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PICES Press

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PICES in transition: The 3rd inter-sessional Science Board and Governing Council meeting

The 3rd inter-sessional Science Board meeting with the participation of Governing Council was hosted by the Alaska Fisheries Science Center and the Northwest Fisheries Science Center, and held at NOAA's Sand Point facilities in Seattle, U.S.A., from April 6-7, 2005. As PICES scientific activities have increased dramatically and its programs have expanded in recent years, the two senior bodies of PICES have recognized the need to communicate more frequently, to be up-to-date, and to chart the future of the Organization. Particularly, it is important to realize that PICES is in transition now as it completes its Climate Change and Carrying Capacity (CCCC) Program, which has been the main scientific activity of PICES so far. The CCCC Program is now moving towards synthesis, and will convene a symposium on "Climate variability and ecosystem impacts on the North Pacific: A basin scale synthesis" in Honolulu, U.S.A., from April 19-21, 2006. PICES is also making first steps in developing another major inter-disciplinary and integrative scientific program that will suit the interests of all member countries and their scientists. The 3rd inter-sessional meeting focused on implementing decisions and recommendations from PICES XIII in Honolulu (October 2004), and provided time for in-depth discussions on the PICES Strategic Plan, Committee Action Plans, up-coming symposia/workshops and publications, and the on-going activities of PICES. The highlights are described below.

Next major integrating program of PICES

Development of the next major integrative program of PICES was initiated effectively at the first inter-sessional Science Board and Governing Council meeting, held in April 2003, in Victoria, Canada (see PICES Press Vol. 11, No. 2). The Science Board reviewed progress made and recommended the establishment a new study group to develop recommendations for one or more new Integrative Scientific Program(s) to be undertaken by scientists in PICES member countries. This recommendation was later approved by Council. The entire PICES community, from individual scientists, PICES committees and groups, governments of member countries to international organizations, is expected to be engaged in the development of the next integrative program, with the PICES Strategic Plan and Committee Action Plans at hand. PICES member countries must share common interests in the program(s) and find the program relevant to their governments. At the same time the support from the scientific community is essential for active participations from scientists. The program should be strategic and provide an opportunity for PICES to become a world leader and to gain international respect beyond the North Pacific. The program should also bring "new blood" and fresh ideas into PICES to keep the Organization up-to-date and dynamic. The announcement of the new themes is planned for PICES XV (Yokohama, 2006).

Action and Strategic Plans

An Action Plan for each Committee will identify how to implement the ideas contained in the PICES Strategic Plan on the short (annual) to medium (~5 years) time scales. These Action Plans will be prepared using a standard template, and will be posted on the PICES website. Science Board will review all Action Plans, and circulate them to Council for approval by October 2005. Science Board will also develop a Strategic Plan template (based on the format of BIO's Strategic Plan) to be used for all committees.

High-priority PICES activities for external funding

At PICES XIII, Council asked Science Board to develop a list of high-priority PICES projects that are strong candidates for external funding. Upon this request, Science Board identified the next North Pacific Ecosystem Status Report (expected to be published in 2007) and activities related to the development of future integrative scientific program(s) as the highest-priority projects. Next in priority, in order of importance, are the PICES-ICES Young Scientists Conference, international exchange and capacity building, and GOOS integration.

Future of carbon cycle studies in PICES

The success of WG 13 on *CO_2 in the North Pacific* in 1998-2001 (chaired by Drs. R. Feely and Y. Nojiri) and WG 17 on *Biogeochemical data integration and synthesis* in 2002-2005 (chaired by Drs. A. Dickson and Y. Nojiri) are often cited as models of regional cooperation for the globally important scientific problem of carbon cycle studies. Recognizing the need for a regional group that has a longer lifetime than the typical Working Group, and that will allow the Organization to maintain its pre-eminence in this arena while ensuring that the important basin–scale problems of carbon cycling in the North Pacific are adequately addressed, Science Board supported a WG 17 proposal and recommended the establishment of a Section on *Carbon and Climate*, under the direction of POC and BIO. This recommendation was later approved by Council. It is expected that this Section will provide clear channels of communication between PICES and the SCOR-IOC International Ocean Carbon Coordinated Project (IOCCP), and large-scale IGBP programs such as SOLAS and IMBER.

Analysis of performance/input from past and existing PICES temporary groups

Upon a request from Council, Science Board initiated a review of temporary groups (Working Groups, Study Groups, Task Teams and Advisory Panels) established since the inception of the Organization. The purpose of the review is not to evaluate the performance of any single group, but to get an idea of whether the current approach of the formation and financing of these groups is working. It is expected that this analysis will assist in preparing guidelines for future temporary groups.

Committee Chairman and Vice-Chairman positions

At PICES XIII, a proposal to establish a Vice-Chairman position for each committee was discussed, but consensus was not reached. Science Board re-visited this issue and recommended an amendment to the PICES Rules of Procedure to provide flexibility in establishing a Vice-Chairman position (with a maximum term of 3 years) for committees. As with the position of the Vice-Chairman of Science Board, the Vice-Chairman of a Committee should

Participants at the 2005 interim meeting of Science Board and Governing Council: (left to right from back) Alexander Bychkov, Tokio Wada, Samuel Pooley, George Boehlert, Michael Foreman, Lev Bocharov, Vera Alexander, Laura Richards, Chul Park, Robin Brown, Jeffrey Napp, Jae Soo Park, Igor Shevchenko, Michael Dagg, Yukimasa Ishida, Suam Kim, Skip McKinnell, John Stein, Harold Batchelder, Dong Sil Park, and Kuh Kim.

Dr. Gary Stauffer of NMFS welcomes participants to the Sand Point facilities where the 2005 interim SB/GC meeting was held.

Drs. John Stein, George Boehlert and Vera Alexander wind down with a drink at the group dinner.

PICES staff Ms. Rosalie Rutka and Ms. Christina Chiu with Dr. and Mrs. Warren Wooster at the group dinner.

be from the opposite side of the Pacific as the Chairman, and should assist the Chairman with the duties of planning and running the committee business on an on-going basis throughout the year. Science Board also suggested that there needs to be flexibility for the extension of terms for committee Chairmen (their 3-year terms are not renewable or extendable under the current Rules of Procedure).

Climate Change and Carrying Capacity Program

The 2006 PICES/GLOBEC Symposium will be the major milestone towards the CCCC synthesis. The symposium is organized around three main themes (each day is devoted to a different theme): (1) Regime shifts, (2) Ecosystem productivity and structural responses to physical forcing and (3) Pan-Pacific comparisons. Closing perspective talks will be given by Drs. Makoto Kashiwai (Japan) and John Davis (Canada), who were asked to provide their impressions of success and failures of the CCCC Program, and if we had failures, what we might have done differently to achieve success. Selected papers from the symposium will be published in a *Progress in Oceanography* special issue, by the fall of 2007.

The CCCC Program will not end with the symposium and will likely be coupled with PICES activities for as long as GLOBEC activities continue, until 2009/2010. The CCCC synthesis activities will be carried out by two Task Teams. The CFAME Task Team, formed to look at large-scale aspects of climate forcing in ecosystems, had a workshop on "Developing a working plan for CCCC synthesis" in May 2005, in Victoria, Canada (see a separate article in this issue). The MODEL Task Team will convene a workshop in November 2005 in Tokyo, Japan, to extend NEMURO.FISH to fish stocks in other geographic locations. This workshop will be co-sponsored by the Fisheries Research Agency of Japan, APN, IAI, GLOBEC and PICES. Selected papers on NEMURO and NEMURO.FISH models will constitute a special issue of *Ecological Modelling* to be published in 2006.

Activities of Committees

BIO

The Advisory Panel on *Micronekton sampling inter-calibration experiment* completed its first field cruise off Hawaii just prior to PICES XIII, and data analysis is now taking place. Plans are under development for a follow-up experiment in the subarctic North Pacific. A workshop to discuss a proposal for a multi-national project entitled "**O**ceanic **E**codynamics **CO**mparison in the **S**ubarctic Pacific" took place in May 2005, in Corvallis, U.S.A. (see a separate article in this issue).

FIS

Working Group 16 on *Climate change, shifts in fish production, and fisheries management* has prepared a draft report that has to be finalized by PICES XIV. Input to this

report from the U.S. will be provided by the Alaska Fisheries Science Center.

MEQ

The Report of the Study Group on "Ecosystem-based Management Science and its Application to the North Pacific" was published as PICES Science Report No. 29 in January 2005. The Harmful Algal Blooms Section is working on developing and implementing annual HAB reporting procedures that will be consistent with those used in ICES. It is expected that event records will be compiled and stored in the IOC joint ICES/PICES Harmful Algae Event Data Base (HAE-DAT), in order to assess the impacts of HAB events globally, and to improve prediction capability. Introductions and spread of non-indigenous species is an area of considerable interest to MEQ both scientifically and for building collaboration with ICES. A joint PICES/ICES workshop on "Introduced species in the North Pacific" will be held at PICES XIV. The workshop aims to discuss the establishment of a Working Group on introduced species under MEQ.

POC

A report of the workshop on the "Understanding North Pacific carbon cycle change: Data synthesis and modeling" appeared in PICES Press (January 2005), and selected papers from the workshop will appear in a special issue of *Journal of Geophysical Research* in late 2005 or early 2006. Work continues on the "Guide to best practices for oceanic CO_2 measurements and data reporting" and should be completed this year. An international workshop on "East Asian Seas Time-series", which was proposed as part of the CREAMS/PICES Program at PICES XIII, will be held April 21-22, 2005, in Seoul, Korea (see a separate article in this issue). POC is planning to launch a new Working Group to evaluate climate change projections for the North Pacific and its marginal seas based on predictions from the latest global models submitted to the Inter-governmental Panel on Climate Change (IPCC) for their 4th assessment report, and to work with CFAME to apply the IPCC model to the biological components.

TCODE

TCODE will be carrying out a "federated search" pilot project to establish a federated sharing capability between the North Pacific Ecosystem Metadatabase and the Korean Ocean Data Center. This capability allows searches in multiple metadatabases with a single query. It is expected that findings from the project will be published as a PICES Scientific Report.

The PICES website is at your fingertips for up-to-date news and information about reports, projects, and meetings. Please visit the PICES website (http://www.pices.int) today and be part of it.

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Dr. Kuh Kim was elected Chairman of the PICES Science Board in October 2004, at PICES XIII in Honolulu, Hawaii, U.S.A. Kuh was born and raised in Seoul, Korea. In his childhood, he dreamed of being an inventor and natural scientist someday, after reading stories about Thomas Edison. Kuh's experiment with a home-made rocket that he made failed and caused a complete loss of his eyesight for a while when he was 13 years old, but fortunately he recovered with minor damage, and graduated from middle school with the highest honor. Kuh became interested in geometry in his high school days and entered the Department of Mathematics, College of Natural Sciences, Seoul National University in 1964. In his second year in college, he had a chance to take a boat, for the first time in his life, from one port to another along the southern coast of Korea, and found another world which had been yet unknown to him. This experience led him to transfer to the Department of Physics to study fluid mechanics under the late Prof. Chul-Soo Kim, his lifetime mentor. Kuh was advised to further his study on fluid mechanics at the Graduate School of Seoul National University. Kuh's research for his Master of Science degree on the instability of conducting fluid between two rotating, concentric cylinders was published in the Journal of Physical Society of Japan *in 1970 as his first scientific paper. Kuh wrote in his application to the Massachusetts Institute of Technology (M.I.T.)–Woods Hole Oceanographic Institution Joint Program of Oceanography, that our understanding of the ocean is far less than of the moon, and was admitted with a Whitney Fellowship from M.I.T in 1970. There, Kuh became fascinated in the dynamics of ocean currents as he participated in several cruises of the Mid-Ocean Dynamics Experiments, during which the complexity of meso-scale ocean currents was unravelled for the first time. He completed his PhD in 1975 on "Instability and Energetics in a Baroclinic Ocean", which was published in* Deep-Sea Research *in 1978.*

Kuh joined the Department of Oceanography, Seoul National University in 1978, and introduced new knowledge and methods which were emerging out of intense programs, such as MODE and POLYMODE, to investigate ocean currents around Korea and neighboring countries. In particular, Kuh recognized that international collaborations are essential for a complete understanding of ocean currents and circulation in Asian marginal seas and worked closely with the late Prof. Takashi Ichiye of the Texas A&M University (U.S.A.) and Prof. Kenzo Takano of the Tsukuba University (Japan) to organize the First JECSS (Japan/East and East China Seas Study) Workshop in 1981, at Tsukuba University. Since then, JECSS workshops have been held every two years, providing a unique forum for sharing scientific interests, knowledge, new findings and data among marine scientists from not only Asian countries, but also from the U.S.A., U.K., France, Italy and other countries. Over time, the area of common interests has expanded and interactions between Asian marginal seas and the North Pacific Ocean have become an important subject of many presentations. Thus the workshop became PAMS (Pacific-Asian Marginal Seas)/JECSS and its 13th Workshop has just been held July 13-15, 2005, in Bali, Indonesia. Kuh has been serving as Chairman of PAMS/JECSS Steering Committee since 1993.

Kuh also organized international expeditions called CREAMS (Circulation Research of the East Asian Marginal Seas) to investigate the circulation and its variability in the Japan/East Sea during 1993–1998 with Japanese and Russian colleagues. Precise CTD data together with direct observations of currents in the deep waters of the Japan/East Sea revealed, for the first time, that this sea resembles big basins such as the Pacific Ocean and the Atlantic Ocean in its hydrographic structures, proving that it is, indeed, a miniature ocean. Kuh gave an opening lecture on CREAMS as a model study for an international and interdisciplinary project at PICES VI, October 1997. In 1999-2004 CREAMS-II became the largest and most extensive project in the Japan/East Sea as more than 20 U.S. marine scientists from the Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, University of Washington, University of Rhode Island, the Naval Research Laboratory and other institutions participated in the Japan/East Sea Program supported by the Office of Naval Research and other funding agencies in the U.S. A further evolution has produced CREAMS-III as the PICES Science Board endorsed the CREAMS/PICES Program at PICES XIII, which covers all disciplines of ocean sciences, including biological and fisheries oceanography.

Kuh is currently a professor at the School of Earth and Environmental Sciences (SEES), Seoul National University and is Director of "Brain Korea 21" for 1999–2006, funded by the Korean Ministry of Education and Human Resources to build a world-class school in Korea. He has been with PICES as member of the Physical Oceanography and Climate (POC) Committee since 1996, and served as Chairman of POC from 2002-2005. Kuh is also on the International Steering Team for the Argo project, which is deploying a global array of profiling floats to monitor the state of the ocean.

New and upcoming PICES publications

PICES Scientific Report Series, 2005

- King, J. (Ed.) 2005. Report of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Sci. Rep. No. 28, 162 p.
- Jamieson, G. and Zhang, C.I. (Eds.) 2005. Report of the Study Group on Ecosystem-Based Management. PICES Sci. Rep. No. 29, 72 p.
- Brodeur, R. and Yamamura, O. (Eds.) 2005. Micronekton of the North Pacific (Working Group 14 Final Report). PICES Sci. Rep. No. 30, 115 p.
- Takeda, S. and Wong, C.S. (Eds.) 2005. Proceedings of the 2004 Workshop on *In Situ* Iron Enrichment Experiments in the Eastern and Western Subarctic Pacific. PICES Sci. Rep. No. 31.

PICES Special Publications, 2004-2005

- Marine ecosystems of the North Pacific. 2004. PICES Spec. Publ. No. 1, 280 p.
- Perry, R.I. and McKinnell, S.M. (Eds.) 2005. Marine life in the North Pacific Ocean: The known, unknown and unknowable. PICES Spec. Publ. No. 2, 46 p.

