PICES Press

WINTER 2012
VOL. 20, NO. 1

Newsletter of the North Pacific Marine Science Organization

2011 PICES Science: A Note from the Science Board Chairman

2011 saw another busy year for the PICES community. PICES continued to demonstrate excellence in many areas for advancing marine science in the North Pacific. These included the co-sponsoring of meetings, publication of special issues in primary journals, planning and conducting capacity developments activities, facilitating international cooperation with other organizations and programs and, most of all, moving forward with FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems), the flagship scientific program of PICES.

To begin with, PICES co-sponsored many meetings and symposia during the year. Through the organization of these scientific meetings, the aim of PICES was not only to facilitate the exchange of ideas and information among scientists, but to develop international collaborations across disciplines, institutions, and national boundaries. Since last year's Annual Meeting in Portland (U.S.A.), PICES was extremely busy in making logistical and financial arrangements for more than 20 inter-sessional symposia, sessions, workshops and meetings convened at various locations around the North Pacific and the world at large. A major highlight was the 5th International Zooplankton Production Symposium on "*Population connections, community dynamics, and climate variability*" held in March 2011, in the scenic town of Pucón, Chile. PICES and ICES (International Council for the Exploration of the Sea) were the major sponsors along with COPAS (Center for Oceanographic Research in the Eastern South Pacific), Universidad de Concepción. Although most of the Japanese contingent was unfortunately unable to make the meeting due to the devastating tsunami that had occurred off Honshu just two days before the start of the symposium, almost 300 scientists from 36 countries were in attendance, making this event, only the second to be held outside of Europe, an outstanding success.

The Amur River encased in a golden glow at dusk.

In This Issue

ISSN 1195-2512

Participants of the Governing Council meeting posing in front of the Conference Hall in Khabarovsk: (front row, from left) Vladimir Radchenko (Russia), John Stein (U.S.A.), Lev Bocharov (Russia), Laura Richards (Canada), Chul Park (Korea), Hyun Taek Lim (Korea), Yukimasa Ishida (Japan) and Gongke Tan (China); (back row, from left) Alex Bychkov (PICES Secretariat), Igor Shevchenko (Russia), Patricia Livingston (U.S.A.), David Gillis (Canada), Darlene Smith (Canada), Kyung-Chul Lee (Korea), Yieren Li (China), Ungyul Yi (Korea), Yingren Li (China), Taro Ichii (Japan), Masaki Sugamiya (Japan), Oleg Katugin (Russia) and Dosoo Jang (Korea).

The Pucón symposium was followed in quick succession by the 2nd inter-sessional workshop of our FUTURE program (April), and then by the 2nd ESSAS (Ecosystem Studies of Sub-Arctic Seas) Open Science Meeting (May), with PICES providing organizational support and travel support for a number of early career scientists to attend the meeting. The FUTURE workshop on "*Indicators of status and change within North Pacific marine ecosystems*" focused on various issues related to ecosystem-level indicators and assessments, ecosystem resilience, and indicator uncertainty. Discussions eventually led to the formulation of a new FUTURE-related working group (see more on this group later in the article). A detailed account of the workshop can be found in the 2011 summer issue of PICES Press (Vol. 19, No. 2). In October, just prior to the 2011 PICES Annual Meeting, a joint PICES/ICES workshop on "*Development and application of Regional Climate Models (RCM)*" was held in Seoul, Korea. The workshop dealt with various aspects of regional climate modeling such as different approaches, downscaling, parameterizations, and coupling to General Circulation Models. It also covered the coupling of RCMs to ecosystem models. Discussions at the workshop guided the development of another new FUTURE-related working group (more on this group later in the article).

A standard way to keep a record of scientific findings from such meetings and other activities is through PICES publications. Highlights from primary journal issues in 2011 include:

- a special issue of the *ICES Journal of Marine Science* (Vol. 67, Is. 9) based on papers from the 2009 ICES/PICES/UNCOVER Symposium on "*Rebuilding depleted fish stocks: Biology, ecology, social science, and management strategies*" held in Warnemünde, Germany;
- a special issue of the *ICES Journal of Marine Science* (Vol. 68, Is. 6) based on papers from the 2010 PICES/ICES/FAO Symposium on "*Climate change effects on fish and fisheries*" held in Sendai, Japan;
- a special issue of *Fisheries Research* (Vol. 122, Is. 3) based on selected papers from the PICES-2009 Topic Session on "*Ecosystem-based approaches for the assessment of fisheries under data-limited situations*".

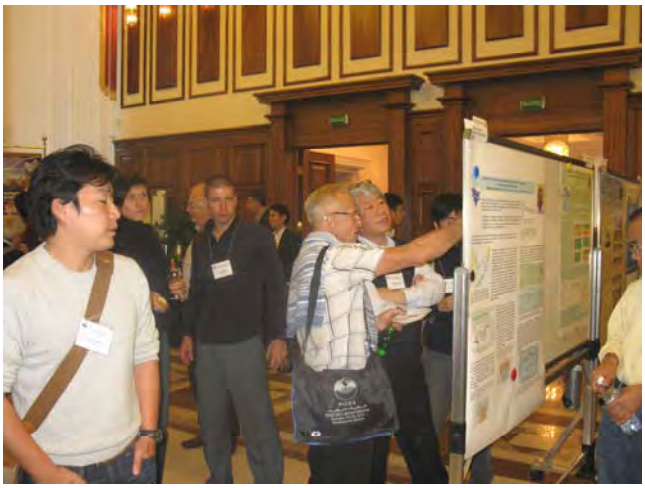
Several publications are expected in the near future from the 2011 meetings mentioned above. The development of a comprehensive non-indigenous species database and an atlas on non-indigenous marine and estuarine species in the North Pacific has been completed by Working Group on *Non-indigenous Aquatic Species*. The atlas has been peer-reviewed and is now ready to be published on-line. This vast assemblage of biological characteristics and global distribution of 700 non-indigenous aquatic species is 1,800 pages long. It is a major achievement of the Working Group and is an exemplary FUTURE product. In addition, other special publications are in progress and you will see more coming soon.

Fall foliage of the Amur River park near the main venue of the 2011 PICES Annual Meeting, Khabarovsk, Russia.

One of PICES' roles, as stated in the Convention and Strategic Plan of the Organization, is to respond to requests from the Contracting Parties and other organizations to provide advice on scientific issues. In 2010, the Canadian *Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River* asked PICES for advice on the status and trends of marine ecosystems where Fraser River sockeye are known to occur and on potential effects of recent ecosystem variability on their survival, distribution and migration. In response to this request, an advisory report on "*The decline of Fraser River sockeye salmon Oncorhynchus nerka (Steller, 1743) in relation to marine ecology*" was developed by a team that was led by Dr. Skip McKinnell and included Drs. Enrique Curchitser, Masahide Kaeriyama, Kees Groot and Katherine Myers. The report was presented to the Commission and is now available as Technical Report No. 4 at the Cohen Commission website (http://www.cohencommission.ca/en/TechnicalReports.php). This is an excellent example of a FUTURE product that engages with society.

