Major Outcomes from the 2008 PICES Annual Meeting: A Note from the Chairman

The Seventeenth Annual Meeting of PICES was held from October 23 to November 2, 2008, under the theme "*Beyond observations to achieving understanding and forecasting in changing North Pacific: Forward to the FUTURE*". About 400 scientists and administrators from 16 countries and several organizations attended this meeting, which was hosted by the State Oceanic Administration of the People's Republic of China in Dalian, a beautiful seaside city with a great deal of exotic atmosphere. With the expansion of PICES' activities, tight collaboration with non-member countries and other organizations and programs, efficient administration and alternation of generations of scientists have been essential for the sustained development of the Organization.

Cooperation with non-member countries

Scientific cooperation with non-member countries and other international organizations is crucial for extending the activity of PICES, and has been an important subject of discussion in Council, especially because many of the issues addressed by PICES are not unique to the North Pacific. At the 2006 Annual Meeting (Yokohama, Japan) a Study Group on *Scientific Cooperation between PICES and Non-member Countries* (SG-SC) was established to explore options on how scientific cooperation with other (non-member) countries could be best achieved. A draft SG-SC report was presented at the 2007 inter-sessional Science Board/Governing Council meeting (Yokohama), and a final report was given and adopted by Council at the 2007 Annual Meeting (Victoria, Canada). The Study Group was unanimously negative to the idea of amending the PICES Convention to expand the "area concerned". However, recognizing the scientific necessity and advantages of cooperating with non-member countries, it was proposed that an affiliate member status be established by PICES, similar to the arrangement implemented some time ago by ICES. A draft *Affiliate Member Policy* was extensively discussed at the 2007 Annual Meeting, but Council was unable to reach consensus on the adoption of the document.

In Dalian, Council went back to the basics of this discussion, and agreed with an alternative option—to amend the PICES Rules of Procedure (ROP) in order to accommodate experts from non-member countries and/or other organizations to our expert groups. The current ROP already has a clause that allows representatives of other organizations and non-member countries, with the endorsement of the Science Board and approval of the Council, to become *ex-officio* members of an Advisory Panel. We considered applying similar clauses to other subsidiary bodies of our Standing Committees. An amended ROP will be tabled for discussion at the next inter-sessional Science Board/Governing Council meeting

Participants at the 2008 Governing Council meeting in Dalian: (front row, left to right) – Yukimasa Ishida, George Boehlert, Doan Jeong, Zhanhai Zhang, Laura Richards, Tokio Wada and Lev Bocharov; (back row, from left to right) – Jeonghwa Kim, Baoying Zhu, Handi Guo, Igor Shevchenko, Sik Huh, Serge Labonté, Yingren Li, Patricia Livingston, Harumi Yamada, Elizabeth Tirpak, Samuel Pooley, Oleg Katugin, Alexander Bychkov, Gongke Tan and Dongmei Tang.

(April 2009, Qingdao, China) and/or at the 2009 Annual Meeting (October 2009, Jeju, Korea). These amendments should allow the recruitment of essential experts to our activities from outside of the PICES member countries, and thus to contribute to further development of our Organization.

Scientific priorities and outcomes

With the expansion of PICES' activities, expectations from Contracting Parties on the scientific outcomes have been increasing year by year. The North Pacific Ecosystem Status Report (NPESR) is an example of an important outcome. The pilot report titled *Marine Ecosystems of the North Pacific* was published in 2004 (PICES Special Publication No. 2), based on the scientific results from the PICES-GLOBEC Climate Change and Carrying Capacity (CCCC) Program, the first integrative scientific program of PICES. This report provided a status of the ecosystems of coastal and oceanic regions throughout the North Pacific, approximately covering the 5-year period from 1998–2002, and addressing system components from climate and hydrography to fish, birds and mammals. The document was regarded as a useful and timely one for policy making by Contracting Parties. The preparation of the next NPESR, with focus on status and trends in marine ecosystems of the North Pacific and its marginal seas for the period 2003–2008, has just started under the direction of the Science Board. Publication of a report for a scientific audience and a brochure for policy makers, managers, and other interested members of society, is expected in 2010.

FUTURE, an acronym for **F**orecasting and **U**nderstanding of **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems, is the second integrative scientific program of PICES, and it will be the highest priority activity for the next decade. The FUTURE Science Plan was approved in principle by Council at the 2007 Annual Meeting, and its final version has been posted on the PICES website in February 2008 (http://pices.int/members/scientific_programs/FUTURE/FUTURE_final_2008.pdf). The Implementation Plan is now under development, with a goal of initiating the program in 2009. As a successor of the CCCC Program, FUTURE aims to understand the responses of North Pacific marine ecosystems to climate change. At the same time, FUTURE has some new aspects. It will evaluate the human dimensions of ecosystem dynamics and improve the communication of scientific results to policy makers and stakeholders. These are the outcomes expected by Contracting Parties. Council has also been paying great attention to linkages between our scientific outcomes and the ocean management policies of our Contracting Parties. Council, in consultation with Science Board, will advise FUTURE on the direction of its scientific progress and well-timed feedback of its outcomes.

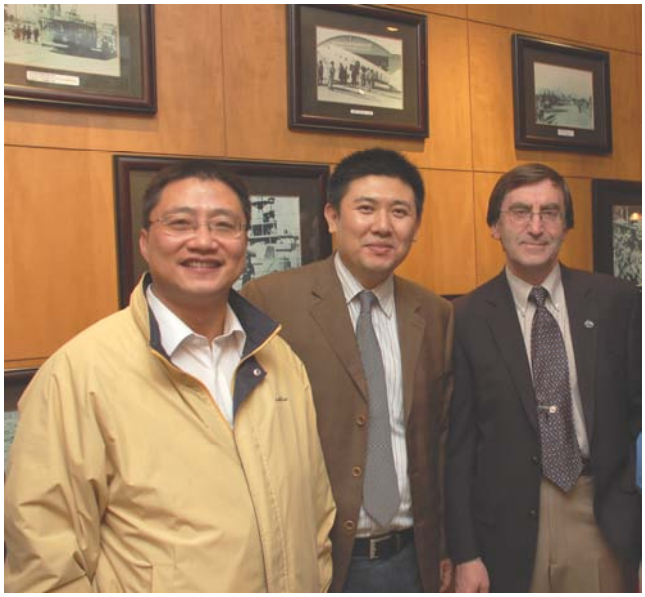
Capacity building

Encouraging the involvement of young talents in marine scientific research and activities of PICES is an issue of great importance for the Organization. Holding special conferences, summer schools and training courses for early career scientists, and providing financial support for their participation in our Annual Meetings and symposia, are essential components of PICES' strategy for capacity building. Participating in these events will allow young individuals not only to broaden their knowledge and to share their ideas, but also to interact with scientists from other nations and to build networks across disciplines and international borders that will persist for decades.

The PICES Intern Program, commenced in 2000, aims at the professional development of marine scientists and managers from PICES member countries. By working in the PICES Secretariat for periods of up to 12 months, they

gain experience in the operations of intergovernmental scientific organizations and the coordination of multi-disciplinary international ecosystem research programs.

At this year's Annual Meeting, two former PICES interns from the State Oceanic Administration, Gongke Tan (First Institute of Oceanography) and Chuanlin Huo (National Marine Environmental Monitoring Center), were the nucleus of the Local Organizing Committee and contributed greatly to the success of the meeting. It is an indicator that our Intern Program is working effectively!



Former PICES interns, Gongke Tan (left) and Chuanlin Huo (centre), with Dr. Alexander Bychkov, PICES Executive Secretary (right) at the Chairman's Reception in Dalian.

Restructuring of the PICES Annual Meeting

Under the current severe economic conditions, we must find an appropriate way to adjust our activities to fit within what can be allowed by the financial constraints of the Contracting Parties, and PICES itself. The Annual Meeting is our most important event, and the recent expansion of these meetings in scale and duration is evidence that PICES has become an internationally renowned scientific organization. However, this expansion has also been a burden for the host countries, participants, and the PICES Secretariat. Council discussed this issue and agreed to establish a Study Group on *Restructuring of the Annual Meeting* (SG-RAM) to consider ways of improving the time balance and order among various activities of the Annual Meeting, while also shortening its duration. Clarifying the responsibilities of the Science Board, Financial and Administration Committee, and Scientific and Technical Committees in the PICES decision-making process is viewed as a secondary task of this Study Group. The SG-RAM membership includes one representative from each Contracting Party, as well as the Chairman and Vice-Chairman of PICES, the Chairmen of Science Board and Finance and Administration Committee, and the Executive Secretary and Deputy Executive Secretary. It is expected that initial recommendations from SG-RAM will be discussed at the 2009 inter-sessional Governing Council meeting.

In keeping with the six-year rotation cycle, Council also confirmed host countries of next PICES Annual Meetings: the Republic of Korea (Jeju) in 2009, the United States in 2010, and the Russian Federation in 2011.

Elections

By consensus of Council, I and Dr. Lev Bocharov (Russia) were re-elected for a new 2-year term as the Chairman and Vice-Chairman of PICES, respectively. Dr. Laura Richards (Canada), the Chairperson of the Finance and Administration Committee, completed her second term and stepped down from the position at the conclusion of this year's Annual Meeting. Ms. Patricia Livingston (U.S.A.) was appointed as the new Chairperson. With Dr. John Stein, the Science Board Chairman, and Dr. Alexander Bychkov, Executive Secretary, we will do our best for the further development and smooth administration of the Organization. We would like to ask for your kind cooperation.

During this Annual Meeting, we suffered great sorrow at the sad news that Professor Warren Wooster, the principle founder and first Chairman of PICES, passed away at 87 years of age on October 29, 2008, in Seattle, U.S.A. He was a world renowned oceanographer who dedicated his life to the development of marine science and to the progress of international cooperation in this field. Without his great effort and distinguished leadership, PICES would not have been established, and we would never have got together to discuss the marine science of the North Pacific. It was a great loss for us and the world of marine science. I believe that the realization of the spirit of international scientific cooperation beyond borders is Warren's desire, and PICES is his legacy for us. I would like to sincerely pay my last respects to Professor Wooster, along with the PICES community.

Tokio Wada
Chairman of PICES
E-mail: wadat@affrc.go.jp

PICES Science – 2008

Highlights of scientific activities and publications

Since our 2007 Annual Meeting in Victoria, Canada, the PICES community has been very active scientifically. We co-organized and participated in major international symposia, convened meetings of PICES expert groups and held joint theme sessions and workshops with other organizations and programs, such as the International Council for the Exploration of the Seas (ICES), Intergovernmental Oceanographic Commission (IOC) and GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas (ESSAS). Below, I highlight key events for 2008.

PICES was involved in several major international symposia during the spring and summer of 2008:

- In May, an International Symposium on "*Effects of climate change on the world's oceans*" was organized in Gijón, Spain, with PICES, ICES and IOC as primary international sponsors;
- In July, PICES co-sponsored an International Symposium on "*Coping with global change in marine social-ecological systems*" in Rome, Italy (co-organized by GLOBEC, EUR-OCEANS and FAO);
- In August, a PICES/ICES/GLOBEC International Symposium on "*Herring: Linking biology, ecology and status of populations in the context of changing environments*" was held in Galway, Ireland.

Other joint events included:

- In April, an ICES/PICES workshop on "*Environmental interactions of mariculture*" held in Victoria, Canada, resulting in a proposal to establish a new PICES Working Group on *Environmental Interactions of Marine Aquaculture* (approved in 2008);
- In September, workshops on "*Model comparisons of the ESSAS regions*" and "*IPCC modeling and down-scaling atmosphere to advection*" co-convened at the ESSAS Annual Meeting in Halifax, Canada;
- In September, joint Theme Sessions on "*Coupled physical and biological models: Parameterization, validation, and applications*", "*Marine spatial planning in support of integrated management – tools, methods, and approaches*", and "*New methodology for tracking fish, mammals, and seabird behaviour and migrations*" held at the ICES Annual Science Conference in Halifax, Canada;
- In October, a PICES/ICES Theme Session on "*The effects of ocean acidification on fisheries and ecosystems*" convened at the International Symposium on "*The ocean in a high CO_2 world – II*" organized by SCOR, IOC, IAEA and IGBP in Monaco.

PICES expert groups also organized several workshops:

- In February, WG 19 on *Ecosystem-based Management Science and its Application to the North Pacific* met in Seattle, U.S.A., to discuss the structure and timelines of their final report;
- In March, WG 21 on *Non-indigenous Aquatic Species* held a workshop in Busan, Korea, to evaluate the protocols and reach final agreement on standards, data elements and data entry templates for the Marine Invasive Species Database;
- In April, CFAME had a workshop on "*Linking and visualizing climate forcing and marine ecosystem changes: A comparative approach*" in Honolulu, U.S.A.;
- Also in April, a workshop was convened in Seattle, (U.S.A.) to develop an Implementation Plan for the new PICES scientific program, FUTURE;
- In August, the 4th PICES Workshop on "*The Okhotsk Sea and adjacent waters*" was held in Abashiri, Japan.

Participants at the 2008 Science Board meeting in Dalian: (front row, left to right) – Sinjae Yoo (Vice-Chairman), Harold Batchelder (CCCC), John Stein (Chairman), Michio Kishi (CCCC) and Gordon Kruse (FIS); (back row, from left to right) – Hiroya Sugisaki (MONITOR), Fangli Qiao (China), Mikhail Stepanenko (FIS), Michael Foreman (POC), Michael Dagg (BIO), Glen Jamieson (MEQ), Bernard Megrey (TCODE) and Skip McKinnell (Secretariat).

It was another good year for publishing PICES science from our collaborative and coordinated research on the North Pacific and on key global issues. Selected papers were published from the:

- Topic Session on "*The human dimensions of jellyfish blooms*" at the 2006 PICES Annual Meeting as a special issue of *Plankton and Benthos Research* (Vol. 3, Supp.) in March 2008 (Guest Editors: Hitoshi Iizumi and Haruto Ishii);
- 4th International ICES/PICES/GLOBEC Zooplankton Production Symposium (2007) on "*Human and climate forcing of zooplankton populations*" as a special issue of *ICES Journal of Marine Science* (Vol. 65, No. 3) in April 2008 (Guest Editors: Michael J. Dagg, Roger Harris, Shin-ichi Uye and Luis Valdés);
- PICES/GLOBEC Symposium on "*Climate variability and ecosystem impacts on the North Pacific: A basin-scale synthesis*" (2006) in a special issue of *Progress in Oceanography* (Vol. 77, Nos. 2–3) in June 2008 (Guest Editors: Harold P. Batchelder and Suam Kim);
- 5th International Conference on "*Marine bioinvasions*" (2007) as a special issue of *ICES Journal of Marine Science* (Vol. 65, No. 5) in July 2008 (Guest Editors: Judith A. Pederson and A.M.H. Blakeslee);
- International Conference on "*The Humboldt Current system: Climate, ocean dynamics, ecosystem processes, and fisheries*" (2006) as a special issue of *Progress in Oceanography* (Vol. 79, Nos. 2–3) in December 2008 (Guest Editors: Arnaud Bertrand, Renato Guevara-Carrasco, Pierre Soler, Jorge Csirke and Francisco Chavez).

Andrew Dickson, Christopher Sabine and James Christian served as editors of the "*Guide to best practices for ocean CO_2 measurements*", which appeared as a PICES Special Publication No. 3 in December 2007. This joint effort with the International Ocean Carbon Coordinated Project (IOCCP) and the Carbon Dioxide Information Analysis Center (CDIAC) was the first update in 13 years of the manual published by the U.S. Department of Energy (DOE) when the international ocean carbon community mounted the Global CO_2 Survey as part of the World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS). Finding ways to make comparable measurements and consistent data sets based on many individual national programs has become one of the highest priorities, and the Guide is receiving world-wide distribution. To increase the use of the Guide, volunteers are being sought to assist with its translations to languages other than English. Prof. Liqi Chen (State Oceanic Administration, China) will be translating the Guide for the Chinese community.

Two more volumes were published in the PICES Scientific Report Series:

- Hollowed, A., Beamish, R., Okey, T. and Schirripa, M. (Eds.). 2008. *Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish.* PICES Sci. Rep. No. 34, 101 pp.
- Beamish, R. (Ed.). 2008. *Impacts of Climate and Climate Change on the Key Species in the Fisheries in the North Pacific.* PICES Sci. Rep. No. 35, 215 pp.

The PICES North Pacific Ecosystem Status Report (PICES Special Publication No. 1) was also acknowledged in 2008 with the Merit Award for the category "Books – Complete Design" from the Society of Graphic Designers of Canada.

2008 PICES Annual Meeting

The Seventeenth Annual Meeting of PICES was held from October 23 to November 2, 2008, at the Kempinski Hotel in Dalian, People's Republic of China. The meeting was hosted by the State Oceanic Administration (SOA), in coordination with the PICES Secretariat. Local arrangements made by the National Marine Environmental Monitoring Center (NMEMC) of SOA ensured the success of the meeting.

A total of 390 scientists from 15 countries attended 14 sessions, 5 workshops and 24 meetings of the committees and expert groups, and presented 262 talks and 159 posters. A Topic Session on "*End-to-end food webs: Impacts of a changing ocean*" was held in cooperation with IMBER (Integrated Marine Biogeochemistry and Ecosystem Research), and workshops on "*Status of marine ecosystems in the sub-arctic and arctic seas – Preliminary results of IPY field monitoring in 2007 and 2008*" and "*Marine ecosystem model inter-comparisons*" were organized jointly with ESSAS. Representatives from more than 20 international and regional organizations and programs were present as observers, and participated in scientific activities and business meetings to further our collaborative relationships.

There was also some sad news, unfortunately. During the meeting we learned that Dr. Warren Wooster, the principle founder and first Chairman of PICES, had passed away. At the Closing Ceremony, Dr. Tokio Wada, PICES Chairman, asked for a moment of silence for the "father of PICES". Warren was an outstanding scientist, an energetic and persistent supporter of international science, and a mentor and inspiration to many scientists in PICES and around the world. His leadership, wisdom, and vision for PICES and marine science overall will be long remembered and greatly missed.

The theme of our Annual Meeting was "*Beyond Observations to Achieving Understanding and Forecasting in a Changing North Pacific: Forward to the FUTURE*", which was intended to further build on and support development of our next integrative scientific program – FUTURE (**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems). The keynote lecture in the Science Board Symposium was given by Dr. Fangli Qiao (First Institute of Oceanography, SOA) on "*Wave-tide-circulation coupled model: To improve the forecasting capability of FUTURE*". This talk highlighted the progress made recently to predict future

conditions of North Pacific marine ecosystems but also illustrated gaps in understanding that will require further research for forecasting future. The keynote lecture was followed by 6 invited presentations by Lawrence Hamilton (U.S.A.), Eitaro Wada (Japan), Icarus Allen (UK), Hiroaki Saito (Japan), George Sugihara (U.S.A.) and Paul Harrison (Canada/Hong Kong), interspersed with 7 contributed papers. The winner of the Science Board Award for the best presentation was Dr. Emanuele Di Lorenzo (U.S.A.) for his paper on "*North Pacific decadal variability in the future*", co-authored by J. Furtado and N. Schneider.

Congratulations are also in order for the recipients of the best presentation awards given by the Standing Committees and the CCCC (Climate Change and Carrying Capacity) Program. The awards for best oral presentations are given to scientists early in their career, and the recipients were: BIO – Tomonori Isada (Japan), FIS – Anastasia M. Khrustaleva (Russia), MEQ – Shang Chen (China), MONITOR – Kohei Mizobata (Japan), POC – Chuanyu Liu (China), TCODE – Hao Ma (China) and CCCC – Xunqiang Yin (China). There are also awards for best posters which are open to all presenters, and were given to: BIO – Russell Bradley (U.S.A.), FIS – Chiyuki Sassa (Japan), MEQ – Yubo Liang (China), MONITOR – Hongli Fu (China), POC – Masatoshi Sato (Japan), TCODE – In-Seong Han (Korea) and CCCC – Yasumasa Miyazawa (Japan).

It is also important to acknowledge service to PICES and changes in leadership. At this Annual Meeting we thanked Dr. Gordon Kruse (U.S.A.) for his leadership of the Fishery Science Committee (FIS) since 2005, and welcomed Dr. Mikhail Stepenanko (Russia) as the next Chairman of FIS (see p. 44 of this newsletter for his brief biography). We also acknowledged the service of Drs. Harold Batchelder and Michio Kishi as Co-Chairmen of the CCCC Program, the first major science program of PICES. This had special significance because it was the last formal meeting of the CCCC Program.

For details on the Wooster Award and POMA recipients, refer to the 2008 PICES Awards article in this issue.

