

Study Group on *Fisheries Ecosystem Responses to Recent Regime Shifts* completes its mandate for the provision of scientific advice

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Dr. Jacquelynn King is a research scientist in Groundfish Stock Assessment, at the Pacific Biological Station in Nanaimo, Canada. Her research focuses on the impacts of climatic and oceanographic variability on marine fish population dynamics and the implications for fisheries management. She has published research on a suite of disciplines including marine fish life history strategies, statistical methodology, climate impacts on ecosystems, ageing methodology, stock assessment, fish population dynamics and behavioural ecology. Dr. King is a member of the PICES WG 16 on Climate Change, Shifts in Fish Production, and Fisheries Management and is Chair of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts.



The North Pacific Marine Science Organization (PICES) received a formal request for scientific advice from the United States government in October 2003. The request focused on the implications of the 1998 regime shift for North Pacific fisheries. Following the strong 1997-1998 El Niño, the North Pacific climate underwent a rapid and striking transition, the persistence of which suggests that a regime shift had occurred. Previous regime shifts have had serious implications for ecosystems, and consequently for fish populations and the fishing industry. As such, the National Marine Fisheries Service requested scientific advice from PICES that addresses six specific questions:

1. Has the North Pacific shifted to a different state or regime since the late 1980s?
2. What is the nature of the new state?
3. What are the ecosystem responses?
4. How long can the shift be expected to last?
5. Is it possible to predict when the regime will shift back and what indicators should be used to determine when it happens?
6. What are the implications for the management of marine resources?

FERRRS Study Group

The PICES' Science Board established a 20-member Study Group on *Fisheries and Ecosystem Responses to Recent Regime Shifts* (FERRRS) to provide a response to the United States' request for advice. The Study Group was chaired by Jacquelynn King (Canada) and was comprised of PICES scientists from Canada (William Crawford, David Mackas, Gordon McFarlane, Jacob Schweigert), Japan (Akihiko Yatsu), People's Republic of China (Qi-Sheng Tang, Jin-Ping Zhao), Republic of Korea (Suam Kim), Russian Federation (Victor Lapko), the United States

of America (Harold Batchelder, Jennifer Boldt, Anne Hollowed, Alec MacCall, Nathan Mantua, James Overland, Jeffrey Polovina, Franklin Schwing) and PICES ex-officio members (Alexander Bychkov, Stewart (Skip) McKinnell, Ian Perry).

The Study Group held its first meeting on February 9-10, 2004, in Victoria, Canada, to organize activities and outline a report that would provide the background material necessary to prepare responses to the six questions posed in the request for advice (*PICES Press*, Vol. 12 (2): 19-20).

The background material was reviewed by the Study Group at a 3-day workshop convened June 14-16, 2004, in Seattle, U.S.A. A major focus for the workshop was the description of coherent regional responses to the 1998 regime shift and development of advice on resource management approaches. Answers to the six questions were formulated.

FERRRS report

The Study Group has prepared a report which will be published as a PICES Scientific Report in January 2005, and available for download from the PICES website. The report contains an *Executive Summary* with responses to the six questions posed by the United States. It also retains the detailed scientific information used by the Study Group in formulating its advice. Chapter 2 (*Decadal-scale Climate Events*) provides information on climate-ocean indices and basin-scale events. Chapter 3 (*Coherent Regional Responses*) provides summaries of the ecosystem responses to recent regime shifts. Detailed descriptions of the observed regional responses to the 1998 basin-wide shift are provided in Appendices 1-5. Chapter 4

(*Implications for the Management of Marine Resources*) outlines the conceptual framework for the provision of scientific advice and the development of resource management policy given impacts of regime shifts on ecosystems and fish productivity.