Capacity building has always been a high priority issue for PICES, and we continued our many capacity building activities in 2011. The training workshop on "*Rapid assessment survey (RAS) methodologies for detecting non-indigenous marine species*", organized jointly with WESTPAC (IOC Sub-Commission for the Western Pacific), took place from July 19–21, 2011, in Phuket, Thailand. More than 25 researchers from 8 countries, mostly from Southeast Asia, participated in this event. Planning is in progress for another methodological RAS workshop in 2012, in collaboration with FRA (Fisheries Research Agency, Japan), NOWPAP (Northwest Pacific Action Plan) and WESTPAC. PICES also sponsored a training course on "*Remote sensing data analysis*", again with NOWPAP and WESTPAC, held October 8–12, 2011, in Vladivostok, Russia. The course, consisting of lectures by experts and hands-on tutorial sessions on analysis of satellite data to monitor and assess the coastal and marine environment, was attended by 22 trainees from 7 countries. Travel funds were provided for three early career scientists from PICES member countries (Canada, China and U.S.A.) to join the 5th SOLAS Summer School, a biennial, international event teaching a variety of fields, held from August 29 to September 10, 2011, in Corsica, France. PICES also supported the travel of eight graduate students and four postdoctoral fellows from Canada and U.S.A. to participate in the 7th International Conference on Marine Bioinvasions convened from August 23–25, 2011, in Barcelona, Spain. For the 2011 PICES Annual Meeting, more than 40 travel grants were provided to students and early career scientists.

Summing up scientific activities in 2011 was the Annual Meeting, PICES-2011, held October 14–23, 2011, in the picturesque city of Khabarovsk, Russia. The meeting was hosted by the Russian Federal Agency for Fisheries in cooperation with the government of the Khabarovsk Region and in coordination with the PICES Secretariat. Local arrangements were made by the Pacific Research Fisheries Centre (TINRO-Centre) and the Khabarovsk branch of TINRO-Centre. We thank Prof. Vyacheslav Shport, Governor of Khabarovsk Region, and Dr. Vasily Sokolov, Deputy Head of the Federal Agency for Fisheries, for giving opening remarks on behalf of the host country. The overall theme for PICES-2011 was "*Mechanisms of marine ecosystem reorganization in the North Pacific Ocean*", and the meeting covered a broad range of timely and very relevant marine science issues. About 330 scientists and managers from 17 countries and 28 international and regional organizations and programs attended 12 sessions, 4 workshops and 23 business meetings of our standing committees and their expert groups and presented about 200 talks and 140 posters.



A time to mingle as well as discuss science at the Poster Session.

Drs. Toshitaka Gamo, Tomoharu Senjyu, Joji Ishizaka and Toru Suzuki looking for directions to either a cultural event or a place to have a good beer.

It was with both great sadness and pleasure to announce that the 2011Wooster Award was given posthumously to Dr. Bernard Megrey who suddenly passed away in 2010. We will remember his great contributions to PICES and

fisheries science. The 2011 PICES Ocean Monitoring Service Award (POMA) went to the NFRDI Serial Oceanographic Observation Network (NSO), Korea. NOS has monitored the marginal seas of the Northwest Pacific for many decades since the 1920s, providing data with clear signals of regime shifts and warming. We also presented awards for best oral presentations and posters, and I encourage you to visit the PICES website (http://www.pices.int/publications/presentations/) to see who the worthy recipients were this year.

Mrs. Ronette Megrey accepting the 2001 Wooster Award on behalf of her late husband, Bernard.

The PICES Strategic Plan was originally developed and approved in 2004, and there has been an urgent need to update it in light of changes that have taken place since then, such as the implementation of our second integrative science program, FUTURE, and to ensure that the Plan reflects the vision of all Contracting Parties for the direction of PICES over the next 5–10 years. A revised draft of the Plan that has been prepared during the past year was finalized at PICES-2011. In the coming months, every PICES standing committee will revise its Action Plan to bring it in line with the new Strategic Plan.

WESTPAC observer, Dr. Apple Chavanich, listening attentively with Working Group on Non-indigenous Aquatic Species members, Drs. Hisashi Yokoyama and Takeo Kurihara, at the Working Group meeting during PICES-2011.

Taking aim during the host country's sporting event at the indoor rifle range at the Army Sport Club in Khabarovsk.

At PICES-2011, some leadership changes took place. Elizabeth Logerwell (U.S.A.) replaced Mikhail Stepanenko (Russia) as Chair of the Fishery Science Committee (FIS), and Xianshi Jin (China) replaced Gordon Kruse (U.S.A.) as FIS Vice-Chair. Won-Duk Yoon (Korea) replaced Young-Shil Kang as Co-Chair of the Working Group on *Jellyfish Blooms around the North Pacific Rim: Causes and Consequences*. I thank the outgoing Chairs and Co-Chairs for their dedicated service, and welcome the new Chairs onboard.

Two Chairs (Dr. Sinjae Yoo, Science Board and Dr. Lev Bocharov, PICES) enjoying the Closing Session.

As many of the scientific and capacity building issues addressed by PICES are not confined to the North Pacific, but are shared by other parts of the world, it is important to promote cooperation with other international scientific organizations and programs of regional and global scale. At PICES-2011, we discussed and approved joint activities and future plans for collaboration with ICES, IOC (Intergovernmental Oceanographic Commission of UNESCO), SCOR (Scientific Committee on Oceanic Research), IMBER (Integrated Marine Biogeochemistry and Ecosystem Research), WESTPAC, NOWPAP, LOICZ (Land-Ocean Interactions in the Coastal Zones), and SOLAS (Surface Ocean - Lower Atmosphere Study),

among others. I expect that cooperation with these and other international organizations and programs will continue to be strengthened. With ICES, in particular, PICES has been developing a framework for cooperation through a joint Study Group on *Developing a Framework for Scientific Cooperation in Northern Hemisphere Science* (SG-SP) since 2009. SG-SP prepared a draft plan, which was approved at the annual meetings of each organization. This was especially significant as it specifies a formal framework that will serve as the basis for linking ICES and PICES science plans, and for longer-term strategic planning between the two organizations.

Beside the exciting scientific exchanges and communication at the forum of the Annual Meeting, the most important progress made during PICES-2011 was the formation of new expert groups to advance FUTURE. Although FUTURE has been active into its second year, it still did not have enough workhorses. Earlier in 2011, two new working groups were established: Working Group on *North Pacific Climate Variability and Change* (WG 27) and Working Group on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (WG 28). At PICES-2011, the Governing Council, at the recommendation of Science Board, approved four more new expert groups: two sections, one working group and one study group.

The first one is the Section on *Climate Change and Marine Ecosystems* (S-CCME), which is a sequel to the joint ICES/PICES Working Group on *Forecasting of Climate Change Impacts on Fish and Shellfish* and will continue to be a joint effort of ICES and PICES. S-CCME's major goal is to perform a regional synthesis of future projections of ecosystem change and communicate research findings to the outside world. To do this S-CCME will use the global model outputs from the Intergovernmental Panel on Climate Change (IPCC) in making regional predictions which can, in turn, be incorporated into the next synthesis on the part of the IPCC. It will work with many expert groups within the FUTURE framework, acting at the same time as an interface with IPCC and ICES.

Two Co-Chairs (Drs. Anne Hollowed and Suam Kim) fine tune terms of reference for the new Section on Climate Change and Marine Ecosystems.