FUTURE – progress and next steps

A major focus at this Annual Meeting was further development and implementation of FUTURE. At the 2008 inter-sessional Science Board meeting in April, a Writing Team to develop the Implementation Plan for FUTURE was established, with James Overland (U.S.A.) and Hiroaki Saito (Japan) as Co-Chairmen. Between the inter-sessional meeting and the Annual Meeting, a first draft of the Implementation Plan was prepared and made available to the PICES community for their review and comments. In Dalian, the Writing Team and Science Board met in the evening of October 28 to discuss this draft. An Open Forum was also held at the Annual Meeting on October 30, where the Co-Chairmen presented their progress and comments were received. There was a good and lively discussion with the broader PICES community. This type of meeting proved to be very useful for refining the scope and direction of implementation of FUTURE. Discussions revolved around issues such as: (1) what we mean by clients; (2) are we ready as an organization to take on operational forecasts, and how do we balance the work on developing forecasts; and (3) the need to improve our understanding of the physics to ecological interactions, and research to uncover the mechanisms in all of these areas that are essential if we are to develop and improve forecasts that have reduced uncertainty. In addition, it was pointed out that in FUTURE we have highlighted two areas for increased or new emphasis: coastal processes and the associated anthropogenic forcings, and the human dimension. We cannot lose sight of this objective and need to be explicit on these topics in the Implementation Plan. There were comments on the scope of FUTURE, and that while it is only one slice of the science of PICES and should be focused, it is also our next major scientific program and should be structured to be appealing to all of the science elements within the Organization. There was agreement that the Writing Team should look to a phased approach in implementing FUTURE, and that we will re-visit the Implementation Plan in 3–5 years to review the progress and make adjustments if needed. In summary, in the next draft of the Implementation Plan, the focus will be on clearly defining the terms we are using, providing much more detail on the specific tasks, highlighting that there is a major component in FUTURE intended to improve our understanding of processes and mechanisms, and defining the structure of FUTURE and the responsibilities of the Standing Committees in delivering the tasks. It is important that these Committees be fully engaged with this effort to help ensure that all of the scientific capabilities within the Organization are contributing. Determining how the Committees and Science Board are to be specifically involved in carrying out FUTURE will be a major consideration in developing the next draft.

A well-attended FUTURE Open Forum in Dalian.

The goal is to have a final draft of the Implementation Plan ready for approval by the Governing Council at their inter-sessional meeting in April 2009.

North Pacific Ecosystem Status Report

Another high priority project for PICES is the production of a second North Pacific Ecosystem Status Report (NPESR).

This report will focus on the status and trends in marine ecosystems of the North Pacific and its marginal seas for the period 2003–2008. Co-editors of the report, Drs. Skip McKinnell (PICES Secretariat) and Michael Dagg (BIO Chairman), lead authors and disciplinary advisors (an Advisory Group has been established to provide disciplinary oversight of the report's development) met in Dalian to review what was learned in developing the first NPESR (2004), and how improvements and enhancements could be made. Discussion focused on revisions to the structure of the report, the time period of interest for this edition, tasks and responsibilities of lead authors and advisors, and a future 3-day workshop to develop a synthesis chapter of the report. Publication of the report for a scientific audience and a brochure for policy makers, managers, and other interested members of society is expected in the first half of 2010. This report is a major product of PICES and, if you are asked to participate in developing a chapter or to provide data, I encourage you to give the request the attention it deserves, as we want the second NPESR to build on the success of the inaugural edition.

Capacity building

Building capacity in the PICES member countries and in other Pacific Rim countries is a key strategic objective for the Organization. In August 2008 in Hakodate (Japan), we held the second PICES Summer School on marine sciences on "*Ecosystem-based management and ecosystem approach*" that was a great success. This year, we also provided travel support for early career scientists to attend the PICES Annual Meeting and other PICES-sponsored symposia to give them the opportunity to present their science at international meetings and begin to build international connections with early career scientists from other nations.

A new area of capacity building for PICES is the enhancement of monitoring programs that may mitigate the expansion of harmful organisms and will establish a free exchange of information about harmful algal blooms (HABs) in the Pacific Rim. Recent increases in HAB events have caused damage to fisheries and disturbance of ecosystems in the North Pacific and areas to the south. In order to minimize the impact and expansion of harmful organisms and lower the occurrence of damage to fisheries, a first step is building capacity in developing nations through focused training. In this effort, which is funded by the Ministry of Agriculture, Forestry and Fisheries of Japan, through the Fisheries Agency of Japan, PICES has partnered with IOC to determine which countries have the greatest need and a strong interest in improving HAB monitoring and testing, and a commitment to sustainability. Site visits to labs in Vietnam and the Philippines, as well as participation in the 2nd Asian GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) conference in January 2008 (Nha Trang, Vietnam), and the 7th WESTPAC Scientific Symposium in May 2008 (Sabah, Malaysia), facilitated country selection. The initial training course will occur in January 2009 and will focus on assisting the Bureau of Fisheries and Aquatic Resources (BFAR), which is the agency that manages HAB events in the Philippines. This project is being led by our Section on *Harmful Algal Blooms*.

Looking ahead

The next year is looking to be scientifically as fruitful and productive as 2008. PICES will be expanding co-operation with other international organizations, such as ICES, IOC, IMBER and NOWPAP. The areas of partnership include joint scientific sessions and working group activities, and a common database. To highlight such activities, PICES will be one of the co-sponsors for the 3rd GLOBEC Open Science Meeting (June 22–26, 2009, in Victoria, Canada). PICES will also co-sponsor the 6th International Conference on "*Marine Bioinvasions*" (August 24–27, 2009, in Portland, Oregon, U.S.A.), with ICES, the U.S. Sea Grant, Pacific States Marine Fisheries Commission, and Portland State University, and the international symposium on "*Rebuilding depleted fish stocks: Biology, ecology, social science and management strategies*" (November 3–6, 2009, in Warnemünde, Germany), with ICES and UNCOVER. To continue capacity building, a 3rd PICES Summer School on "*Satellite oceanography*" is scheduled for August 2009, in Seoul Korea. This school will coincide with the launch by Korea of the first geostationary ocean color satellite.

Our next Annual Meeting, PICES–2009, will be held from October 23 to November 1, on beautiful Jeju Island, Korea, under the theme "*Understanding ecosystem dynamics and pursuing ecosystem approaches to management*". Science Board has selected and approved many sessions and workshops that should be of great interest to PICES and the broader scientific community. Planning was also initiated for PICES–2010 to be held in the United States, under the theme "*North Pacific ecosystems today, and challenges in understanding and forecasting change*".

To close, it has been a busy and productive first year for me as the Chairman of the PICES Science Board, and I enjoyed working with, and meeting even more of, my fellow 'PICESians'. I look forward to much success in 2009, as together, in the collaborative spirit of PICES, we work to complete the Implementation Plan and launch FUTURE, make good progress on the second NPESR, and continue to do our part to help train and mentor the next generation of marine scientists active in the North Pacific.

John Stein
PICES Science Board
Chairman
E-mail: John.E.Stein@noaa.gov

2008 PICES Awards

The presentation ceremony for two prestigious PICES awards took place on October 27, 2008, during the Opening Session of the PICES Seventeenth Annual Meeting in Dalian, China.

In 2000, PICES established an award in honour of Dr. Warren S. Wooster, the principal founder and the first Chairman of PICES, a world renowned researcher and statesman in the area of climate variability and fisheries production, and an ambassador of international scientific cooperation. The award is to be given annually to an individual who has made significant scientific contributions to North Pacific marine science; has achieved sustained excellence in research, teaching, administration or a combination of these in the area of the North Pacific; has worked to integrate the various disciplines of the marine sciences; and preferably someone who is or has been active in PICES (award description, nomination process and selection criteria are posted on the PICES website at http://www.pices.int/Wooster_Award/default.aspx). Prior recipients of the Wooster Award are Michael Mullin (2001), Yutaka Nagata (2002), William Pearcy (2003), Paul LeBlond (2004), Daniel Ware (2005), Makoto Kashiwai (2006) and Kenneth Denman (2007).

In Dalian, Dr. John Stein, PICES Science Board Chairman, announced that the Wooster Award recipient for 2008 was Dr. Charles B. Miller (Oregon State University, U.S.A.), a nationally and internationally distinguished biological oceanographer specializing in studies of zooplankton. The citation presented by Dr. Stein is included in the 2008 PICES Annual Report (http://www.pices.int/publications/annual_reports/Ann_Rpt_08/2007%20OPENING_f.pdf), and major steps of Dr. Miller's career can be found in his selected biography published in this issue of PICES Press. A commemorative plaque was given to Dr. Miller by Dr. Tokio Wada, PICES Chairman, who also read the following tribute sent by Dr. Wooster:

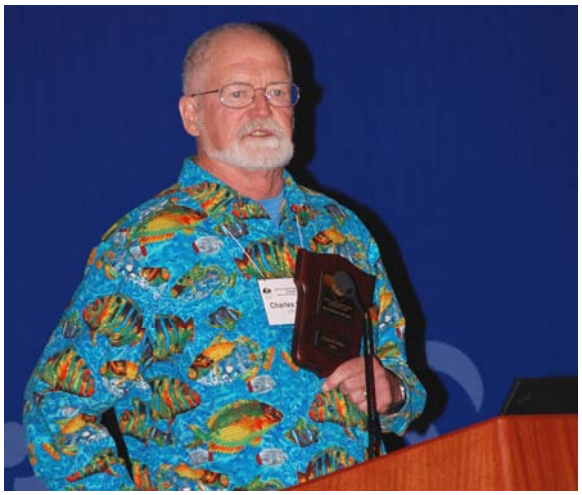
It is a pleasure to acknowledge selection of Charlie Miller to receive the 2008 Wooster Award. His contributions to understanding of zooplankton ecology in the northern North Pacific tie in beautifully with studies of physical changes in the ecosystem. Eventually predictions of these physical changes will lead to predictions of ecosystem changes, with all sorts of applications to fisheries and other problems of PICES concern. Monitoring the ecosystem with the Continuous Plankton Recorder (CPR) and studies in OECOS (Ocean Ecodynamics Comparison in the Subarctic Pacific), both of these involving Charlie Miller, are keys to understanding ecosystems of the region. This work has often made me wish I had chosen zooplankton ecology as the field in which to specialize – too late for me but not too late to appreciate the contributions of Charlie and his colleagues. Congratulations to him for his major contributions to PICES projects in this field.

Very sadly, this was the last public statement by Dr. Wooster who passed way two days later on October 29, 2008, in Seattle, U.S.A. He had influenced generations of scientists and his legacy and spirit will live on in PICES.

After the Annual Meeting, Dr. Miller sent the following note to the PICES Secretariat:

I have always been dubious of awards in science, because so many who deserve them are never recognized. I am still dubious, but getting the Wooster Award is very gratifying, and I thank PICES for it.

Receiving the Wooster Award at this time comes with some sadness because Warren Wooster died just as I was being honored in Dalian. Warren called many times with PICES tasks for me, and I always said "no". I always ended up doing whatever he asked. That was one of Warren's many gifts: he could turn "no" into "yes" with his magical



Dr. Warren S. Wooster, the principal founder and first Chairman of PICES (left), and Dr. Charles B. Miller, the recipient of the 2008 Wooster Award (right).

powers. Forty-five years ago, he and Polly were very kind to the graduate students at Scripps, offering me and others the initial social outreach from the faculty to newcomers. It was a warm touch of humanity in a ferociously competitive place and never forgotten. Warren's shift in interest from marine chemistry and physics to fisheries and ocean policy has been of great benefit to ICES, PICES, the University of Washington and every aspect of our concern for the ocean. We will miss him personally, but his lasting gifts to us will carry his spirit onward.

Very few work at science alone. I cannot thank everyone here who has pursued ocean ecology with me; I made a list of my more important associates and it came out around eighty! However, I have been especially fortunate in working down the years with Bruce Frost, John McGowan, Peter Wiebe, William Fager, Abe Fleminger, William Peterson, Martha Clemons, Harold Batchelder, Patricia Wheeler and Tim Cowles (in order of appearance in my life). Thanks to them and everyone studying life in the oceans. Keep going, there is much yet to be learned.

Top row, left to right: the Oshoro-maru I as a 31-m wooden brigantine built in 1909, the Oshoro-maru II as a 42-m steel barkentine built in 1927, and the Oshoro-maru III as a 67-m 1,180-ton stern trawler built in 1962; bottom row: the Oshoro-maru IV as a 73-m 1,383 t stern trawler built in 1984, and the 2008 POMA presentation ceremony (Dr. John Stein on the left, Dr. Tokio Wada in the centre and Dr. Akihiko Hara on the right).

The PICES Ocean Monitoring Service Award (POMA) was established in 2007 to recognize organizations, groups and outstanding individuals that have contributed significantly to the advancement of marine science in the North Pacific through long-term ocean monitoring and data management (award description, nomination process and selection criteria are posted at http://www.pices.int/awards/POMA_award/POMA_award.aspx). At the presentation ceremony, Dr. Stein introduced POMA and announced that the very first award was unanimously voted to be given to the training ship T/S *Oshoro-maru* of Hokkaido University, Japan.

The observations made aboard T/S *Oshoro-maru* have contributed to the rapid progress of marine science in the region. The annual summer cruises since 1955 have allowed long-term ecosystem observations, and have advanced cooperative research among PICES countries. The data collected during T/S *Oshoro-maru* cruises are invaluable for addressing current scientific problems of the North Pacific. More than 250 scientific papers have been published using these data. For a brief history of the ship, refer to the PICES Press article by John Bower published in 2001 (Vol. 9, No. 1).

After Dr. Stein quoted the Science Board citation (included in the 2008 PICES Annual Report (http://www.pices.int/publications/annual_reports/Ann_Rpt_08/2007%20OPENING_f.pdf), Dr. Wada presented a commemorative plaque and a certificate to the representative of the recipient, Dr. Akihiko Hara (Dean, Graduate School of Fisheries Sciences, Hokkaido University), who accepted the award with remarks of appreciation.

We congratulate Dr. Charles Miller and T/S *Oshoro-maru*, respectively, as recipients of the Wooster Award and POMA for 2008.

Charles B. Miller – A Selective Biography

by Harold P. Batchelder and William T. Peterson

Professor Charles (Charlie) B. Miller has been described by his oceanographic colleagues at various times as smart, thoughtful and insightful, by his friends as concerned for the good of mankind, by his students as a terrific and demanding mentor, by some as curmudgeonly and by some as intimidating, but by all as Charlie. Charlie grew up far from the ocean in Minnesota, raised by a grammar-correcting English teacher and a physician to whom "thinking scientifically" was a religious tenet. A high point of his life was being drum major of his high school band. He attended Carleton College in Northfield, Minnesota, graduating in 1963 with an academic record including, among other low points, a D in German. But, he was very good at Graduate Record Examination tests, which got him into graduate school. Charlie's interest in marine biology and biological oceanography was stimulated by a summer course at the University of the Pacific's marine station at Tomales Bay, taught by Joel Hedgpeth and Jefferson Gonor. Diverted from medical school by this experience, he enrolled in a Ph.D. program at the Scripps Institution of Oceanography. Scripps in the 1960s was the pre-eminent place in the U.S. for graduate work in Oceanography. Charlie studied with John McGowan, who taught his bevy of grad students that to learn about the ocean, one must go to sea, go frequently and go over sustained periods. Other particularly influential mentors while Charlie was at Scripps were William Fager, Abraham Fleminger and Edward Brinton.

After receiving his Ph.D. in 1969, Charlie spent a year in New Zealand as a National Science Foundation fellow, working with Prof. R. Morrison Cassie. In 1970, Charlie started work as an Assistant Professor at Oregon State University (OSU), landing in an office that he continues to occupy daily as an emeritus professor of Oceanography. While Charlie has enjoyed work as a visitor at several institutions (Woods Hole Oceanographic Institution, Scripps, Station Zoologique in Villefranche-sur-Mer, the Ocean Research Institute in Tokyo and University of Maine), he has maintained his interests in the zooplankton ecology and processes in Oregon's coastal ocean and the oceanic subarctic Pacific.

Charlie's early career at OSU was marked by research on the composition of mesozooplankton in the Oregon coastal upwelling region, in collaboration with OSU faculty members, Bill Pearcy and Jeff Gonor. It provided research opportunities and training for post-docs and technicians like Sally Richardson and Bill Peterson, and for several students (such as Peter Rothlisberg and Gregory Lough). Key papers from the early Oregon work included recognition of the strong seasonality in zooplankton species composition caused by the reversals of alongshore currents between north and south, descriptions of zooplankton community composition variation in space and time, and some suggestions of mechanisms by which zooplankton species maintain populations in upwelling zones in the face of offshore transport (Peterson and Miller, 1976; Peterson *et al*., 1979).

To understand the ecology of marine zooplankton, Charlie believes there is no substitute for knowing your organism, which means observing the morphology, behavior and ecology of species. Charlie's observations of zooplankton led to (1) detailed discoveries about how siliceous copepod teeth are formed and the use of tooth-development staging to determine the phase of copepodites within their molt cycle, as well as results from more traditional incubation-based methods to quantify development rates (Miller *et al*. 1980; Miller *et al*. 1984; Miller *et al*., 1990; Miller and Tande, 1993; Aksnes *et al*. 1997; Crain and Miller, 2001); (2) description of growth rules for copepods (work done with his Ph.D. student Ken Johnson; Miller *et al*., 1977), (3) detailed studies of the phenology and life history of several dominant subarctic oceanic copepods and chaetognaths (done with many colleagues, but most notably Bruce Frost, Hal Batchelder, Martha Clemons, Richard Conway and Makoto Terazaki) and (4) copepod sex determination and mating behavior (Tsuda and Miller, 1998; Crain and Miller, 2000; Miller *et al*., 2005).

In the late 1970s, Charlie and Bruce Frost of the University of Washington realized that the Canadian Ocean Weather-ship program that had been ongoing at Station PAPA in the eastern subarctic Pacific was nearing an end, as the primary function of ships collecting weather data were being replaced by satellite observations. Since 1956, vertical plankton hauls had been conducted from the ships one to several times per week. They realized that the weatherships provided a platform for frequent depth-stratified sampling of plankton both day and night, and that it would take a year of very deep sampling to get adequate data to describe the life histories of the large, ontogenetically migrating copepods of the region. With funding from the National Science Foundation (NSF) and the cooperation of the Canadian Coast Guard and Institute of Ocean Sciences, Charlie initiated weekly sampling of plankton communities at Station PAPA in early 1980. The plankton sampling was done by three technical workers: Richard Conway, Martha Clemons and Hal Batchelder. Sampling continued until the final weathership cruise in June 1981, providing a 1.5-year time series with *ca*. weekly sampling of the water column from the surface to 2000 meters. At the time, and perhaps to this day, this sample set was the best long-term, vertically resolved time series of zooplankton from a deep ocean site. Several significant papers (Miller and Clemons, 1984; Miller *et al*. 1984; Terazaki and Miller, 1986) resulted directly from these collections. Three other

significant events are associated with this sampling at Station PAPA. First, it sowed the seeds for future big-program interdisciplinary ocean research to understand the spring–summertime dynamics of the planktonic ecosystem in the subarctic oceanic Pacific (SUbarctic Pacific Ecosystem Research, a.k.a. SUPER). Second, the project entrained a recent M.Sc. graduate student (Hal Batchelder) into the world of zooplankton ecology. Ultimately, Batchelder would complete a Ph.D., with Charlie as his advisor, that focused on the population dynamics and ecology of the subarctic Pacific copepod, *Metridia pacifica*. Finally, Martha Clemons, cribbage champion of weathership tournaments, later became Charlie's wife.

Professor Miller's leadership role in collaborative research to understand ecosystem ecological processes regulating plankton abundance and production in the open subarctic Pacific was critical to the success of project SUPER. Charlie was the organizing force, and the glue, that held together the pieces of the SUPER projects of the mid-1980s. SUPER was a large, multidisciplinary group of scientists that had a common goal: to understand the spring–summertime dynamics of the planktonic ecosystem of the eastern subarctic Pacific. In more recent terminology, the eastern subarctic is a High Nitrate, Low Chlorophyll (HNLC) region, and multiple hypotheses, including iron limitation, microzooplankton grazing capacity, and early-season macrograzing capacity provided by the unique life cycles of *Neocalanus*, were advanced to explain the lack of a spring phytoplankton bloom in this environment that experienced strong seasonal physical forcing. The SUPER team (including Hal Batchelder, Suzanne Strom, Thomas Powell, Nick Welshmeyer, Beatrice Booth, Pat Wheeler, Mike Dagg, Mike Landry, Dian Gifford and many others) went to sea for month-long cruises in spring and summer of 1984, 1986 and 1987 to examine these hypotheses. For some of these efforts, SUPER collaborated with Canadian investigators (Dave Mackas, Ken Denman and others) for multi-national, multi-vessel investigations of the eastern subarctic Pacific. A unique aspect of the SUPER research was the focus on examining the system in its entirety—from ocean hydro-dynamics and turbulence to nutrient–phytoplankton interactions to phytoplankton–microzooplankton–macro-zooplankton interactions. The research resulted in the SUPER synthesis (Miller *et al*., 1991), successfully modelled by Bruce Frost (1993), which was later called the "ecumenical iron hypothesis" by John Cullen (Cullen, 1995). That synthesis, which attributes the lack of bloom to both grazers and iron limitation, remains the right way to see the functioning of iron-limited HNLC systems. As part of the SUPER effort, Charlie discovered (it was probably recognized earlier by other investigators, but never documented) and described *Neocalanus flemingeri*, and wrote all of the early papers about the unusual life history of this important North Pacific copepod (Miller, 1988; Miller and Clemons, 1988; Miller and Nielsen, 1988; Miller and Terazaki, 1989).