Special issues of primary journals, 2005-2006

- Linkages between open and coastal systems (Guest Editors: S. McKinnell and G. McFarlane) - *Deep-Sea Research II*. 2005. Vol. 52, Nos. 5-6, pp. 665-843.
- Mechanisms that regulate North Pacific ecosystems: Bottom up, top down, or something else? (Guest Editors: G. Hunt and S. McKinnell) - *Progress in Oceanography* (2006).
- Hot spots and their use by migratory species and top predators in the North Pacific (Guest Editors: W. Sydeman, A. Bychkov, R. Brodeur, C. Grimes and S. McKinnell) - *Deep-Sea Research II* (2006).
- Selected papers on NEMURO and NEMURO.FISH models (Guest Editors: S.I. Ito, M. Kishi, B. Megrey and F. Werner) - *Ecological Modelling* (2006).

Other publications, 2005

- PICES Advisory Report on Fisheries and ecosystem responses to recent regime shifts in the North Pacific. 2005, 12 p.
- Tjossem, S. 2005. The journey to PICES: Scientific cooperation in the North Pacific.

PICES hosts GLOBEC Symposium on "Climate Variability and Sub-Arctic Marine Ecosystems" in Victoria

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Dr. Kenneth Drinkwater is a fisheries oceanographer conducting research on climate variability and its effects on the marine ecosystem, with a special interest in fish populations. Having worked many years at the Bedford Institute of Oceanography in Canada, he is now working at the Institute of Marine Research in Bergen, Norway. Ken is a member of the GLOBEC Focus 1 Working Group on Retrospective Analysis, and Co-Chairmen of the Scientific Steering Committee (SSC) of a new GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas (ESSAS).

Dr. George Hunt has joined the School of Aquatic and Fishery Sciences at the University of Washington as a Research Professor after retiring from the University of California, Irvine. He received his BA (1965) and PhD (1971) in Biology from Harvard University, and began teaching and research at UCI in 1970. Now he divides his time between Seattle and Friday Harbor, Washington. George started his career studying the behavioral and reproductive ecology of gulls in southern California and British Columbia. This work led to studies of seabird reproductive ecology on the Pribilof Islands and the foraging ecology of seabirds in the Bering Sea, the Barents Sea, the North Water Polynya, and the Southern Ocean. More recently, he has participated in ecosystem-level studies of the southeastern Bering Sea and the Aleutian Archipelago. He chairs the BEST (Bering Sea Study) SSC and co-chairs the SSC of ESSAS. He is the past Co-Chairmen of PICES WG 11 on "Prey consumption by marine mammals and seabirds in the PICES area", and is a newly appointed member to the CFAME (Climate Forcing and Marine Ecosystems) Task Team.

The Sub-Arctic seas support stocks of commercial fish that generate a major portion of the fish landings of the nations bordering them. They also support subsistence fishers along their coasts, and vast numbers of marine birds and mammals. Several factors make these seas unique: seasonal ice cover, large quantities of freshwater from ice-melt and runoff, dramatic seasonality, reduced sunlight and low biodiversity. Climate-forced changes in these systems will have major economic and societal impact.

In recent decades, components of Sub-Arctic sea ecosystems have shown unexpected changes in abundance or distribution that, in many cases, correlated with physical variability. The high spatial and inter-annual variability of the Sub-Arctic seas provide the opportunity to use short-term variability as a proxy for studying their responses to variability at longer time scales. There is growing concern about the expected level of anthropogenic-induced climate change in the Sub-Arctic seas: these areas are forecast to undergo the largest changes outside of the high Arctic. Understanding the underlying processes responsible for ecosystem responses is the basis for providing good stewardship as these dynamic regions evolve.

With this background, a new GLOBEC regional program, **E**cosystem **S**tudies of **Sub-Arctic S**eas (ESSAS), has recently begun, whose objectives are to compare, quantify and predict the impact of climate variability and global change on the productivity and sustainability of Sub-Arctic marine ecosystems. Improved insights into the role of climate variability on Sub-Arctic marine ecosystems will be sought through comparative studies between the Sub-Arctic regions.

To kick off ESSAS, GLOBEC organized a symposium on "Climate Variability and Sub-Arctic Marine Ecosystems" at the magnificent Conference Centre in Victoria, B.C., Canada, on May 16-20, 2005. The Symposium's scientific

Highlights of the ESSAS Symposium

Panel-led discussion on regional comparisons on the first day of the Symposium.

Participants mingle at the Poster Session.

Drs. Ken Drinkwater, Francisco Werner and Keith Brander at the Museum Reception.

Drs. Takashige Sugimoto, Sanae Chiba, Masahide Kaeriyama, Yasunori Sakurai and Alexander Bychkov at the Poster Session.

On-site symposium staff: Jin-Yong Lee (PICES), Dawn Ashby (GLOBEC), Christina Chiu (PICES) and Edmand Fok (DFO). [Not in photo: Jill Bell (DFO) and Julia Yazvenko (PICES)]

Closing Session summary discussion panel: Drs. Anne Hollowed, Richard Beamish, Svein Sundby and Egil Sakshaug.

objective was to present current knowledge of the effects of seasonal to multi-decadal climate variability on the structure and function of Sub-Arctic marine ecosystems. A total of 224 scientists from 16 countries participated in the meeting. The meeting began on Monday (May 16) with a one-day workshop on the new U.S. **B**ering **S**ea **ST**udy (BEST) attended by 132 scientists, the majority of whom were from the United States. The workshop focussed on the Implementation Plan for BEST, and will help to develop the future structure of the program.

After the workshop, there was a splendid reception for all symposium and workshop participants in the First Nations Gallery of the Royal British Columbia Museum. This reception afforded participants the opportunity for informal visiting among a spectacular collection of artefacts from the civilizations that have lived along the shores of the Pacific Northwest coast of North America.

The BEST workshop was followed by the 3-day symposium consisting of 69 oral presentations and 105 posters. The oral presentations began with a keynote talk by Richard Barber (U.S.A.) on how ocean warming in the next 50 years will affect Sub-Arctic marine ecosystems. Based on the output of 6 coupled climate ocean models with identical CO_2 forcing, the results suggested that the region between 40 and 60 degrees North would experience the most rapid warming (Fig. 1), and that there would be increased primary production levels in the Sub-Arctic and Arctic regions. These increases in primary production will be offset by reductions in the tropical and temperature oceans, resulting in little or no net change globally.

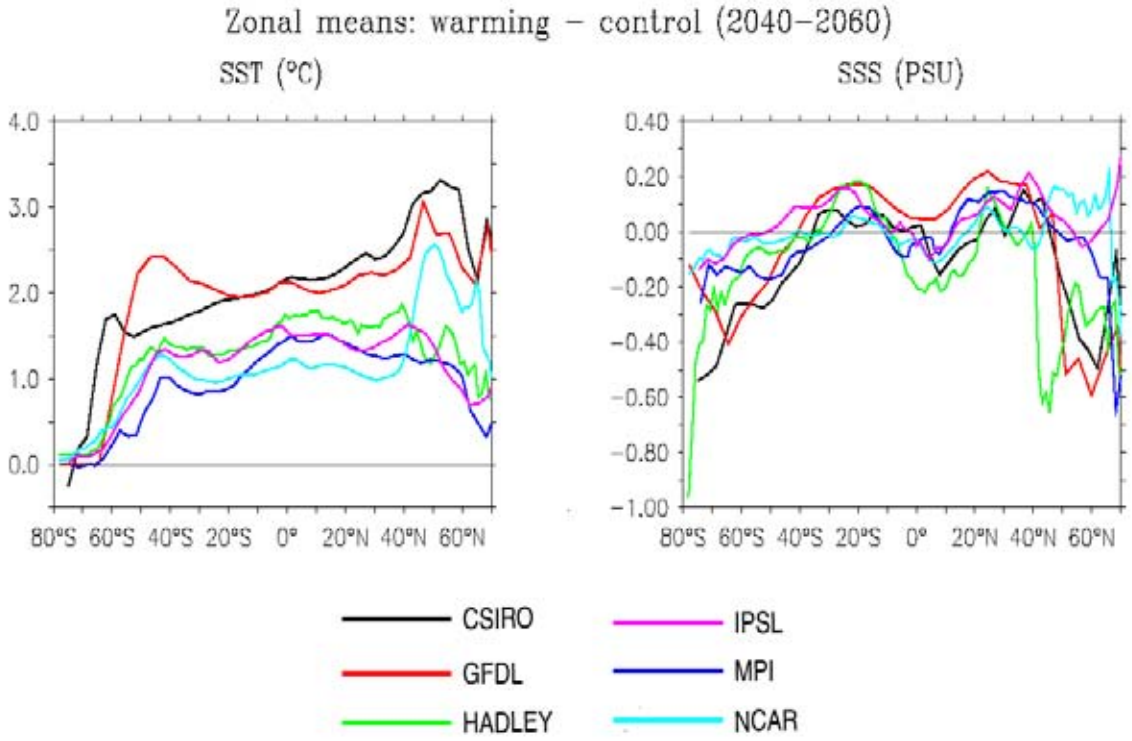

Fig. 1 The results of 6 models showing expected mean change in the Pacific Ocean SST and SSS as a function of latitude. All models predict that the greatest change in ocean temperatures will be in the northern Hemisphere between 40 and 60 degrees North (from the presentation of Barber et al. *at the ESSAS Symposium).*

Regional reviews on the physical oceanography and biology of 6 major Sub-Arctic regions (Barents/Norwegian Sea, Iceland, Labrador/Newfoundland, Bering Sea, Sea of Okhotsk and Oyashio) and the Antarctic were then given to provide background information and highlight similarities and differences between regions. In these talks and in presentations later in the program, several authors provided information showing increased secondary production by zooplankton and warmer temperatures (*e.g.*, Fig. 2). A panel discussion followed to focus attention on what and how comparisons should be undertaken.

The second and third days were taken up with plenary theme sessions dealing with such issues as: what are the major biological responses in the water column to physical forcing; how will climate warming impact trophic coupling; will climate change affect the potential for trophic cascades; and what have been some of the recent climate-related changes in ecosystem structure or function. In addition, Wednesday (May 18) afternoon was spent on 4 disciplinary parallel sessions on: physics and chemistry; primary production; secondary production; and fish, shellfish, seabirds and mammals. The final theme session

of the symposium dealt with the human dimension side of climate variability in the Sub-Arctic regions. We heard from sociologists, native leaders, archaeologists and geographers on the socio-economic impacts of climate covering time periods from thousands of years ago to the present.

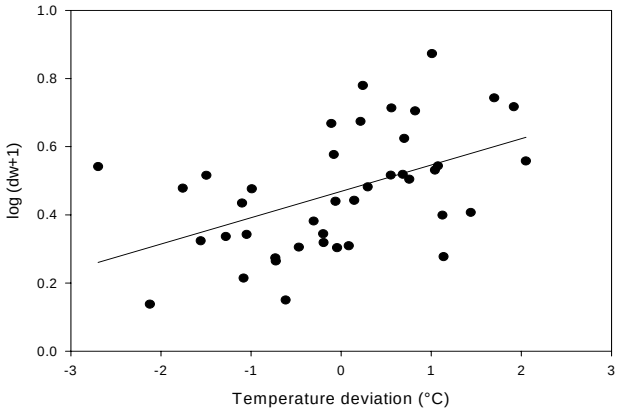

Fig. 2 Biomass of zooplankton north of Iceland as a function of temperature deviation from the long term mean (from the presentation of Astthorsson et al. *at the ESSAS Symposium).*

While it is impossible to highlight all of the results, it was clear that there has been strong warming with subsequent reductions in sea ice in recent years in most Sub-Arctic seas, the Sea of Okhotsk being an exception with notable cooling. In this and former periods of regional warming, northward shifts in the distribution of several plankton and fish species, and earlier spring and later autumn migrations of fish were observed. Major changes in community structure are occurring, as well as changes in the productivity and abundance of major commercial fish species. Given that modest levels of warming are expected to lead to higher primary production, and with warmer temperatures, also higher secondary production, it seems possible that production of temperate-zone fish may shift northward and increase in the Sub-Arctic seas, while more Arctic species will retreat to higher latitudes.

Large-scale atmospheric forcing of the Sub-Arctic regions was documented that can account for similar responses in widely separated Sub-Arctic seas, and opposite responses between other regions. Physical and biological data suggest a direct influence of the Pacific on the Sub-Arctic seas in the Atlantic. Biophysical models have made great strides during the past 5 to 10 years in their ability to simulate the observations and offer even greater potential within the lifetime of the ESSAS program to improve our understanding and predict future changes.

A panel discussion at the end of the presentations and reflections by Victor Smetacek (Germany) highlighted several important points. While it is clear, from the work presented, that climate variability affects the marine ecosystems, it is also equally clear that man, through industrial fishing, has played a major role in the restructuring of these ecosystems. One challenge to the scientists within ESSAS will be not only to better understand the ecosystem responses to climate forcing, but also to evaluate how these natural forcing factors interact with fishing to produce the changes that we observe. A second major challenge is to make the results of the research understandable and relevant to the communities affected, including fisheries management.

Arrangements have been made to have about 45 papers from the Symposium published in a quadruple volume of *Progress in Oceanography*. Guest editors for the volume will be Kenneth Drinkwater, George Hunt, David Mackas and Skip McKinnell. Manuscripts are due September 15, 2005, and it is hoped to have the volume published by late 2006.

The last day of the meeting was taken up with a workshop to discuss implementation plans for ESSAS. Eighty-eight enthusiastic participants heard from 12 national and international representatives on various Sub-Arctic ecosystem studies and how they might fit into the ESSAS program. In the afternoon, breakout groups provided their suggestions on how ESSAS should approach the comparison between Sub-Arctic regions and what topics should be given priority. Their ideas will be summarized and will help to formulate a way forward for ESSAS.

As convenors, we were delighted with the high quality science and the excellent presentations. The enthusiasm for the programs, and the congenial nature of the participants added greatly to the events of the week. We wish to thank all those who participated, and in particular the invited speakers and the panellists. We send a special thank you to the co-sponsors, including the U.S. National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the Alaska Fisheries Science Center (AFSC), the North Pacific Research Board, (NPRB), Fisheries and Oceans Canada (DFO), the North Pacific Science Organization (PICES), the Global Ocean Ecosystem Dynamics Program (GLOBEC) and the Norwegian Research Council (NRC). The PICES and GLOBEC offices provided vital support, and their dedication and help were critical in making the meeting a great success.

First CREAMS/PICES Workshop on East Asian Seas Time-series

Harold P. Batchelder, Alexander Bychkov and Kyung-Ryul Kim

Workshop description

The first workshop on East Asian Seas Time-series (EAST), co-sponsored by the Ministry of Maritime Affairs and Fisheries (MOMAF) of the Republic of Korea, the School of Earth and Environmental Sciences of the Seoul National University, and PICES, was held April 21-22, 2005, at Seoul National University. More than 50 marine scientists from 7 countries attended the workshop (see photo below), which provided a forum for exchange of scientific information and expertise, and to explore how earlier experiences of time-series studies might assist in the development of future East Asian Seas Time-series. PICES recently produced a North Pacific Ecosystem Status Report (PICES Special Publication 1, 2004) which described conditions in many North Pacific ecosystems. Production of future updated status reports requires that there be an ongoing ocean/climate/ecosystem observing system to document change, and analytical capacity to interpret any changes observed. This workshop brought together experts from other Pacific time-series sites with Asian scientists looking to develop future observation programs in East Asian seas. Emphasis for the first workshop was on reviewing prior research and monitoring programs in the Japan/East Sea (JES), and on developing a framework for a future JES program. This was envisioned as the beginning of a workshop series that will eventually generate implementation plans for other East Asian seas (*e.g.*, Okhotsk Sea, Bohai/Yellow Sea, East China Sea and South China Sea).

