

2008 PICES Workshop on “*Climate Scenarios for Ecosystem Modeling (II)*”

by Michael Foreman, Anne Hollowed and Suam Kim

A key component of FUTURE (an acronym for Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems), the new over-arching science program within PICES, is understanding and communicating the impacts of climate change on North Pacific marine ecosystems. Whereas FUTURE's predecessor, the Climate Change and Carrying Capacity (CCCC) Program, focussed primarily on past climate change effects, this new program will have a stronger emphasis on future changes, and thus rely heavily on the global climate model projections described in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Toward that end, the CFAME (*Climate Forcing and Marine Ecosystems*) Task Team of the CCCC Program has laid some of the groundwork for FUTURE by collaborating with the Working Group on *Evaluations of Climate Change Projections* (WG 20) in analysing downscaled atmospheric and physical oceanographic projected changes from a suite of global climate models to determine their impact on states of three North Pacific ecosystems: the California Current System, the Kuroshio/Oyashio System, and the Yellow and East China Seas System (see PICES Press, Vol. 16, No. 2, for the summary of their April 2008 workshop). A joint workshop of these two groups on “*Climate scenarios for ecosystem modeling (I)*” took place at the 2007 PICES Annual Meeting in Victoria, Canada, and a follow-up 1.5-day workshop, jointly organized by CFAME, WG 20, and a prospective new ICES/PICES Working Group on *Forecasting Climate Change Impacts on Fish and Shellfish*, was held at the 2008 PICES Annual Meeting in Dalian, China. This article summarizes some highlights of this second workshop that was co-convened by Michael Foreman, Anne Hollowed, Suam Kim, and Gordon McFarlane.

The workshop opened with an invited presentation by Thomas Okey (Pew Fellow in Marine Conservation) on the challenge of forecasting changes to marine biota and fisheries in the year 2035. He summarized discussions from, and collaborations established at, a workshop preceding the conference on “*The Effects of climate change on the world's oceans*” held in Gijón, Spain, in May 2008, and outlined the motivation for the new ICES/PICES Working Group that is being led by Anne Hollowed. The next two speakers, James Overland and Young-Shil Kang gave updates of their work relevant to the CFAME terms of reference. In particular, Jim stressed that among the 22 global climate models that he and his colleagues Muyin Wang and Nicholas Bond investigated, no one model was uniformly best in capturing all the important oceanic features in the North Pacific. However, he did show a “wall of fame/shame” table rating model relative performance and indicated a group of approximately six

models that gave generally acceptable results over a standard evaluation period, and that should be used in future ensemble estimates of climate change in the North Pacific.

Five out of the next six presentations were progress updates given by WG 20 members. Yasuhiro Yamanaka described recent results received with the COCO-NEMURO coupled biophysical climate model for the Kuroshio/Oyashio region. Emanuele Di Lorenzo gave a preview of his subsequent award-winning Science Board presentation describing his North Pacific Gyre Oscillation (NPGO) analysis of variability in North Pacific sea surface elevations and its links with ENSO signals. Jim Christian described the development of a carbon cycle component within the next generation of the Canadian Global Climate Model. Enrique Curchitser showed preliminary results of improved upwelling arising from embedding and fully coupling his 10-km regional ROMS model for the Northeast Pacific within the NCAR global climate model. Michael Foreman described wind downscaling results and new regional climate and ecosystem model initiatives in Canadian waters. Within these updates, Qigeng Zhao described his simulations of acidification in the Pacific.