Charlie (age 2) with his schoolteacher mother.

Charlie (age 10) riding "Smokey" during a stay in the Rocky Mountains.

Charlie speaking with Dr. Patricia Kremer at the SUPER planning workshop (1982), where the SUPER team was put together and which resulted in the funding of the first round of SUPER. Behind Pat, with back to camera, is 2007 Wooster Award winner, Dr. Kenneth Denman.

Charlie at sea (clockwise from top left): sampling with a Van Dorn Bottle in a more laissez-faire era—no hard hat, no PFD vest (1960); an equipment test cruise prior to the first SUPER cruise (1984); a cruise in Puget Sound, WA (2002); and a cruise to Dabob Bay, WA (2004).

Charlie's research on zooplankton and pelagic ecology in the oceanic subarctic Pacific spans more than 40 years—beginning with cruises while a graduate student at Scripps in the summer of 1964, his sampling at Station PAPA in the early 1970s, the time series sampling he initiated from the Canadian weatherships during their last year of Station PAPA operations, the large interdisciplinary research conducted as part of the SUPER programs of the 1980s, and continuing with his involvement in the PICES' OECOS planning and workshops.

Charlie has not restricted his research interests solely to North Pacific zooplankton. He has had a long-standing interest in understanding the phenology and population dynamics of *Calanus finmarchicus*, the dominant large copepod of most North Atlantic systems, work that he initiated with Helen Grigg in the UK during the late 1980s (Miller and Grigg, 1991; Miller *et al.*, 1991). This interest in *C. finmarchicus* continued in the U.S. GLOBEC Northwest Atlantic/Georges Bank system program in the 1990s, a large-group collaboration enabled by his long-time friend and colleague, Peter Wiebe of Woods Hole. This connection allowed Charlie to lead, with Kurt Tande of Norway, the Trans-Atlantic Studies of *C. finmarchicus* (TASC) program of ICES. This was a multinational effort, involving scientists from the United States, Canada, and many countries of the European Union, to complete an intensive, cross-regional comparison of a single species from many sites in the North Atlantic—all in one year—The year of *Calanus* in 1997. Of course, that turned out to be a realization of "Miller's Law": (in brief) *Big programs always operate in ecologically unusual years*. Several post-study workshops were held, co-chaired by Charlie, Roger Harris (UK) and Kurt Tande, and resulted in a TASC publication "Population Dynamics of *Calanus* in the North Atlantic" in the ICES *Journal of Marine Science*.

Charlie has provided extensive service at both national and international levels. Within the U.S., he has served on NSF review panels and on the Exxon Valdez Oil Spill Scientific and Technical Advisory Committee (2003–2005). In the 1980s, Charlie spent 6 years (2 years as Chairman) on the UNOLS (University–National Oceanographic Laboratory System) Advisory Council in the U.S. UNOLS is the

organization that provides both short- and long-term planning for the U.S. oceanographic research fleet.
Internationally, Charlie has contributed to the ICES Working Group on *Zooplankton Ecology*, to the ICES TASC effort (described above) and to several PICES activities. In the initial PICES years, he served on the MONITOR Task Team. In 2000, Warren Wooster and Mike Mullin asked him to chair the PICES Advisory Panel on *Continuous Plankton Recorder (CPR) Survey in the North Pacific*. In that role (continued until 2008), he served as an outside reviewer and supporter of the CPR work between Alaska and the U.S. West Coast, with the actual work sustained entirely by the program PIs, Sonia Batten of SAHFOS in the UK and David Welch of DFO, Canada. The PICES CPR program was eventually expanded to include up to three runs each year from Vancouver to Yokohama, passing through the western Bering Sea on a great circle track. A bird and mammal observer was placed on that run as well. Charlie, with Tom Ikeda (Japan), organized and continues to co-chair the PICES project titled Ocean Ecodynamics Comparison in the Subarctic Pacific (OECOS). The goal of this multinational (Japan, Canada and U.S.A.) project is a detailed and parallel comparison of plankton processes and dynamics of the western and eastern subarctic gyres during spring. The Japanese component was funded and conducted their investigations during spring 2007. Charlie co-convened (with Atsushi Yamaguchi) a workshop on OECOS-West results at the 2008 PICES Annual Meeting (see article in this issue of PICES Press).

Organizers of the PICES' OECOS project, Tom Ikeda and Charlie Miller, posing with a rooster-hat death mask.

Charlie's editorial contributions included several years of service on editorial boards of major journals: *Limnology and Oceanography* in the 1980s, *Plankton Biology and Ecology* of the Plankton Society of Japan (1996–2001), and *Progress in Oceanography* from 1983–2003. He served as Co-Editor-in-Chief of *Progress in Oceanography* from 2003–2006. Beyond these formal editorial roles, Charlie often reads, and rewrites into more standard English, manuscripts on marine plankton sent to him by authors (whose native language is not English) prior to submission of the paper to a journal for publication. This valuable service is rarely recognized in the ocean sciences community.

Charlie Miller advised (as major professor) 10 master and 12 Ph.D. students (including both co-authors of this biography). Charlie has served on the committees of other oceanography students, and has influenced most oceanography students passing through OSU in the past thirty-plus years.

Awards and honors bestowed upon Charlie include being a fellow of the American Association for the Advancement of Science, receiving the best presentation award at the 1997 ICES Annual Science Conference, and being the recipient of the Excellence in Mentoring (2001) and Excellence in Teaching awards (2003) from the College of Oceanic and Atmospheric Sciences at OSU. At the Third International Zooplankton Production Symposium in Gijon, Spain (May 2003), Charlie was invited by the symposium conveners to summarize the sense of the meeting—the progress in the field of zooplankton ecology.

Charlie retired from OSU a few years ago, but he can still be found occupying his office nearly every day. In the first years of his retirement he authored a textbook, *Biological Oceanography* (2004), which is widely used in graduate "core courses" across the U.S. and elsewhere. Bruce Frost, professor emeritus at the University of Washington, referred to the book as "a masterful synthesis of biological oceanography". At the same time, together with Hal Batchelder, Marnie Jo Zirbel and aided by Bruce Frost, Charlie completed a project estimating the mortality rates of *Calanus pacificus* eggs (before hatching) in Dabob Bay, WA. He promises us to publish the results very soon.

The 2007 Zooplankton Production Symposium in Hiroshima: Charlie with his daughter, Caroline, and wife, Martha Clemons, at the symposium dinner.

Charlie has two sons, Eric, a transportation planner, and Matthew, a magazine editor and poet, and a daughter, Carrie, a linguist, waitress and expert snow boarder. They are spread all over the U.S.: Bellevue (WA), Orlando (FL) and Steamboat Springs (CO). Charlie and Martha greatly enjoy visits near Seattle with their two grandchildren, Eric's kids. For the past five years or so, Charlie has been socially proactive within his local community in Oregon. In just the past few years he has organized community

Three generations of North Pacific zooplanktologists: on the left is Bill Peterson (Ph.D. student of Charlie Miller), on the right is Charlie Miller (Ph.D. student of John McGowan), and in the center is John McGowan. This photo is from the early 2000's on the occasion of McGowan's retirement.

Charlie and Hal Batchelder, his former Ph.D. student, at the Chairman's Reception of the 2008 PICES Annual Meeting in Dalian.

forums to inform the general public about pressing social issues—including, but not limited to, forums on health care issues, global warming and associated social changes, energy alternatives to oil, and war and peace issues. He doesn't just talk about these issues, he acts locally. He and Martha run their car on bio-diesel, and they installed both solar hot water and photovoltaic systems on the roof of their house in an effort to promote more sustainable energy use. In recent times, Charlie has volunteered at a homeless-men's shelter in Corvallis—a community attempt to keep homeless guys from hypothermia on cold, wet winter nights.

Clearly, our understanding of the functioning of the oceanic realm of the North Pacific has been advanced dramatically by Charlie Miller's ability to identify the big outstanding scientific issues (*e.g.*, the lack of blooms in subarctic HNLC regions), to formulate plans and assemble scientific teams to investigate the issues, and to carry the research through to synthesis and publication. Just as clear has been Charlie's role in the study of the phenology and life history of key zooplankton species in several ecosystems and ocean basins.

In summary, Charlie is an oceanographer, teacher and good citizen of planet Earth. He is an active leader in the field of zooplankton ecology and has made very significant contributions to understanding the ecosystem function of several pelagic ecosystems (Oregon coastal upwelling, oceanic subarctic Pacific, Georges Bank) and the life stories of planktonic animals. He has published some 60 papers on these topics. Charlie is also generous with his time to colleagues, students and the general public. Charlie is still intellectually challenging to those around him and full of creative energy. We (and he) hope he can keep it going for years to come.

We congratulate Professor Charles Miller as the recipient of the PICES Wooster Award for 2008.

[Interested readers could access the references cited in this article on the PICES website at http://www.pices.int/Wooster_Award/2008-Miller/miller_ref.pdf.]

Latest and Upcoming PICES Publications

- *Climate variability and ecosystem impacts on the North Pacific: A basin-scale synthesis* (Guest Editors: H. Batchelder and S. Kim). *Prog. Oceanogr.* 2008. Vol. 77, Nos. 2–3, pp. 83–268.
- *The northern Humboldt Current System: Ocean dynamics, ecosystem processes, and fisheries* (Guest Editors: A. Bertrand, R. Guevara-Carrasco, P. Soler, J. Csirke, F. Chavez). Prog. Oceanogr. 2008. Vol. 79, Nos. 2–4, pp. 95–412.
- Hollowed, A., Beamish, R., Okey, T. and Schirripa, M. (Eds.). 2008. *Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish.* PICES Sci. Rep. No. 34, 101 pp.
- Beamish, R. (Ed.). 2008. *Impacts of Climate and Climate Change on the Key Species in the Fisheries in the North Pacific.* PICES Sci. Rep. No. 35, 260 pp.
- Kashiwai, M. and Kantakov, G. (Eds.). 2009. *Proceedings of the Fourth PICES Workshop on the Okhotsk Sea and Adjacent Areas.* PICES Sci. Rep. 36.
- Jamieson, G., Livingston, P. and Zhang, C.-I. (Eds.). 2009. *Ecosystem-based management science and its application to the North Pacific* (PICES WG 19 final report), PICES Sci. Rep. No. 37.

2008 OECOS Workshop in Dalian

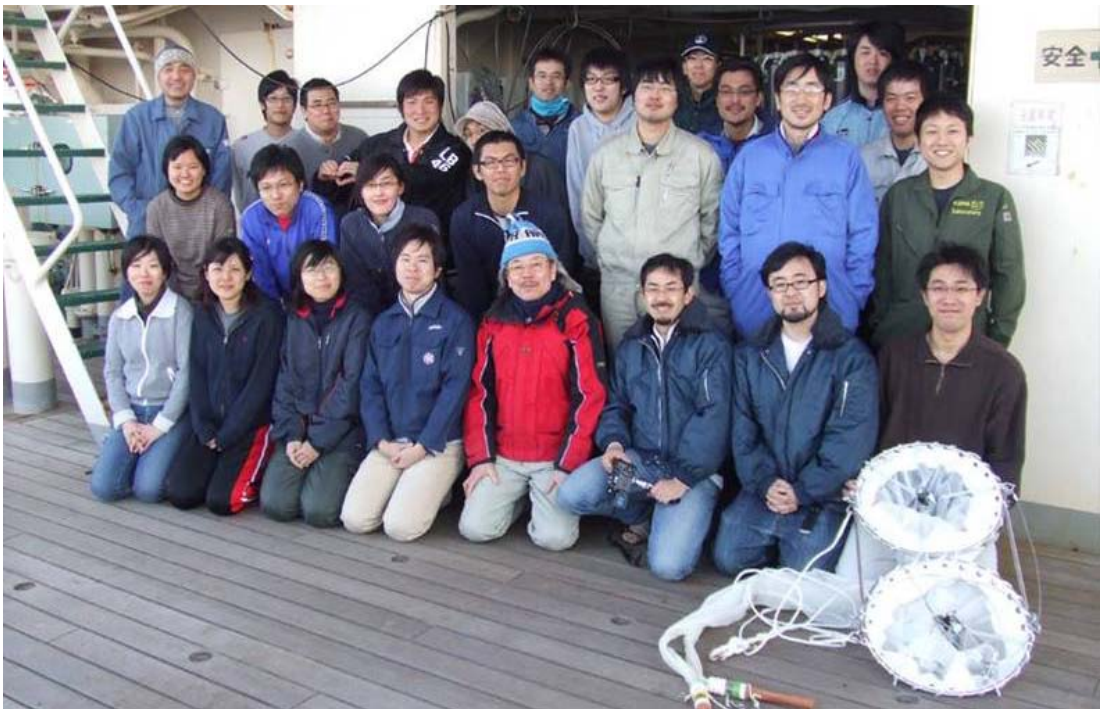
by Charles B. Miller

The 2008 PICES Annual Meeting in Dalian, China, included a 1-day workshop, held on October 26, for presentation and discussion of the Japanese OECOS expeditions in the Oyashio region during the spring bloom of 2007. OECOS is an acronym for **O**ceanic **E**codynamics **CO**mparison in the **S**ubarctic Pacific. It is a PICES program originally intending a comparison of processes in the Oyashio and in the oceanic Gulf of Alaska during the spring increase of phytoplankton production rates. These areas share similar mesozooplankton communities, particularly four species of interzonally migrating copepods. However, the Oyashio supports a strong spring bloom, while the Gulf of Alaska is consistently "HNLC" (High Nitrate, Low Chlorophyll) with continuously low chlorophyll levels, usually less than about 0.6 mg m^{-3}. The observational goals were spring time series in both areas, exceeding one month duration. A team from Japan, led by Professor Tsutomu Ikeda, obtained funding for the Oyashio work which was carried it out in March to May 2007. A North American team failed to convince government agencies to fund its proposal. The workshop was an opportunity for initial, international presentations of the Oyashio results and of some insights gained by the Gulf of Alaska workers from programs other than OECOS.

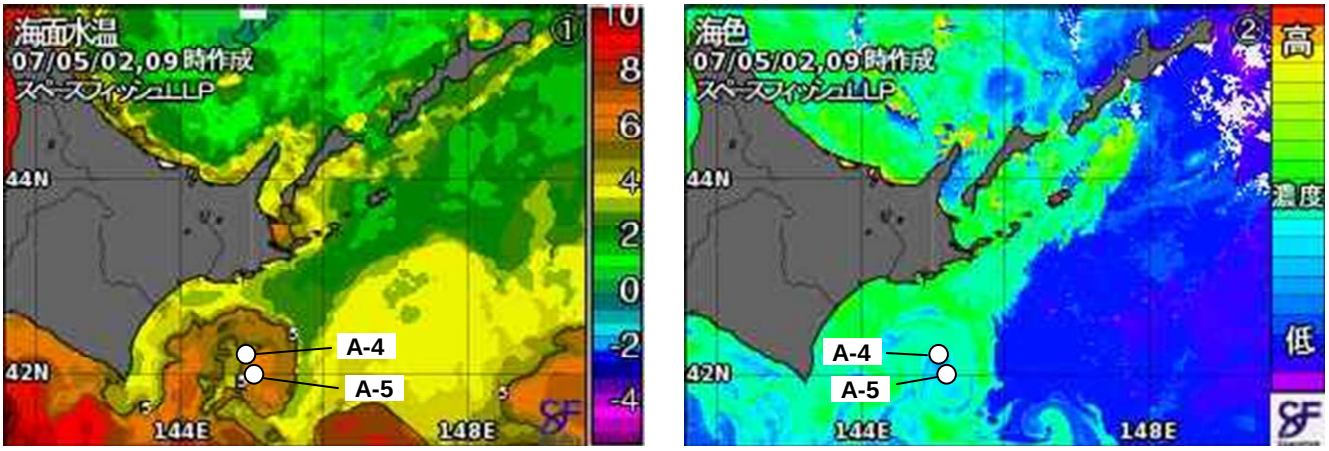
The workshop was chaired by Drs. Atsushi Yamaguchi (Graduate School of Fisheries, Hokkaido University) and Charles Miller (Oregon State University). Fortunately, all of the registered participants were able to attend the workshop. Affiliations of the presenters are listed in the meeting program. The workshop presentations can be summarized as follows:

Dr. Yamaguchi reviewed the history of the successful Japanese expeditions to the Oyashio region from March 8 to March 15, 2007 (onboard T/S *Oshoro Maru*) and from April 5 to May 1, 2007 (onboard R/V *Hakuho Maru*). He reported that the Japanese team of "OECOS–West" has held two conferences after the expeditions to discuss the results.

Dr. Tokihiro Kono described the hydrographic conditions during the cruises. Stations occupied were along the A-line extending southeast from Hokkaido's east coast, with much of the station work concentrated at station A-4. Frequent CTD casts during both cruises showed strongly shifting proportions of offshore Oyashio Water (OYW) – a northern influence, coastal Oyashio Water (COW) from over the Hokkaido shelf and modified Kuroshio Water (MKW) that appeared in satellite images as a Kuroshio loop or boundary eddy. MKW was most prevalent at station A-5, but mixtures of all three types were present throughout the April cruise. Highest chlorophyll concentrations were associated with greater proportions of COW. The importance of advective variation was evident in all variables (T, S, chlorophyll and other biology).



Group photo of 26 participants of the R/V Hakuho-Maru *cruise (April 5 to May 1, 2007). In front row: Prof. Tsutomu Ikeda in red jacket and Dr. Atsushi Yamaguchi holding the nets.*



Satellite images of temperature (left) and chlorophyll (right) during the OECOS cruises. Samplings were conducted at stations A-4 (42˚15'N, 145.07'E) and A-5 (42˚00'N, 145˚15'E) on the A-line. A warm water eddy can be seen at the stations. Chlorophyll peaked on April 9, 2007.

Dr. Kenshi Kuma reported measures of dissolved and total (including particulate) iron concentration. Dissolved iron values were remarkably similar between pre-bloom and bloom periods, 0.3–0.5 nM and 0.4–0.6 nM, respectively. However, total iron shifted sharply upward from the March values of 3–5 nM during strong, deep vertical mixing to 10–25 nM during the intrusions with highest chlorophyll (10–23 μg/l) in April. At stations along the A-line, iron supply appeared to vary with the sources of advection.

Dr. Tomonori Isada detailed the ambitious set of phytoplankton observations completed during the cruises. Flora in the bloom period was strongly dominated by diatoms, shifting from *Thalassiosira* species initially to *Chaetoceros* species. There were several species of each in the two successive bloom phases. Nano- and picophytoplankton became progressively more important toward the end of the cruise. There were signs in the physiology of diatoms (F_v/F_m and flavodoxin/ferrodoxin ratio) that iron stress was significant despite high total iron and abundant macronutrients.

Results of dilution experiments to measure phytoplankton growth and microzooplankton grazing rates were presented by Dr. Takashi Ota. Grazing rates were very low, mostly 5–15% of initial chlorophyll stock per day, or 10–30% of primary production. Phytoplankton growth rates were high during the events with highest chlorophyll stocks, up to 0.52 d^{-1}.

Dr. Yamaguchi described the time series sampling for mesozooplankton using three different net systems. Most of the *Neocalanus* stock was in the upper water column with no discernible vertical migration, while *Metridia pacifica* migrated in early April but stopped (except for C6-females) toward the end of the cruise, staying during night at the daytime depth. The reason was not clear. Developmental progression was obvious for *Neocalanus flemingeri* (C1–C4) and for *N. cristatus* (C2–C4). Only part of the *Eucalanus bungii* population migrated into surface layers at night, the females producing eggs near the surface. Spawning rates were determined for that species only.

Dr. Toru Kobari reported that gut content chlorophyll of *N. cristatus* and *E. bungii* varied with water column chlorophyll levels, with extreme amounts in the diets associated with the highest bloom levels. The overall copepod community feeding rate was estimated as 0.1 to 1.2 gC m^{-2} d^{-1}. This was a significant fraction of the primary production, reported by Dr. Isada as 0.5 to 3.5 gC m^{-2} d^{-1}. Copepod grazing was not sufficient to prevent further development of the bloom at any point, but phytoplankton must have been the major constituent of the copepod diet, unlike the situation in continuously oligotrophic areas farther seaward. Establishing this point was a major goal of OECOS.