Participants of the first CREAMS/PICES workshop on East Asian Time series (August 21-22, 2005, Seoul, Korea).

The workshop opened with a welcome address by Kyung-Ryul Kim (Korea), one of the workshop convenors [other convenors were Harold (Hal) Batchelder (U.S.A.), Vyacheslav Lobanov (Russia) and Yasunori Sakurai (Japan)]. Then followed a keynote talk by Steven Emerson (U.S.A.) and 7 invited talks on time-series observations at other locations in the North Pacific, and a poster session with more than 40 posters displayed. Information on selected Pacific Ocean time-series discussed at the workshop is shown in Table 1.

Steven Emerson gave a plenary lecture on biological and physical processes that can be informed by time-series observations of gases, focusing on diurnal oxygen cycles (to characterize diurnal changes one needs to average data over many days because of several diverse processes that impact dissolved oxygen; *e.g.*, approximately 150 days of remotely measured dissolved oxygen data from a mooring were used to observe diurnal changes in Puget Sound, Washington, U.S.A.), annual cycles of oxygen, nitrogen and noble gases, and decadal changes in upper thermocline gas concentrations as an indication of ocean ventilation. Several new technologies (moorings, floats, gliders) were described that will be used to provide more global coverage of net annual oxygen production, gross photosynthesis and decadal-scale changes.

David Checkley (U.S.A.) summarized 55 years of observations of the California Current by CalCOFI (California Cooperative Fisheries Investigations), including the rationale for the sampling (to understand causes of sardine population fluctuations), methods of sampling, new technologies (CUFES—Continuous Underway Fish Egg Sampler; DNA-specific probes), and accomplishments of the program. The primary achievements were to describe temporal variability in the California Current, to hypothesize and examine processes that might be responsible for observed phenomena (*e.g.*, warming leading to deeper or stronger stratification, reduced nutrient supply and reduced production), and to provide information useful for management of long-standing fisheries (sardines) and new fisheries (market squid).

Table 1. Selected Pacific Ocean time-series discussed at the EAST workshop.

Location	Sampling Period	Presenter
Scripps Pier SST CalCOFI (multiple stations)	1916- (ca. 90 years) 1949- (56 years)	David Checkley
Northeast Pacific (multiple stations) GAK1 (59.845˚N, 149.467˚W) Seward Line Newport Line	1997–2004 (ca. 7 years) 1970- (ca. 35 years) 1997- (7+ years) 1969-73; 1983; 1996-(not continuous, but spanning multiple regimes)	Harold Batchelder
Station PAPA (50˚N, 145˚W) and Line P	1956- (ca. 50 years)	Frank Whitney
HOT (22.75˚N 158˚W) Station November (30˚N 140˚W)	1988- (ca. 18 years) 121 cruises between July 1966 & May 1974 (8 years)	Michael Landry
Line A (transect south of Hokkaido)	1988- (18 years)	Atsushi Tsuda
Station KNOT (44˚N, 155˚E)	1998-2001 (3 intensive years; less intensive recently)	Toshiro Saino
Station SEATS (18˚N, 115.6˚E)	1999- (ca. 6 years)	Kon Kee Liu

Hal Batchelder reviewed a much shorter (7-8 years) period of observations by the U.S. Global Ocean Ecosystems Dynamics (GLOBEC) Program in the Northern California Current and coastal Gulf of Alaska. An important component of U.S. GLOBEC studies in the Northeast Pacific is the nested analysis of spatial and temporal scales—spanning from a few meters to basin-scale in space, and a few minutes to centennial in time. The broad spatial and temporal scales to be considered in understanding the linkages between climate, ocean conditions and ecosystem and population responses, require a diversity of approaches, including process-oriented studies, broad-scale observations, retrospective analysis, and modeling. Examples of spatial-temporal approaches were shown. The influence of remote large-scale forcing on local processes was illustrated using a 2002 hypoxia event off central Oregon that resulted from anomalously strong southward transport of high-nutrient, cold and fresh ("minty") subsurface water from the Eastern Subarctic Gyre.

Frank Whitney (Canada) described insights from the physical, chemical and biological measurements made along Line-P since sampling began in 1956 at Ocean Station PAPA in the Eastern Subarctic Gyre of the North Pacific. Principal milestones were the improved understanding of mixed layer dynamics, interannual variability and, more recently, warming trends, and recognition of both spatial and temporal variation in conditions. Time series observations along Line-P have been complemented by focused, process-oriented research programs such as the SUPER program evaluation of the grazing control hypothesis in the 1980s, and JGOFS and SERIES studies on iron and light control of phytoplankton production in the last 15 years.

Michael Landry (U.S.A.) summarized the core ocean physics, biogeochemical and organismal biology measurements made at the Hawaiian Ocean Time Series (HOT) station in the northern subtropical Pacific since 1988. Regular time-series sampling at HOT has revealed significant temporal variability at scales spanning months to decades. Time series of mesozooplankton has shown both significant seasonal variability in biomass (factor of 2 from summer to winter), and a long-term increasing trend since the late 1990s, with the latter due to the non-migrant, surface-resident plankton. This illustrates the importance of finer-grained analysis of the trophic compartments of the plankton. HPLC-derived pigments indicate substantial increases in *Prochlorococcus* and cyanobacteria in 1996. The presentation emphasized that there is significant temporal variability at multiple scales, and that understanding the mechanisms underlying the community changes requires observations of most, if not all, of the trophic levels.

Toshiro Saino (Japan) described the JGOFS North Pacific Process Study that was carried out at Station KNOT (44ºN, 155ºE) in the Western Subarctic Gyre. The most intensive study period was 1998-2001, when 27 cruises were conducted. The goal of this intensively sampled period was to characterize the seasonal and spatial variability of biological productivity and biogeochemical cycles, to develop a carbon budget, and to compare the results with other JGOFS stations (HOT, BATS, PAPA). Phytoplankton biomass (as chlorophyll-*a*) exhibited a diatom peak in spring, but remained low during the rest of the year; picophytoplankton abundance peaked in late June-August, after the diatom peak.

Atsushi Tsuda (Japan) reviewed the history of sampling along the Akkeshi transect (A-Line) south of Hokkaido, and described the seasonal and interannual variability in the Oyashio region. Since 1990, physics, currents, nutrients, net plankton, various optical measurements, size-fractioned chlorophyll, and other biogeochemical parameters have been measured 7 times per year. Significant seasonal variations in temperature, surface nutrients, chlorophyll and zooplankton biomass are now documented. Many stations that were occupied in June-July, after the termination of the spring bloom, have residual nitrate and silicate, suggesting limitation by something other than macronutrients—

perhaps iron. Iron is highest in winter, lower in spring, and very low in May. On longer time scales, observations of the Oyashio region extending back to the late 1960s indicate an approximately 20% decline of subsurface dissolved oxygen concentration, superimposed with decadal scale fluctuations of a nearly similar magnitude (Fig. 1).

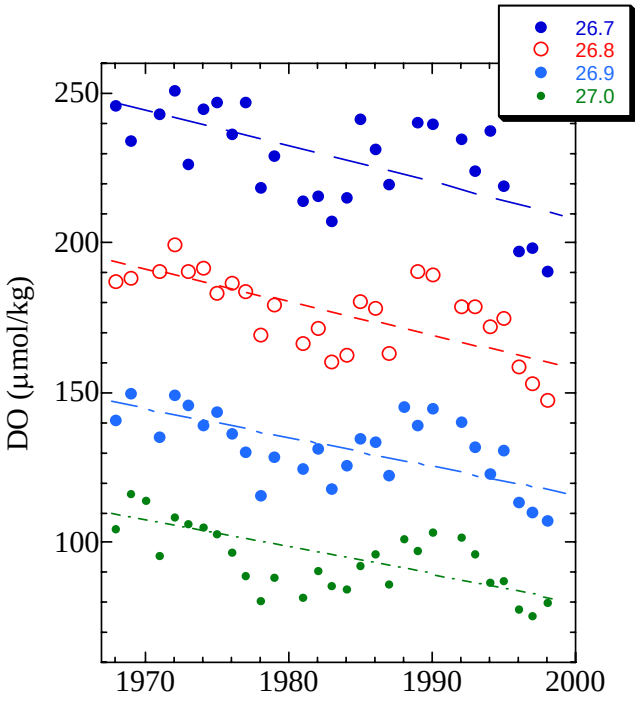

Fig. 1 Long term (from 1968 to 1998) declining trend of subsurface oxygen concentration (at isopycnals 26.7-27.0) in the Oyashio region of the western North Pacific (from Ono et al. *2002.* Can. J. Fish. Aquat. Sci. *55: 1878-1893).*

The final presentation on the first day was by Kon-Kee Liu (China-Taipei) on the South-East Asia Time-series Study (SEATS) station in the South China Sea. SEATS goals are to understand how monsoonal forcing and ENSO control biogeochemical cycling in this region; to monitor how episodic events, like typhoons and eddies, impact upper ocean biology; and to link present biogeochemical processes with paleo-records to examine climate change impacts on ocean biogeochemistry. Ship-based sampling has been conducted bi-monthly or quarterly at the SEATS station (18ºN 115.6ºE) since September 1999. SeaWiFS and ship-board observations indicate significant seasonal variation in phytoplankton biomass, with highest values in mid-winter and lowest in summer. This cycle is correlated with monsoonal winds, with highest values occurring at the peak of the NE monsoon, and summertime low values during the relatively weak SW monsoon. SeaWiFS data from >6 years indicate significant interannual variation that appears more related to ENSO effects and the Indian Ocean Dipole Moment, than to local wind anomalies.

Two activities were carried out during the second day of the workshop: (1) a series of 9 presentations on previous and potential future research and monitoring of the Japan/East Sea (Fig. 2), and (2) a group discussion about the process for developing a mission statement, an implementation plan, and listing of specific goals and hypotheses for future JES studies.

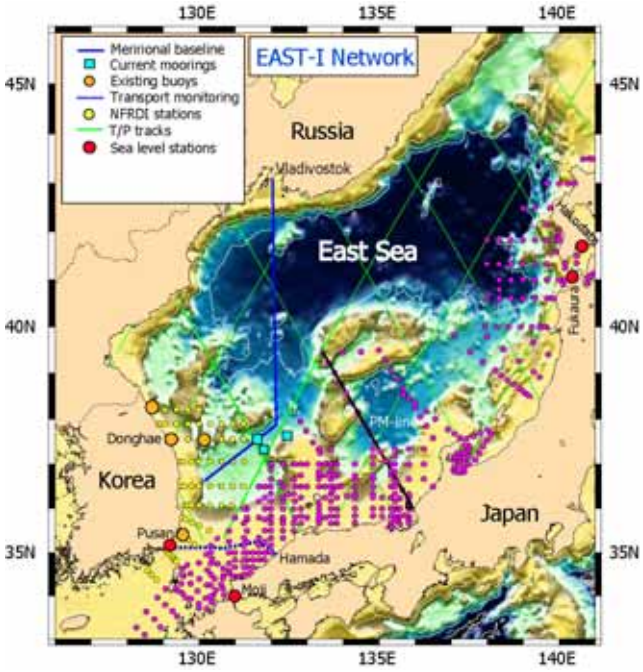

Fig. 2 Potential components of an EAST Japan/East Sea observation network (from presentation by K.-I. Chang at the workshop).

Toshitaka Gamo (Japan) made the case for the JES being a small "model" ocean. The JES has several deep basins, a subarctic gyre, a subtropical gyre, deep-water formation isolated from global deep water formation, and high primary production and export flux. All of these make the JES a good model system for the larger oceans. Sanae Chiba (Japan) described several Japanese time series datasets of the JES. These include the PM Line across the Tsushima Current region (1972-present; black line in Fig. 2), spawning and nursery ground surveys for fisheries, and the Hirota plankton collections from 1966-1990. There is a N-S gradient in nutrient availability and in timing of the spring bloom (earlier in the south). The copepod community in the northern JES has large calanids, similar to the Oyashio region, while the southern JES has smaller, subtropical copepods, more typical of the Kuroshio region. Regime shifts and decadal variation were observed in community structure and biomass, with different responses in southern and northern parts of the JES. Mechanisms responsible for these responses were discussed. Biological observations, especially along the PM line, need to be continued, and perhaps expanded, and more monitoring is needed in the northern JES.

Vyacheslav Lobanov (Russia) presented results from recent (1995-2005) Russian studies of deep convection, ventilation, mesoscale eddies and coastal upwelling. Extremely cold winter conditions of 2000-01 resulted in the production of new bottom water in the JES. No similar bottom water renewal event had been observed for perhaps 50 years. Yury Zuenko (Russia) reviewed past ocean research of the TINRO-Center in the JES. Effort has varied through time, driven primarily by fisheries demands. High sampling efforts off Korea and Russia in the 1950s and 1980s were motivated by the need to understand the dynamics influencing active mackerel and sardine fisheries, respectively. When these fisheries collapsed, so did the need for ocean observations. Fisheries surveys and ichthyoplankton monitoring in recent years have focused on Russian near-shore shelf regions of the JES.

Kyung-Il Chang (Korea) described a future Korean CREAMS/PICES program called CHEESE for Circulation, Hydrography, and Ecosystem Response in the East Sea, which has as goals (1) understanding the multi-scale (seasonal to interdecadal) variability of hydrography and circulation, (2) identifying processes controlling carbon cycling, (3) understanding climate impacts on physical and chemical conditions of the JES, and (4) establishing permanent observation stations and a data exchange network. Core observations would be repeat ship surveys, ocean moorings, volunteer observing ships, satellite-tracked floats, and satellite observations (Fig. 2). Suggestions on modifications to the program were welcomed.

Tongsup Lee (Korea) described initial plans for CarboEAST, which is a program to examine carbon cycling of the JES, with emphasis on meso-scale processes, feedbacks and climate sensitivity. Sinjae Yoo (Korea) argued that the JES ecosystem provides a model for basin scale ecosystem changes since the JES has two gyres, a subpolar front, deep thermohaline circulation, warm core rings, ice formation and melting, and strong seasonal cycles in forcing. Importantly, the JES has strong, unambiguous signals of long-term ecosystem change (PICES Special Publ. 1, 2004) and shows high variability in ecosystem properties in space (northern gyre, southern gyre, and coastal regions). However, much remains unknown about the JES ecosystem, particularly the spatio-temporal variability of photosynthesis, bacterial production and microbial loop dynamics, and size composition of lower-trophic levels. Long-standing issues in pelagic ocean ecology, such as changes in production throughout (due to physical forcing), changes in food web structure, and timing (match-mismatch) of seasonal cycles, are amenable to investigation in the JES.

Chul Park (Korea) reviewed the plankton, hydrographic and nutrient chemistry surveys that have been conducted bi-monthly since 1961 around the entire Korean peninsula (yellow dots in Fig. 2). He assessed the strengths and weaknesses of the current sampling program, and proposed changes to improve the efficiency and effectiveness of the surveys. The strength of continuing the existing plan is that there is a long continuous record, and reluctance to change time-series midstream. However, insufficient manpower and funds to process the data create difficulties in making the products of the surveys available. Dr. Park proposed a modified program which would reduce the bi-monthly survey to a quarterly survey (in February, May, August and November), supplemented by higher frequency (bi-weekly) sampling of a few (2-3) key stations. Several scientific objectives were proposed to achieve better knowledge of (1) zooplankton community ecology, (2) physiological and behavioral dynamics of ecologically important zooplankton species, (3) trophic studies of energy/biomass transfer from zooplankton to fish, and (4) climate change influence on zooplankton community ecology.

