed the same topics:

- background (setting),
- climate,
- hydrography,
- nutrients,
- plankton,
- phytoplankton (chlorophyll),
- zooplankton,
- fish/invertebrates,
- seabirds,
- marine mammals,
- issues,
- critical factors causing change.

The first chapter of the report used a thematic approach cutting across all regions. For example, it addressed large-scale atmospheric and ocean forcing of these ecosystems and, in particular, looked across all regions at subarctic coastal systems, central oceanic gyres, and temperate coastal and oceanic systems. In addition, the synthesis examined (briefly) the human pressures on the North Pacific, aquaculture, and other pan-Pacific issues.

The emphasis in each chapter was on the “most recent” data and information, *i.e.*, conditions over the past 5 years (if available), put into the context of the existing time series. The readership was assumed to be interested marine scientists, and possibly the interested public and non-governmental organizations. More work could be done for future releases to better identify and clarify the audience, which would make a more

targeted product. For example, if the goal of future reports is to advise citizens and governments of Pacific Rim countries on the state of the ocean, then better development of synthetic indicators would be required.

In producing each chapter, information was drawn from existing ocean status reports (*e.g.*, Canada) and ecosystem summaries (*e.g.*, California Current, Bering Sea) whenever possible. Where such reports were not available, regional workshops were convened with local experts to present and synthesize recent information. This was the approach used for the Japan/East Sea (workshop held at Seoul National University, August 2002), the Okhotsk Sea (workshop held at TINRO Center, June 2003), and the Yellow and East China Seas (workshop held during the PICES Twelfth Annual Meeting in Seoul, Korea, October 2003). For some regions, individual “countries” were invited to convene local experts to develop the various chapter sections. This was the approach taken for the Eastern Subarctic Gyre (Alaska), the Oyashio/Kuroshio region and the Western Subarctic Gyre (Japan), and the Gulf of California (Mexico). For each of the species-specific chapters (tuna, Pacific halibut, and salmon) fishery organizations were responsible for their content.

Significant data gaps

This first report on North Pacific marine ecosystems was intended as a pilot project. As such, it was not expected to cover all topics in equal detail. Indeed, it is not possible to cover all topics in equal detail as such data do not exist for many topics. Regional coverage of some chapter components was uneven, in particular for chemical oceanography (especially nutrients), and benthos. It is not clear whether the absence of these issues in the report represents an actual lack of data or lack of awareness of data. Another notable omission was regional data on harmful algal blooms. An active Section of the PICES Marine Environmental Quality (MEQ) Committee is examining harmful algal blooms in the North Pacific; their participation in the next report would

serve to greatly increase the information on this important topic. Future efforts to produce the PICES marine ecosystem report might make good progress at filling these data gaps by convening workshops of disciplinary experts from around the North Pacific to address specific topics, *e.g.*, nutrient data.

The report also contained several themes that were only weakly developed in the various chapters. These include:

- contaminants,
- inter-tidal / sub-tidal ecosystems,
- “human dimensions” (*e.g.*, fishing effort, *etc.*),
- large, basin-scale physical oceanography/ocean circulation (in particular with Argo data),
- development and presentation of common and synthetic “ecosystem indicators”.

All chapters have some level of abundance and/or biomass measures for fish. Several chapters have some level of abundance and/or biomass information for highest and lowest trophic levels. However, only a few chapters (*e.g.*, the eastern Bering Sea and Gulf of Alaska) include synthetic information, such as information on species diversity and recruitment.

Eastern Bering Sea chapter highlights

The report highlights the following recent general conditions in the eastern Bering Sea:

- Oceanographic and ecosystem dynamics are dominated by sea ice, and sea ice has been diminishing in recent years;
- There have been shifts in abundance of fish and invertebrates over past 20 years; groundfish populations appear to have stabilized, whereas some crab stocks remain at low levels;
- There are concerns about declines of western Steller sea lion and northern fur seal and North Pacific Right whale populations;
- Significant issues include sea ice and climate warming, unusual phyto- and zooplankton blooms, interactions of fishing with bottom habitats, marine mammal population declines and their unusual distributions.

Key messages

Key messages from the synthesis of these regional and species chapters include:

Climate

A new atmospheric pattern altered storm tracks across the North Pacific after 1998. This new climate pattern was associated with a change from warm to cool conditions from northern Vancouver Island to the Baja California Peninsula, and warming in the central Pacific, but had little effect in the northern Gulf of Alaska and Bering Sea which stayed warm or in the Okhotsk Sea which stayed cool. This pattern, named the Victoria Pattern, has subsequently changed again.