Doctoral candidate Hye Seon Kim reported on the metabolism and growth of two species of euphausiid abundant in the Oyashio: *Euphausia pacifica* and *Thsanoessa inspinata.* Euphausiid abundance varied with the chlorophyll concentration, suggesting that supply to the A-line stations was affected by the varying water sources. Length distributions of both species indicated only slight growth during the April cruise. It was noted that all *T. inspinata* less than the modal size were male; all those larger were female. This suggests protandrous hermaphroditism, a unique finding for euphausiids but occurring in some decapod crustaceans. Metabolic rates did not vary much with the temperature or food availability during the two-cruise series, even though chlorophyll levels were very different between March and April.

Mid-water trawl and acoustic estimates of mesopelagic fish were reported by Mr. Tadanori Fujino. Scattering layers at 200 m appeared to stay in that vicinity day and night. Dominant species captured with a 16 m^2 trawl were *Diaphus theta* and *Stenobrachius leucopsaurus.* The estimated abundance of the two species, 6.9 g m^{-2}, was characterized as less than typical for the region.

Three papers were presented by participants in the failed "OECOS–East" attempt to obtain funding for a parallel study in the Gulf of Alaska. Drs. Michael Dagg and Suzanne Strom reported results from the GLOBEC Northeast Pacific program work on the Alaskan shelf. In apparently iron-limited waters at the shelf edge, Dr. Dagg found that grazing by *Neocalanus* spp. could be (1) keeping large phytoplankton from blooming – balancing their slow growth rate with grazing, and (2) releasing nano- and picophytoplankton from predation by microherbivores. Dr. Strom reported on the lower trophic level community composition in shelf-edge waters, showing the parallel to definitively iron-limited communities farther seaward. Events are observed in which iron limitation is relieved at and beyond the shelf edge by both river discharges laden with sediment and by wind-borne dust plumes.

Dr. Miller reviewed the original OECOS–East plan to investigate the likely causal correlates of sub-seasonal variation in phytoplankton stock abundance at Station P. He stressed that detailed evaluation of relations at the lowest trophic levels *without* supplementing the iron availability is needed to reveal the ecodynamics of HNLC systems. The key is to determine the phase relations of physics, nutrients, floristics, microherbivores and macrozooplankton to the sub-seasonal variation of chlorophyll and to more explicit measures of phytoplankton biomass.

It is clear from the reports that OECOS-West produced excellent results and valuable insights about ecosystem function during the Oyashio spring bloom. Another attempt at such a time series should consider moving farther away from Hokkaido and from the Kuroshio–Oyashio frontal region. Such a project might well be undertaken under Russian auspices some place well offshore from Sakhalin or southern Kamchatka. The work proposed by OECOS–East remains to be done and will be eminently worthwhile.

PICES Calendar

- PICES Harmful Algal Bloom Training Course, January 15–23, 2009, Manila, Philippines;
- Third Argo Science Workshop: The future of Argo (co-sponsored by PICES), March 25–27, 2009, Hangzhou, China;
- 11th Salmon Ecology Workshop (related to the development of the North Pacific Ecosystem Status Report for the Alaska Current, California Current and the Bering Sea), April 7–8, 2009, Juneau, U.S.A.;
- North Pacific Ecosystem Status Report Workshop on "*Status and Trends in East Asian Marginal Seas*", April 21–22, 2009, Busan, Korea, in conjunction with the 15th Pacific−Asian Marginal Seas (PAMS) meeting "*Observations, Understanding, and Prediction of Climate Variability in PAMS*", April 23–25;
- Inter-sessional Science Board and Governing Council meetings and Workshop to develop an Implementation Plan for the new PICES integrative scientific program, FUTURE, April 26–29, 2009, Qingdao, China;
- 3rd GLOBEC Open Science Meeting (co-sponsored by PICES), June 22–26, 2009, Victoria, Canada;
- Third PICES Summer School on "*Satellite Oceanography*", August 25–28, 2009, Seoul, Korea;
- 6th International Conference on Marine Bioinvasions (co-sponsored by ICES, PICES, U.S. National Sea Grant College Program, Pacific States Marine Fisheries Commission and Portland State University), August 24–27, 2009, Portland, U.S.A.;
- ICES/PICES Symposium on "*The Effects of Environmental Variability on Cephalopod Populations*", (CIAC'09), September 3–11, 2009, Vigo, Spain;
- OceanObs'09 Conference—*Ocean information for society: Sustaining benefits, realizing the potential* (co-sponsored by PICES), September 21–25, 2009, Venice, Italy;
- ICES/PICES Theme Sessions on "*Climate Impacts on Marine Fishes: Discovering Centennial Patterns and Disentangling Current Processes*" and "*Global Ocean Observing Systems*" at the ICES Annual Science Conference, September 21–25, 2009, Berlin, Germany;
- PICES Eighteenth Annual Meeting (PICES-2009), October 23–November 1, 2009, Jeju, Korea;
- International Symposium on "*Rebuilding Depleted Fish Stocks: Biology, Ecology, Social Science and Management Strategies*" (primary sponsors: ICES, PICES and UNCOVER; co-sponsoring organizations: NAFO, DFO and IMR), November 3–6, 2009, Warnemünde Germany;
- North Pacific Ecosystem Status Report Synthesis Workshop, December 1–3, 2009, Honolulu, U.S.A. (by invitation);
- PICES/ICES Symposium on "*Forecasting Climate Change Impacts on Fish and Shellfish*", April 26–29, 2010, Sendai, Japan;
- 26th Lowell Wakefield Symposium on "*Ecosystems 2010: Global Progress on Ecosystem-based Fisheries Management*", spring or fall 2010, Anchorage, U.S.A.;
- PICES Nineteenth Annual Meeting (PICES-2010), October 2010, Portland, U.S.A.;
- ICES/PICES Symposium on "*Carrying Capacity: What does it mean in a Changing Ocean?*", 2010, Lisbon, Portugal;
- 5th International Zooplankton Production Symposium (primary sponsors: PICES and ICES), March 2011, Pucon, Chile;
- PICES Twentieth Annual Meeting (PICES-2011), October 2011, Russia.

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

by Michael Foreman, Anne Hollowed and Suam Kim

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

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

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

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

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

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

Different frameworks for delivering IPCC model output were discussed. It was agreed that the ideal framework would be one where oceanographers and climatologists from each member nation work with their biologists and modellers to develop relevant forecasts. However, it was noted that James Overland, Muyin Wang, and Nicholas Bond from the Pacific Marine Environmental Laboratory would be willing to assist various groups, when necessary and as time permits.

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

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

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

Dr. Michael Foreman (mike.foreman@dfo-mpo.gc.ca) is a physical oceanographer and numerical modeller for Fisheries and Oceans Canada at the Institute of Ocean Sciences in Sidney, British Columbia. His research interests include coastal circulation and river modelling, biological transport, tidal analysis, and climate change. Within PICES, he has been Chairman of the Physical Oceanography and Climate Committee since 2005, and Co-Chairman of Working Group 20 on Evaluations of Climate Change Projections *since 2006.*

Dr. Anne Hollowed (anne.hollowed@noaa.gov) is a Senior Scientist at the NOAA's Alaska Fisheries Science Center, in Seattle, U.S.A. She holds a M.S. in Oceanography from Old Dominion University, and a Ph.D. in Fisheries from the University of Washington. She is an Affiliate Associate Professor at the University of Washington and a Fellow of the Cooperative Institute for Arctic Research at the University of Alaska. Anne has served on panels for U.S. GLOBEC, PICES CCCC, the North Pacific Research Board, and Comparative Analysis of Marine Ecosystem Organization, and is a member of the Scientific and Statistical Committee of the North Pacific Fisheries Management Council.

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

PICES/ESSAS Workshop on "*Marine Ecosystem Model Inter-Comparisons*"

by Bernard A. Megrey, Masahiko Fujii and Shin-ichi Ito

A 1-day workshop on "*Marine ecosystem model inter-comparisons*", co-sponsored by PICES and ESSAS (a GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas), was held on October 25, 2008, in conjunction with the PICES Seventeenth Annual Meeting in Dalian, China. This was the first meeting under a new modeling project endorsed by PICES in 2007.

Comparative analysis is a valuable scientific activity because the size and complexity of marine ecosystems precludes conducting controlled *in situ* experiments. It is also a powerful technique for understanding the important similarities and differences between and among ecosystems. Modeling is a central approach to comparative analyses of ecosystem structure, function and responses. It is important to understand whether inter-relationships among physical, chemical and biological variables vary geographically, and the extent to which any particular conclusions depend on the model used to derive them.

The project is organized to promote model comparisons by applying multiple marine ecosystem models to the same location/species and using an ensemble model forecast to identify and compare predicted and observed responses of marine ecosystem types to global changes. This assessment is similar to the widely-accepted approach used by the IPCC (Intergovernmental Panel on Climate Change) to evaluate alternative climate prediction models. It is expected that this process will allow one to identify and characterize components of the major marine ecosystems which are likely to be affected at an early stage by global changes, to understand the responses to global change of each component of the ecosystem, focusing primarily on zooplankton which provide the prey base for upper trophic level fish species, and to detect which of the candidate models are the most successful at hindcasting in each of the ecosystems chosen for study. This kind of comparative approach should be one of the core activities of the new PICES science program on "**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems" (FUTURE). A 3-year duration for the project was suggested, which would be sufficient to accomplish the initial project goals, but will still allow the work to be integrated into FUTURE when that program is operational.

The workshop opened with a brief introduction by Bernard Megrey. An audience of 40 to 55 people listened then to several stimulating presentations. The keynote talk was given by Fei Chai (U.S.A.). He introduced a model comparison exercise conducted under US-JGOFS in which 12 lower trophic level biogeochemical models of varying complexity were objectively assessed in two distinct regions (Equatorial Pacific and Arabian Sea) and evaluated by three methods: (a) data assimilated into the models at each station individually, (b) data assimilated into the models at two stations simultaneously, and (c) data assimilated into the models at each station individually and then the tuned model parameters were switched with each other (**Fig. 1**). Icarus Allen (UK) introduced the topic of model skill assessment (**Fig. 2**) and described several objective approaches of assessing model skill. One tool includes the Taylor diagram (**Fig. 3**), which is useful for conveying information about the similarity between model predictions and observations based on the ratio of variances, correlation and root mean squared error differences between model predictions and observed data.

William Peterson, Harold Batchelder (U.S.A.), and Toru Kobari (Japan) reviewed krill and copepod biology and ecology, as these species were chosen as the modeled indicator species.

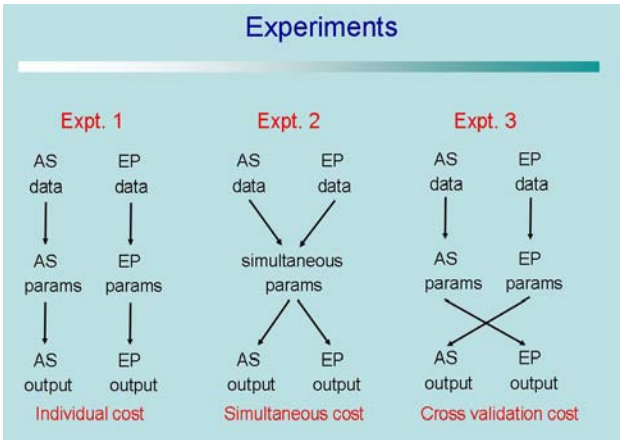


Fig. 1 Schematic of three model comparison experiments applied to two locations (Equatorial Pacific - EP and Arabian Sea - AS). From Friedricks, M.A.M. et al.*, 2007:* J. Geophys. Res.*, 112, C08001, doi: 10.1029/2006JC003852.*

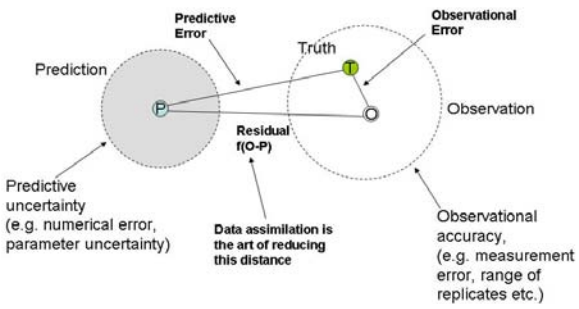


Fig. 2 Schematic depicting the relationship between the true state of nature (T), our observation of the state of nature (O), a models prediction (P) and prediction uncertainty.

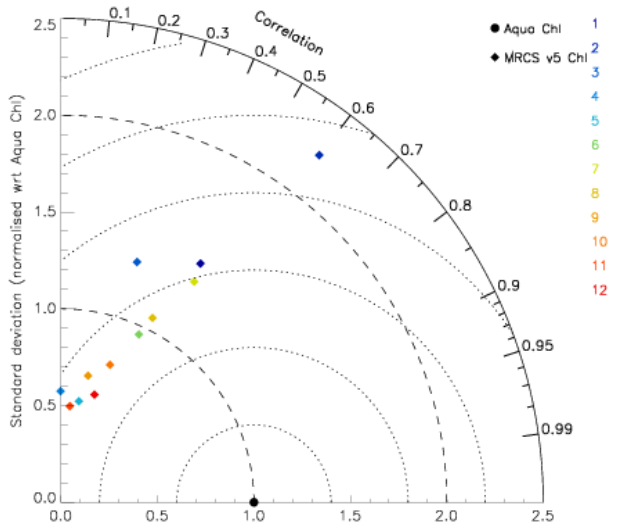


Fig. 3 Example of a Taylor diagram. A perfect model would have a correlation coefficient of 1, a RMSE (root mean squared error) of 0, and a ratio of observed to model variance ratio of 1.

After the presentations, a lengthy discussion took place on five main issues which were intended to frame the preparation of a work plan: (1) identify the objective of the models for inter-comparisons; (2) select potential models and evaluate their data needs; (3) nominate location(s) for comparisons; (4) identify protocols to compare model performance (model skill assessment), given data needs against location data availability and compatibility; and (5) name the most appropriate indicator species to be used as the "metric" for correct model behavior.

Plans are being developed to solicit active participation in the project and contribution of models. The objective of the model inter-comparison will be to apply several models to one location in order to identify important mechanisms that control secondary production abundance and variability, as well as bounding the levels of uncertainty in model predictions by calculating ensemble statistics. This approach can be applied to several places simultaneously, however discussions should be held to select suitable locations where the models can be applied.

During the workshop a schedule of activities was proposed and accepted. Participants will be contacted via e-mail to get confirmation of their willingness to stay involved and be active. A detailed work plan will be developed to prepare for a hands-on modeling workshop to be held in conjunction with the 2009 PICES Annual Meeting in Jeju, Korea. The goals of the next workshop will be to compile observational data and begin model construction, parameterization and comparison.

[This research is contribution **EcoFOCI-0703** to NOAA's Fisheries-Oceanography Coordinated Investigations]

Dr. Bernard A. Megrey (bern.megrey@noaa.gov) is a research fisheries biologist with NOAA's Alaska Fisheries Science Center (U.S.A.) where he has worked since 1982. His research involves studying the dynamics of exploited North Pacific fish populations, relationships of environment to recruitment variability, climate impacts on marine ecosystem production and application of computer technology to fisheries research and natural resource management. Bern is Chairman of the PICES Technical Committee on Data Exchange (TCODE) and former Co-Chairman of the PICES MODEL Task Team. He is Co-Chairman of the ESSAS (Ecosystem Studies of Sub-Arctic Seas) Working Group 3 on Modeling Ecosystem Response.

Dr. Masahiko Fujii (mfujii@ees.hokudai.ac.jp) is an associate professor at the Graduate School of Environmental Science, Hokkaido University (Japan), where he achieved his PhD in Environmental Earth Science in 2001. Masahiko worked as a postdoc at the National Institute of Environmental Studies (Japan) and at the University of Maine (U.S.A.), studying marine ecosystem modeling and helping to develop NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) for several years. His current activities are more relevant to sustainable sciences, focusing on balancing marine ecosystem and human activities such as fisheries and marine tourism. He is also Co-Chairman of the ESSAS Working Group 3.

Dr. Shin-ichi Ito (goito@affrc.go.jp) is a Chief Scientist of the Physical Oceanography Section in FRA's (Fisheries Research Agency of Japan) Tohoku National Fisheries Research Institute. Shin-ichi completed his graduate work in Theoretical Physical Oceanography at Hokkaido University and converted to an observational physical oceanographer in FRA. His research includes the development of a fish growth model coupled to a lower-trophic-level ecosystem NEMURO.FISH (North Pacific Ecosystem Model for Understanding Regional Oceanography For Including Saury and Herring) model. He is a member of the PICES Physical Oceanography and Climate Committee (POC) and former Co-Chairman of the PICES MODEL Task Team. He also co-chairs the ESSAS Working Group 3.

The Opening Session room was packed with participants.

Opening Session head table.

Part of the Korean delegation gathers for a photo at the Welcome Reception.

The Study Group on Communication in session.

CCCC/POC/FIS Workshop in session.

Working Group 21 members discussing results from their Rapid Assessment Survey in Dalian.

MEQ Committee meeting.

Dr. John Stein leading discussions at the FUTURE Open Forum.

The main Poster Session display area.

A well-attended POC Paper Session.

The FIS Committee Meeting in session.

Five participants of the "unofficial" sports event of PICES XVII – swimming in late October Dalian waters.

Participants applaud our Chairman for a very successful Annual Meeting at the Closing Session.

Our Chairman, Executive Secretary and F&A Chairman relaxing at the Chairman's Reception.

Alter egos of US Delegate Dr. Sam Pooley and Secretariat staff Julia and Christina surface on Halloween Day.

2008 PICES Summer School on "*Ecosystem-Based Management*"

by Yasunori Sakurai, Masahide Kaeriyama, Michio J. Kishi and Shin-ichi Ito

The Advisory Panel for a CREAMS/PICES Program in East Asian Marginal Seas (CREAMS-AP) was established in 2005. One of its goals is to develop a Capacity Building Program, and summer and winter schools on marine science for students and young researchers is an important component of this program. The first PICES Summer School on "*Ocean circulation and ecosystem modeling*", with 37 attendees from 8 countries (including all 6 PICES member countries), was held August 23–25, 2006, at the National Fisheries Research and Development Institute in Busan, Korea. This event was a resounding success and has set the stage for following schools. The summary report of the school was published in PICES Press (Vol. 15, No. 1).

Fifty students and early career scientists from China, Japan, Korea, Russia and U.S.A. attended the second PICES Summer School on "*Ecosystem-based management and ecosystem approach*" held August 23–26, 2008, at the Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Japan. The major funding for the school was provided by several Japanese programs (Japan–China Student Exchange Program, Japan–Korea Core University Program, and Sustainability Governance Program of Hokkaido University) and by the Japanese Society for the Promotion of Science. Ecosystem-based management (EBM) is an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need.

Participants were welcomed by the hosts and organizers, and after an introduction to PICES by Dr. Skip McKinnell (Deputy Executive Secretary), the first day was taken up by four lectures. Ms. Shiva Niazi (U.S.A.) gave a lecture on "*Ecological footprint analysis of fishing*". Students were introduced to the concept of ecological footprints and some web-based software to allow them to compute their own footprint. This was followed by presentations on "*Idea of ecosystem-based management*" by Dr. Mitsutaku Makino (Japan), "*Risk management*" by Prof. Hiroyuki Matsuda (Japan), and "*Ecosystem-based resource assessments for sustainable fisheries*" by Prof. Chang-Ik Zhang (Korea). In the evening, students and professors adjourned to a local watering hole to meet and enjoy each others' company.

The second morning began with lectures on modelling tools by Drs. Shin-ichi Ito (Japan) and Angelica Peña (Canada), and ecosystem sustainability by Dr. Masahiko Fujii (Japan). In the afternoon, students were divided into groups to discuss various themes related to EBM. Discussions continued through the following morning, with each group giving a presentation at the final plenary session. These presentations were very fruitful, and some of the groups developed posters which were displayed at the 2008 PICES Annual Meeting in Dalian, China.

Student discussion topics	**Leader**
Differences of indicators for Subarctic and Subtropical fish	Zhang, Niazi
Indicators for aquaculture	Kishi
Define numerical index and calculate an example for Pacific saury	Ito
Define numerical index and calculate an example for salmon	Peña
Multiple species and EBM	Matsuda
Social indices and examples	Makino
Sustainable fisheries and EBM	Fujii
Roles of NGO and fishermen	Kaeriyama

Students and professors at the second PICES Summer School at the Graduate School of Fisheries Sciences, Hokkaido University, August, 23–26, 2008.

The 2002 World Summit on Sustainable Development (WSSD) recognized that the management needs for the oceans have changed, requiring integration of ocean management activities across sectors and responding to the necessity of conservation objectives for collective ocean use. Among other defined specific temporal targets relevant to oceans management by 2012, the WSSD expects to implement "Ecosystem-based management (Ecosystem approach to management, EAM)". We believe that ecosystem management and ecosystem science are parallel concepts that require continued interaction to achieve marine resource sustainability.