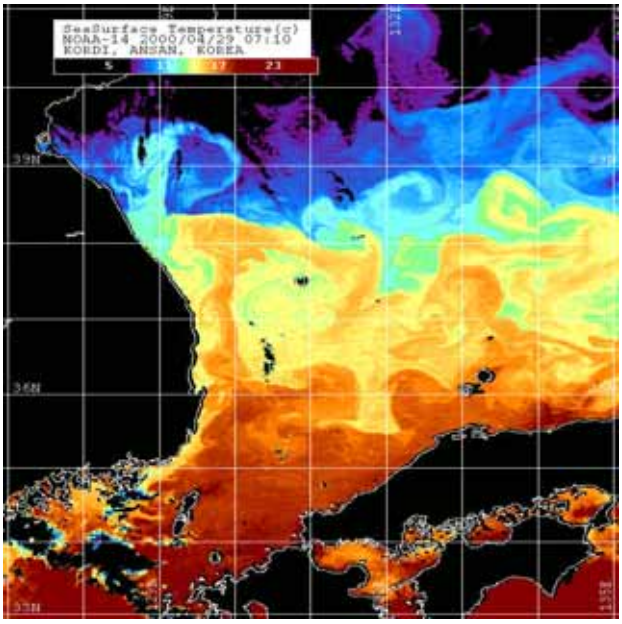

Fig. 3 Sea surface temperature in the southern half of the JES on 29 April 2000. Note the strong gradients in temperature across the subpolar front (blues [<10˚C] to the north, yellows [>15˚C] to the south), and the high mesoscale variation in temperature both at the subpolar front and within the northern and southern gyres (from presentation by S. Kim at the workshop).

Suam Kim (Korea) described fisheries oceanography and fish community structure in the JES, focusing on commercially important pelagic and demersal fisheries. He noted that the JES is dynamic, with two different current systems colliding in the middle to form a meandering subpolar front, and that eddies and recirculation of currents due to fronts and topographic steering creates significant biological heterogeneity and gradients in productivity (Fig. 3). Walleye pollock are important fisheries in the

northern JES, and as studies off Alaska have shown, transport, retention and survival of pollock larvae are important in establishing large year classes. Catch of pollock in the JES has varied markedly through time, with peaks in the 1930s and 1970-1985 (with a maximum in 1981-82). Catches are low throughout most of the 1950s, 1960s, and since the late 1980s. Studies are needed to examine the biophysical coupling that determines larval pollock survival in the JES. Distribution of adult fish (and squid) is controlled by hydrodynamics and water mass characteristics, but additional studies are needed to explore these relations. Ecosystem structure in the JES changed after the 1976-77 regime shift: biomass of phytoplankton, squids, and some fish (small sharks, Pacific saury, sandfish) declined, while many other fish (walleye pollock, Pacific sardine, other small pelagics) increased. Mechanisms responsible for these changes are unclear, and should be investigated by integrated modeling of lower and higher trophic levels.

At the conclusion of the series of presentations, a general discussion of EAST studies in the JES ensued. This discussion was led by H. Batchelder and K.-K. Liu. It is important that EAST has specific goals, objectives and scientific hypotheses. We debated whether there needed to be clear "societal benefits" of the EAST program *vs.* "improved scientific understanding". A consensus on this point was not reached, even though it was argued that long-term funding of open-ended time series programs is difficult to maintain unless there are clear societal goals (improving ocean health, more sustainable fisheries, *etc*.).

Discussion focused on basic science, mission statement, and defining general goals for an EAST JES program; details for a specific implementation of the program was deferred to a later time. In addition to general comments, there was discussion of specific hypotheses that might be part of an EAST program in the JES. Below, in an unprioritized order, are the key points raised during the discussion; these are listed as recommendations, but some are more ideas than recommendations. As a next step, it was strongly advised that an Advisory Panel should be formed under PICES to initiate and oversee the program and to develop the workshop summary into a science plan for EAST (see full report online on the PICES website).

Recommendations

- The development/design of the EAST JES program should follow the format used previously by SEATS.
- A TEN year plan should be prepared that can consider climate change and variability issues, and that uses the JES as a "miniature model ocean". The JES may be a logistically manageable sized system in which key process can be understood that will have application to the much larger North Pacific Ocean. Its isolation and small size make it feasible to monitor the entire system (using the technologies described above) at low cost (compared to instrumenting the entire Pacific).
- A JES study could provide an example of what the impacts of climate change might be on a regional sense. Related to this, it was mentioned that the EAST JES program must be a multinational collaborative effort between Russia, Japan and Korea, since the JES is a shared ocean, and perhaps when the EAST implementation plan is developed, the IGBP IMBER program, which includes both biogeochemistry and ecosystem structure and function elements, should be approached for "endorsement" or "sponsorship".
- A product of the EAST JES program should be scientific knowledge, and also improved ideas about how to coordinate and integrate a multinational Ocean Observing System. EAST leaders, after development of an implementation plan, should explore formal connections with the Global Ocean Observing System (GOOS), and in particular its component for the North East Asia Region (NEAR-GOOS).
- New scientific knowledge from the program should have eventual application to management and public policy, specifically, to document the effect of anthropogenic activities on the oceanography of the East Asian marginal seas. A question was raised about whether we understand the natural variability well enough to discriminate/differentiate between natural and anthropogenic causes of change.
- The issue of two-way connections was mentioned. Anthropogenic activities, such as pollution, climate change, fishing, mariculture, *etc*., can certainly have impacts on ocean systems, but it is just as important to recognize the human dimension issues, *e.g.*, that natural and human impacts can have feedback on human populations and activities.
- Although the emphasis of the workshop was specifically on the JES, it was noted that CREAMS is an East Asian marginal seas program, which might eventually include many other regional seas (Yellow, ECS, Bohai, South China Sea, Okhotsk), and that the plan developed for the JES may be a model for other regions to follow in the future. The EAST JES study and other time-series studies in the East Asian marginal seas, such as SEATS, may form a regional network as a part of GOOS. Inter-calibration and other joint activities may be implemented in the future.

Specific hypotheses/goals

- Climate (atmospheric pressure patterns, winds, freshwater balance, *etc*.) variability controls physical forcing (ocean circulation, stratification, surface and boundary fluxes) in the JES, and its interaction with adjacent basins;
- Climate impacts the JES ecosystems and linkages across trophic levels;

- Biogeochemical processes are controlled by climate variability/change and physical processes at shorter time scales (seasonal and eddy scales);
- Explore projected IPCC global and regional forcing (What are the most important time-scales of physical forcing in the JES?);
- Resolve multiple temporal scales; at least down to event scale (a few days?);
- Study the role of episodic dust storms on the productivity of the JES;
- Explore flow (mesoscale activity)-topography interactions in providing productive ecosystems;
- Develop a community three-dimensional physical circulation model of appropriate vertical and horizontal resolution that can be used for biogeochemical and ecosystem studies;
- Develop a community biogeochemical (and ecosystem) model coupled to a physical circulation model;
- Couple observational system data with models (data assimilation) of physical, biogeochemical and ecosystem processes.

Workshop summary and future activities

Overall, the first CREAMS/PICES workshop on East Asian Seas Time-series was successful in establishing a solid framework for developing a detailed implementation plan for future integrated multi-national time-series observations and accompanying process research in the JES. The overview talks of the first day provided strong evidence for the value of time-series programs from diverse regions of the North Pacific. The presentations from the second day described many past, ongoing, and planned time-series programs in the JES, and provided valuable fodder for the subsequent group discussions which are summarized above. The next step in this process is to form a leadership body that will prepare a draft implementation plan, using the information from this workshop as a basis for future observing programs in the JES.

The hospitality of our Korean hosts was unmatched. The venue was well organized, well staffed, and the workshop enabled old friends to reconnect and new friendships to be formed. All in all, an excellent (fun and productive!) workshop.


Dr. Harold (Hal) Batchelder (hbatchelder@coas.oregonstate.edu) is a Professor (Senior Researcher) at the Oregon State University, and Executive Director of the U.S. GLOBEC Northeast Pacific Regional Coordinating Office. Previously he served for 6 years as the Scientific Director of the National U.S. GLOBEC Steering Committee Office. He is Co-Chairman of the Climate Change and Carrying Capacity Program of PICES. His research uses models to examine the interactions of plankton populations and physical flow fields, using in particular Lagrangian-Eulerian approaches that allow coupling of complex biological states and behaviors with lower trophic levels.

Dr. Alexander Bychkov (bychkov@pices.int) has been the Executive Secretary of PICES since 1999. He graduated from the Moscow State University, received his Ph.D. in Chemistry from the USSR Academy of Sciences, and then spent more than 20 years working as a Research Scientist at the Pacific Oceanological Institute in Vladivostok. In pre-PICES life, his scientific interests focused on the carbon cycle in the North Pacific and its marginal seas. He was involved in regional (national and international) cooperation related to the Joint Global Ocean Flux Study (JGOFS), and was a member of the JGOFS Scientific Steering Committee (1996-2003), the Co-Chairman of the JGOFS North Pacific Task Team (1997-2001) and the Chairman of the JGOFS North Pacific Synthesis Group (2001-2003).

Dr. Kyung-Ryul Kim is a Professor of the School of Earth and Environmental Sciences, Seoul National University (SNU), Korea, and is Director of the Research Institute of Oceanography at SNU. Kyung-Ryul received his B.S. and M.S. degrees in Chemistry from Seoul National University, and his Ph.D. in Oceanography from the University of California, San Diego. He has been involved in CREAMS (Circulation Research of the East Asian Marginal Seas) since 1993. His research has focused on the material cycle and circulation by various chemical tracers in the Japan/East Sea. His scientific interests also include the carbon cycle and its relation to climate change.

PICES workshop discusses Oceanic Ecodynamics COmparison in the Subarctic Pacific (OECOS) - a project proposal

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Workshop organizers, Drs. Ikeda and Miller, with rooster-hat death mask.

Dr. Tsutomu (Tom) Ikeda is a plankton biologist specializing in experiment-oriented research on zooplankton ecology. He has worked at the University of Miami, the Australian Institute of Marine Science, Australian Antarctic Division, the Research Institute of the Japanese Fisheries Agency (at Niigata, Nagasaki, Hiroshima), and is now a professor at Hokkaido University. His major achievement to date includes the evaluation of unique biology and physiology of Antarctic krill through the development of a long-term lab maintenance technique, establishment of metabolism-body mass-habitat temperature equations of epipelagic mesozooplankton across polar to tropical waters, and life history patterns of various zooplankton in the Japan Sea and Oyashio region. Within PICES, he has been a member of the Biological Oceanography Committee and served as the Chairman of the Committee from 1999-2001.

Dr. Charles Miller is a biological oceanographer specializing in studies of zooplankton, particularly in subarctic habitats of the Pacific and Atlantic Oceans. Much of this work has emphasized the importance and flexibility of diapause phases. He and co-workers have contributed life history analyses for copepod species dominant in the Gulf of Alaska, and studies of lower trophic level ecodynamics in that area. As a member of the SUPER program in the 1980s, he contributed to the current (if incomplete) understanding of processes in HNLC pelagic ecosystems. He is currently a professor emeritus at the Oregon State University, where 32 years of teaching enabled writing of a recent textbook titled "Biological Oceanography" (2004, Blackwell, Oxford). Charlie is also the Chairman of the PICES Advisory Panel on the Continuous Plankton Recorder Survey in the North Pacific.

The Oregon State University (OSU, Corvallis) was the site of an international workshop sponsored by PICES (with assistance from the OSU Research Office and the OSU College of Oceanic and Atmospheric Sciences) on May 23-24, 2005. Japanese and North American scientists (see table and picture on next page) discussed the fundamental questions and observational details of proposed comparative studies of ecological processes in the upper waters of the oceanic subarctic Pacific.

It is established that the high-nitrate, low-chlorophyll (HNLC) character of these waters is attributable to the limited availability of iron in the euphotic zone. Several mesoscale iron-addition experiments (the Japanese **S**ubarctic Pacific Iron **E**xperiment for **E**cosystem **D**ynamic **S**tudy – SEEDS, in the western subarctic Pacific, and the Canadian **S**ubarctic **E**cosystem **R**esponse to **I**ron **E**nrichment **S**tudy – SERIES, in the eastern subarctic Pacific) have shown that adding soluble iron induces strong increases in standing stocks of microplanktonic diatoms and algae, that without iron addition, are present in very low abundance. With iron-limitation firmly established, it remains to explain fully the processes and variations of the lower trophic levels under normal circumstances without iron addition. OECOS proposes that much can be learned from parallel studies and comparisons of processes in the eastern and western subarctic sectors, taking advantage of both differences and similarities between them.

While much planning remains, the initial notion is to study a site in the western subarctic receiving sufficient iron to support a spring phytoplankton bloom with HNLC conditions established afterward, and to compare that to an eastern site (Station P or similar) that exhibits continuously HNLC conditions. Both sites would be examined by high-resolution time-series sampling in the April-May period of the spring transition, when the water column above the permanent halocline (~100 m) becomes divided by a seasonal thermocline (~35 m). This is the time of the spring bloom in the west and of a sharp increase in phytoplankton production rates in the oceanic east. At both sites the time-series of measurements will establish the relations among light, stratification, iron availability (amounts and chemical speciation), nitrogen dynamics,

algal floristics, algal growth rates, microheterotroph grazing and phytoplankton stocks.

These contrasting sites, and the entire region, have a common list of zooplankton species dominant during spring (five species of copepod). Preliminary data suggest that the difference in phytoplankton species and standing stocks, perhaps a difference in the length of their food chain, causes these zooplankton to have very different growth rates, fast in the west, and much slower in the east. Measuring these growth rates by common methods will be a focus of studies at both sites.

OECOS/PICES workshop participants: (back row from left) Cowles, Ikeda, Strutton, Miller, Furuya, Saitoh, Batchelder; (middle row) Cullen, Chase, Dagg, Welschmeyer, Selph; (front row) Kuma, Kobari, Yamaguchi, Ota, Strom, Erdner.