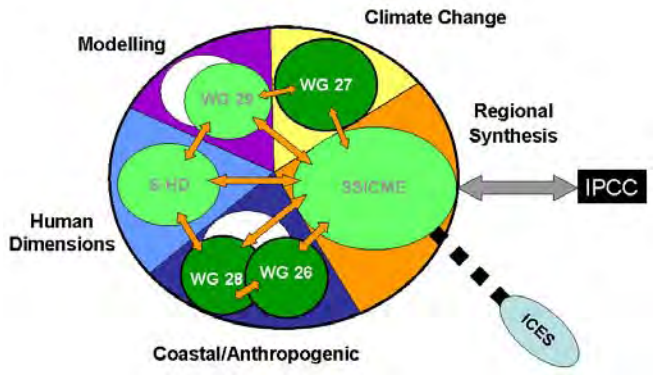
Dr. Sinjae Yoo chairing the joint FUTURE Advisory Panel meeting at PICES-2011 (top), with Drs. Yukimasa Ishida and Akihiko Yatsu listening in.

The Section on *Human Dimensions of Marine Systems* (S-HD) has an important bearing on FUTURE in that it will explore the consequences to, and responses of, human social systems to climate-induced changes in marine ecosystems. It will also deal with communication issues. This Section will facilitate academic cooperation with other international research efforts such as ICES, IMBER, and LOICZ. Thus S-HD will work not only on the key scientific questions on the interactions between human societies and ecosystems but also on developing FUTURE products.

Working Group on *Regional Climate Modeling* (WG 29) is established to facilitate regional-scale modeling. While global climate models capture large-scale climate behavior, they have limitations for regional assessments due to their coarse spatial resolutions. Therefore, regional climate modeling skill is needed to implement mesoscale features which are particularly important in the North Pacific and its marginal seas. The role of this Working Group is vital in making regional predictions.

Lastly, the Study Group on *Marine Pollutants* (SG-MP) will identify novel or promising approaches to monitor pollutant trends over space and time and to evaluate impacts on biota at the population level. SG-MP will lay foundations to address the key question of FUTURE: *How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems*?

With these new and existing expert groups, FUTURE now has enough power to move forward. However, more elements mean a need for better coordination. Complicated connections among expert groups require well-planned coordination with specified products and information flows. The scope, role, and duration of each expert group should be clearly defined within the big picture. These issues will be discussed and hopefully resolved at the inter-sessional FUTURE workshop planned in May 2012.



The FUTURE clockwork starts to tick.

Participants of the "Pollutants in a changing ocean" workshop posing at the entrance to the Conference Center in Khabarovsk.

Local organizers from TINRO-Centre Eugeniy Mirzazyanov, Tanya Semanova, Ekaterina Kurilova (Khabarovsk branch) and Anna Skvortsova being acknowledged for their hard work in making the Meeting a success.

To conclude, I will give a brief preview of the planned activities in 2012. In February 8–9, the workshop on "*Introduction to Rapid Assessment Survey methodologies for detecting non-indigenous marine species*" will be held in Nagasaki, Japan. This is a continuation of the capacity building activities of 2011. The second joint PICES/ICES Early Career Scientist conference, titled "*Oceans of change*" will take place from April 24–27, 2012, in Calviá Majorca, Spain (http://www.ices.dk/marineworld/oceans/index.asp). The goal of this conference is to encourage future generations of ocean scientists from the Atlantic and North Pacific meet early in their careers to establish long lasting links and collaborations with each other. Another capacity building event is the IMBER-led international ClimECO3 summer school on integrated earth system models in July 2012 in Turkey. PICES will support early career scientists to attend the summer school. I would like to welcome you to take part in the second international symposium on the "*Effects of climate change on the world's oceans*" to be held May 14–20, 2012, in conjunction with Ocean Expo-2012 in Yeosu, Korea (http://www.pices.int/climatechange2012.aspx). As with the first successful symposium held in Gijón, Spain, in 2008, PICES will again be working with ICES and IOC on preparations for the second symposium. Immediately following this symposium, an inter-sessional Science Board meeting and a third FUTURE Workshop will take place from May 22–25, 2012, in Busan, Korea.

Finally, out next annual meeting, PICES-2012, will be held from October 12–21, 2012, in Hiroshima, Japan. The theme is "*Effects of natural and anthropogenic stressors in North Pacific ecosystems: Scientific challenges and possible solutions*". Many interesting sessions and workshops, covering a wide range of topics, are planned. In summary, we have another busy, yet exciting, year ahead of us.

Sinjae Yoo
Science Board Chairman

2011 PICES Awards

The presentation ceremony for two prestigious PICES awards took place on October 17, 2011, during the Opening Session at the 2011 PICES Annual Meeting in Khabarovsk, Russia.

Wooster Award

In 2000, PICES established an annual award for scientists who have made significant contributions to North Pacific marine science; have achieved sustained excellence in research, teaching, administration, or a combination of these in the area of the North Pacific; have worked to integrate the various disciplines of the marine sciences; and preferably, all of these in association with PICES. The award was named in honour of Professor Warren S. Wooster, a principal founder and the first Chairman of PICES, a world-renowned researcher of climate variability and fisheries production. He was not only a distinguished scientist, but also an ambassador of international scientific cooperation. Though Professor Wooster passed away in October 2008, his spirit will live in our minds through this award. 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 were Michael Mullin (2001), Yutaka Nagata (2002), William Pearcy (2003), Paul LeBlond (2004), Daniel Ware (2005), Makoto Kashiwai (2006), Kenneth Denman (2007), Charles Miller (2008), Kuh Kim (2009) and Jeffrey Polovina (2010).

The presentation ceremony was conducted by Drs. Lev Bocharov (PICES Chairman) and Sinjae Yoo (PICES Science Board Chairman). Dr. Yoo introduced the award and read the following Science Board citation:

It is with both great sadness and pleasure I announce that the late Dr. Bernard Megrey is the recipient of the 2011 Wooster Award.

As many of you know, Bern passed away suddenly at the age of 60, almost one year ago (October 1, 2010). The Wooster Award is given annually to an individual who has made significant scientific contributions to North Pacific marine science. In particular, the award recognizes sustained excellence in research, teaching, administration or a combination of the three in the area of North Pacific marine science. Special consideration is given to individuals who have worked to integrate knowledge from the disparate disciplines of marine science.

Bern was born in July 1950, in Latrobe, Pennsylvania. Along his educational pathway, he earned an Associate of Science degree (1971) and a Bachelor of Arts degree (1974) from Cleveland State University in Ohio. Bern began his scientific career in 1978, with a Masters in Environmental Science from Miami University in Ohio, and carried out his doctoral research at the University of Washington. During his doctoral research, Bern found a position with the U.S. National Oceanic and Atmospheric Administration (NOAA), working for the National Marine Fisheries Services at the Northwest Fisheries Science Center and Alaska Fisheries Science Center. In 1987, he became a permanent employee of NOAA. There, he worked on recruitment prediction, and his focus broadened from single species to ecosystems. During his time with the Alaska Fisheries Science Center, Bern's career spanned a broad spectrum of activities within his chosen disciplines, including fish population dynamics, stock assessment, fish reproductive biology, ecosystem simulation and climate impacts on marine ecosystem production.

Bern also worked tirelessly for several professional organizations, most notably the American Fisheries Society (AFS), International Council for the Exploration of the Sea (ICES), Global Ocean Ecosystem Dynamics (GLOBEC) and Ecosystem Studies of Sub-Arctic Seas (ESSAS) projects, and PICES.