Clockwise from top left: Dr. Angelica Peña (Institute of Ocean Sciences, Canada) preparing for the final plenary session (top right), student discussion with Prof. Chun-Hong Yuan (Hokkaido University, Japan) at the laptop, another student discussion group, Prof. Masahide Kaeriyama (Hokkaido University, Japan), Prof. Chang-Ik Zhang (Pukyung National University, Korea) and Dr. Shin-ichi, Ito (Tohoku National Fisheries Research Institute, Japan).

4th PICES Workshop on "*The Okhotsk Sea and Adjacent Areas*"

by Makoto Kashiwai

The 4th PICES Workshop on "*The Okhotsk Sea and adjacent areas*" was held from August 27–29, 2008, at the Okhotsk Campus of the Tokyo University of Agriculture (TUA) in Abashiri, Japan. The goal of the workshop was to develop an Okhotsk Sea component of the new PICES integrative science program, FUTURE (**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems). The workshop brought together a team of international scientists interested in the region and the marine ecosystems embraced by them. Recognizing the concerns for increasing impacts of climate change, participants reviewed "what is known", and identified key scientific questions and necessary approaches to answer these questions. Convenors of the workshop were Prof. Makoto Kashiwai (TUA) and Dr. Gennady Kantakov (Sakhalin Research Institute of Fisheries and Oceanography).

Workshop convenors: Dr. Gennady Kantakov and Prof. Makoto Kashiwai.

The list of participants included 64 scientists (Japan–45; Russia–17; Canada–1; PICES–1) and 8 students. Many of the Russian scientists came to Abashiri by a ferry, crossing La Perouse (Soya) Strait. Perhaps the choice was a consequence of marine scientists preferring a sea route, but it meant that the limited travel funds could be allocated to a larger group of researchers. Some participants came from Hakodate after attending the PICES Summer School on "*Ecosystem-based Management*" at Hokkaido University. It was a special honour to have a Wooster Award winner, Prof. Yutaka Nagata (Emeritus, University of Tokyo), in attendance. He was a leading convenor of all previous PICES Okhotsk Sea workshops.

Abashiri is the southernmost port and fisheries base in the Okhotsk Sea. In winter, the coast is inundated by sea ice so tourists can enjoy sea ice scenery from the comfort of an icebreaker. The Abashiri Campus of TUA is on a hilltop located about a 20-minute drive (at legal speeds) from downtown. It offers a fine distant view of the mountains of the Shiretoko Peninsula and other isolated volcanoes, and the lakes of Abashiri and Notoro.

The workshop began with welcome addresses by Prof. Michinari Yokohama (Dean, Faculty of Bioindustry, TUA) and Mr. Koji Kamada (Director, Abashiri Construction and Development Department Office, Hokkaido Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism). Three plenary sessions were held on the first day and two parallel sessions on the second day. A total of 46 papers were presented including one by Dr. Skip McKinnell (Deputy Executive Secretary of PICES) on the status and trends of FUTURE implementation.

The first plenary session PS1 on *Climate/Ocean Dynamics* (Chairs: A. Andreev and K.I. Oshima) produced results of the studies concerning long-term changes of the climatic regime (Glebova *et al*.), sea ice coverage (Tachibana and Ogi; Muktepavel and Shatilina), dense shelf water formation (Sasajima *et al*.), and seawater temperature, salinity and chemical parameters (Oshima *et al*.; Andreev) in the Okhotsk Sea. Future research should involve: (1) monitoring long-term changes of heat and moisture fluxes, wind regime and Amur River discharge and its influence on the water temperature, salinity stratification, circulation and ice coverage in the Okhotsk Sea; (2) organization of time-series observations and research vessel expeditions in the region to detect the climate change impact on physical and chemical parameters of the seawater; and (3) modelling to compare with observations and to study the impact of tides on the spatio-temporal variations of the nutrient fluxes, chlorophyll (Chl) concentrations and primary production in the Okhotsk Sea and Kuril Straits area.

In the plenary session PS2 on *The Amur River and Geo-chemical Cycles* (Chairs: M. Kishi and A. Peña), five papers were given by scientists from Japan, Russia and Canada. Presentations included: a review of the Pacific Oceanological Institute program on the Amur River estuary and adjacent areas (Lobanov *et al*.); a study of the link between biogeochemical cycles in the Amur River and the western subarctic Pacific, in particular the transport of iron in Okhotsk Sea Intermediate Water (OSIW) to the western subarctic Pacific (Nakatsuka *et al*.); a study of factors controlling biogeochemical cycles in coastal waters using a biogeochemical model (Peña); and the last two papers focusing on the effect of sea ice on nutrient fluxes (Nomura

et al.) and material fluxes (Hiwatari *et al*.) in the Okhotsk Sea. In the future, a joint Japan-Russia-China project on the Okhotsk Sea will provide information on the role of iron/OSIW on biogeochemical cycles. A bio-geochemical model embedded within a high resolution 3-D physical model must play an important role in improving our understanding of the transport of iron and material cycles. These research activities will facilitate predictions of future ecosystem states, including higher trophic levels. Field observations must be extended to cover the annual cycle, especially variables measured under ice during winter. Icebreaker expeditions focusing on biogeochemical studies will aim to clarify winter time processes.

The plenary session PS3 on *Primary Production – Zooplankton – Marine Mammals* was chaired by S. Saitoh, A. Trukhin, M. Kobayashi and A. Shiomoto. It was noted that high primary production at a scallop farming area in the southern Okhotsk Sea was sustained after the spring bloom by the development of a frontal area (Cold Belt) along the Soya Warm Current (SWC) in summer, and by enforcement of the East Sakhalin Current in autumn. The summer bloom occurs as a result of instability of the SWC, contributing >50% of annual total primary production in the area (Muzzneena and Saitoh). Offshore from there, the maximum concentration of Chl-*a* was found in the surface layer in spring, but shifted to ~20 m depth in summer and autumn (Kasai *et al*.). Seasonal variability of integrated primary production within the euphotic layer was low. Although no significant relationships were found between photosynthetic parameters and temperature or nutrients, the surface primary production during August and September was correlated significantly with Chl-*a* concentrations. This suggests that primary production in summer depended basically on the biomass, and not on their photosynthetic physiology or the light intensity (Isada *et al*.).

A remarkable increase in the abundance of spotted seals near northern Hokkaido has occurred, significantly expanding their range of inhabitation (Trukhin). With global warming, the ice area where seal pups are born is declining, which seems to have had a negative impact on the entire regional population. Seven species of pinnipeds inhabit the Okhotsk Sea, but the Steller sea lion and harbour seal are rare. Of 14 rookeries, 11 are located in the Okhotsk Sea. The abundance of sea lions has stopped decreasing recently. During the last 10 years, increasing abundances of northern fur seals have been observed at Tuleniy Island near Sakhalin (Terpeniya Bay). Examination of 19 mitochondrial DNA haplotypes found in harbour porpoises near Japan indicates that this population was established relatively recently (Taguchi *et al*.). Cooperative studies in the Okhotsk Sea between Russia and Japan will be important for sharing biological samples and data on pinnipeds and other marine mammal species.

Future research on these topics should: (1) summarize and evaluate the available information on the responses of marine organisms of the Okhotsk Sea (from phytoplankton to marine mammals and seabirds) to variability in physical attributes of the ocean, such as seasonal sea ice cover, ocean temperature, stratification, and circulation; (2) clarify the contribution of ice-algae to the total primary production in the Okhotsk Sea; (3) understand the physical mechanism responsible for maintaining the high primary production (Okhotsk Sea Coastal Green Belt), especially the role of

Workshop participants at the venue entrance.

advection of the SWC (Cold Belt); (4) improve the local algorithm of determining Chl-*a* and primary productivity by remote sensing in the Okhotsk Sea and develop an algorithm to determine integrated Chl-*a* concentration within the euphotic zone, and likewise (5) develop an ice thickness algorithm to evalutate ice thickness changes in the Okhotsk Sea; (6) examine contributions of oceanic heat on sea ice melting/freezing/motion analysis and oceanic/ atmospheric heat flux relating to ice variation in relation to marine habitat; (7) collect *in situ* bio-optical measurements of the phytoplankton community in the Okhotsk Sea; (8) understand detailed responses of phytoplankton to sea ice dynamics in conjunction with other physical/bio-chemical parameters (ocean circulation, mixed layer depth, light/nutrients) using a 3-D coupled Ice-Ocean-Ecosystem Model; and (9) understand zooplankton dynamics and population structure in the Okhotsk Sea.

Professors Sei-Ichi Saitoh, Michio Kishi and Akira Taniguchi continue their scientific discussion during the coffee break.

The topic session A1 (Chair: T. Nakanowatari) considered studies on *Current Dynamics* by numerical models and observations. Ocean Global Climate Model (OGCM) experiments provide good representations of oceanic structure and currents in the Okhotsk Sea. The key components of realistic simulations of physical processes in the region involve tidal mixing and sea ice formation. Incorporating feedback from observational data to a numerical model is important to improve the simulation of the ocean circulation in the Okhotsk Sea. One of the presentations (Uchimoto *et al.*) described a model of the circulation of the intermediate layer in the Okhotsk Sea. The OGCM reproduced features on the $26.8\sigma_\theta$ surface reasonably well, despite a relatively coarse resolution. Tracers injected at the model sea surface in the northwestern part of the Okhotsk Sea are transported to the Pacific *via* the Kuril Straits in the intermediate layer. In these experiments, the tidal mixing effect was essential for the realistic simulation of water mass property and circulation in the Okhotsk Sea. Using observational and hindcast data from an OGCM experiment, a model was developed to successfully represent the observed multidecadal-scale cooling in the western North Pacific (Nakanowatari *et al.*). This cooling is related to increased cross-gyre transport of the western boundary current. Since the change in potential temperature originates from the western boundary, this indicates that the mechanism is different from the response to westwardly propagating Rossby waves from the central North Pacific, as has been previously reported by several studies. A linear trend in OSIW temperature was not well simulated.

Vertical movements of water masses in the western Okhotsk Sea are evident in observational data (Kantakov). Temperature inversions inside the dichothermal layer are located at convergence zones and/or close to the thermal fronts in the sea. There are at least two types of convection, one connected with salt transport by the SWC in the warm months and another with cooling and brine rejection during fall and winter. The characteristics of tidal and residual currents for the Shmidt Peninsula, Okhotsk Sea shelf of Urup and Kunashir Island were shown from observational mooring data (Shevchenko *et al.*). The energetic characteristics of tidal and residual sea level oscillations in the Okhotsk Sea were also examined from satellite altimetry data (Shevchenko and Romanov).

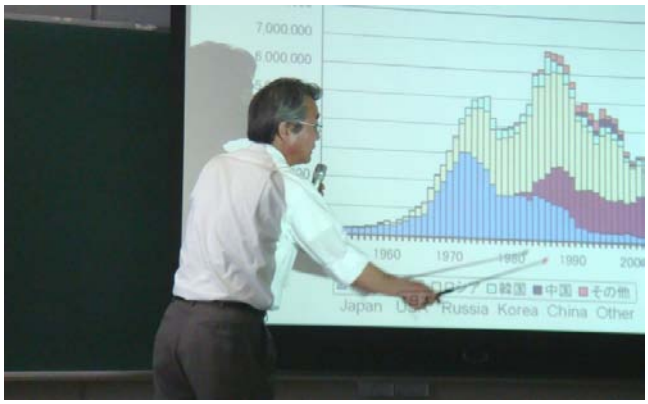
Future current dynamics research should focus on: (1) estimation of the effect of the multi-decadal scale changes in the Oyashio on material circulation and ecology of the North Pacific; (2) realistic simulations of OSIW dynamics; (3) variability of the vertical movements of water masses in the Okhotsk Sea (possibly a part of the FUTURE program due to obvious impacts of those phenomena on marine biota, especially at the early ontogenetic stages), climate oscillations and Okhotsk Sea hydrography.

The topic session A2 on *Sea Ice, Watermass and Freshwater Processes – Coastal Lagoons* was chaired by Y. Tachibana and A. Abrosimova. A study of sea-ice flow from the Okhotsk Sea through Nemuro Strait in 2008 (Motoi *et al.*) revealed that in addition to wind drift, the southwestward flow of the coastal Oyashio and Oyashio currents are important factors controlling sea-ice drift along the southern coast of Hokkaido and result in ice blocking of some bays. Data obtained by the Hokkaido Kushiro Experimental Station indicated that outflow water from the Okhotsk Sea influences coastal Hokkaido (Nagata). Evidence of deep convection in the Okhotsk Sea was found (Kashiwai). This winter convection at open ocean polynya can be an important process, along with the progress of global warming. A study of the influence of Amur River discharge on hydrological conditions of the estuary area during a spring–summer flood found that a mesoscale lens of Amur River water is formed during a spring–summer flood (Abrosimova *et al.*). Re-analysis data was used to investigate the relationship of Amur River discharge with vertically-integrated atmospheric horizontal moisture flux (Oshima *et al.*). It was shown that variations in the Asian monsoon and Arctic circulation play an important role in the freshening of the Okhotsk Sea. A review of the coastal lagoons of the Okhotsk Sea found high biodiversity and

important species for mariculture (Brovko). Future studies should focus on: (1) paths of outflow of Okhotsk Sea water; (2) mechanisms and frequencies of deep convection; (3) dynamics, conditions of formation, and evolution of the Amur River plume; and (4) oceanography and ecosystems of lagoons, as well as their influence on biochemical processes in the adjacent marine areas.

The topic session A3 on *New Technology* (Chairs: N. Ebuchi and A. Romanov) heard six reports on topics ranging from HF radar, ionosphere monitoring, diagnostics for earthquakes, spectro-ellipsometry for ecological monitoring, radiometry for ecosystem bio-complexity assessment, and airborne lidar for registration of fish schools and plankton. In the future, these technologies should be verified and improved by international cooperation under the umbrella of PICES, and new technologies should be developed to: (1) monitor ice-covered oceans in winter; (2) provide stable isotope analyses of sea water and biological samples; (3) assess biodiversity by DNA analyses; (4) improve remote sensing technology, and (5) create tools and methods for biological process studies, especially for monitoring the environment in the Okhotsk Sea. Inviting technical specialists from various fields to future Okhotsk Sea workshops should be considered to enhance our monitoring technologies.

Presentations in the topic session B1 on *Biological Processes – Disturbance by Oil and Gas Development* (Chairs: A. Yamaguchi and V. Labay) dealt with phytoplankton (Shimada *et al.*), zooplankton (Asami *et al.*; Yamaguchi *et al.*), river fish communities (Kanaiwa *et al.*), and benthos (Kashiwai and Kantakov; Samatov and Labay). Five points are summarized as a future research plan: (1) Remote sensing provides only the total amount of phytoplankton (pigment), but to understand spatial and temporal changes in phytoplankton community structure, detailed species composition is needed, especially for toxic species like *Alexandrium tamarense*; (2) The zooplankton community in the Okhotsk Sea is classified into a coastal community (dominated by *Pseudocalanus* spp.) and open sea community (dominated by *Metridia okhotensis*). Since *M. okhotensis* is the predominant component in the open part of the Okhotsk Sea, this species is considered a key species in this region. To evaluate its quantitative role in the biogeochemical cycle in this region, its ecology, especially its life cycle, should be studied; (3) Liquid natural gas (LNG), oil and gas activities on the east coast of Sakhalin Island, Magadan and western Kamchatka demand that the impact of such human development on marine ecosystem, especially benthos, should be addressed; (4) Since the characteristics of the Okhotsk Sea differ among locations (*e.g.*, depth, water masses, sea ice) affecting the spatial distribution of biota, cooperative research between Russia and Japan will be needed in the future; and (5) Since sampling and analytical procedures vary by country, making it difficult to make direct comparisons, establishing standard sampling and analytical methods for biological processes should be considered.



Prof. Yasunori Sakura describes the variation in walleye pollock catches.

Finally, the topic session B2 on *Walleye Pollock* (Chairs: Y. Sakurai, A. Varkentin and V. Kulik) heard that despite such a long period of walleye pollock study in the Okhotsk Sea, new information is still emerging about its biology. It has been established recently that Okhotsk Sea waters off the northern Kuril Islands and southwestern Kamchatka area is the traditional region of spawning by animals from East Kamchatka (Buslov and Varkentin). Future studies should: (1) summarize and evaluate available information on the responses of marine organisms of the Okhotsk Sea (from phytoplankton to marine mammals and seabirds) to variability in physical attributes of the ocean, such as seasonal sea ice cover, ocean temperature, stratification, and circulation; (2) assemble existing biophysical datasets and time series from the Okhotsk Sea ecosystem to facilitate joint comparative studies and future climate change issues; (3) conduct ecosystem studies of the Okhotsk Sea every year at the same time periods and at the same area polygons – until then statistical analysis of strong and significant multivariate, canonical and other analyses may lead to unacceptable biological nonsense; (3) improve ichthyoplankton survey methods in view of new knowledge about walleye pollock biology in the Okhotsk Sea waters off the northern Kuril Islands and in southwestern Kamchatka to clear up the rates and reasons of walleye pollock migrations to the Okhotsk Sea, and investigate in detail the hydrological conditions in this region; (5) examine interannual walleye pollock reproductive strategy changes depending on climate and food conditions, stock level and other factors; and (6) explore how the extent of ice cover affects the fate of walleye pollock around the Okhotsk Sea.

The final day was held in plenary to develop session reports and proposals for FUTURE. After the announcements for the preparation of workshop proceedings, the co-conveners provided closing remarks. The results of the workshop will be published in the PICES Scientific Report Series in early 2009.

PICES WG 21 Rapid Assessment Surveys

by Thomas Therriault and Graham Gillespie

Since its inception in 2006, PICES' Working Group on *Non-indigenous Aquatic Species* (WG 21) has been advancing our understanding of marine non-indigenous species in the North Pacific Ocean. In 2007, the Japanese Government (Ministry of Agriculture, Forestry and Fisheries of Japan, through the Fisheries Agency of Japan) provided a voluntary contribution to PICES for a 5-year (2007–2012) project entitled "*Development of the prevention systems for harmful organisms' expansion in the Pacific Rim*" to develop international systems to collect, exchange and store relevant data, and to foster partnerships with non-PICES countries and international organizations. The project has two distinct components, one on harmful algal blooms carried out by the PICES Section on *Ecology of Harmful Algal Blooms in the North Pacific*, and the other on marine non-indigenous species conducted by WG 21. Two specific initiatives have been identified within the latter component. The first initiative is the development of a comprehensive database for non-indigenous species with Dr. Henry Lee II (U.S. Environment and Protection Agency, Lee.Henry@epa.gov) serving as the principal investigator. The second is a taxonomy initiative led by Dr. Thomas Therriault (Fisheries and Oceans Canada, Pacific Biological Station, Thomas.Therriault@dfo-mpo.gc.ca). The taxonomy initiative will focus on rapid assessment surveys for native and non-native species in a variety of habitats in commercial ports of PICES member countries, and on a collector survey to characterize the distribution of fouling organisms at a number of locations in each PICES member country. The rapid assessment survey will be discussed in this article, but look for future PICES Press articles on the much anticipated collector survey to be conducted in 2009!

In an ideal world, scientists would have the resources to maintain a vigilant watch for the arrival of non-indigenous species. However, the reality is that no country has the resources, financial or personnel, to do this. Thus, a rapid assessment survey (RAS) is one means to identify native, non-native and cryptogenic species present at a specific location at a specific time. By conducting RAS over time, an important baseline is developed which allows researchers to identify the arrival of new species. For the PICES project, we have elected to survey commercial ports in PICES member countries, as ports have a greater probability of containing non-indigenous species. Not only do these locations serve as a recipient environment for organisms transported by commercial shipping (ballast water, ballast sediment, hull fouling), they also often have high levels of secondary traffic (recreational or small craft, aquaculture transfers) and tend to be more disturbed than natural environments, a factor that could enhance invasion success. Although it may not be possible to characterize all habitat types within a port, our survey focuses on major ecosystem components, namely intertidal and subtidal habitats. Intertidal habitats are sampled using both a timed walk and quadrat/grab sampling methods, and subtidal habitats are sampled using (tunicate) collectors, trapping for macrofauna (primarily fish and crabs) and a survey of the fouling communities on floating docks and their associated structure. The intent of this qualitative survey (not a quantitative one) is to capture the species composition within each location surveyed, not characterize the abundance of any specific species. Population estimates can be made in subsequent surveys, if needed, but are not the principle reason for conducting a RAS. The assignment of native, non-native or cryptogenic status occurs following species identification based on literature accounts, general rules for classification of status, and discussion by WG 21 members.

Although many invertebrate species (not all) would be in greater abundances during the warmer, summer months, we decided it would be more informative for participants if sampling were carried out in conjunction with PICES Annual Meetings. Since many of the RAS participants also attend these meetings, logistical and economic benefits are also realized. Thus, our RAS will be conducted in the host PICES member country the week prior to the Annual Meeting (generally mid-October), as was the case with our first RAS in China. It is possible that some taxonomic groups might not be encountered or species missed, but this is expected and represents one limitation of these types of surveys. If the intent was to fully characterize a location, then sampling should be repeated during other seasons, but this significantly increases the resources needed and the number/type of species added is relatively minor.