OECOS workshop participants:

Harold Batchelder (Oregon State University) – modeling, possibly observations
Zana Chase (Oregon State University) – aspects of iron chemistry
Tim Cowles (Oregon State University) – mixing physics and fine scale profiling of phytoplankton
Jay T. Cullen, (University of Victoria) – iron availability and iron cycling
Michael Dagg (Louisiana Universities Marine Consortium) – mesozooplankton feeding
Deana Erdner (Woods Hole Oceanographic Institution) – *in situ* indices of iron limitation in phytoplankton
Ken Furuya (University of Tokyo) – phytoplankton production and ecology
Moira Galbraith (Institute of Ocean Sciences, Fisheries and Oceans Canada) – mesozooplankton distribution pattern
Tsutomu Ikeda (Hokkaido University) – zooplankton production and respiration
Toru Kobari (Kagoshima University) – zooplankton development and growth
Kenshi Kuma (Hokkaido University) – marine chemistry (iron)
David Mackas (Institute of Ocean Sciences, Fisheries and Oceans Canada) – mesozooplankton distribution pattern
Charles Miller (Oregon State University) – mesozooplankton growth rates
Takashi Ota (Ishinomaki Senshu University) – microzooplankton
Sei-ichi Saitoh (Hokkaido University) – satellite evaluation of phytoplankton and physics
Karen Selph (University of Hawaii) – phytoplankton biomass and systematics with flowcytometry and microscopy
Suzanne Strom (Western Washington University) – microzooplankton variability and activity
Peter Strutton (Oregon State University) – water column monitoring from station-marking floats
Nicholas Welschmeyer (Moss Landing Marine Laboratories) – phytoplankton growth rates (^{14}C and ^{14}C-dilution experiments)
Atsushi Yamaguchi (Hokkaido University) – macro/mesozooplankton

(*cont. on page 23*)

The state of the western North Pacific in the second half of 2004

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Mr. Toshiyuki Sakurai is a scientific officer of the Office of Marine Prediction at the Japan Meteorological Agency (JMA). He is working as a member of a group in charge of oceanic information in the western North Pacific. Using a new "Ocean Comprehensive Analysis System" (in operation since January 2001), this group produces surface and subsurface temperature, salinity and current maps with 0.25× 0.25 resolution in waters adjacent to Japan. Monthly averaged fields obtained from the system are included in the "Monthly Ocean Report" published by JMA. Mr. Sakurai is now involved in developing a new daily analysis system for sea surface temperature in the global ocean, using in situ *observations and data from several satellites with infrared and microwave sensors.*

Sea surface temperature

Figure 1 shows monthly mean sea surface temperature (SST) anomalies in the western North Pacific from July to December 2004, computed with respect to JMA's 1971-2000 climatology. Monthly SSTs are calculated from JMA's MGDSST (Merged satellite and *in-situ* data Global Daily SST), which is based on AVHRR/NOAA data, microwave sensor (AMSR-E/AQUA) data, and *in situ* observations. Time series of 10-day mean SST anomalies are presented in Figure 2 for the 9 regions (indicated in the bottom panel).

SSTs were generally above normal in the seas adjacent to Japan, except for September (Figs. 1 and 2). Positive SST anomalies exceeding +2ºC prevailed in the Japan Sea from October through December, and south of the Kuril Islands in August. Those anomalies were most significant over the past 9 years in Region 1 in November, and in Region 2 in August.

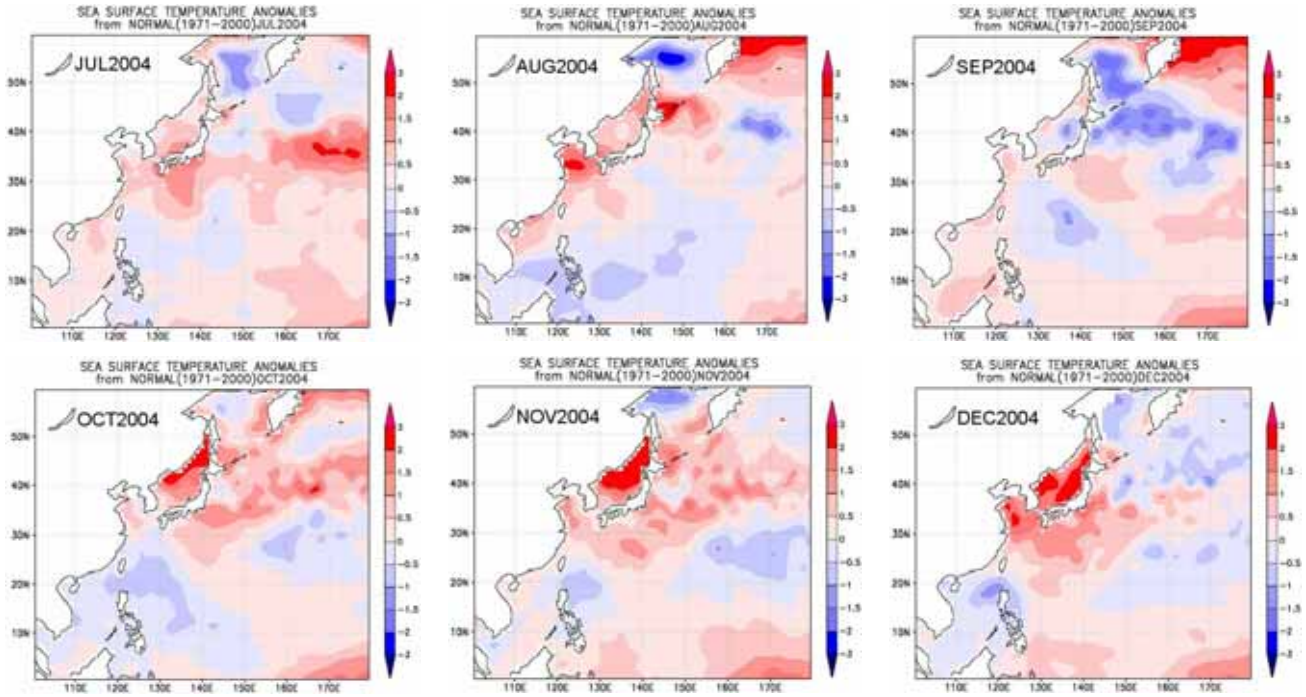

Fig. 1 Monthly mean sea surface temperature anomalies (ºC) from July to December 2004. Anomalies are deviations from JMA's 1971-2000 climatology.

Negative SST anomalies had persisted in the seas east of Honshu Island since 2003; however, those changed to be near normal or slightly positive in the second half of 2004 (Region 4 of Fig. 2). In September, SSTs were generally below normal, except for southeast of Japan, and negative SST anomalies exceeding –1ºC were found in the Sea of Okhotsk, along 40ºN, and around 22ºN, 138ºE. Although positive SST anomalies dominated around the Philippines from 1998 to early 2004, negative SST anomalies were often observed after May 2004.

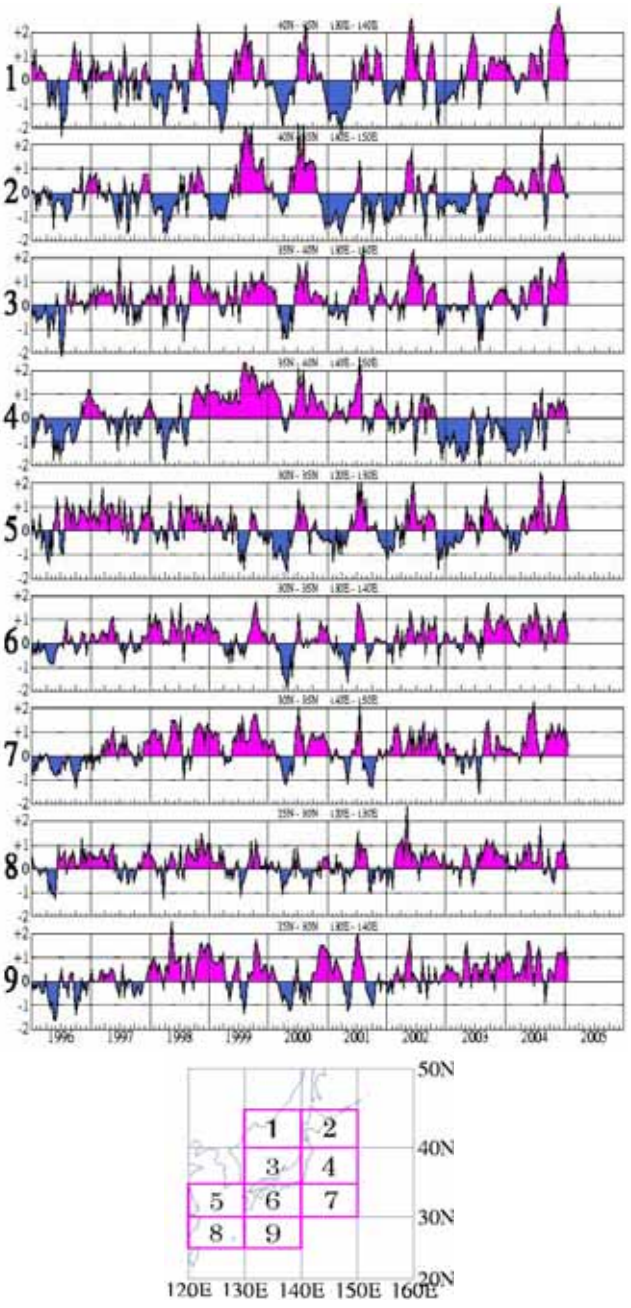

Fig. 2 Time series of the 10-day mean sea surface temperature anomalies (ºC) from JMA's 1971-2000 climatology for the areas shown in the bottom panel.

Kuroshio

The Kuroshio flowed far off the coasts in the seas south of Shikoku Island from mid-April through mid-July (Fig. 3). Its path was gradually moving to the coast of Shikoku and moving southward around 138ºE in July. Then a large-meander path was formed off Tokai in August. This large-meander path has persisted as of December 2004, with its size varying slightly with small perturbations.

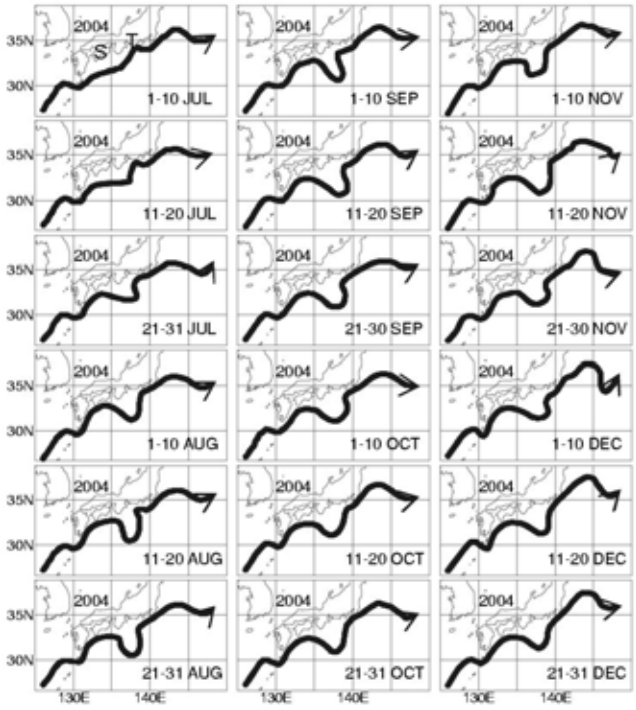

Fig. 3 Location of the Kuroshio axis from July to December 2004. "T" on the top-left map denotes the Tokai area, and "S" denotes the Shikoku area.

Carbon dioxide

JMA has been conducting observations of carbon dioxide (CO_2) in the surface seawater and overlying air in the western North Pacific, on board the R/V *Ryofu Maru* and R/V *Keifu Maru*.

Figure 4 illustrates the distribution of the difference in CO_2 partial pressure (pCO_2) between the surface seawater and overlying air, denoted as ΔpCO_2, observed in the western North Pacific in each season of 2004. The ΔpCO_2 value represents the direction of CO_2 gas exchange across the air-sea interface, indicating the ocean to be a potential source (or sink) for atmospheric CO_2 in the case of a positive (or negative) value of ΔpCO_2.

(*cont. on page 29*)

The Bering Sea: Current status and recent events

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Current status of the Bering Sea ecosystem

Water temperatures in the southeastern Bering Sea continue to be warm, and the southernmost penetration of sea ice is significantly less far than in the 1970s, 1980s, and 1990s. Both the winter minimum and summer maximum temperatures have increased over the southeastern middle shelf (Fig. 1). A higher winter heat content for the water column means that northerly winds must be colder and blow longer to result in significant penetration of ice into the southeast Bering Sea. Furthermore, as the Arctic Ocean loses ice, northerly autumn and winter winds are less likely to be as cold as in previous decades. Since these winds are responsible for the formation of ice in the northern Bering and advection of ice into the southeast, this will result in later ice formation in the Bering Sea (Overland and Stabeno, Eos, 2004, Vol. 85, No. 33, p. 309-316).

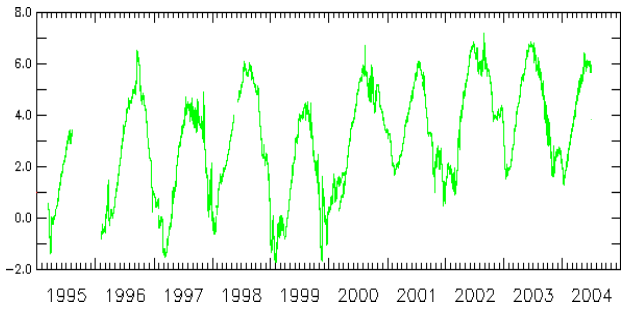


Fig. 1 Average water column temperature in the southeastern Bering Sea from 1995 – 2004 as measured at the Mooring 2 site. Source: P.J. Stabeno, NOAA – PMEL.

In recent years, there appears to have been a shift in the currents around the Pribilof Islands. This was particularly noticeable in 2004, when the northward flow along the west side of the Pribilof Islands was absent until July. This flow pattern was evident in both current meters and satellite-tracked drifters (http://www.pmel.noaa.gov/foci/lobec/gl_drifters.shtml). The typical pattern of a relatively strong (~20 cm s^{-1}) eastward flow along the south side of St. George Island, which turns northward following the 100 m isobath, has been hypothesized as an important source of nutrients to waters in and around the Pribilof Islands.

At the recent ESSAS symposium (see below), there were oral reports of other anomalous observations for the eastern Bering Sea. For example, summer mesozooplankton wet weight over the shelf may be decreasing, and the zooplankton community assemblage may differ from what was observed in this region during the 1980s and 1990s. In the summer of 2004, nesting planktivorous birds at the Pribilof Islands showed increased levels of stress hormones indicating difficulty in finding food. This shift was coincident with a shift in water movements. Other seabird species experienced unexpectedly poor reproductive success there. How the patterns in observed seabird recruitment are tied to recent changes in circulation around the Pribilof Islands is an area of active investigation. Scientists presenting these and other results at the ESSAS symposium are completing their research and preparing results for publication in a peer-reviewed symposium volume.

Ecosystems Studies of Sub-Arctic Seas (ESSAS)

A GLOBEC Symposium on "Climate variability and subarctic marine ecosystems" was held May 16-20, 2005, in Victoria, Canada. PICES co-sponsored the meeting and served as a local organizer for this event. Co-convenors Drs. George Hunt, Jr. (U.S.A.) and Kenneth Drinkwater (Norway) enthusiastically welcomed 224 scientists from 15 countries to the symposium. A symposium on climate effects is timely because recent changes in ecosystem

function appear to correlate with fluctuations in the physical environment, and because of growing concern about anthropogenically-induced climate change. Participants heard from a diverse group of scientists about recent changes in the Barents, Norwegian, Bering and Okhotsk Seas, and the Arctic, Antarctic, and North Pacific Oceans. Papers addressed changes within the physical, chemical and biological realms, including changes to fisheries and top trophic levels. Many of the presentations discussed localized warming in particular regions, however, it was interesting to note that several areas (*e.g.*, NW Atlantic, two sectors in the Antarctic) have exhibited cooling in recent years. Three days of oral presentations and two poster sessions demonstrated the rich variety of research conducted in the subarctic seas. Most sessions were plenary, although the sessions on the afternoon of May 18 were run concurrently. The purpose of the symposium was, in part, to launch a new GLOBEC program called ESSAS (**E**cosystems **S**tudies of the **S**ub-**A**rctic **S**eas; see details on the GLOBEC website at http://www.pml.ac.uk/globec/structure/regional/essas/essas.htm). The symposium was followed on May 20 by a workshop to review and discuss a draft Implementation Plan for ESSAS. Implementation of ESSAS will encourage and support undertakings by scientists to conduct comparative and synthesis efforts in the earth's subarctic ecosystems. Such an approach is necessary to understand, on a global scale, the climate teleconnections that exist among ecosystems.