The remaining presentations provided information on efforts to forecast the implications of climate change on fish and shellfish in the North Pacific. Anne Hollowed discussed a framework for making forecasts by using statistical methods to select credible IPCC models and extract their expected forcing. This forcing could then be incorporated into statistical age-structured models to project impacts on commercial fish populations. Gordon Kruse presented a qualitative method that could be used to forecast climate change impacts on red king crab stocks in the Eastern Bering Sea. Suam Kim talked about the response of Korean chub mackerel populations to climate forcing, showing that salinity is significantly correlated to year-class strength and suggesting that shifts in transport may play a key role in recruitment variability of this stock. Michio Kishi examined the role of climate variability on the growth of salmon, pollock and squid in the northwestern Pacific using a bio-energetic model. Preliminary results of this study suggest that chum salmon may not survive in waters off Hokkaido in 2100. Richard Beamish gave two talks on the impact of climate change on salmon stocks in British Columbia. His first talk showed that poor marine survival of chinook salmon in the Strait of Georgia appears to be related to reduced growth resulting from a declining carrying capacity in the area, while his second talk compared two sockeye salmon runs that exhibited different population trends. As was the case in the first talk, the different trends appear to be related to the spatial distribution of food and the behaviour of juvenile salmon.

The final half-day of the workshop was devoted to discussions on the proposed new ICES/PICES Working Group on *Forecasting Climate Change Impacts on Fish and Shellfish* (WGFCCIFS). Manuel Barange, one of the ICES Co-Chairs for this group, provided an overview of ICES-community interest in this effort and noted that ICES had already approved the formation of WGFCCIFS and its terms of reference. Individuals from PICES member countries identified several research programs that would contribute to the activities of the working group.

The participants discussed the rationale for start and end dates of 2035 and 2100, respectively, for the investigations. The former date was selected because it is the projected time when the climate change signal will begin to overwhelm the interannual and interdecadal signal in the North Pacific. The end date was selected because after it, forecasts will be heavily dependent on which particular IPCC emission scenario is chosen for predicting the rate of greenhouse gas build-up in the atmosphere. Mikhail Stepanenko noted that managers are most interested in forecasting future fish populations over short time horizons, and therefore, we should not ignore any efforts to also improve short-term projections. A clear linkage between short-term and long-term projections will be model validation activities. By examining the performance of projections in the short-term, analysts should be able to quantify expected inaccuracies associated with the long-term projections.

Different frameworks for delivering IPCC model output were discussed. It was agreed that the ideal framework would be one where oceanographers and climatologists

from each member nation work with their biologists and modellers to develop relevant forecasts. However, it was noted that James Overland, Muyin Wang, and Nicholas Bond from the Pacific Marine Environmental Laboratory would be willing to assist various groups, when necessary and as time permits.

The participants had a lively discussion of the topic of communicating uncertainty. George Sugihara mentioned that forecasting is a complicated science and that there is a variety of analytical tools that have been developed for the business community which could be applied here. Jake Rice noted that the issue of communicating uncertainty requires that we identify the stakeholders who might be interested in our forecasts. It was noted that the advice of PICES and ICES on the future status of marine resources around the world could be used to address the following issues:

- global food security;
- implications on northward shifts in stocks on managing domestic fisheries, including shifts in the locations of fishes (*e.g.*, sardines, hake) and rights-based (communities and businesses) solutions;
- new fisheries in the north (especially for Canada, Russia and U.S.A.);
- assessing species and populations at risk (what are appropriate recovery targets for species in a changing world?).

Patricio Bernal (Intergovernmental Oceanographic Commission of UNESCO) indicated that his organization would be very interested in this new ICES/PICES effort. It was agreed that potential collaborations with IOC, FAO and other organizations would be investigated.



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Dr. Suam Kim (suamkim@pknu.ac.kr) received his B.Sc. (1976) and M.Sc. (1979) from the Seoul National University and his Ph.D. in Fisheries Oceanography from the University of Washington in 1987. Currently, he is a Professor of the Pukyong National University, Busan, Korea. His areas of interest include fisheries ecology, especially recruitment variability focusing on early life histories of fish in relation to oceanic/climate changes. Suam represented Korea on several international organizations/programs such as PICES, GLOBEC, CCAMLR, IGBP, NPAFC and SCAR. Currently, he serves as President of NPAFC.