The goal and success of this type of survey requires the participation of taxonomic experts with broad knowledge of their taxonomic group, in addition to the participation of taxonomic generalists who are able to help with sampling and species identification (primarily *via* the use of identification keys). Also, this type of survey can provide some training to taxonomic generalists, but more importantly can serve as a forum where taxonomic experts can discuss the organisms encountered. For example, experts with extensive knowledge from the North American side of the Pacific can discuss species found in Asian RAS with taxonomic experts familiar with these species there. It also provides an opportunity to highlight and potentially resolve taxonomic issues that can arise among countries, given differences in language and taxonomic advancements since the development of identification keys. For example, some taxa recently have been re-described based on either traditional morphological techniques or more modern genetic ones. Our RAS forum provides an opportunity for taxonomists to discuss these changes and/or advances. Given logistical constraints of

The 2008 PICES Rapid Assessment Survey team.

these types of surveys, our RAS uses members of WG 21 and as many taxonomic experts from the host country as possible. Participation of students is encouraged for logistical support and training. For some taxonomic groups experts might not exist in the host country, and so these "key" taxonomic experts are sought to participate. If you are a taxonomic expert wishing to be involved in our planned RAS in Korea in 2009, please feel free to contact Dr. Therriault about potential participation.

Taxonomy for some species will be controversial, and reference collections are important to document the occurrence of non-indigenous species, thus it is imperative that voucher specimens be maintained for future reference. Within our project, the host PICES member country is maintaining organisms encountered during the RAS in suitable archives. Further, all species records will be entered into the PICES WG 21 Non-indigenous Species Database.

PICES WG 21's first RAS was conducted in October 2008 in China, with two commercial ports targeted, Dalian on the Yellow Sea and Bayu Quan on the Bohai Sea. One unforeseen obstacle to sampling international ports was security concerns raised by port authorities. Thus, the port sampling was graciously co-ordinated by our Chinese hosts under the supervision of Dr. Lijun Wang from the National Marine Environmental Monitoring Center of the State Oceanic Administration (SOA). A total of 18 samples were collected according to the RAS sampling guidelines and preserved for identification by our international team of taxonomic experts. In addition to ourselves and Dr. Wang, this team consisted of Darlene Smith (National Headquarters, Fisheries and Oceans Canada), Zhisong Cui and Li Zheng (First Institute of Oceanography, SOA, China), Hiroshi Kawai (University of Kobe, Japan), Vasily Radashevsky, Eduard Titlyanov and Tamara Titlyanova (Institute of Marine Biology, FEB RAS, Russia), Liudmila Budnikova (Pacific Research Institute of Fisheries and Oceanography, Russia), Blake Feist (Northwest Fisheries Science Center, NMFS, U.S.A.) and Judith Pederson (MIT Sea Grant Program, U.S.A.). Further, Dr. Wang also provided our RAS team with laboratory space, equipment, and reference materials, at the brand new National Marine Environmental Monitoring Center facilities in Dalian, and his hospitality ensured the RAS team was happy and productive during our visit to China.

Preliminary results of the Dalian RAS include algae (45 taxa), arthropods and molluscs (25 taxa each), polychaetes (6 taxa), fish (5 taxa), bryozoans, cnidarians, echinderms, platyhelminths and poriferans (2 taxa each) and one taxon each of hydrozoan, nemertine and tunicate. Most taxa were identified to the species level, although many are provisional identifications. Some taxa could only be identified to the genus, family or order levels until further investigation. However, we were able to classify three species as non-indigenous: shells were collected from the bivalve molluscs *Argopecten irradians*, *Mizuhopecten yessoensis* and *Mactra chinensis*. The former two species are actively cultured in China, and the latter is readily

available in local markets. As only shells were collected, we cannot be certain whether these species have established viable populations in Dalian. It is possible that other non-indigenous species were encountered in some of the other taxonomic groups, notably algae, amphipods, and polychaetes, but identifications and classifications are pending. As our surveys continue, generating distributional data for a number of taxa among PICES member countries, it will be possible to better understand the extent of non-indigenous marine species in coastal waters of the North Pacific Ocean.

Dr. Thomas Therriault (Thomas.Therriault@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station in Nanaimo, BC. Tom is working on aquatic invasive species (research, monitoring, risk assessment, and rapid response planning) both within DFO and through the Canadian Aquatic Invasive Species Network (CAISN). He also conducts research on forage fishes, notably eulachon and Pacific herring, from conservation and ecosystem perspectives. Tom is a Principal Investigator on the Taxonomy Initiative of PICES' WG 21 on Non-indigenous Aquatic Species *that will include rapid assessment surveys for non-indigenous species in PICES member countries.*

Graham Gillespie (Graham.Gillespie@dfo-mpo.gc.ca) is a Research Biologist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station in Nanaimo, BC. Graham is the Head of the Intertidal Bivalve and Crab Programs, conducting stock assessments for commercially important species, providing scientific advice for the SARA-listed Olympia oyster and participating in ecosystem-level research involving these groups. He also coordinates an Aquatic Invasive Species project which examines distribution, dispersal and impacts of intertidal non-indigenous species on the Pacific coast of Canada. He is a member of PICES' WG 21 on Non-indigenous Aquatic Species.

PICES Interns

We offer sincere thanks to **Mr. Key-Seok Choe** (left), the 2008 PICES intern from the Korea Ocean Research and Development Institute, who completed his term at the Secretariat at the end of January, and has returned to Korea. We appreciate his dedicated work during this past year and wish him great success in his career.

We are pleased to announce that **Mr. Yongling Zhu** (right) will join the Secretariat in February as the 2009 PICES Intern. He has a Masters Degree in Business and Administration and has worked at the Second Institute of Oceanography of the State Oceanic Administration (Hangzhou, People's Republic of China) since 1998. We look forward to his involvement in PICES activities.

PICES @ Oceans in a High CO_2 World

by Skip McKinnell

Le Musée Océanographique de Monaco.

If anywhere in the world there is a cathedral to oceanography, it must certainly be *le Musée* in Monaco. Names of the earliest research vessels, *Challenger*, *Vityaz*, *Albatross*, and others adorn its exterior. Its halls tell the stories of nearly two centuries of research on the sea. It was here that the organizers of the conference on "*The oceans in a high CO_2 world–II*" chose to convene their second major symposium on this increasingly important topic from October 6–9, 2008.

Under the High Patronage of His Serene Highness Prince Albert II, 220 scientists from 32 countries assessed what is known about ocean acidification impacts on marine chemistry and ecosystems. The symposium was sponsored by the Scientific Committee on Oceanic Research (SCOR), the Intergovernmental Oceanographic Commission (IOC-UNESCO), the International Atomic Energy Agency's Marine Environmental Laboratory (IAEA-MEL) and the International Geosphere–Biosphere Programme (IGBP). They invited PICES and ICES to jointly organize a session on *Fisheries, food webs, and ecosystem impacts.* Each organization was asked to identify one invited speaker and to encourage contributed papers by scientists working under their auspices. PICES nominated Dr. Yukihiro Nojiri (National Institute of Environmental Science, Tsukuba, Japan), who gave an invited talk on "*An ocean acidification simulation experiment with benthic animals using a precise pCO_2 control system*" that he co-authored with Yoshihisa Shirayama, Hideshi Kimoto, Takeshi Egashira and Katsumoto Kinoshita. They described a new technology under development that will allow controlled experiments on calcifying organisms. The PICES contributed paper selected by the organizers for oral presentation was "*Salmon pHishing in the Northeast Pacific: An archaeological dig in the North Pacific survey data (1956–1964)*" that was prepared by Skip McKinnell, James Christian (Co-Chairman of PICES' Section on *Carbon and Climate*), Nancy Davis, and David Mackas (member of PICES' Biological Oceanography Committee). The northern North Pacific is one of a few regions in the World Ocean where the aragonite saturation horizon is relatively shallow. Below this horizon, aragonite shells dissolve when exposed to seawater. Richard Feely and colleagues have found aragonite-undersaturated waters on the North American continental shelf. Recognizing that several species of Pacific salmon are known to eat pteropods, especially *Limacina helicina* (a shelled mollusc that is part of the holoplankton), Skip McKinnell and his co-authors reviewed where and when pteropods are important prey for salmon. For example, a modelling study published in 2005 by Kerim Aydin, Gordon McFarlane, Jacquelynne King, Bernard Megrey and Katherine Myers in the PICES special issue on *Linkages between coastal and open ocean ecosystems* in *Deep Sea Research II* (Vol. 52, Nos. 5–6) suggests that pteropods can be very important to pink salmon in the Gulf of Alaska near Station Papa in winter.

The Conference Room at Musée Océanographique de Monaco.

Within PICES, the Section on *Carbon and Climate*, currently chaired by Drs. James Christian (Canada) and Toshiro Saino (Japan), has the main responsibility for promoting and coordinating international research on ocean acidification in the North Pacific Ocean.

Dr. Skip McKinnell (mckinnell@pices.int) is Deputy Executive Secretary of PICES, and all he asks for is a tall ship and a star to steer her by.

Coping with Global Change in Marine Social–Ecological Systems: An International Symposium

by R. Ian Perry, Samuel Pooley, Mitsutaku Makino and Rosemary Ommer

Humans are integral components of marine social–ecological systems, not "exogenous" to an otherwise "natural" ecosystem. Such systems have marine (including physical–biological) and human (including cultural, management, economic, and socio–political) components which are highly inter-connected and interactive. Changes in marine ecosystems have impacts on, and consequences for, the human communities that depend on these systems, and *vice versa*, and how these human communities respond to changes in their environment can have reciprocal impacts on marine ecosystems. However, "natural" marine ecosystems are usually studied separately from their human components, and by different scientific disciplines with different scientific traditions (natural scientists, economists, social scientists, and humanists). Understanding the important issues and collaborating with other disciplines is essential for correctly interpreting the causes and dealing with the consequences of global changes in marine social–ecological systems, and for developing practical and successful methods for managing marine resources using ecosystem-based approaches (which is one of the goals of the PICES FUTURE program).

Meeting this objective was what an international symposium on "*Coping with global change in marine social–ecological systems*", co-sponsored by GLOBEC, Eur-OCEANS, and FAO, held July 8–11, 2008, at FAO Headquarters in Rome, Italy, was intended to achieve by discussing these issues in a truly inter-disciplinary fashion. The symposium was supported by PICES along with the Institut de Recherche pour le Développement (IRD, France), Institut français de recherche pour l'exploitation de la mer (IFREMER), the Scientific Committee on Oceanic Research (SCOR), the International Council for the Exploration of the Sea (ICES), the Integrated Marine Biogeochemistry and Ecosystem Research program (IMBER), the Social Sciences and Humanities Research Council of Canada (SSHRC), and the WorldFish Centre, and was endorsed by the International Human Dimensions Program (IHDP).

The central goals of the symposium were to share experiences across disciplines and to identify the key next steps and common elements and approaches that promote resilience of marine social–ecological systems in the face of global changes. This involved:

- exploring conceptual issues relating to social–ecological responses in marine systems to global changes;
- analysing case studies of specific examples of social–ecological responses in marine systems to significant environmental changes manifested locally;
- synthesising the work of natural and social scientists and building comparisons of social–ecological responses in marine ecosystems subjected to major environmental variability;
- developing innovative approaches to the use of science and knowledge in management, policy and advice; and
- identifying lessons for governance for building resilient social-ecological systems.

The symposium was highly successful, and achieved these goals. Over 150 people from 38 countries participated, and a broad range of disciplines was included, from marine biology and ecosystem modeling to fisheries economics and anthropology. The presentations and posters dealt with issues of economics, society, environment, and technology as these relate to coastal and ocean issues in the face of both social (*e.g.*, globalization) and natural (*e.g.*, climate) global changes. It was noted that wild capture fisheries are fundamentally different than other food production systems, and therefore, their responses to environmental and climate changes must be considered separately from those of terrestrial food production systems.

Participants at the Rome symposium: (from left) James McGoodwin, Svein Jentoft, Ian Perry and Fikret Berkes.

Keynote presentations (by Fikret Berkes, Bonnie McCay, Katrina Brown, and Judith Kildow) emphasized that fisheries are linked social–ecological systems which require a humans-in-ecosystems approach. Including people leads to the recognition of larger and more complex "communities" (*e.g.*, of fish and fishers) which include exploiters, drivers, disrupters, and participants in, and agents of, change. The interactions among multiple social, economic, and environmental stressors are particular challenges (as underlined by recent rises in fuel prices) and suggest that a resilience perspective focused on adaptive capacity would be a useful approach. There was also discussion that we should move from the narrowly-defined government regulatory approach to include broader concepts of governance to deal with these complex systems. One keynote speaker suggested that the solution does not lie with "more technology" but with humans, such as clear understanding of the *interactive* nature of the

issues, effective scientific communication, and public education and engagement.

The final panel and summary session pointed out that not all global changes will be negative, that there will be winners and losers, and that some industrial development strategies, intended to reduce poverty in fishing communities, may inadvertently undermine their economic basis and make their poverty worse. It was also noted that exposure, resilience and susceptibility vary immensely in terms of spatial scale, and that one framework and policy response may not apply to all situations. In which case, the important question is how can policies be developed which are flexible and support a wide range of adaptation situations? Fisheries stock assessments, it was noted, have yet to fully integrate the environment, climate change, ecology and human behavior into their models and management recommend-dations. This is a critical step in the implementation of science-based ecosystem approaches and should be a priority. Thus, continued development of models will remain very important, as will continued synthesis and integration of the work of natural and social scientists.

Several presentations noted that, although life is mostly lived locally, we must continue to think globally, while remembering that most fishers' perspectives are decidedly local, and their lives are embedded in the particular local environment in which they live. There were calls to promote international cooperation and support to help humanity face the challenges posed by global change. It was also emphasized that a coordinated world-wide system to monitor global changes needs much additional development. New conventions may also be needed to help the world's nations to cooperatively engage in problem solving and coping with global change—in particular, as it impacts marine environments. Organizations and programs such as PICES, ICES, FAO, UNEP, GLOBEC, and others can play important leadership roles to bring about this enhanced international cooperation.

The participation at this symposium by both "natural" and "social" scientists, who do not normally meet together, and discussions during breaks and in the evenings, was extraordinary. As one of the members of the Closing Panel (Mitsutauku Makino, Japan) commented, the symposium poster represented a good balance of the topics of the symposium: 4 people and 3 and a half fish! The symposium demonstrated the significance and timeliness of the topic of this symposium. Several comments were made that a follow-up symposium should be held in a few years, perhaps devoted to more specific topics. There is great scope for continued progress in studying such coupled marine social–ecological systems. Publication of the symposium proceedings, in both an edited book and a special issue of the journal *Marine Policy*, is planned for the near future. Further information about the symposium, including links to the presentations and posters, is available on the symposium website at http://www.peopleandfish.org.

Dr. Ian Perry (Ian.Perry@dfo-mpo.gc.ca) is a fisheries oceanographer with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, BC, Canada. His research expertise includes the structure and function of marine ecosystems, developing ecosystem-based approaches to marine resources management, and the human dimensions of marine ecosystem changes. Ian is currently the Chairman of the international Global Ocean Ecosystem Dynamics (GLOBEC) program, and is a former Chairman of the PICES Science Board.

Dr. Samuel Pooley (samuel.pooley@noaa.gov) is Director of NOAA's Pacific Islands Fisheries Science Center in Honolulu, Hawaii. An economist, Sam has worked in the inter-disciplinary setting of a marine science laboratory for most of his career. He received his Masters in Economics from the University of Birmingham in England, and his Doctorate in Political Science from the University of Hawaii. Sam has written papers on bio-economic modeling, limited entry fisheries, and cooperative approaches to fisheries management, amongst other matters. He also serves as the United States government representative on the PICES Governing Council.

Dr. Mitsutaku Makino (mmakino@affrc.go.jp), M.Phil. (Cambridge), M.A., Ph.D. (Kyoto), is a researcher with the Fisheries Research Agency of Japan, specializing in fisheries and ecosystem-based management policy analysis. He is a member of PICES WG 19 on Ecosystem-based Management Science *and is involved in many other international scholarly programs such as those of the Food and Agricultural Organization of the United Nations (FAO), Asia Pacific Fisheries Committees (APFIC), World Fisheries Congress (WFC),* etc. *He teaches at several universities in Japan, and currently serves as an editor of the Japanese* Journal of Fisheries Economics.

Dr. Rosemary Ommer (ommer@uvic.ca) is Director of the Institute for Coastal and Oceans Research at the University of Victoria, Canada. She led the Canadian Coasts Under Stress program which examined human and coastal community responses to natural and social changes. Rosemary has been the Research Director of the Institute of Social and Economic Research at Memorial University, Director of the Calgary Institute for the Humanities at the University of Calgary, a member of the GLOBEC Scientific Steering Committee and its Executive Committee, and co-chairs GLOBEC's Focus 4 on the human dimensions of marine ecosystem changes. She was a Co-Convenor of this symposium in Rome.

The State of the Western North Pacific in the First Half of 2008

by Shiro Ishizaki

Sea surface temperature

Figure 1 shows the monthly mean sea surface temperature (SST) anomalies in the western North Pacific from January to June 2008, computed with respect to JMA's (Japan Meteorological Agency) 1971–2000 climatology. Monthly mean SSTs are calculated from JMA's MGDSST (**M**erged satellite and *in-situ* data **G**lobal **D**aily **SST**), which is based on NOAA/AVHRR data, microwave sensor (AQUA/AMSR-E) 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.

In January and February, SSTs were above normal in the area between 15°N and 35°N. In particular, positive SST anomalies exceeding +1°C were found around 25°N, 130°E and east of 150°E, and the latter anomalies remained until June. In March, SSTs were below normal in the seas south of Japan (*e.g.*, Regions 6 and 9 in **Fig. 2**), and negative SST anomalies exceeding –1°C appeared in April. In May and June, negative SST anomalies were also found in the seas east of the Philippines. From January to April, SSTs were below normal in the seas southeast of the Kamchatka Peninsula, where SST anomalies turned positive in May.

Kuroshio and Oyashio

Figure 3 shows the Kuroshio path for the first half of 2008, at intervals of 10 days. In January, the Kuroshio took a meandering path off Tokai (135–140°E). In February, it began to follow a straight path in the same area, and in mid-April returned to a meandering path off Tokai. In May and June, the Kuroshio flowed south of Hachijo Island (33°N, 140°E).

Figure 4 presents the subsurface temperatures at a depth of 100 m in the seas east of Japan for March 2008. This chart is based on the numerical ocean data assimilation system (JMA's Ocean Comprehensive Analysis System).

The Oyashio cold water (defined as areas with temperatures of less than 5°C in **Fig. 4**) is known to extend southward in spring and return northward from summer until autumn (indicated by the green line in **Fig. 5**). In September, November and December 2007, the coastal branch of the Oyashio cold water was indistinct, but it extended almost to its normal location in March 2008 and moved significantly northward in May (**Fig. 5**). Its southernmost point in March was 39.0°N, 142.5°E, which is 50 km north of its normal location.

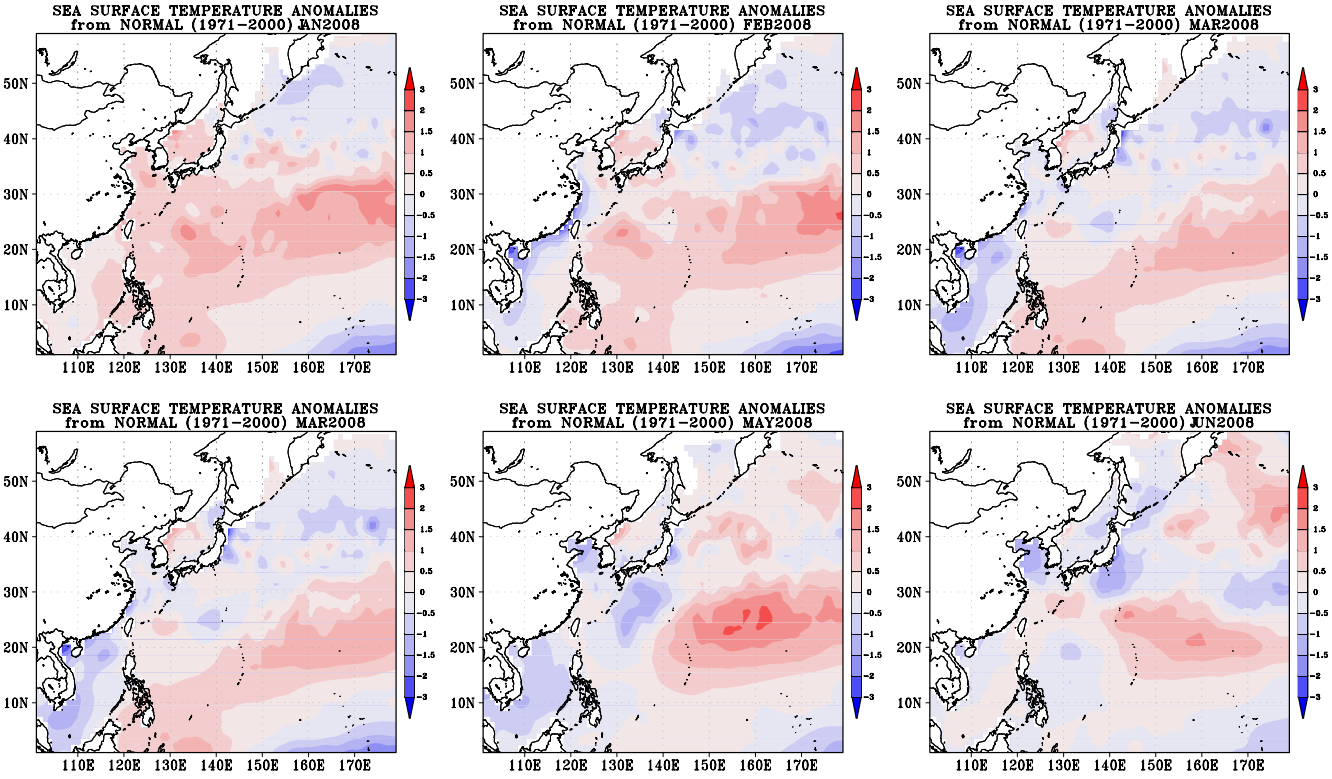


Fig. 1 Monthly mean sea surface temperature anomalies (°C) from January to June 2008. Anomalies are deviations from JMA's 1971–2000 climatology.