Bering Sea Ecosystem Study (BEST)

The ESSAS Symposium was preceded by a one-day workshop to discuss a draft implementation plan for BEST (see details on the ARCUS website at http://www.arcus.org/Bering/oiw/best_workshop_05.html). Over 130 scientists attended the workshop, which was intended to provide an opportunity for the scientific community to critique the draft Implementation Plan written by the BEST Science Steering Committee chaired by Dr. G. Hunt, Jr. The U.S National Science Foundation, the funding agency promoting BEST, will support an initial phase of 3 to 5 years. It is hoped that a successful first phase will lead to a more ambitious second phase. The first phase will focus on physical, chemical and biological processes affected by the reduction of ice in the eastern Bering Sea. Work is expected to be conducted at the leading ice edge as well as to the north, in ice-filled waters, and to the south in open, ice-free waters during spring. If resources are available for a second phase, then other seasons, and geographic areas can be added.

The BEST Science Plan aims to follow processes through the food web from physics to fisheries, marine birds and mammals, and humans. Development of a human dimension component to BEST (HBEST) is ongoing and is being led by Dr. Benjamin Fitzhugh (Univ. of Washington, U.S.A.). A draft outline of HBEST is available at http://www.arcus.org/Bering/hbest/index.html.

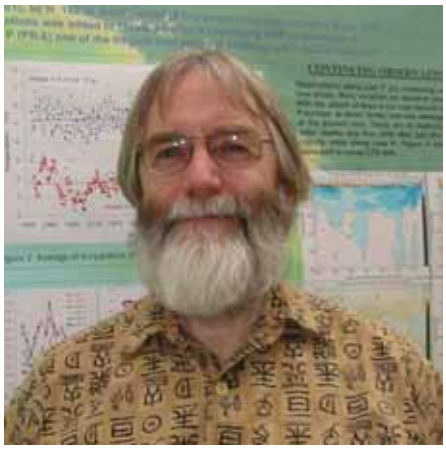
Bering Climate Page

NOAA's Pacific Marine Environmental Laboratory (PMEL) hosts a unique and valuable resource for scientists working in the Bering Sea. The Bering Climate Page (http://www.beringclimate.noaa.gov) provides data and a variety of tools to investigate climate-ecosystem coupling in the Bering Sea (Fig. 2). Created by Drs. James Overland and Sergey Rodionov (U.S.A.), the page contains: a brief overview on current status of the Bering Sea, a quick look at over 25 indices of climate and ecosystem status, links to web accessible scientific reports, essays by topic experts, and perhaps the most valuable feature for researchers, a data page that provides access to climate, atmospheric, oceanic, biological, and fisheries data time series. Each time series is described and its relevance as an index or metric is explained. Users can examine recent trends in each individual index (look at the new regime shift calculator) as well as calculate correlations between indices. The web page is easy to use and a great way to generate hypotheses after looking at data.

Fig. 2 Bering Climate Page. Web page of check boxes and buttons that allow users to examine recent trends in climate, atmospheric, oceanographic, biological, and fisheries data.

Acknowledgement: Many thanks to Drs. George Hunt, Jr. and Phyllis Stabeno who helped create this report.

Recent trends in waters of the subarctic NE Pacific



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Frank A. Whitney has led the Line P program for the past 14 years, carrying out repeat oceanographic sections for WOCE (1991-97) and hosting the Canadian JGOFS program (1992-97) on these cruises. Through this time, his main research interest has been in understanding processes which control nutrient supply to the upper ocean. He has also surveyed meso-scale eddies several times in an attempt to estimate offshore transport of coastal waters in the Gulf of Alaska. Frank has been working in oceanography on the British Columbia coast since 1969.

Nutrient supply to the upper ocean

Several recent publications, when their results are combined, present a compelling argument for "bottom-up" controls on fish production (especially in non-migratory species) in the NE Pacific.

Ware and Thomson (*Science*, May 20, 2005) show strong correlations between annual chlorophyll concentrations, using satellite data, and long-term yield of resident fish in a region extending from southern California to the Aleutian Islands. Iverson (*Limnol. Oceanogr.* 35, 1990) had previously demonstrated a direct relationship between primary productivity (PP) and fish production (FP) over a broad range of world fisheries. One of his figures I have found enlightening, shows that there is essentially no FP when PP is less than ~50 g C m^{-2} y^{-1}; above this there is a linear correlation suggesting ~10% carbon transfer between phytoplankton and carnivorous fish/squid. Low PP regions tend to reprocess nutrients within small plankton, producing very little exportable production (*i.e.*, production available for higher trophic levels).

In the NE Pacific, the Ware and Thomson correlation between chlorophyll and fish catch reveals some surprising results. For example, they show that the most productive regions are at the north end of the upwelling domain in northern Washington and southern British Columbia (Fig. 1). They suggest that this is due to the broad shelf and additional nutrient inputs from rivers. Whitney *et al.* (*DSR II* 52, 2005) have reviewed nutrient supply to shelf regions in the NE Pacific and found that high nutrient supply in this region is also due to tidal mixing in Juan de Fuca Strait and onshore transport through canyons. Ware and Thomson identify rich fish yields in other tidally mixed areas on the British Columbia coast.

Another intriguing finding from the Ware and Thomson paper is that there appears to be an equally efficient transfer of energy from phytoplankton to fish in both the downwelling and upwelling domains. The higher yield where upwelling is weak may be due to a stronger off-shelf transport of PP where upwelling is strong.

Since I have been focusing much of my research on nutrient supply in open and coastal oceans, I extend the Ware and Thomson results to indicate a direct link between physical mixing processes that supply nutrients to the upper ocean (Table 1), and fish production. Recent publications arising from a PICES session in 2003 and the U.S. GLOBEC program provide new insights to nutrient transport in coastal waters of the NE Pacific (*e.g.*, Wheeler *et al.*, *GRL* 30, 2003; Stabeno *et al.*, *CSR* 24, 2004; Whitney *et al.*, *DSR II* 52, 2005; Childers *et al.*, *DSR II* 52, 2005; Ladd *et al.*, *DSR II* 52, 2005). Ware and Thomson identify the richest fisheries in regions where strong tidal mixing and estuarine circulation are coupled. Crawford and Dewey (*Atmosphere-Ocean* 27, 1989) showed that these mixing processes provided more nutrients to the southern British Columbia coast than either upwelling or coastal tidal mixing.

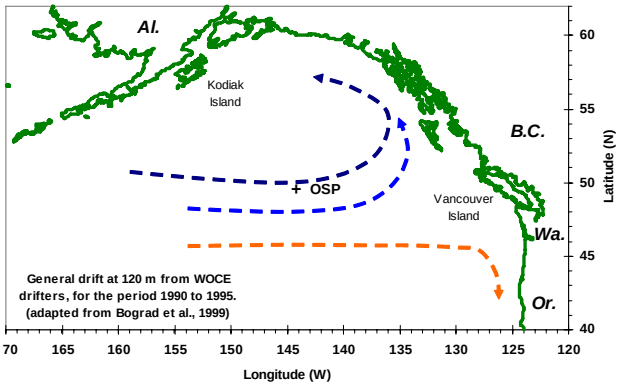

Fig. 1 Map of the NE Pacific Ocean showing general flow in the Subarctic Current past Ocean Station Papa (OSP) to the coasts of Oregon (Or.), Washington (Wa.), British Columbia (B.C.) and Alaska (Al.).

Table 1. Processes providing nutrients to the upper ocean in the NE Pacific.

Process	Region	Importance
Winter mixing	universal	Varies over region and interannually depending on wind intensity
Upwelling	South of ~51ºN	Summer event
Downwelling	North of ~51ºN	Relaxation during summer transports deep waters onto shelf
Rivers	N of ~46ºN	Silicate and iron additions
Tidal mixing	S BC, S Alaska	Nutrients from depth mixed to surface
Estuarine circulation	Coastal inlets and basins	Fresh water outflow draws nutrient rich waters into inlets and straits
Mesoscale eddies	N of ~52ºN	Exchange of nutrients and biota between coastal and open oceans
Bathymetric steering	Vicinity of Vancouver and Kodiak Islands	Directs coastal currents onshore through canyons
Summer winds	Alaska coast	Bursts of increased mixing, upwelling
Changes in subarctic circulation	Oregon coast	High nutrient, low oxygen waters upwelled onto the coast, resulting in hypoxia (fish and crab kills)

Winter conditions along Line P

Briefly, our February 2005 Line P survey [south British Columbia coast to Ocean Station Papa (OSP)] shows that surface waters stay warm compared with our 1956-1991 climatology (Fig. 2).

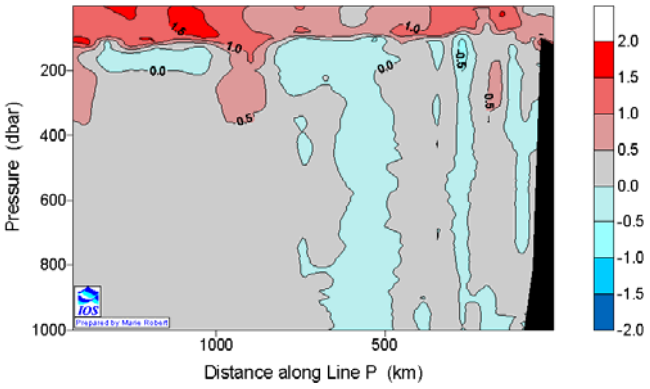

Fig. 2 Temperature anomalies along Line P in February 2005 (courtesy, M. Robert).

Even though the surface waters remained warm, the mixed layer depth at OSP deepened to ~110 m following 2 years of abnormally shallow winter mixed layer (<90 m). Mixed layer nitrate is typical for winter, concentrations lying between the minimum levels seen in 1998, and the highs observed in cool years (1989, 1999). However, silicate concentrations are lower than those measured in winter 1998, from about 500 to 1200 km along Line P. Silicate is a crucial nutrient for diatom growth and export production, and can become limiting in the subarctic NE Pacific when iron supply to the open ocean increases (Wong and Matear, *DSR II* 46, 1999; Whitney *et al.*, *DSR II* in press).

A reasonable prediction for the coming summer would be to see silicate limitation along much of Line P (not the coastal waters) and decreased particulate flux to the deep ocean. A more tentative prediction would be for coccolithophores to be more abundant than usual in spring or early summer. I base this speculation on the tendency of plankton along Line P to be either siliceous or carbonaceous.

(cont. from page 17)

Break-out groups were formed during the second day of the workshop to better facilitate in-depth discussions. Groups considered phytoplankton, water column physics and chemistry (including iron), microzooplankton and mesozooplankton. Each group developed scientific questions/hypotheses, and then discussed appropriate methods, measurements and time scales for studies. They considered how to accomplish comparisons and contrasts between the eastern and western gyre systems.

Discussions in Corvallis showed that interests of the eastern and western groups differ because the systems to be studied differ, not only in production dynamics but also in physical oceanography. Moreover, the groups will have different requirements for developing a consensus for support in their respective national oceanographic programs. Each group must work out the justifications for funding the necessary long cruises in its region and develop enthusiasm in rather different scientific cultures, while at the same time sustaining the comparability of measurements in the two OECOS areas. It was resolved to try to do that.

As organizers of the OECOS workshop, we want to thank the participants for coming and for their vigorous discussion of the oceanographic issues. We also thank PICES and OSU for the generous support that made it possible for us to meet and talk.

CFAME workshop on "Developing a working plan for CCCC synthesis"

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*Dr. Kerim Y. Aydin is the Program Leader for the Resource Ecology and Ecosystem Modeling Program of the Alaska Fisheries Science Center (AFSC), NOAA Fisheries. Kerim received his Ph.D. in Fisheries from the University of Washington, in 2000, with a dissertation on the impacts of climate and prey variation on the ocean growth of Pacific salmon (*Oncorhynchus spp.*). He has been a postdoctoral research associate and fishery research biologist with AFSC since 2000. Kerim's main research focus has been on fish trophic interactions, bioenergetics, and ecosystem-scale predator/prey models. He has been an affiliate faculty member of the University of Washington's School of Aquatic and Fishery Sciences since 2003, and is serving as Co-Chairman of the PICES CCCC Climate Forcing and Marine Ecosystems (CFAME) Task Team.*

Dr. Akihiko Yatsu is Head of the Population Dynamics Section at the National Research Institute of Fishery Science (NRIFS). His current work includes stock assessment of chub mackerel, spotted mackerel and Japanese sardine, and inter-annual and inter-decadal linkages of stock abundance and marine ecosystems in the Northwest Pacific. He is also the Co-Chairman of the PICES CFAME Task Team and Working Group 16 on Climate Change, Shifts in Fish Production, and Fisheries Management.

A workshop entitled "Developing a working plan for CCCC synthesis" was held by the Climate Forcing and Marine Ecosystem (CFAME) Task Team on May 14-15, 2005, in Victoria, Canada. In attendance were 23 scientists from Canada, Japan, Korea, Russia and the United States. The CFAME Task Team was formed in 2004 with the objective of synthesizing, over the next several years, regional and basin-wide studies of the PICES Climate Change and Carrying Capacity (CCCC) interdisciplinary program. The goal of the first CFAME workshop was to focus a broad range of hypotheses linking climate and marine production into a working plan for the Task Team.

The first day of the workshop was devoted to scientific presentations, while the second day was dedicated to developing both terms of reference and a working plan for the Task Team. The meeting opened with a statement on the purposes of the workshop by Co-Convenors, Drs. Kerim Aydin and Akihiko Yatsu. Then Dr. Kazuaki Tadokoro (Japan) gave an invited talk entitled "Decadal variations in mesozooplankton biomass in North Pacific with comparison of their environments". One of the highlights of his talk was a summary of the mesozooplankton biomass changes in the North Pacific after three regime shifts (Fig. 1). Dr. Harold Batchelder, CCCC Co-Chairman, reviewed plans for the 2006 PICES/GLOBEC Symposium on "Climate variability and ecosystem impacts on the North Pacific: A basin-scale synthesis", and presented a perspective of CCCC activities. Dr. Michael Foreman attended on behalf of the Physical Oceanography and Climate Committee (POC) and discussed upcoming physical oceanographic model products which may be available for developing biological hypotheses. Dr. Jacquelynne King updated the participants on the recent efforts of the PICES Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts (FERRRS), and Dr. Skip McKinnell gave a presentation on the appropriate use of climate indices in biological correlation studies. Finally, Task Team members presented recent research from member countries. Emphasis in presentations was on linkages between climate forcing and ecosystem responses.