Held in the highest regard by his colleagues, he never missed a chance to collaborate, share research, or help others break into or advance their careers in fisheries science. During the course of his career, Bern either wrote or contributed to over 80 articles in primary scientific literature.

*In PICES, Bern chaired the Technical Committee on Data Exchange (TCODE) and co-led the MODEL Task Team under the Climate Change and Carrying Capacity (CCCC) Program. The greatest achievement of this Task Team was the development of the NEMURO (**N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography) model. Bern made significant contributions to North Pacific marine science, including understanding of how fluctuations in climate may impact marine ecosystem production.*

The American Fisheries Society recognized Bern's lifetime achievement in 2009 with the Oscar Elton Sette Award for sustained excellence in marine fishery biology. PICES honored Bern's leadership in building an inventory of biophysical data for the North Pacific and creating the PICES Marine Metadata Federation with the 2009 PICES Ocean Monitoring Service Award. In 2011, NOAA awarded him the NOAA Distinguished Career Award for lifetime contributions to NOAA's fishery management.

Bern was highly regarded regionally, nationally and internationally in the field of marine fishery science professionals. His wife, Ronnette, and daughter, Sarah, are

here today to accept the award, and we welcome them to the Russian Federation, to Khabarovsk, to PICES, and to this meeting where we can honor Bern's memory.

Reading of the citation by Dr. Yoo was accompanied by a slide show dedicated to Dr. Megrey (see http://www.pices.int/Wooster_Award/Wooster_recipients/2011_Megrey/2011-Wooster-Award-Megrey.pdf). A commemorative plaque was presented to Dr. Megrey's wife, Mrs. Ronnette Megrey, and his daughter, Sarah (a permanent plaque identifying all recipients of the Wooster Award resides at the PICES Secretariat). After the Annual Meeting, Mrs. Megrey sent the following note to the PICES Secretariat:

"*Our children, Sarah, Nick and Chris, and I would like to thank PICES for honoring Bern with this posthumous award. It is with great appreciation and gratitude that Bern's many friends and colleagues keep his memory alive and honor the work that he performed over his 30+ year career. We are so very happy, and Bern would be touched, that several early career scientists were able to travel to Khabarovsk for this meeting using the Dr. Bernard A. Megrey Fund established by Dr. Megrey's family and friends to support participation of graduate students and early career scientists in PICES Annual Meetings and conferences co-sponsored by the Organization.*"

*Left photo: Dr. Bernard Megrey (left) posing with some members of the NEMURO (**N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography) team. Right photo: Dr. Bernard Megrey (left) and representatives of the Russian (Dr. Igor Shevchenko), Canadian (Mr. Robin Brown) and Japanese (Dr. Toru Suzuki) Metadata Federation Project teams with Dr. John Stein (PICES Science Board Chairman) and Dr. Tokio Wada (PICES Chairman) at the 2009 POMA Award presentation ceremony.*

POMA Award

Progress in many aspects of marine science is based on ocean observations, monitoring, and management and dissemination of data provided by these activities. However, these activities are often behind the scenes and so inconspicuous that they are seldom evaluated appropriately. To remedy this, a PICES Ocean Monitoring Service Award (POMA) was established in 2007 to recognize the sustained accomplishments of those engaged in monitoring, data management, and communication. This award aims to acknowledge organizations, groups or outstanding individuals who have contributed significantly to the advancement of marine science in the North Pacific through long-term ocean monitoring and data management (http://www.pices.int/awards/POMA_award/POMA_award.aspx). The first award was presented in 2008 to the training ship T/S *Oshoro-maru* of Hokkaido University, Japan, for her long-term ecological monitoring activities in the northern North Pacific. In 2009, the award was given to Dr. Bernard Megrey of NOAA's Alaska Fisheries Science Center and Mr. Allen Macklin of NOAA's Pacific Marine Environmental Laboratory for their sustained efforts, vision, and leadership in building an inventory of biophysical data for the North Pacific, and creating the PICES Marine Metadata Federation. The Station P/Line-P monitoring program that has contributed to the Northeast Pacific's only multi-decadal time series of oceanographic conditions, was the recipient of the award in 2010.

Dr. Yoo introduced the award and read the following Science Board citation:

*Long-term monitoring observations are particularly critical to detecting and understanding ecosystem changes. The PICES Ocean Monitoring Service Award (POMA) was established to acknowledge monitoring and data management activities that contribute to the progress of marine science in the North Pacific. It is my great pleasure to announce that the 2011 POMA award goes to the NFRDI (National Fisheries Research and Development Institute of Korea) **N**etwork of **S**erial Oceanographic **O**bservations (NSO).*

Since the foundation of the Fisheries Experimental Station in 1921, the predecessor of NFRDI, NSO has been carried out for the purpose of monitoring climate variability and oceanographic conditions, and also for collecting information on fishing grounds and anthropogenic effects in Korean waters. The unique data and information collected by the observations provide the basis for assessing the status of the ecosystem and managing fisheries in the seas around the Korean Peninsula. Accumulated data also have enabled

studies of long-term changes in the region. NSO has been one of the key monitoring systems in the marginal seas of the Northwest Pacific and is a good example of long-term oceanographic monitoring in the world.

In the beginning of NSO, 6 observation lines were surveyed occasionally from 2 to 6 times a year. In 1935, 14 observation lines covered the entire seas adjacent to Korea and expanded up to 100 miles from the coast. Among the lines at that time, 4 lines were located in North Korean waters. Oceanographic data collected in North Korean waters, which are hardly obtainable nowadays, were published in the book form of oceanographic charts. The Korea Oceanographic Data Center (KODC) operated by NFRDI keeps these precious old books. In 1961, NSO was reorganized for the Cooperative Study of the Kuroshio project to a bimonthly surveyed grid, with 175 stations from 22 observation lines. The present-day grid includes 196 stations from 25 lines around the Korean Peninsula and in the northern East China Sea surveyed from 4 to 6 times per year.

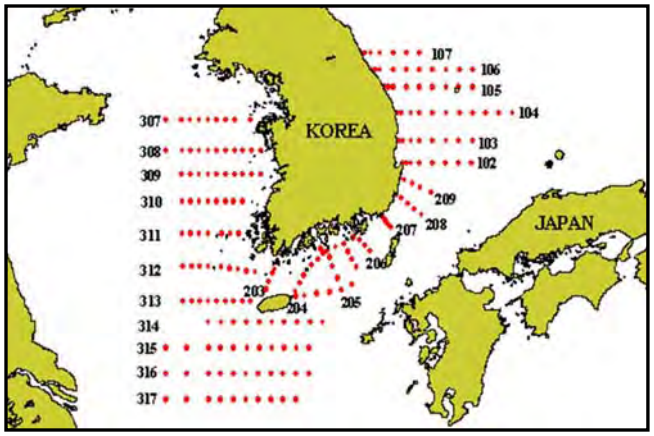


*Fig. 1 The current grid for the Korean **N**etwork of **S**erial Oceanographic **O**bservations (NSO).*

NSO has guided the Korean oceanographic community to modernization of oceanographic equipment and standardization of seawater analysis methods. NFRDI has been provided a huge amount of oceanographic data and information obtained by NSO for domestic and international users in many ways. For example, the "annual reports of NSO" have been published every year since 1952. They include the data on water temperature, salinity, dissolved oxygen, nutrients, zooplankton, and meteorological variables. Statistical analysis of the NSO data has been provided intermittently by the "Oceanographic handbook of the neighboring seas of Korea". NFRDI has sent the NSO data to up to 200 institutes in the world, and those data have been used for various research. The vertical temperature and salinity profiles from ship observations are prepared and released within 2 days of observation time. The NSO data are also released at the KODC website. Near real-time ocean bulletins for several serial lines have been released at the NFRDI website. The data can also be used for monthly ocean forecasts, providing simple statistical information. NFRDI is now planning a real-time/near-real time automated transmission system for oceanographic data to be used for ocean forecast modeling. The accomplishments of NSO are so numerous that we cannot mention all of them here. Many students and researchers have used the NSO data for academic purposes, and the research results are utilized for marine and fisheries policy issues by policy makers. Furthermore, the long-term NSO data have expedited climate research, providing data with clear signals of regime shifts and warming in the Northwest Pacific. In addition, NSO has supported domestic and international researchers to share NSO data and gives an opportunity of boarding its research vessels.