Summary of advice

Overall the Study Group advised that a regime shift did occur in 1998, and that it appeared to have a north-south pattern of spatial variability, unlike many of the previous regimes that had an east-west pattern of spatial variability. The dominant atmospheric pressure systems over the North Pacific (the Aleutian Low and the North Pacific High) have intensified which has resulted in greater upwelling-favorable winds along much of the western United States, and greater downwelling-favorable winds of Canada and southeast Alaska. The 1998 regime shift had the greatest impact in the California Current System, less of an impact in the Gulf of Alaska, and virtually no impact in the Bering Sea. In the southern region of the eastern North Pacific and in the northern region of the western North Pacific, the biological production has improved. Although one might reasonably expect the current regime to last a decade or more, it is currently not possible to reliably predict when a regime will end because we presently lack a good understanding of the mechanisms involved in regime shifts. However, it is possible to detect regime shifts soon after they have occurred. Reliable prediction of the timing of regime shifts requires research investigating the mechanisms and triggers for regime shifts. Agencies need

to develop policies with explicit decision rules and the subsequent actions to be taken when there are preliminary indications that a regime shift has occurred. These decision rules need to be included in long-range policies and plans. Stock assessment advice should indicate the potential consequences to stock viability of alternate management strategies under different levels of recruitment that would be expected in different regime periods.

Overall recommendations

Given the importance of regimes to ecological systems, the Study Group provided four recommendations for incorporating regime shift concepts into fishery management activities:

1. accept the regime concept for marine ecosystems – a wealth of historical evidence suggests regime shifts are a natural and recurring part of marine ecosystems;
2. develop and maintain a comprehensive observational program to monitor state changes in climate, ocean systems and ecosystems;
3. develop climate indices to aid ecosystem monitoring efforts, and support research efforts into linking those climate indices to predictable parts of the climate system (*e.g.*, variability in the El Niño Southern Oscillation);
4. make use of integrated stock assessments, wherein various future regime scenarios can be evaluated to assess the vulnerabilities of fisheries and ecosystems, and to conduct risk analyses for different management strategies.

PICES Calendar

- Workshop on “East Asian Seas Time Series” as part of the CREAMS/PICES project, April 21-22, 2005, Seoul, Korea
- GLOBEC/PICES Symposium on “Climate variability and sub-Arctic marine ecosystem”, May 16-20, 2005, Victoria, Canada
- Workshop on “Study of lower trophic level pelagic ecology in the subarctic Pacific Ocean”, May 23-24, 2005, Corvallis, Oregon, U.S.A.
- ICES/PICES theme sessions on “Fisheries, ecology and life history of small pelagic fish” and on “Comparing and constructing the scientific strategies and output of regional ecosystem projects” at the ICES Annual Science Conference, September 20-24, 2005, Aberdeen, Scotland
- PICES Fourteenth Annual Meeting, September 30-October 8, 2005, Vladivostok, Russia
- ORI/PICES Symposium on SEEDS-II experiment, 2 days in October 2005, Tokyo, Japan
- Workshop to build up a multi-species model extending NEMURO.FISH (potential co-sponsors: APN, IAI, IOC and FRA), September or October 2005, Japan
- NPAFC/PICES Symposium on “The status of Pacific salmon and their role in North Pacific marine ecosystems”, October 30- November 1, 2005, Jeju, Korea
- PICES/GLOBEC symposium on “Climate variability and ecosystem impacts on the North Pacific: A basin-scale synthesis”, April 19-21, 2006, Honolulu, U.S.A.
- ICES/PICES symposium on “Marine bioinvasions”, 3 days in early 2006, Boston, U.S.A.
- Symposium to celebrate the 50th anniversary of sampling along Line P and at Station PAPA, 3 days in summer 2006, Victoria, Canada
- PICES/CREAMS/WESTPAC Workshop (with training component) on “NEAR-GOOS Seas Circulation: What we know and how well can we forecast?”, summer 2006, near Vladivostok, Russia
- PICES Fifteenth Annual Meeting, October 13-21, 2006, Yokohama, Japan
- 4th International Zooplankton Production Symposium (co-sponsored by PICES, GLOBEC and ICES), May 28-June 1, 2007, Hiroshima, Japan
- PICES/ICES Young Scientist Conference, spring or summer of 2007, venue TBD