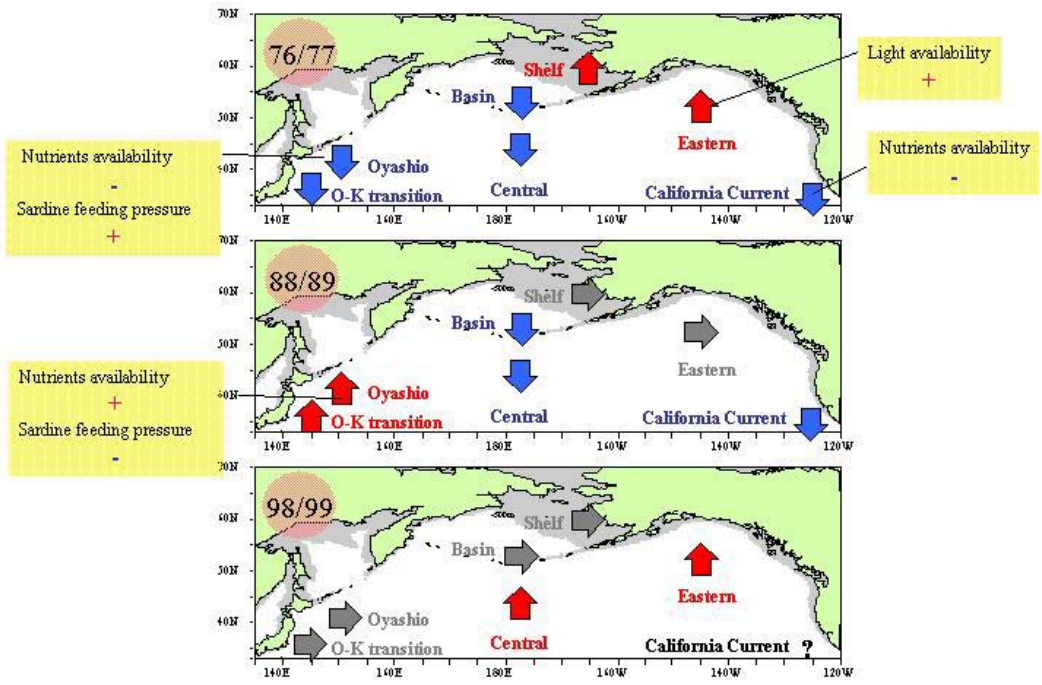

Fig. 1 Summary of the mesozooplankton biomass changes in the North Pacific after three regime shifts: 1976/77 (top panel), 1988/89 (middle panel) and 1998/99 (bottom panel). Red arrows indicate increase, blue arrows indicate decrease, and grey arrows show stationary state.

On the second day, discussion began with an examination of CCCC goals and objectives. The initial Implementation Plan of the CCCC program (PICES Sci. Rep. No. 4, 1996) defined "carrying capacity" as referring to the linkages through which zooplankton and high trophic level carnivore species dominance and productivity respond to changes in ocean climate. To this end, the initial implementation of the CCCC Program set out to develop a new theoretical and mathematical framework to extend the classical single species concept of carrying capacity into the multi-species and ecosystem domains, and to address how climate change affects ecosystem structure and the productivity of key biological species.

To facilitate these goals, CFAME members decided that the Task Team's terms of reference and initial Action Plan should consist of three components: (1) Mechanisms, (2) Ecosystems, and (3) Scenarios. For each of these components, a term of reference and initial action items were developed by break-out groups (see photos next page), then approved by the Task Team:

(1) MECHANISMS

Term of reference:

- CFAME shall act to develop conceptual models of key biological processes, such as growth, survival and recruitment, in relation to climate forcing and human-induced effects. Key processes may include temporal and spatial scale variability in bottom-up forcing and match/mismatch of different life history strategies. This task will be done through comparison, based on common methods, of key species or ecological equivalents identified as important for CCCC.

Action item:

- Hold a 3-day workshop in January 2006 on conceptual/regional models, with a specific goal of providing developed mechanisms for the Symposium on "Climate variability and ecosystem impacts on the North Pacific: A basin-scale synthesis" (April 19-21, 2006, Honolulu, Hawaii).

This workshop will seek to develop regional and Pacific-wide conceptual models describing mechanisms linking climate to fish production by focusing on two methods. For the first method, attendees will develop mechanistic models for the following species in eastern and western ecosystems: pollock, sardine, herring, pink and chum salmon. This approach will include the refining of regional climate indices to specifically and directly represent processes of interest, while allowing for linkages to large-scale climate patterns or models. For the second method, attendees will identify the set of key fish or squid species in the following ecosystems: California Current, East China/Yellow Seas, and Sea of Okhotsk. The set of key species may differ over time within each ecosystem. The aim is to describe the mechanisms between climate, ecosystem history, food web structure, and life history strategies which have led to the selected species playing a pivotal role in their respective ecosystems. It is expected that these descriptions will contribute to understanding

patterns of variation and potential for changes in overall ecosystem structure, stability, or other ecosystem properties.

(2) ECOSYSTEMS

Terms of reference:

- CFAME shall act to review and develop the next generation of robust ecosystem indices, including physical forcing, species-specific responses, and ecosystem aggregate indices. The indices should represent key processes linking climate, ocean, and biology. The indices, as an ensemble, will focus on detecting and potentially predicting changes on a number of temporal scales, including seasonal, interannual, and interdecadal variability, and longer-term trends. Further, the indices should be tested against a range of plausible future scenarios of climate change, to ensure that they continue to track key processes.
- CFAME shall collaborate, for example, with the CCCC MODEL Task Team, in the development of multi-species, ecosystem, and comparative life history models that connect lower and upper trophic level processes, incorporating multiple life history strategies as well as a range of temporal and spatial scales. A preliminary result of this modeling will be describing differences in ecosystem structure and life history types as it may apply to predicting different responses to climate and human forcing.

Action items:

- Revise the definition of carrying capacity to include current knowledge;
- Hold a workshop prior to the PICES Fifteenth Annual Meeting (October 2006, Yokohama, Japan) on changes in ecosystem structure in response to climate forcing, in preparation for a 2007 joint POC/CFAME scenario exploration workshop (see under Scenarios, below).
- Collaborate with the PICES/NPRB (North Pacific Research Board) project entitled "Integration of Ecological Indicators for the North Pacific with emphasis on the Bering Sea".

(3) SCENARIOS

Terms of reference:

- CFAME shall act to build upon identified mechanisms to investigate a range of species and ecosystem responses to climate forcing scenarios and forecasts; *e.g.*, distributional changes, changes in ecosystem community structure (*e.g.*, replacement of species), and changes in survival at life stages.

Action items:

- Hold an interim POC/CFAME workshop in 2007 for climate modelers to provide regional indicators identified at the January 2006 workshop, and for CFAME to apply climate output to developed conceptual models.

It is hoped that this threefold approach will greatly aid the success of CCCC synthesis activities in the coming years.

Break-out groups on "Mechanisms" (top photo: Kazuaki Tadokoro, Sanae Chiba, Akihiko Yatsu, William Crawford, Sukyung Kang and Masahide Kaeriyama), "Ecosystems" (middle photo: Gordon (Sandy) McFarlane, Kerim Aydin, William Peterson and Vera Agostini) and "Scenarios" (bottom photo: James Overland, Brenda Norcross, Yoshiro Watanabe, Jacquelynne King and Takashige Sugimoto) discuss terms of reference and components of the CFAME Action Plan.

What is winter?

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Skip M[c]Kinnell (right, photographed with Ian Perry at the ESSAS Symposium) is Deputy Executive Secretary of PICES. He is frequently found as a Guest Editor of PICES-sponsored special issues in various primary journals, and had a non-trivial role in the development of the first PICES North Pacific Ecosystem Status Report. This PICES Press article is the second in what may become a series of articles on climate, data, indices, and biology. It is an abstract of some ideas presented during an invited seminar at the PICES CFAME workshop in Victoria in May 2005, and at the Centre de Recherche Halieutique Méditerranéenne et Tropicale in Sète, France, in June 2005.

It is common practice in our business to define *winter* as a mean of some climatic variable of interest during some often variable period of time, typically centered on January. The practice is so widely accepted that the appearance of *djf* (December, January, February average) is rarely questioned. Whether it is the PDO (Pacific Decadal Oscillation), the NPI (North Pacific Index), the ALPI (Aleutian Low Pacific Index), the SOI (South Oscillation Index) or any number of climate indices, winter is defined as the average of the winter monthly values of these indices. The arithmetic mean is the most widely used measure of central tendency, and as such it is supposed to be, and we would like it to be, representative of something meaningful. But is it always? The particular thought-tangent is laid out in the examples that follow.

Let us define the monthly intensity of the Icelandic Low (IL) as the latitude-adjusted integral of sea-level pressure (SLP) of all grid points < 1007 mb within the domain (70°N - 30°N, 70°W - 2.5°W), calculated from the monthly mean data (http://www.cdc.noaa.gov/cdc/reanalysis/reanalysis.shtml) from the NCEP/NCAR re-analysis. The weights compensate for the convergence of grid points with increasing latitude, and were set to range in values from 1.0 for grid points at 20°N to 0.36 at 70°N. The resulting index is a time-series of measurement of the IL from 1948 to 2005 for each winter month. Comparing Decembers with Januarys and Januarys with Februarys, it immediately becomes apparent that there is no within-year persistence in the intensity of the IL during the winter months (Fig. 1). Correlations among months range from –0.18 to 0.02. This means that the intensity of the IL in any month provides no indication of its intensity in subsequent months.

There is also no within-year persistence in the mean latitude of the IL; correlations between winter months range from –0.15 to 0.2 among months across years, and there is no within-year persistence in the mean longitude of the IL; correlations range from –0.16 to 0.07 among months across years. This means that the location and intensity of the IL in any month is independent of the previous month. Perhaps this result is trivial because it is not unexpected from a "white-noise" climate system, but the implications are not so trivial for the study of the relations between climate and marine ecosystems especially when winter averages (*e.g. djf*) are so commonly reported as the climate index of interest.

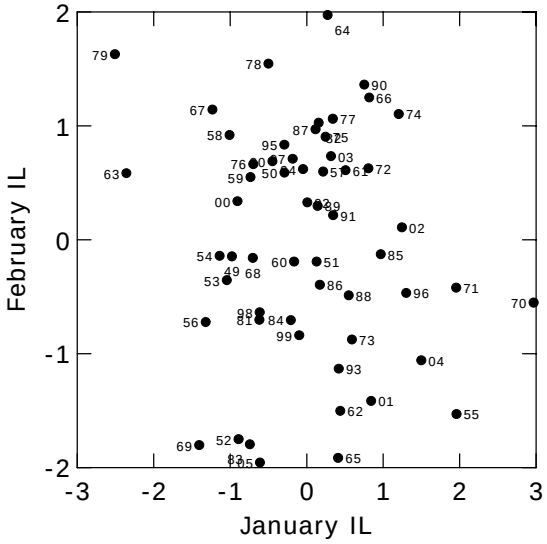

Fig. 1 Index of the intensity of the Icelandic Low (IL) in February (measured in standard deviations, positive is stormier) versus intensity of the IL in January from 1948-2005. Plot point symbols indicate years.

An average *djf* IL winter index can arise from various scenarios: three consecutive months of average conditions, a very stormy December, a moderately windy January, and a calm February, or from a year with a calm December, a moderately windy January, and a very stormy February. Although the annual *djf* values of these scenarios are identical, the implications for the marine ecosystem are not, because both the physical and the biological components of the system have a high amplitude annual cycle. Indeed, the annual cycle is the dominant forcing cycle in the temperate/subarctic latitudes, so the temporal evolution of events is important. The consequences for the annual survival of a marine species that spawns in February, for example, may depend on whether it is stormy or calm during that particular month. Yet if we compare the annual survival of the species against *djf* winter averages, there may be no apparent effect of climate because the "winter" average was not the most important feature for this species.

Years with average values of the IL (*djf*) do indeed include some of the most stormy and most calm months in the time-series. December 1970 was very calm (3 s.d. less than the mean), while December 1998 exceeded the mean by 3 s.d., yet the winter IL (*djf*) values for both years are near average. This problem occurs in part because the mean of a small sample (n=3 months) is not well determined and in part from the stochastic nature of Sea Level Pressure (SLP) data in this region. But the main conclusion is that the winter IL (*djf*) is not a consistent index of "winter". This same phenomenon occurs in the North Pacific with various measures of the intensity and location of the Aleutian Low.

A convenient example of potential problems with climate indices landed on my desk as I wrote this. The over-winter survival of least auklet (*Aethia pusilla*) near the Aleutian Islands is reported to be better in years when the August to April average values of the NPI were low, *i.e.* during stormy August-April periods (Jones *et al*. 2002). However if the climate index is disaggregated by month and compared with annual survival, there is indeed a significant relationship between survival and late winter/early spring pressures (Fig. 2), but it leads to the opposite conclusion. Calm, rather than stormy months of February and March are associated with better survival. As it is not known when the birds actually die, neither hypothesis is falsified by this result, but disaggregating the climate index allows a greater range of potential hypotheses to be explored.

The degree to which a multi-month average index is representative of a period in question at an arbitrary location can be approximated from the temporal e-folding scale, *i.e.* how quickly does the autocorrelation decay? Where there is persistence in some features among months, time-averaged indices of monthly data are more representative of conditions over the interval than if there is no persistence. The 1-month lag correlation at all grid points in the NCEP/NCAR SLP data indicates that the tropical latitudes and the Southern Ocean are regions where SLP persistence is greater (Fig. 3). Seasonal indices of SLP in these regions are probably more representative than elsewhere.

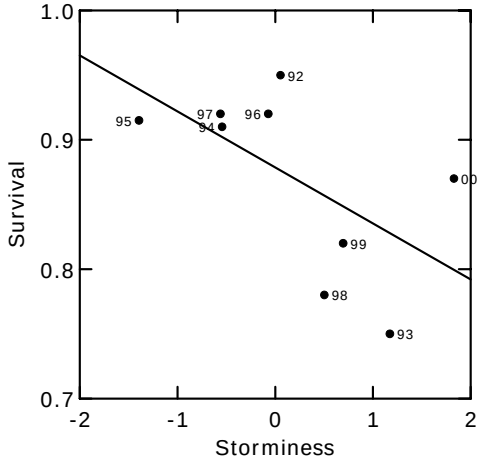

Fig. 2 Least auklet over-winter survival versus an inverse variant of the North Pacific Index for March (+ values are stormy); years indicated.

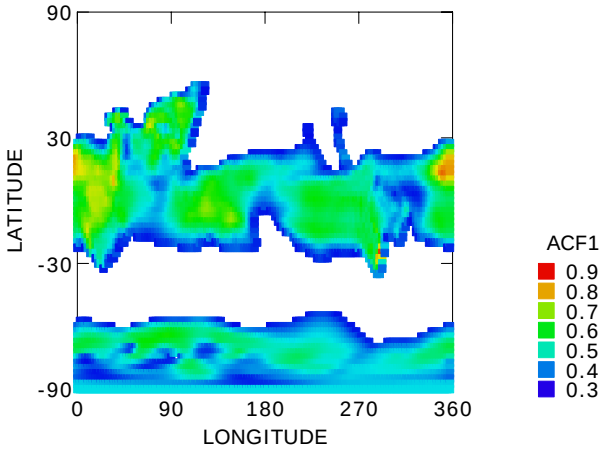

Fig. 3 Magnitude of 1-month lag correlations (greater than |0.3|) at all grid points in the NCEP/NCAR SLP re-analysis data from 1948-2005.

An example of a winter SLP index with some promise to explain SST variation in the Northeast Pacific has emerged in the western tropical Pacific warm pool region, where SLPs are rather autocorrelated (r ~ 0.5-0.6) among winter months. For convenience, let's call it the WTP Index. The point of maximum correlation between the WTPI and Northeast Pacific SSTs is located near the Solomon Sea (7.5°S 152.5°E), essentially embedded within the WTP warm pool. Winter average values of the WTPI (*djf*) at this location are substantially better correlated with spring SSTs in the Northeast Pacific than are the classical indices (SOI, NINO 3.4 SST) of tropical climate (Fig. 4). It suggests that the physics of the teleconnection between the tropics and

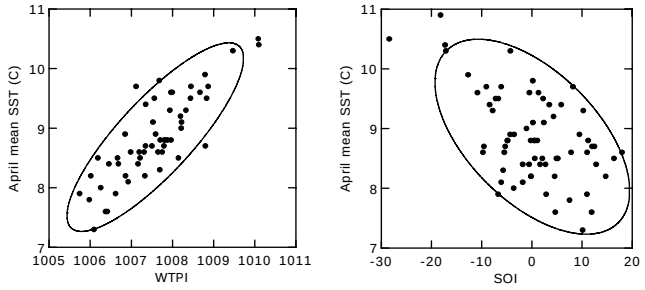

Fig. 4 Kains Island SST in April versus (a) winter Western Tropical Pacific Index and (b) Southern Oscillation Index from 1948-2004.

the mid-latitude Northeast Pacific is more closely associated with the annual ocean/atmosphere physics of the western tropical Pacific than to ENSO *per se*.