Please join me in congratulating Dr. Yangho Choi, NFRDI senior researcher, who is receiving the 2011 POMA Award on behalf of the hundreds of people, past and present, who contributed to the Korean Network of Serial Oceanographic Observations over the past nine decades.

Dr. Yangho Choi (left) accepting the POMA Award from Dr. Lev Bocharov (PICES Chairman).

Reading of the citation was accompanied by a slide show dedicated to the NFRDI Network (see http://www.pices.int/awards/ POMA_award/2011-POMA/2011-POMA.pdf). A commemorative plaque (a permanent plaque identifying all recipients of POMA resides at the PICES Secretariat) was presented to Dr. Choi who accepted the award with the following remarks of appreciation:

"*It is a great honor for me to have a chance to accept this award on behalf of the Korean **N**etwork of **S**erial Oceanographic **O**bservations (NSO). First of all, I would like to thank PICES and its MONITOR Committee and Technical Committee on Data Exchange for selecting our Network for this year's PICES Ocean Monitoring Service Award. As you know, our Network has a very long history–more than 90 years. I am not sure that this could be achieved without any contributions and sacrifices. On behalf of the NSO Monitoring Group, I would like to thank the hundreds of people, past and present, who contributed to this monitoring program over the past 90 years. I am confident that every member of the NSO Monitoring Group will work hard to serve the best data to you all. Thank you very much.*"

Beyond the Terrible Disaster of the Great East Japan Earthquake

by Yasunori Sakurai, Tokio Wada and Satoshi Katayama

Ten months have passed since the terrible disaster of the Great East Japan Earthquake in the Tohoku region of Japan on March 11, 2011. We are very thankful for the many consoling and encouraging words from PICES and ICES members. The fishing industry in the Tohoku region was destroyed and damage to the coastal fishery and aquaculture industry is immeasurable. Rebuilding these industries will require huge financial investments and many years. A serious situation continues in the aftermath of the nuclear accident in Fukushima Prefecture. Some radioactive contamination has been observed in the vicinity of the nuclear power plant. Fortunately, tests for contamination of fish and shellfish were mostly negative or remained at an extremely low level.

We would like to express again our hearty thanks for the financial donation from PICES and ICES. The Japanese Society for Fisheries Oceanography (JSFO) used the donation to establish a fund to support fisheries and oceanographic research in the areas affected by the earthquake. The Fund name is "*PICES/ICES/JSFO fund for fisheries and oceanographic researches on the recovering from the Great East Japan Earthquake*". The outline of the fund operation is as follows:

- *Qualifying topics*: Fisheries and oceanographic research related to the Great East Japan Earthquake (*e.g.*, assessment of the effect on fisheries and marine ecosystems, mitigation and restoration of damaged coastal fishing grounds, developing fishing and aquaculture technologies, developing recovery plans for fisheries and fishing villages) and holding workshops *associated with these topics.*
- *Eligibility*: Research institutes, universities and colleges, and other public institutions which undertake fisheries and oceanographic research and development in the disaster areas (especially Iwate, Miyagi, and Fukushima Prefectures) and their staff (JSFO membership is not essential).

Great damage (photos taken in April 2011).

Great recovery (photos taken in September 2011).

- *Award amounts*: Up to 500,000 JPY per project.
- *Schedule, etc.*: A call for proposals was issued in late May, with the deadline for receiving proposals in late June. Selection/adoption of proposals was completed by mid-July, with a distribution of grants by the end of July. The selection and adoption of projects in 2011 based on written proposals was made by a special committee organized by the president, vice-presidents, and some officers of JSFO. The results of this research will be presented at a topic session at the 2012 PICES Annual Meeting in Hiroshima, Japan.

JSFO funded the following 12 projects:

1. Impact assessment of the Great East Japan Earthquake on the coastal fisheries of Iwate Prefecture and monitoring of fish stocks for rebuilding sustainable fisheries.
2. Investigation of the impact of the Great East Japan Earthquake on the fisheries resources in the rocky shore of Iwate Prefecture and monitoring of their recovery.
3. Studies on the relationship between the occurrence of shellfish poisoning in Iwate Prefecture and the tsunami caused by the Great East Japan Earthquake.
4. Studies on the impacts of the Great East Japan Earthquake on the fishing grounds along the rocky shore coast of Fukushima Prefecture.
5. Studies on water quality and bottom sediment in Matsukawa-ura Bay, Soma City, Fukushima Prefecture.
6. Observation of larvae distribution of Pacific oysters for collecting seeds for oyster farming.
7. Changes in the community structure of microscopic plankton in Ofunato Bay, Iwate Prefecture – Examination of the growing factors of genus *Alexandrium*, the causative organisms of paralytic shellfish poisoning.
8. Changes in the migration style in amphidromous fishes.
9. Monitoring of the recovery process of lower trophic production in the surface layer in Onagawa Bay, Miyagi Prefecture.
10. Monitoring of the recovery process of lower trophic production in the surface layer in Onagawa Bay, Miyagi Prefecture.
11. Observation of the drifting and deposited marine debris leaked by the Great East Japan Earthquake.
12. Studies on the impact of the tsunami on the ecosystem of Otsuchi Bay, Iwate Prefecture, and its recovery process.

A JSFO symposium entitled "*Subjects of the fisheries oceanography for revival and recovery after the disaster at the Tohoku coast, Japan*" (co-convenors: Satoshi Katayama, Sei-Ichi Saitoh and Tokio Wada) was held on November 13, 2011, in Hakodate, Japan. This symposium sought to discover the problems that fisheries and fishing communities are facing, and to examine the evolution, since the earthquake, of the oceanography, marine living resources, fishing, aquaculture, seafood processing and supply-chain. A brief summary of the reports made at the symposium is included below.

Landings of Pacific saury and bonito at damaged harbors have recovered relatively smoothly, but returns of salmon were low. The price of walleye pollock remains low because the processing plants in Ishinomaki, a major food processing area in the Tohoku district, had not been restored. In the aquaculture sector, production will decrease from previous years, but seed collection and preparation of oyster, wakame- and nori-seaweed has progressed. It was noted, however, that scallops may remain at a low level of seed collection in 2012.

In rocky areas, inner bays and open water, red tide and oligo-hypoxia were generally not found. Although there was no significant change in water quality, muddy deposition and suspending silts were a concern for production of benthic resources in rocky areas and the sea floor. From the viewpoint of whole fisheries systems, including supply-chain, processing, and consumption (including exports) under current conditions, fisheries economic activity was slowed and depressed by the slow redevelopment of infrastructure in the fisheries community.