Ocean productivity

Blooms of various species of harmful phytoplankton are increasing around the North Pacific. Some species are detrimental to fish and shellfish mariculture operations, and some species have harmful effects on marine mammals as the toxins are passed up the food web. An unusual bloom of coccolithophorid phytoplankton occurred in the Bering Sea during equally unusual ocean conditions in the summer of 1997, which created milky-coloured water visible from space. Jellyfish blooms have appeared and disappeared in Asian waters and Bering Sea without satisfactory explanations. Large changes in the mix of subarctic and temperate zooplankton species have occurred in the eastern North Pacific.

Living marine resources

There have been significant successes in maintaining productive fish stocks through a combination of active and conservative management. Total Pacific salmon catches were at historical high levels through the 1990s, supported by large releases of chum and pink salmon from hatcheries on both sides of the Pacific, and wild sockeye salmon. Walleye pollock abundance in the eastern Bering Sea has been relatively stable while elsewhere in the North Pacific, its abundance has been declining. The total biomass of Pacific halibut has remained high

in the Gulf of Alaska throughout the 1990s as a result of several years of good recruitment.

Some species/stocks, however, have not fared so well. Rockfishes in the California Current System, walleye pollock in the Okhotsk Sea, and hairtail in the Yellow Sea are heavily or overexploited. Many individual salmon populations, especially of coho and chinook, declined dramatically during the 1990s in the southern part of their North American range, but there have been encouraging signs of recovery since 1999. Small pelagic fishes, which naturally undergo very large changes in abundance, have also undergone fluctuations in recent times. Pacific sardine abundances were very high in the late 1980s throughout the entire North Pacific, except in California, but declined abruptly in the early 1990s and have generally remained low since then. This synchrony suggests an important role of a large-scale force such as climate in determining abundance. In the California Current System, sardines remained low in the 1980s but began recovering in the late 1990s. The western populations of Steller sea lions are currently at very low abundances. Despite new conservation measures (and increased research), large-scale recovery has not yet occurred. Mass mortalities of marine mammals (pinnipeds) have occurred over the past decade in the Gulf of California and off the State of California, due to unusual harmful algal blooms. Intensive mariculture is increasing dramatically around the North Pacific rim and is well-established in the southwestern North Pacific.

Future plans for the marine ecosystem report

PICES convened a workshop at its 2005 Annual Meeting (PICES XIV) to review the successes and shortcomings of the first (pilot) report and to decide how future reports should look. Discussion focused on several key topics or questions:

- What should the report contain?
- Who is the intended audience?
- How often should it be “published”?
- What form should it take?
- Who would be responsible for preparing it?

Those attending emphasized the need for timely information and suggested that the product,

audience, and format might be best addressed in future iterations if a staggered or nested approach was used, whereby some (easy to obtain) information would be readily available on an annual basis, while some of the more synthetic information and analyses would be available less frequently. The group also discussed the need to make some products specifically for policy makers from the PICES member countries. The group settled on the following approach (Table 5),

whereby some of the time series were made available to users on an annual basis via the worldwide web. Syntheses and interpretations (similar to the first North Pacific Ecosystem Status report) would be published on the web and in hardcopy less frequently (say every 3 to 5 years) and longer range outlooks for policy makers might be published once every 5 to 10 years or more frequently if there were emerging issues that warranted concern or special attention.

Table 5 Proposed system of future PICES North Pacific Ecosystem Status report products, audience, and which group within PICES should be responsible for their preparation.

Product	Audience	Period	Form	Who
time series	<ul style="list-style-type: none"> • scientists, • public 	annual	web	?
syntheses/interpretations of ecosystem status	<ul style="list-style-type: none"> • scientists, • public, • policy makers 	3–5 years	web and hardcopy	Working Group
outlooks	<ul style="list-style-type: none"> • policy makers 	5–10 years	brochure	Study Group

Main conclusions

- The PICES North Pacific Ecosystem Status report (2004) was a highly successful pilot project, and it will evolve with the next iteration. Discussions have begun to define its audience more clearly, *e.g.*, decision makers and general public, or ocean management specialists and scientists, and to consider best formats to present the varying types of information contained in the first report;
- The process to define significant data gaps has also begun. What are the gaps and what is the best way to fill them? Should PICES conduct its own analyses and develop indicators? Which indicators would it use? Should it connect with PICES/NPRB Indicators workshop conclusions?
- PICES workshops continue to address the significant information and understanding that can be gained by using large-scale, basin-wide

comparisons. To do these comparisons of large marine ecosystems (LMEs) we must consider developing indices based on selected species/functional species groups or key features which are shared or common across LMEs.

In developing ecosystem indicators, in particular for the eastern Bering Sea and coastal Gulf of Alaska, the experience of the PICES report on *Marine ecosystems of the North Pacific* demonstrates the value of a comparative approach in which (at least) key indicators and key species are compared across a geographic area wider than just the target region.

Reference

PICES. 2004. *Marine ecosystems of the North Pacific Ocean*. PICES Spec. Publ. 1, 280 p.