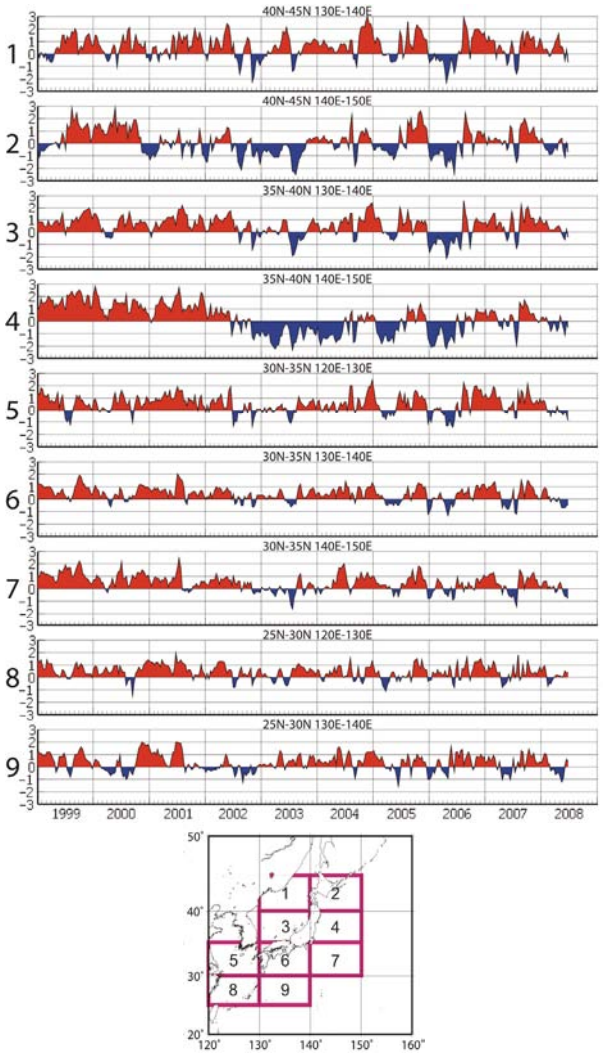


Fig. 2 Time series of 10-day mean sea surface temperature anomalies (°C) averaged for the sub-areas shown in the bottom panel. Anomalies are deviations from JMA's 1971–2000 climatology.

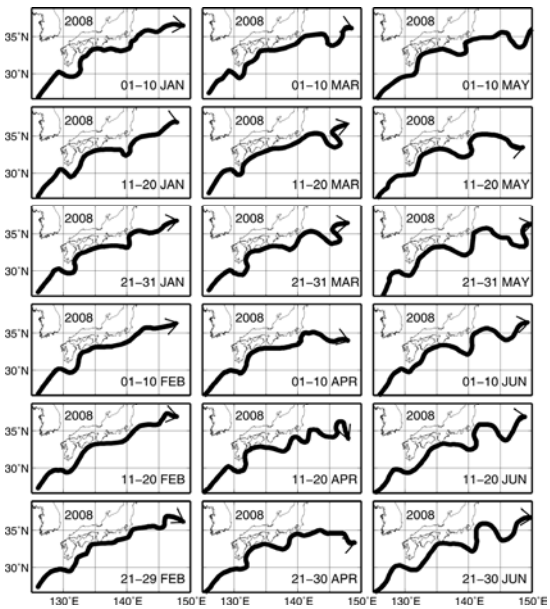


Fig. 3 Location of the Kuroshio path from January to June 2008.

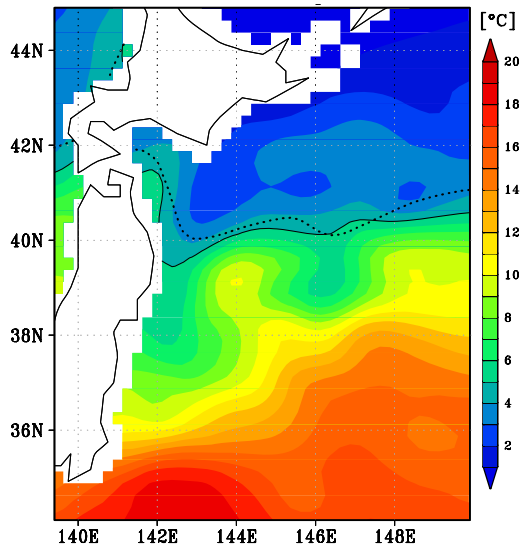


Fig. 4 Subsurface temperatures (°C) at a depth of 100 m east of Japan for March 2008. The solid line denotes the 5°C isotherm, while the dotted line is its climatology (30-year average values from 1971 to 2000).

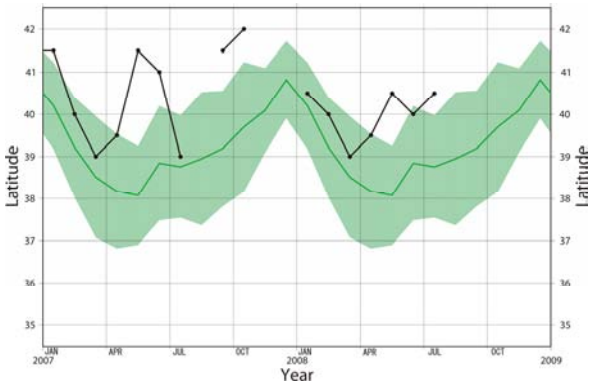


Fig. 5 The southernmost position of the coastal branch of the Oyashio cold water from January 2007 to July 2008 (black line), and the 30-year average values (green line), with a range of one standard deviation (green shading) from 1971 to 2000. In September, November and December 2007, no distinct coastal branch was detected.

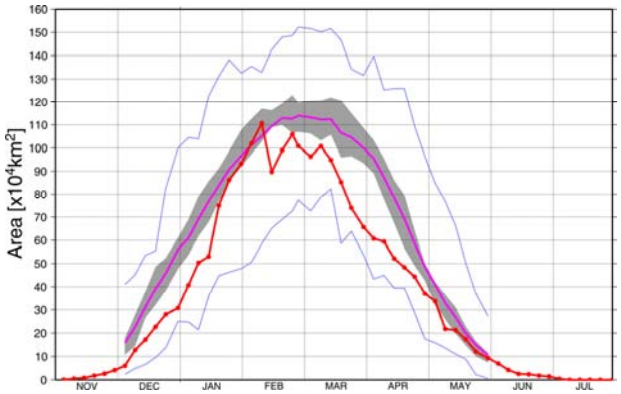


Fig. 6 Time series of sea ice extent in the Sea of Okhotsk from November to July 2008 (red line: 2007–2008 analysis; pink line: JMA's 1971–2000 climatology; blue lines: maximum/minimum sea ice extent since 1971; gray area: normal range).

(*continued on page 39*)

State of the Northeast Pacific through 2008

by William Crawford and Skip McKinnell

Anomalous winds during the winter of 2007/08 are shown by black arrows in **Figure 1a**. The center of the North Pacific High (NPH) moved westward of its normal position, bringing northerly (weaker southerly) winds near the coast. The Aleutian Low (AL) was eastward of its normal winter location so anomalously strong westerly winds persisted between the AL and the NPH. Ekman flow to the right of these prevailing anomalies could have set up cool sea surface temperatures (SST) in the mid Gulf of Alaska and upwelled cool water along the continental margin (see negative anomalies in **Figure 1b**). Positive SST anomalies formed close to the center of the NPH, likely due to Ekman divergence of surface waters under this high pressure system. The winter SST anomalies generally persisted into summer 2008 despite a change in direction of wind anomalies from winter to summer (comparing **Figures 1a and 1c**). The line of zero temperature anomaly in the mid Gulf of Alaska moved somewhat to the south, perhaps in response to anomalous westerly winds in this region. A tongue of warm water moved toward the northwest by September 2008 (**Fig. 1d**), and can be attributed to the reversal of direction of wind anomalies here from winter to summer.

The mesoscale Sitka and Haida eddies that form every winter were much weaker than normal in 2008, due to stronger westerly winds in winter, and ensuing lower sea levels along Canada and Alaska. The absence of these eddies is noted in **Figure 2**. Similar images of most previous winters reveal more closed contours of sea surface height anomalies (SSHA) in the northeast Gulf of Alaska. Also evident in **Figure 2** is the northward movement of low chlorophyll water between spring and summer in mid ocean, an April bloom in the northern Gulf and along the Canadian and Alaskan margins, and coastal plumes along the continental United States. These two images, whose SSHA are levelled to the Foreman *et al*. (2008) sea surface, are able to represent absolute sea surface height anomalies accurately, and therefore, reveal the strong tendencies for chlorophyll contours to track SSHA contours in most regions.

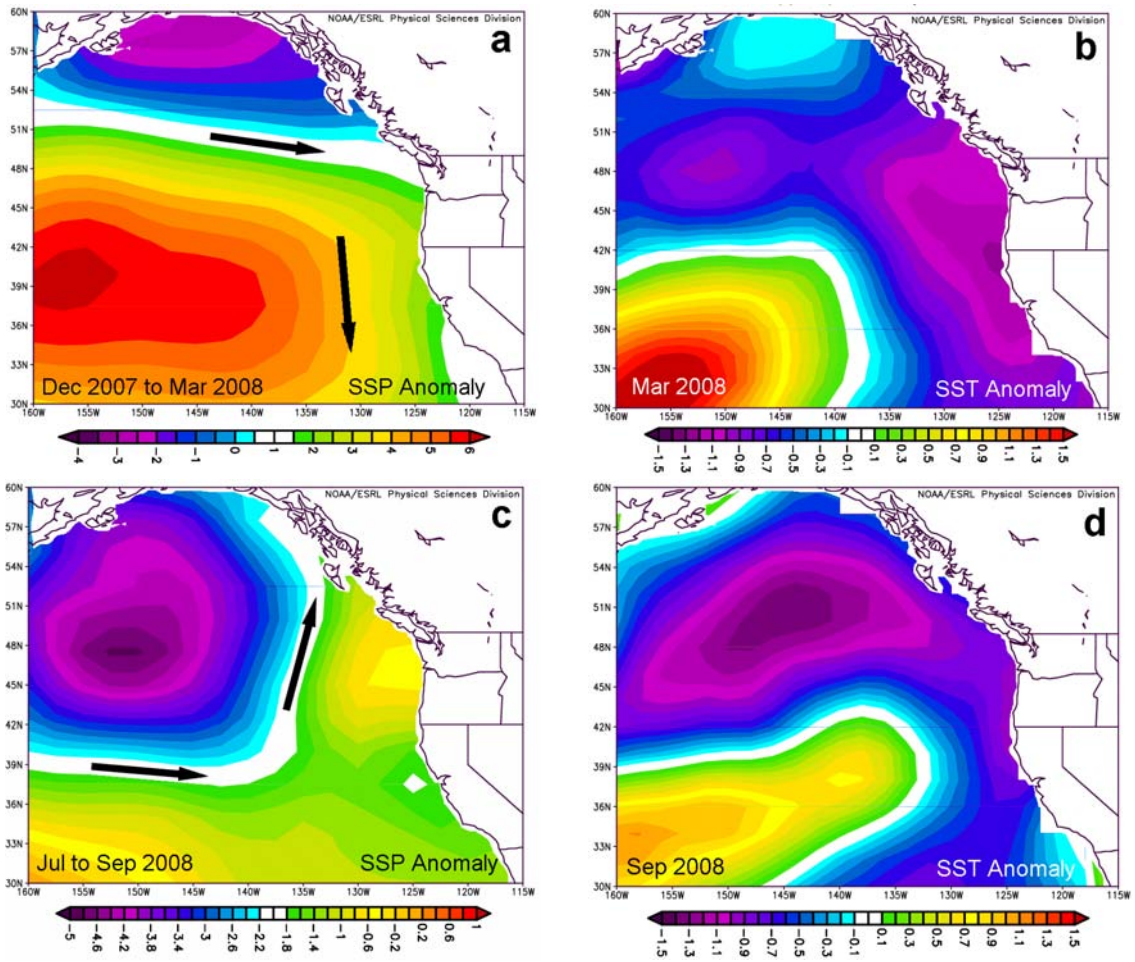


Fig. 1 Anomalies of sea surface pressure (SSP) and sea surface temperatures (SST) in winter and summer of 2008 in the Northeast Pacific Ocean. Images are from NOAA/ESRL Physical Sciences Division (http://www.cdc.noaa.gov/cgi-bin/Composites/printpage.pl).

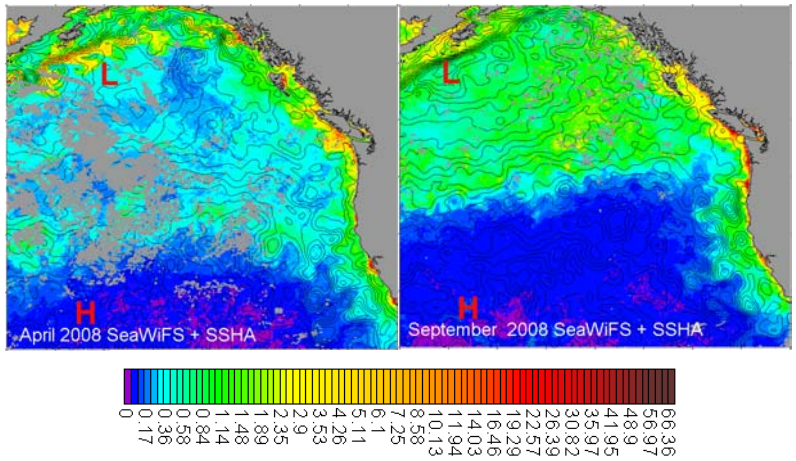


Fig. 2 Monthly composites of sea surface chlorophyll in April and September 2008, as measured by SeaWiFS, plotted over contours of sea surface height anomaly. Colour scale for chlorophyll in mg m $^{-3}$ is at the bottom of the figure. SeaWiFS data provided by NASA. Black contours of sea surface height anomaly (SSHA) are at intervals of 5 cm. Lowest and highest sea levels are indicated by L and H. SSHA for this image is based on data provided by AVISO, and referenced to the dynamic ocean topography of Foreman et al. *(*Geophys. Res. Lett. *2008, L22606) that resolves sharp changes in sea level in the continental margin.*

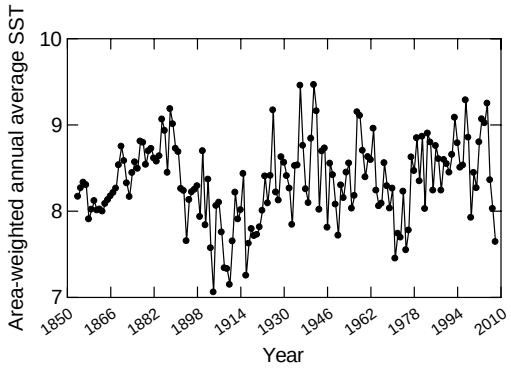


Fig. 3 Annual area-weighted average of SST in the Gulf of Alaska (1854–2008).

The surface of the Gulf of Alaska was cold in 2008. An area-weighted annual average SST, computed from the NOAA/Extended Reconstructed SST database, in the region 50–60°N, 165°W–coast, reveals that 2008 was the tenth coldest year in the Gulf of Alaska since 1854 (**Fig. 3**). The final month of 2008 had the highest value of a North Pacific Index (not shown, but calculated from NOAA/NCEP (National Center for Environmental Prediction) sea level pressure data after Trenberth and Hurrell, 1994) observed in any December since the beginning of the NCEP re-analysis period in 1948.

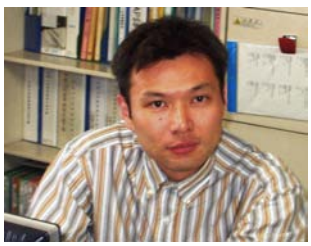
Dr. William (Bill) Crawford (bill.crawford@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada, at the Institute of Ocean Sciences. He co-chairs the Fisheries and Oceanography Working Group that prepares the annual State of the Ocean Report for Canada's Pacific Region and neighbouring waters.

Dr. Skip McKinnell (mckinnell@pices.int) helps out when he can. He is the Deputy Executive Secretary of PICES and currently an Editor-in-Chief of the PICES North Pacific Ecosystem Status Report that is scheduled for publication in 2010.

(*continued from page 37*)

Sea ice in the Sea of Okhotsk

The extent of sea ice in the Sea of Okhotsk was below normal (30-year average values from 1971 to 2000) throughout almost the whole period from December 2007 to May 2008 (**Fig. 6**). It reached its seasonal maximum of 110.69×10^4 km^2 on February 10, exceeding the highest value for the previous season. The accumulated sea ice extent, defined as the sum of the 5-day sea ice areas from December to May, was 2058.54×10^4 km^2. This was smaller than the previous season, and its ratio to the normal value (1971–2000 average of 2574.3×10^4 km^2) was about 80%.



Shiro Ishizaki (s_ishizaki@met.kishou.go.jp) is a Scientific Officer of the Office of Marine Prediction at the Japan Meteorological Agency (JMA). He works as a member of a group in charge of oceanic information in the western North Pacific. Using the data assimilation system named "Ocean Comprehensive Analysis System", this group provides an operational surface current prognosis (for the upcoming month) as well as seawater temperature and an analysis of currents with a 0.25 × 0.25 degree resolution for waters adjacent to Japan. Shiro is now involved in developing a new analysis system for temperature, salinity and currents that will be altered with the Ocean Comprehensive Analysis System.

The Bering Sea: Current Status and Recent Events

by Jeffrey Napp

Current status of the Bering Sea ecosystem

The Bering Sea remained cool through the second half of 2008, with a substantial cold pool over the eastern Bering Sea shelf during summer (**Fig. 1**). The relatively low summer sea surface temperatures enabled the moderately rapid cooling of the shelf during the fall of 2008. At the time of this writing (early January 2009), 90% of sea ice has penetrated the coastal regions of inner Bristol Bay and over the middle and outer shelf. The ice edge is just south of 60°N at about 170°W (*i.e.*, at about the latitude of Cape Newenham). Drift vectors for the ice are headed east south east at about 15 nautical miles per 168 hr. Thus, 2008 was one of the most extensive ice years since the very cold period of the early 1970s, and was the third year in a row where both winter and summer conditions were cold relative to recent years (**Fig. 2**).

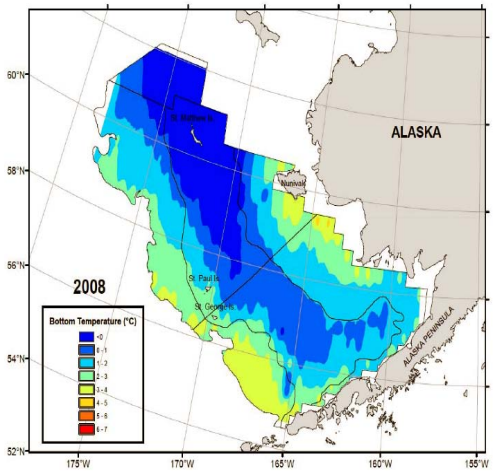


Fig. 1 Bottom water temperatures over the eastern Bering Sea shelf collected by NOAA's Alaska Fisheries Science Center (AFSC) during summer bottom trawl fish and crab surveys. The cold pool (water < 2°C) extended over most of the shelf. Figure courtesy of R. Lauth (NOAA-Fisheries, AFSC, RACE Division).