The symposium inspired a proposition to examine "issues of fisheries oceanography based on the fisheries field". Although there was agreement toward the flag mark of the fishery that substantial cooperation of each field of oceanography and fisheries biology, supply-chain and processing is indispensable, there was no consensus for extracting a concrete subject. For that purpose, planning and the sharing of research results among the relevant researchers in the field is needed. On that basis, with insight into problems that prevent the revival of fisheries, fisheries oceanography should meet the challenge to overcome it.

Finally, we wish to thank PICES members again for their consoling and encouraging words. We promise to support the recovery toward healthy coastal marine ecosystems and sustainable fisheries in the local communities of the Tohoku region to reach beyond the terrible disaster of the Great East Japan Earthquake.

Dr. Yasunori Sakurai (sakurai@fish.hokudai.ac.jp) is a Professor at the Faculty of Fisheries Sciences, Hokkaido University in Hakodate, Japan. His research interests include reproductive biology, strategy, and stock fluctuations of gadid fish (walleye pollock, Pacific cod, and Arctic cod) and cephalopods (ommastrephid and loliginid squids) related to climate change, and biology of marine mammals (Steller sea lion and seals). He has directed a number of national research projects and programs with focus on ecosystem-based management for sustainable fisheries in Japan. Dr. Sakurai served on several PICES expert groups and committees and has been a member of the Cephalopod International Advisory Counsel (CIAC), Scientific Steering Committee of Ecosystem Study of Sub-Arctic Ecosystem (ESSAS). He has been President of the Japanese Society for Fisheries Oceanography (JSFO) since 2009.

Dr. Tokio Wada (wadat@affrc.go.jp) is Director General of the National Research Institute of Fisheries Science at the Fisheries Research Agency of Japan. His specialty is population ecology of small pelagic fishes, especially sardine. He has been leading various projects on fish stock assessment and fisheries management conducted by the Government of Japan. In PICES, Tokio served as a founding member of the Fisheries Science Committee (FIS) and co-chaired the Working Group on Small Pelagic Fishes (WG 3), which was one of the first working groups of PICES. He was the Chairman of PICES from 2007 to 2010.

Dr. Satoshi Katayama (skata@m.tohoku.ac.jp) is a Professor at the Faculty of Agriculture, Tohoku University in Sendai, Japan. Satoshi is studying coastal fisheries biology and its relationship with environmental conditions in an attempt to reveal the fluctuation mechanism of coastal resources and to theorize the fisheries management for them. He has been a member of the Executive Board since 2005 and a senior editor of the Bulletin of the Japanese Society of Fisheries Oceanography (JSFO) since 2009.

A New Era of PICES-ICES Scientific Cooperation

The North Pacific Marine Science Organization (PICES) and the International Council for the Exploration of the Sea (ICES) have recently agreed on a framework to enhance scientific cooperation between the two organizations. This will provide scientists in their respective organizations with a means to improve scientific understanding in the Northern Hemisphere. The new agreement identifies research foci that are currently, or soon to become, areas of joint interest including:

- Climate change;
- Ecosystem assessments, including modeling;
- Marine spatial planning;
- Ocean acidification and hypoxia/anoxia.

Scientific cooperation between PICES and ICES was initiated in 1998 when the Chairman of PICES and the President of ICES signed a Memorandum of Understanding on scientific cooperation that provided a first opportunity for the two organizations to explore each other's interests in marine science and to determine how new advances might be made through cooperative activities.

The new *Framework for PICES-ICES Scientific Cooperation* that was adopted in October 2011 identified specific topic areas that can be enhanced by greater cooperation between the two organizations. Under this framework, cooperation can take the form of co-sponsored symposia, workshops, or topic sessions at each other's annual meetings, or developing expert groups and strategic initiatives where PICES and ICES appoint scientists to focus on topics of joint interest. Likewise, there was a desire by both organizations to foster and enhance collaboration in areas such as training, knowledge exchange, and communication.

The *Framework* was developed by a Study Group that first met during the 2010 ICES Annual Science Conference in Nantes, France, to plan its work. PICES Study Group members included: Sinjae Yoo (Science Board Chairman), Skip McKinnell (PICES Secretariat), Thomas Therriault and Hiroaki Saito (Science Board members). Membership from ICES included: Manuel Barange (SCICOM Chairman), Adi Kellermann (ICES Secretariat), Begoña Santos and Mark Dickey-Collas (SCICOM representatives). The first meeting had the benefit of some invited guests: Jürgen Alheit (Germany) and William Karp (U.S.A.) from ICES, and Anne Hollowed (U.S.A.) and Suam Kim (Korea) from PICES. The Study Group met again in April 2011, immediately prior to the inter-sessional PICES Science Board meeting in Honolulu, U.S.A. The final report of the Study Group and the description of the *Framework* can be found on the PICES website at http://www.pices.int/members/study_groups/Disbanded_Study_Groups/SG-SP.aspx. It aspires to provide guidance to the scientists working in the ICES and PICES communities to develop joint activities and information on the specific (and necessary) procedures of the two organizations that will ensure timely and beneficial results.

The process that led to the establishment and flourishing of the joint PICES/ICES *Working Group on Forecasting Climate Change Impacts on Fish and Shellfish* is an example for developing a joint initiative. It has now evolved within PICES to become the newly established Section on *Climate Change Effects on Marine Ecosystems* (S-CCME) to complement the new Strategic Initiative on *Climate Change and Marine Ecosystems* that was established within ICES. The *Framework* will ensure that "*ICES and PICES will become the leading international organizations providing science and advice related to the effects of climate change and variability on marine resources and ecosystems*". Their expanded role came as a result of successful planning and implementation of their joint activities by the scientists from both organizations. The most important of these was the PICES/ICES/FAO symposium on "*Climate change effects on fish and fisheries: Forecasting impacts, assessing ecosystem responses, and evaluating management strategies*" convened in Sendai, Japan, in April 2010, and published as a proceedings in the *ICES Journal of Marine Science* (Vol. 68, No. 6) in 2011.

To further collaboration with ICES, PICES currently is developing a webpage to allow on-line submissions of proposals for jointly-sponsored topic sessions and workshops at PICES Annual Meetings. Both organizations have agreed to share lists of proposed sessions and workshops in advance our Science Board (PICES) and SCICOM (ICES) meetings in the fall to allow greater opportunities for co-sponsorship. The kickoff for the new era of cooperation begins in April 2012 with the second PICES/ICES conference for early career marine scientists (http://www.ices.dk/marineworld/oceans/index.asp).