Figure 4b suggests that Northeast Pacific SSTs in spring are affected by the state of the tropics only during ENSO years *i.e.* if the El Niños are removed from this panel, there is no significant correlation, whereas Figure 4a indicates that variation in winter SLP in the western tropical Pacific is the major determining factor of spring SSTs in the Northeast Pacific, throughout the full range of variability in both variables. Stripping off the El Niños does not affect the statistical significance of this relationship; it holds even in non-ENSO years. The hypersensitive response of the Northeast Pacific SSTs in spring might be the result of several correlated responses, each contributing to affect SST anomalies in a similar way (*e.g.*, heat fluxes and advection), and this should be investigated.

Climate indices aspire to distill complexity to its essence. But it seems that the distillation process is equally capable of producing black sludge as perfume, and the bottles are not always clearly labeled. So we might benefit from a bit of circumspection before the contents of these bottles are used for ecological problem-solving. In particular, it seems that the spatial and temporal integrals over which the indices are computed require greater attention to ensure that they represent the major features of a process/forcing of interest. The consequences of not getting this right could be a prolonged academic diversion down a dead-end in our search for better understanding. I encourage the development and exploration of better indices, and the thoughtful application of the ones we have.

(*cont. from page 19*)

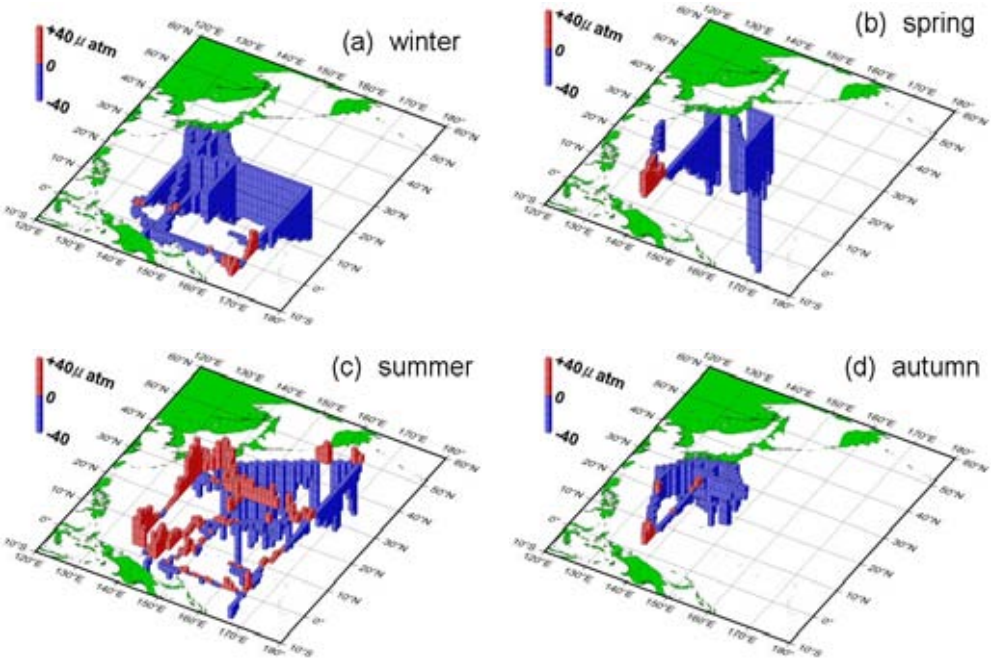

Fig. 4 Difference in the CO_2 partial pressure between the ocean and the atmosphere in the western North Pacific in 2004. Red/blue pillars show that oceanic pCO_2 is higher/lower than atmospheric pCO_2.

In the western subtropical Pacific, oceanic pCO_2 was lower than atmospheric pCO_2 in winter, spring and autumn 2004, implying that the ocean acted as a sink for atmospheric CO_2, whereas this region changed to be a source in the summer. In the western subarctic Pacific, oceanic pCO_2 was lower than atmospheric pCO_2 in wide areas in summer 2004. In the equatorial Pacific, the ocean usually acts as a source for atmospheric CO_2. Oceanic pCO_2 in the region, however, has been at low levels since 2002, and was greatly lower than atmospheric pCO_2 in winter 2004.

The first specimens of Humboldt squid in British Columbia

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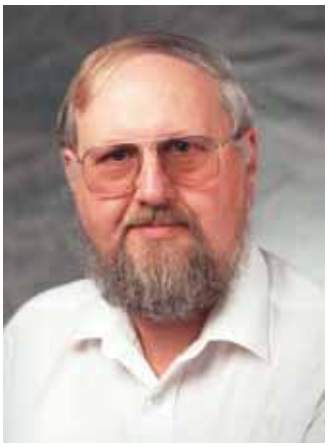


A scuba diver for more than 45 years and a certified diving instructor since 1971, James Cosgrove has long been interested in the plants and animals of the ocean. For 30 years he served as the Diving Safety Officer at the University of Victoria (UVic) and is a founding member of the Canadian Association for Underwater Science. Jim remains an external member of the UVic Diving Control Board. After obtaining Bachelor and Master of Science degrees (Marine Biology), he worked for 10 years in the Biology Department of a community college before moving, in 1987, to a new position at the Royal British Columbia Museum, where he is currently working as the Manager of the Natural History Section. He supervises a staff of 12 who research and care for more than half a million specimens. As a scientist, Jim continues his research into the life histories of the octopuses and squids of British Columbia.

It all began, as these things often do, with an e-mail from a colleague. "Jim, are you getting reports of strange squid in British Columbia? Albacore fishers in Washington and Oregon are reporting finding hundreds of large squid mixed in with the schools of albacore." A quick check with local Fisheries and Oceans staff did not reveal any sighting of these strange squid in British Columbia waters.

Several weeks later, I received another e-mail with photos of the strange squid. From the photos it was clear that this squid was *Dosidicus gigas*, the Humboldt or jumbo flying squid. Two things were very unusual about this find. One, Humboldt squid seldom come farther north than central California, and this picture was taken near Sitka, Alaska. Two, if there were Humboldt squid in Alaska there were sure to be Humboldt squid in British Columbia, too.

Within a couple of days, the Royal British Columbia Museum (RBCM) received a phone call from a local fisher saying that he had a large squid caught while salmon fishing off the entrance to Juan de Fuca Strait. It was anticipated that it was probably a specimen of *Dosidicus*, however it could have been *Moroteuthis* or *Ommastrephes*, both large squid known to be in waters of British Columbia. It turned out that my anticipation was correct, and we received our first Humboldt squid specimen and the first documented specimen ever retained in British Columbia (Photo 1).

The specimen was in good condition having only a couple of cuts from the fishing line and having lost one eye to a hook on the fishing gear. Easily identified by its size, broad fins and hole-saw-like rims on its suckers, the Humboldt squid has a unique pattern on the tentacular suckers (Photo 2).

Photo 1. Senior Collection Manager Kelly Sendall with the RBCM's first Humboldt squid specimen.

Photo 2. Note the toothed rims on the suckers to hold captured prey.

The media were notified of this large addition to the RBCM collection, and a Times Colonist reporter did a story on the find. To everyone's surprise, the interest in this specimen generated a number of other requests to see the specimen and to interview RBCM staff. Three of the reports (1 from Alaska and 2 from British Columbia) stated having seen Humboldt squid in previous years, and 1997/98 was the most common time. Of interest is the fact that the northeastern Pacific was experiencing an El Niño at the time.

The Times Colonist article also went worldwide and generated a number of new reports (7 from Alaska, 2 from Washington State and 9 from British Columbia) of encounters with the squid. The article also resulted in the RBCM receiving an additional 7 specimens, including 4 from the Canadian Coast Guard Ship *W.E. Ricker*. The Chief Scientist, Dr. Marc Trudel, noted that 10 specimens were captured at one time, but only 4 were retained. Some fishers reported having seen "hundreds" of squid at a time, and one reported steaming through thousands of squid lying on the surface at night.

The RBCM also received a document from Mr. Frank Whitney of the Ocean Chemistry Section of the Institute of Ocean Sciences (Fisheries & Oceans Canada), showing that this year the ocean waters in British Columbia and Alaska were the warmest ever surveyed, reaching 18.9°C at one site.

In Figure 1, surface temperature along Line P in August 2004 is compared to the 3 previously warmest years (late summers of 1994, 1997 and 1998). Warmest waters this August were seen between 127ºW and 134ºW. Temperature anomalies (Fig. 2; computed by Marie Robert) show that surface waters were as much as 4ºC above the 1959-1991 average for August.

All through October and early November, sightings were reported and specimens were caught up and down the coast. There were also mass strandings, estimated in the thousands of animals, of Humboldt squid in Oregon and Washington.

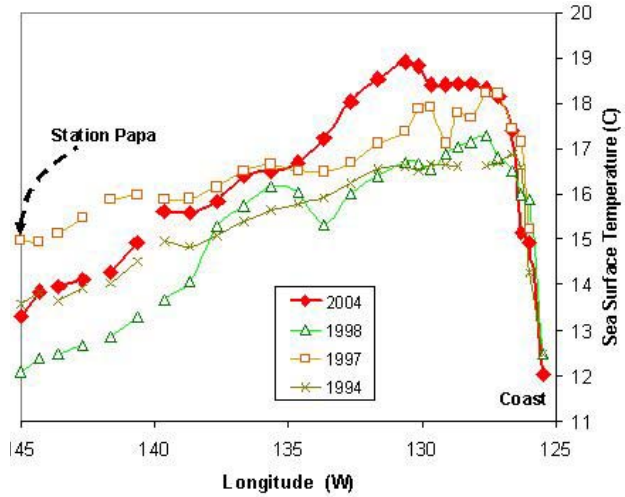


Fig. 1 SST along Line P during the warmest years of the 1990s and in August 2004.

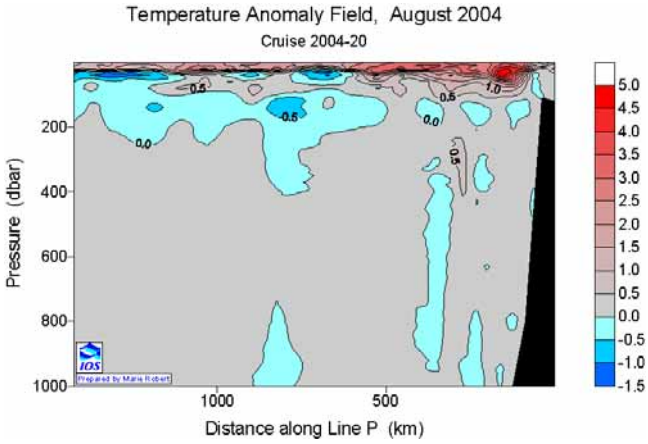
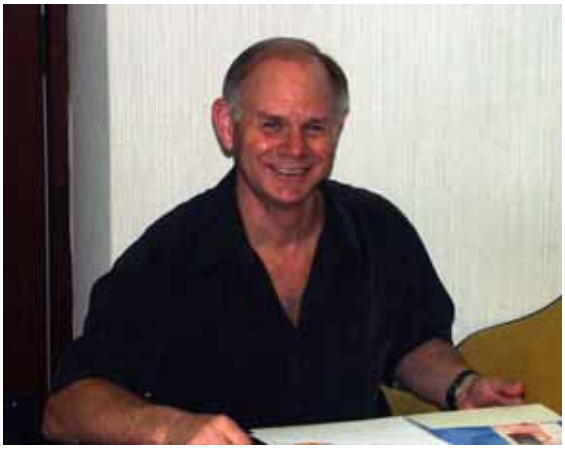


Fig. 2 Temperature anomalies along Line P in August 2004 (courtesy, M. Robert).

What was the cause of this influx of these large predators? While it is yet to be proven, there does appear to be a relationship between the unusually warm surface water and the large number of Humboldt squid reported. Will these animals return next year with the predicted El Niño? Time will tell.

Obituary - Dr. Daniel M. Ware



It is with deep regret that PICES announces the passing of Dr. Daniel M. Ware on July 31, 2005, at home in Nanaimo, B.C., Canada. He was 62 years old. Dan was the first Science Board Chairman of PICES, serving from October 1992 to November 30, 1995. His leadership in the early formative years of PICES was crucial to the solid scientific establishment of the Organization. In early June, Dan was awarded the prestigious Timothy R. Parsons Ocean Sciences Award by the Department of Fisheries and Oceans Canada for his research in fisheries ecology. To recognize his scientific expertise and contribution to PICES, Dan was selected as this year's Wooster Award winner by the current Science Board in May. He was very happy about this news and travel arrangements were even started for Dan to go to PICES XIV in Vladivostok to receive the award, when his cancer suddenly became more aggressive. He will be deeply missed.

PICES Calendar

- PICES Fourteenth Annual Meeting, September 30-October 8, 2005, Vladivostok, Russia
- MEQ workshop on "Review of selected harmful algae in the PICES region: I. *Pseudo-nitzschia and Alexandrium*", September 29-30, 2005 (in conjunction with PICES XIV)
- MONITOR workshop on "Filling the gaps in the PICES North Pacific Ecosystem Status Report", October 1, 2005 (in conjunction with PICES XIV)
- IFEP/MODEL workshop on "Modeling and iron biogeochemistry: How far apart are we?", October 2, 2005 (in conjunction with PICES XIV)
- PICES/ICES workshop on "Introduced species in the North Pacific", October 4-5, 2005 (in conjunction with PICES XIV)
- ORI/PICES workshop to synthesize results from the second *in situ* iron enrichment experiments in the western subarctic North Pacific (SEEDS-II), October 17-18, 2005, Tokyo, 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
- FRA/APN/IAI/GLOBEC/PICES workshop to extend NEMURO.FISH to fish stocks in other geographic regions, November 14-17, 2005, Tokyo, Japan
- 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.
- PICES/NPRB workshop on "Integration of ecological indicators for the North Pacific with emphasis on the Bering Sea", May 24-26 or May 31-June 2, 2006, Seattle, U.S.A.
- Symposium on "Time series of the Northeast Pacific Ocean: A symposium to mark the 50th anniversary of Line-P" (co-sponsored by DFO Canada and PICES), July 5-7, 2006, Victoria, Canada
- PICES Fifteenth Annual Meeting, October 13-21, 2006, Yokohama, Japan
- ICES/PICES/MBIC symposium on "Marine bioinvasions", March 2007, Washington, DC, U.S.A.
- 4th International Zooplankton Production Symposium on "Human and climate forcing of zooplankton populations" (co-sponsored by PICES, ICES and GLOBEC), May 28 - June 1, 2007, Hiroshima, Japan
- PICES/ICES Young Scientists Conference, summer 2007, venue TBD
- PICES XVI, September 28-October 7, 2007, Victoria, Canada
- A series of workshops to update the PICES North Pacific Ecosystem Status Report, in 2006-2007

Erratum

PICES Press Vol. 13(1), January 2005, "CO_2 data integration activity for the North Pacific"

On page 30 of this article, the bio for Dr. Sachiko Oguma should have stated that she received her Ph.D. from Tohoku University. We express our sincere apologies for the error.

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