For the reviewed period, the sea surface temperatures (SSTs) of the entire Bering Sea and Sea of Okhotsk have either small positive or small negative anomalies, while SST anomalies off the west coast of North America were more strongly negative (**Fig. 3**). The monthly Pacific Decadal Oscillation index, (PDO, first EOF of North Pacific SSTs) was strongly negative from April through November 2008. The Multivariate ENSO Index (www.cac.noaa.gov/ENSO/ enso.mei_index.html) has been negative from July/August to the present, although equator SST anomalies were slightly positive from August to November, indicating that the former La Niña conditions at the equator that have persisted for the past 2 years have not completely disappeared. Given cold temperature anomalies and sea ice conditions in the Bering Sea, the coincidence of cold temperature anomalies throughout the North Pacific, and strong negative PDO since spring 2007, we do not anticipate that the Bering Sea is ready to shift back to warmer conditions within the next year.

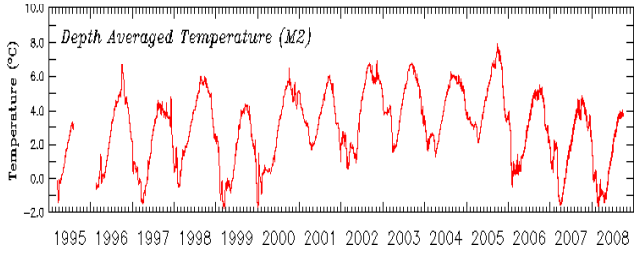


Fig 2 Average water column temperature for the last 14 years over the southeastern middle shelf. Temperatures measured at NOAA's mooring M2 (56.9°N, 164.1°W). Note that the maximum average water column temperature during the summer of 2008 (~ 4 °C) was one of the lowest during recent years. Data courtesy of P. Stabeno (NOAA's Pacific Marine Environmental Laboratory).

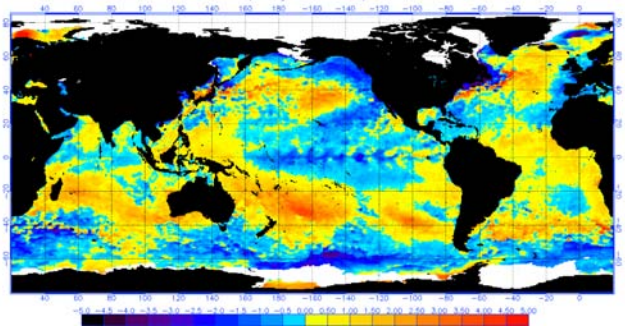


Fig. 3 NOAA/NESDIS sea surface temperature anomalies for January 5, 2009. White areas in the Bering Sea denote sea ice. Source: www.osdpd.noaa.gov/PSB/EPS/SST/data/anomnight.1.5.2009.gif.

Arctic IPY research

March 2007 to March 2009 was designated International Polar Year (IPY) by the International Council for Science (ICSU) and the World Meteorological Organization (WMO). Within PICES, scientists reported on their IPY activities during the workshop on "*Status of marine ecosystems in the sub-arctic and arctic seas - Preliminary results of IPY field monitoring in 2007 and 2008*" at the 2008 PICES Annual Meeting in Dalian, China. The workshop was sponsored by the MONITOR Technical Committee and ESSAS (a GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas). Presentations were made by scientists from most PICES member countries: Canada, China, Japan, Russia, and the United States. There were also invited talks from Great Britain and Norway. The workshop featured a great diversity of research subjects and approaches to the IPY studies, with a common theme of understanding the potential impacts of sea ice loss. It was encouraging to see the amount of effort that

PICES scientists were expending on IPY research in the waters north and south of Bering Strait. Copies of their presentations are available on the PICES website at http://www.pices.int/publications/presentations/default.asp. One of the presenters, Dr. Kohei Mizobata (Tokyo University of Marine Science and Technology, Japan) won the Best Presentation Award from the MONITOR Technical Committee for the paper entitled "*Japanese IPY activities in the western Arctic Ocean and the Bering Sea*" co-authored by K. Mizobata, K. Shimada, S. Saitoh, T. Hirawake and M. Hori.

BEST/BSIERP activities in 2008

The Bering Ecosystem Study (BEST) and Bering Sea Integrated Ecosystem Research Program (BSIERP) have been working hard to synthesize results from their first full field year (2008) in the eastern Bering Sea. Principle Investigators met twice this fall, once in October 2008 in Girdwood, Alaska, and again this January in Anchorage, Alaska. The result of the meetings was a compilation of "headlines" for each of the following five major themes or cardinal hypotheses that are used to organize the individual projects of the two programs:

- Climate-induced changes in physical forcing will modify the availability and partitioning of food for all trophic levels through bottom-up processes;
- Climate and ocean conditions influencing water temperature, circulation patterns and domain boundaries will impact fish reproduction, survival and distribution, the intensity of predator–prey relationships and the location of zoogeographic provinces through bottom-up processes;
- Later spring phytoplankton blooms are a result of early ice retreat and will increase zooplankton production, thereby resulting in increased abundances of piscivorous fish (pollock, cod, and arrowtooth flounder) and a community controlled by top-down processes (Oscillating Control Hypothesis);
- Climate and ocean conditions influencing circulation patterns and domain boundaries will affect the distribution, frequency, and persistence of fronts and other prey-concentrating features and thus the foraging success of marine birds and mammals largely through bottom-up processes;
- Climate–ocean conditions will change and thus affect the abundance and distribution of commercial and subsistence fisheries.

Each headline provides a new research result from this year and a figure describing this result (for example see **Fig. 4**). The results cover studies from physics to seabirds, and marine mammals, as well as humans, that rely on the ecosystem. These headlines will be publically available on the North Pacific Research Board website (bsierp.nprb.org/) by the time this issue of *PICES Press* is published, so that others can learn about conditions during 2008 (observation and process studies) as well as what progress has been made on retrospective studies, modeling and forecast capabilities.

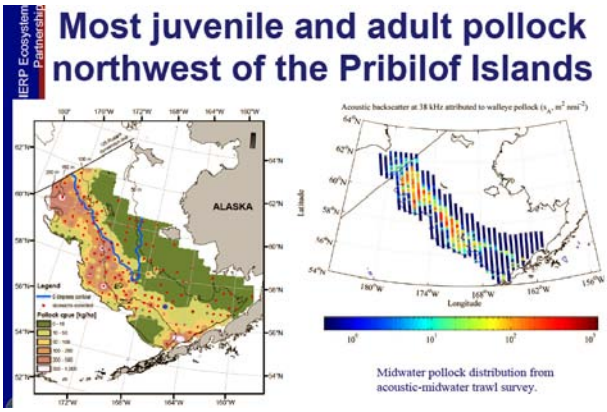


Fig. 4 One example of the many "headlines" from the 2008 BEST/BSIERP research effort in the eastern Bering Sea. This particular example is courtesy of C. Wilson and R. Lauth (NOAA-Fisheries, AFSC, RACE Division) and describes the summer distribution of walleye pollock based on the annual groundfish bottom trawl survey and the biennial mid-water acoustic assessment.

Bering Sea activities in 2009

Cruise and ship opportunities in 2009 are likely to be very similar to what occurred during 2008. BEST/BSIERP will continue to have several eastern Bering Sea spring ice breaker cruises and a mid-summer cruise aboard a U.S. UNOLS (University–National Oceanographic Laboratory System) vessel. The Alaska Fisheries Science Center intends to conduct its annual summer shelf groundfish bottom trawl survey. The biennial mid-water fish assessment will be in the Bering Sea again to support BEST/BSIERP, not the Gulf of Alaska, as it would normally. Other NOAA investigations of interest are: a July/August cruise with an autonomous underwater vehicle to look at skate nursery areas, a spring ice seal survey that will utilize unmanned aircraft systems to assess ice seal distribution and abundance (www.afsc.noaa.gov/nmml/polar/research/uastests.php) and an intensive look at the ecology of the endangered North Pacific right whale (Pacific Right Whale Evaluation Study, *aka* PRIEST, www.afsc.noaa.gov/Quarterly/jas2008/divrptsNMML3.htm) during August.

The RUSALCA (Russian–American Long Term Census of the Arctic) hydrographic, plankton and fisheries cruise, cancelled in 2008, is scheduled for late August 2009, to work in the northern Bering and Chukchi Seas. The T/S *Oshoro-maru* (Hokkaido University, Japan), winner of the first PICES Ocean Monitoring Service Award (POMA) will again spend summer in the Bering Sea. The R/V *Mirai* (JAMSTEC, Japan) will work in the western Arctic from late summer through early fall (www.iarc.uaf.edu/highlights/2007/chukchi_sea_cruise_07/). If there are major expeditions by other PICES member countries, please write to me and let me know so that I can include them in my next column.

(*continued on page 43*)

An Opinion Born of Years of Observing Timeseries Observations

by Skip McKinnell

It is common practice in our business to present an idea to an audience with a graphic that features a time-ordered sequence of observations, a timeseries. It is argued frequently that some pattern of temporal variation in one particular timeseries is caused by variation in some other timeseries of observations, based on real or imagined interconnections between them. Likewise, it may be argued that two timeseries share a similar history as a consequence of variation caused by some third timeseries. Regardless of the argument made, its evaluation and interpretation rests squarely on the similarity of the timeseries under consideration. The methods used to make such comparisons are the subject of this opinion.

Most of us can recognize a typical timeseries (**Fig. 1**). Time appears on the abscissa, while some variable of greater interest appears on the ordinate. Each value is plotted at a time that corresponds to when the observation was made; often a line is drawn to connect them in sequence. Less often, variable magnitudes are represented by the heights of vertical bars. Trends, cycles, periodicity, or step shifts reveal themselves if they are the dominant features of a timeseries.

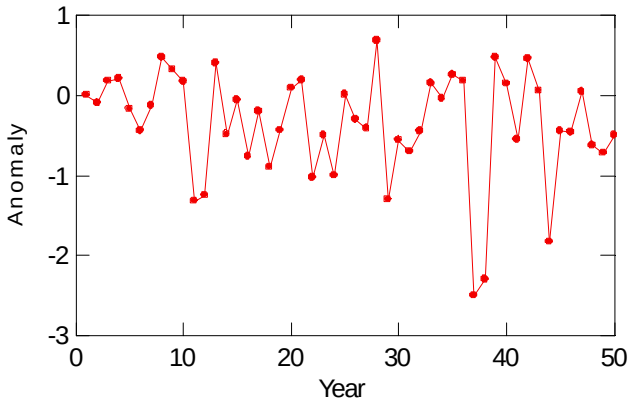


Fig. 1 A timeseries of 50 years duration.

At issue, however, is the best way to compare two (or more) timeseries that may have one or more of these characteristic patterns. Unfortunately, the most common practice for displaying variation in one timeseries has been adopted as common practice for displaying variation in two or more, by superimposing all on one abscissa. It is this practice that I hope will become less common in future for the reasons that I will describe in more detail.

In the simple case of comparing two timeseries, four outcomes are possible when two variables are measured at the same time. The two values may diverge (one increases while the other decreases), or they may converge (one value increases and one decreases), or both can increase, or both can decrease. In climate or ecological timeseries plots, where longer is almost always better, a 50-year series of annual values is not uncommon nor is a 50-years series of monthly values (n = 600).

In a 15 or 20 minute oral presentation most graphics can stay on the screen for only 45–60 seconds. How is it possible for an observer to make an assessment of the pattern of co-variation, if four outcomes are possible at each time step? One's ability to understand some argument is based on one's ability to interpret the pattern co-variation across 50–600 observations, each one having at least 4 potential outcomes. Furthermore, the similarity of two timeseries is based not only on how often they both do the same thing (in phase), but also how often they do the opposite (out of phase). In a 50-year timeseries of annual values, for example, there are 50 comparisons with 4 possible outcomes at each step. Should their variances be unequal, the problem is compounded by one series occupying more of the "visual real estate" on a graph than another.

Perhaps I am slowing, but I cannot make this judgment in the 45 seconds allowed by most speakers. At best, I might notice that a couple of outliers in the two series occurred at the same time and perhaps with similar magnitude. I may also notice that both share some low-frequency pattern that may or may not be offset by some lag. Regardless, the main point is that my eye must make 50–600 comparisons in a very short period of time, and my brain is simply not up to the challenge of processing anything but the gross-level co-variation in the two series. It is not, or should not be, a practice of science to give a speaker the "benefit of the doubt." It is our job to be critical of what is being presented. Fortunately, there is a better way to minimize the demands on those of us who are perceptively challenged—scatterplots!

Whether in phase or out of phase, timeseries observations that are in perfect synchrony (at zero lag) will, as a bivariate scatterplot, lie exactly along a diagonal line. Some might argue that two identical timeseries, when superimposed, will be indistinguishable. The difference in the two approaches becomes evident when the correspondence is less than exact. In a scatterplot, if two timeseries are highly correlated, the scatter of points forms a narrow diagonal ellipse. As two timeseries become less correlated, the shape and orientation of this ellipse changes; with no diagonal ellipse, there is no association. The extent to which they are correlated is immediately apparent by the extent of dispersion from a diagonal and the rotation off diagonal. The only demand on the brain to fully understand the degree of correspondence between two timeseries is to

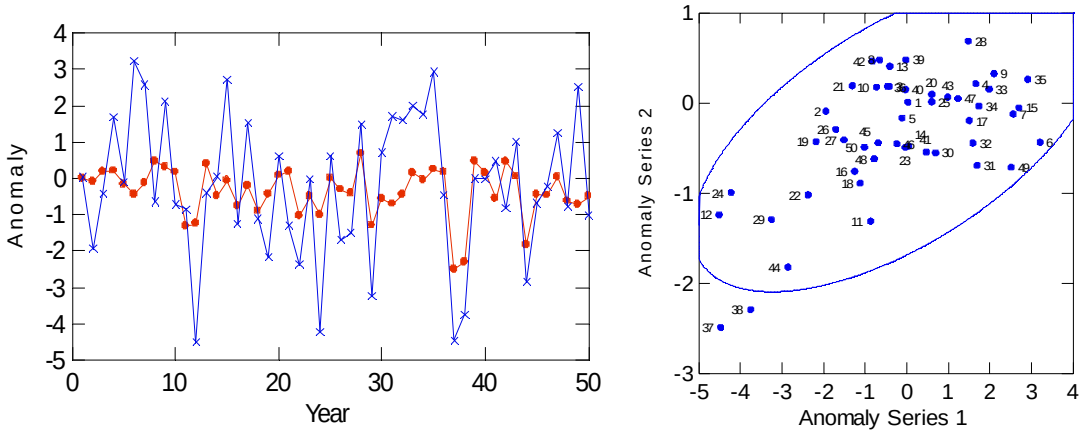


Fig. 2 Two arbitrary timeseries with a correlation of 0.61.

assess the nature of the dispersion pattern. Should there be additional value in showing the temporal order in a scatterplot, plot point labels can be added to indicate time. If the temporal evolution is also important, the points can be interconnected in sequence by a line.

The ability to assess a force and response of nature is particularly important if the arguments being made are causal in nature. In such cases, it is the outliers that become important. If you argue that it is colder when the wind blows by presenting timeseries observations of wind and temperature, most will judge the strength of your argument based on the presence or absence of departures from that model. A scatterplot immediately shows where the outliers can be found against the foundation of your argument—the diagonal running from upper left to lower right. If, in some years it is warm when the wind blows, these values will appear in the upper right quadrant of the figure. In timeseries plots, these outliers tend to be buried in the chatter of temporal variation so you need to look for them. This cannot be done easily in 45 seconds.

So, if you cannot completely give up on the concept of timeseries plots for inter-comparisons, please add a scatterplot on the side so that viewers are not left wondering about hidden outliers. The example in **Figure 2** shows that the relatively high correlation between these two timeseries is a consequence only of about 6 strong negative anomalies out of 50 points. There is no correlation between these timeseries in the other 44 points. This pattern is not revealed by the timeseries comparisons alone, particularly in the 45 seconds normally provided to make a judgment.

(*continued from page 41*)

New Bering Sea publication

A special volume of *Deep-Sea Research II*, "The Marine Ecosystem of the Pribilof Domain, Southeastern Bering Sea" edited by S.A. Macklin, Sharon Smith, Sue Moore and James Schumacher, was recently published (August 2008, Vol. 55, Nos. 16-17). The issue contains original research articles on aspects of ocean ecology from physics to halibut, seabirds and pinnipeds. An overview paper concludes the volume and integrates recent work from the southeastern shelf and updates our understanding about how a warmer Bering Sea might affect the abundance of zooplankton and the recruitment of fish, including walleye pollock.

Acknowledgements

Many thanks to the following PICEans who helped create this report: Drs. George Hunt, Jr., Kohei Mizobata, Robert Lauth, James Overland, Michael Sigler, Phyllis Stabeno, and Chris Wilson.

Dr. Jeffrey (Jeff) Napp (jeff.napp@noaa.gov) is a Biological/Fisheries Oceanographer at the Alaska Fisheries Science Center of NOAA–Fisheries. He is Head of the Recruitment Processes Program at the Center and co-leader (with Dr. Phyllis Stabeno) of NOAA's Ecosystems and Fisheries Oceanography Coordinated Investigations (EcoFOCI). His research is focused on physical and biological processes at lower trophic levels that affect recruitment variability in fish populations. Jeff was active as a Principal Investigator in past Bering Sea research programs (NOAA's Bering Sea FOCI, Southeast Bering Sea Carrying Capacity), and currently is a Principle Investigator on an NPRB-sponsored Bering Sea Integrated Ecosystem Research Plan (BSIERP) project. He formerly served on the BEST (Bering Ecosystem Study) Science and Implementation Plan Steering Committee. Jeff is also a member of the PICES Technical Committee on Monitoring.

New Chairman for the PICES Fishery Science Committee

Dr. Mikhail A. Stepanenko was elected Chairman of the Fishery Science Committee (FIS) in October 2008, at the PICES Seventeenth Annual Meeting in Dalian, China.

Mikhail was born and raised in Primorye in the Russian Far East. During his childhood, he spent a lot of time at the local Ussuri River where he was introduced to aquatic life and sport fishing. He graduated from the Far East State University in Vladivostok in 1968 and was immediately employed by the Pacific Research Institute of Fisheries and Oceanography (TINRO). Mikhail has been working at this institute for 40 years and has been spending several months at sea for field research every year since 1969.

In 1969, TINRO started joint programs with the two science centers of NOAA's National Marine Fisheries Service, the Southwest Fisheries Science Center (SWFSC) in La Jolla and the Northwest Fisheries Science Center (NWFC) in Seattle, and Mikhail worked actively for these cooperative programs, including the California Cooperative Oceanic Fisheries Investigations (CalCOFI), until the early 1990s. In 1978, Mikhail received his Ph.D. degree in Fisheries Science. His thesis focused on biology, population dynamics, reproduction and effect of oceanographic conditions on spawning and recruitment of northern anchovy in the California Current System. His research on fishery resources off Washington, Oregon and California also involved Pacific hake and jack mackerel.

Since the early 1990s, Mikhail has been working on reproduction, population dynamics, stock assessment and fishery management of pollock in the Bering Sea, and has been actively involved in the international regulations of research and fisheries for this species. As a consultant at sea, he participated, in organizing large-scale pollock fisheries in Alaskan waters, and for improving their management.

In the 1980s, Mikhail, as a member of the Russian delegation, participated in several meetings leading to the establishment of PICES. Since Russia joined PICES in 1994, he has been serving on a number of expert groups, including the Technical Committee on Monitoring and FIS.

In addition to PICES, Mikhail is very active in several international organizations, such as the Convention on the Conservation and Management of Pollock Resources in the Bering Sea, Intergovernmental (Russia–U.S.) Consultative Committee and several other North Pacific international (bilateral) agreements.

Mikhail uses his scientific knowledge on marine biology to teach graduate students at the Far East State University and Vladivostok's School of Fisheries.

Dr. Gordon Kruse, outgoing FIS Chairman, leading discussion at the FIS Committee meeting at PICES XVII in Dalian.

PICES thanks Dr. Gordon H. Kruse (University of Alaska Fairbanks, U.S.A.) for his service to PICES as Chairman of the Fishery Science Committee since 2005. Dr. Kruse led the Committee's activities which included, among other things, involvement in the development of the Science Plan and the Implementation Plan for the new integrative scientific program of PICES, FUTURE (**F**orecasting and **U**nderstanding of **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems). He will continue to contribute to PICES as Vice-Chairman of FIS.

PICES PRESS

Published and produced by PICES Secretariat
P.O. Box 6000,
9860 West Saanich Road,
Sidney, B.C., Canada. V8L 4B2
Tel: 1 (250) 363-6366
Fax: 1 (250) 363-6827
E-mail: secretariat@pices.int
http://www.pices.int
ISSN 1195-2512