This article was co-authored by the PICES members of the joint P/ICES Study Group on *Developing a Framework for Scientific Cooperation in Northern Hemisphere Marine Science.*

New PICES Jellyfish Working Group Formed

by Richard Brodeur and Shin-ichi Uye

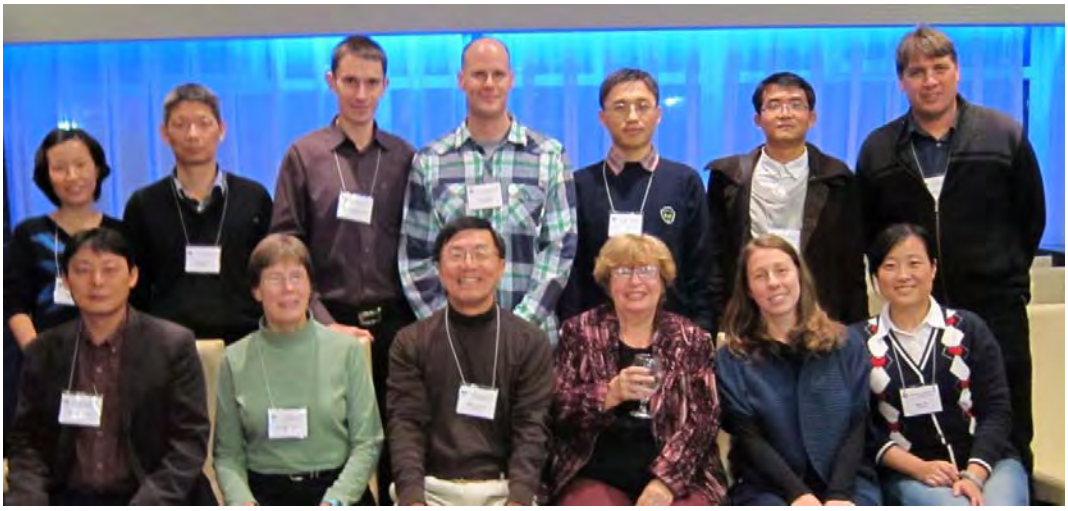
Similar to many other regions in the world, the North Pacific Ocean and surrounding marginal seas have experienced high numbers of jellyfish in recent years, culminating in massive blooms in some coastal areas. This region is among the most productive in the world in terms of fisheries catch, and many millions of people, especially those living in Asia, are dependent on the ocean for their nutritional needs. Scientists and managers have become increasingly concerned about the potential rise in the prevalence and magnitude of jellyfish blooms in recent years, and their potential impact on ecosystem services such as fisheries, tourism, and power generation. PICES has long recognized the importance of gelatinous zooplankton in marine ecosystems and the present limitations to our understanding of what initiates and maintains the blooms and their effects on other marine resources, and scientists from PICES member countries plan to work together to promote understanding and propose solutions to problems affecting the North Pacific. At the 2010 PICES Annual Meeting, a new Working Group on *Jellyfish Blooms around the North Pacific Rim: Causes and Consequence* was established with the explicit goal of bringing together experts from the member countries to address this issue and come up with potential solutions to reverse the increasing trend in jellyfish blooms in coastal waters. The terms of reference and the membership of the Group can be found at http://www.pices.int/ members/working_groups/wg26.aspx.

The Working Group met for the first time this past October in Khabarovsk (Russia), in conjunction with the 2011 PICES Annual Meeting. Fourteen out of 20 Working Group members attended this inaugural meeting. In order to grasp the general status of the jellyfish blooms around the North Pacific Rim, information about current and past jellyfish blooms and related research was presented for each member country.

Lucas Brotz (University of British Columbia, Canada), found that jellyfish have fluctuated over recent decades but have not shown any significant increases in Canadian Pacific coastal waters. He followed this with a presentation on trends in global jellyfish blooms, based on various sources of information from scientific literature to mass media articles. His results suggest that jellyfish have increased globally in recent decades with some certainty in about 70% of 64 Large Marine Ecosystems of the world, and these increases seem to be related to human impacts.

China currently runs two big national projects on jellyfish blooms. Siqing Chen (Yellow Sea Fisheries Research Institute) described the project on "*Key Processes, Mechanism and Ecological Consequences of Jellyfish Bloom in Chinese Coastal Waters*" that aims to understand the causes of jellyfish blooms in Chinese waters and their impacts on the ecosystem. Zijun Xu (North China Sea Environmental Monitoring Center, State Oceanic Administration) explained another project, focusing mainly on the establishment of a monitoring system for early warning of possible jellyfish blooms and determining techniques for minimizing their impacts on human society.

Japanese waters are substantially affected by jellyfish blooms, most intensively by the moon jellyfish *Aurelia aurita* and the giant jellyfish *Nemopilema nomurai*. Japanese scientists are examining the jellyfish problems under two major projects. Hideki Akiyama (Seikai National Fisheries



Group photo taken during a banquet after the 2011 Working Group 26 meeting. Front row from left: C. Han (Korea), J. Purcell (U.S.A.), S. Uye (Japan), E. Dulepova (Russia), K. Cieciel (U.S.A.) and Z. Xu (China). Back row from left: G. Liu (China, non-member), S. Chen (China), A. Zavolokin (Russia), L. Brotz (Canda), X. Pu (China), Y. Xu (China, non-member) and J. Field (U.S.A.). Missing from photo: H. Akiyama and H. Ishii (Japan).

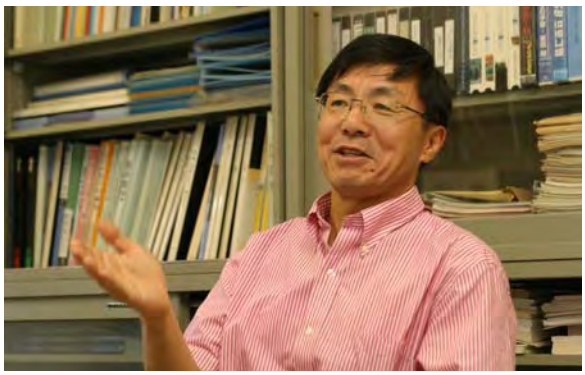
Research Institute) reported on the China-Japan-Korea International Giant Jellyfish Bloom Project, which includes a monitoring component and development of predictive indices. Shin-ichi Uye (Hiroshima University) summarized the results from the project entitled "*Studies on Prediction and Control of Jellyfish Outbreak*" (STOPJELLY), which aims to understand factors leading to the blooms, predict their severity, and develop chemical and biological methods to control jellyfish populations.

Representing Korea, Changhoon Han (National Fisheries Research and Development Institute) explained that his country is also suffering from jellyfish blooms, with a total economic loss of $265 million US in an intense bloom year. The Korean government has established a Jellyfish Monitoring and Countermeasure Center to tackle this problem and has initiated a program to minimize jellyfish damage to fisheries and tourism.

Alexander Zavolokin (Pacific Research Institute of Fisheries and Oceanography) reported that Russian scientists have been studying jellyfish (mainly taxonomic composition, abundance and biomass) since 1990 in the western Bering Sea, Okhotsk Sea and other Russian waters by trawl netting, sampling more than 10,000 stations in these regions. According to the results of their studies, the annual jellyfish biomass has fluctuated widely but did not show any consistent trends in the Bering Sea or Okhotsk Sea.

Jennifer Purcell (Shannon Point Marine Center, Western Washington University, U.S.A.) updated the jellyfish biomass in the eastern Bering Sea, where the jellyfish data have been consistently monitored since 1979. Biomass increased in the 1990s and declined substantially for 8 years after 2000, but has surged again since 2009. She also presented the geographical distribution of jellyfish along Puget Sound, where they are more abundant in waters adjacent to more populated cities, indicating some positive effects by human activity on jellyfish population increase. Finally, studies along the U.S. west coast were summarized, which have attempted to link jellyfish biomass with environmental changes.

The Working Group will be active for at least the next 3 years and is planning to sponsor symposia and workshops at future scientific meetings. A Topic Session on "*Jellyfish in marine ecosystems and their interactions with fish and fisheries*" has been proposed and approved by Science Board for the 2012 PICES Annual Meeting to be held in Hiroshima, Japan, and will be co-sponsored by ICES. The Working Group hopes to sponsor collaborative research cruises among PICES member countries in the future and suggest ways to adapt to, or control, jellyfish blooms. Anyone who has data from within the PICES study region to contribute to the Working Group report is welcome to contact members of the Group.



Dr. Richard Brodeur (Rick.Brodeur@noaa.gov) is a Research Fisheries Oceanographer working in the Fish Ecology Division of the Northwest Fisheries Science Center, NOAA Fisheries, and is based in Newport (Oregon, U.S.A.). Ric began his career working on early life history and recruitment dynamics of walleye pollock in the Gulf of Alaska and Bering Sea for the Alaska Fisheries Science Center and became interested in jellyfish following their dramatic increase in that ecosystem. He came to Oregon to work on habitat preferences and trophic ecology of juvenile salmon and other pelagic fishes as well as recruitment processes in marine fishes. He has published on a variety of topics ranging from satellite oceanography to fish bioenergetics to fisheries acoustics, but has focused much of his research on feeding and food web interactions in the pelagic ecosystem. Ric has been heavily involved in PICES, serving on several committees and expert groups and organizing a number of special sessions and workshops at past meetings. He serves now as a Co-Chairman of the PICES Working Group on Jellyfish Blooms around the North Pacific Rim: Causes and Consequence.

Dr. Shin-ichi Uye (suye@hiroshima-u.ac.jp) is a Professor of biological oceanography at Hiroshima University. He initially studied zooplankton production ecology through intensive research on the population dynamics and productivity of major copepod species in Japanese coastal waters. Around 1990, he noticed a significant increase of unhealthy copepods coated in jellyfish mucus, and then gradually shifted his research interest to jellyfish biology. Shin-ichi is now involved in two Japanese jellyfish research projects: Studies on Prediction and Control of Jellyfish Outbreak (STOPJELLY) and the China-Japan-Korea International Project on the Giant Jellyfish Bloom. He was former President of the Plankton Society of Japan (2001–2004) and former President of the World Association of Copepodologists (2005–2008). Shin-ichi was awarded the Oceanographic Society of Japan Prize in 2010 for his advancement of zooplankton research, particularly on their functional roles in coastal marine ecosystems. He now serves as a Co-Chairman of the PICES Working Group on Jellyfish Blooms around the North Pacific Rim: Causes and Consequence.

PICES Working Group on North Pacific Climate Variability

by Emanuele Di Lorenzo, Shoshiro Minobe, and Michael Foreman

Motivations

In recent years much progress has been made in our understanding of the large-scale physical dynamics of Pacific climate variability and change. New modes of ocean and atmospheric variability over the Pacific have been recognised and shown to influence ecosystem processes. The PICES Working Group 27 on *North Pacific Climate Variability* (http://wg27.pices.int) was established during the inter-sessional Science Board meeting in April 2011 with the goal of "*developing essential understandings of the mechanisms of North Pacific climate variability and change that can better guide the formulation of process-based hypotheses underlying the links between ecosystem dynamics and physical climate.*"

Background

At the 2009 PICES Annual Meeting on Jeju Island, Korea (October 24–25), a 2-day workshop on "*Exploring the predictability and mechanisms of Pacific low-frequency variability beyond inter-annual time scales*" was co-convened by the authors of this article. The overall goal of the workshop was to review our current understanding of the dynamics underlying low-frequency fluctuations of the Pacific and isolate potential mechanisms and linkages (*e.g.*, tropics/extra-tropics coupling, ocean/atmosphere coupling and feedbacks in the western boundary current system) that can provide the basis for low-frequency predictability. This workshop was very well attended, and during the discussion a synthesis schematic (Fig. 1) was agreed on as a starting hypothesis to investigate the dynamics linking the dominant modes of Pacific climate variability. In this schematic there are two sets of dominant dynamics in the Pacific – the El Niño Southern Oscillation (canonical ENSO) with its connections to the Aleutian Low and the Pacific Decadal Oscillation (PDO) (red path on Fig. 1), and the Central Pacific Warming (CPW) El Niño with it connections to the North Pacific Oscillation (NPO) and the North Pacific Gyre Oscillation (NPGO) (blue path on Fig. 1). These two dominant systems are physically linked and connected through ENSO in the tropics.

How are the ocean and atmosphere climate modes of the Pacific useful to understand, quantify and predict ecosystem variability?

Ecosystem studies often conduct simple correlation analyses between one or two of the climate modes (*e.g.*, ENSO, PDO) and ecosystem changes as a way to establish a link between physics and biology. However, these types of correlative analyses ignore the process dynamics that link physics and biology. During the Jeju workshop, it was recognized that there are important gaps in our understanding of the physical processes and dynamics underlying the specific climate modes. This lack of knowledge makes it hard to isolate the mechanistic links between the physical variability associated with the climate modes and the ecosystem response. To this end, WG 27 will develop quantitative approaches to evaluate the role of these ocean/atmosphere modes in explaining physical and biogeochemical climate variability in the North Pacific (*e.g.*, sea surface temperature, ocean circulation, seasonal timing, nutrient fluxes, acidification, hypoxia, upwelling and mixing), and to link this physical and biogeochemical variability to changes in the marine ecosystem.

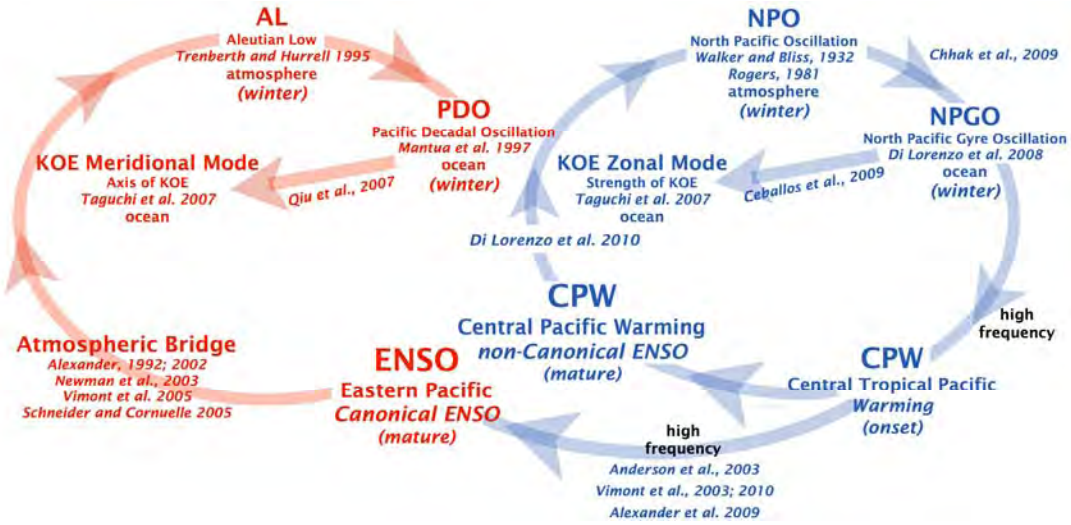


Fig. 1 Synthesis schematic of the dynamics linking the dominant ocean and atmosphere modes of Pacific climate variability.

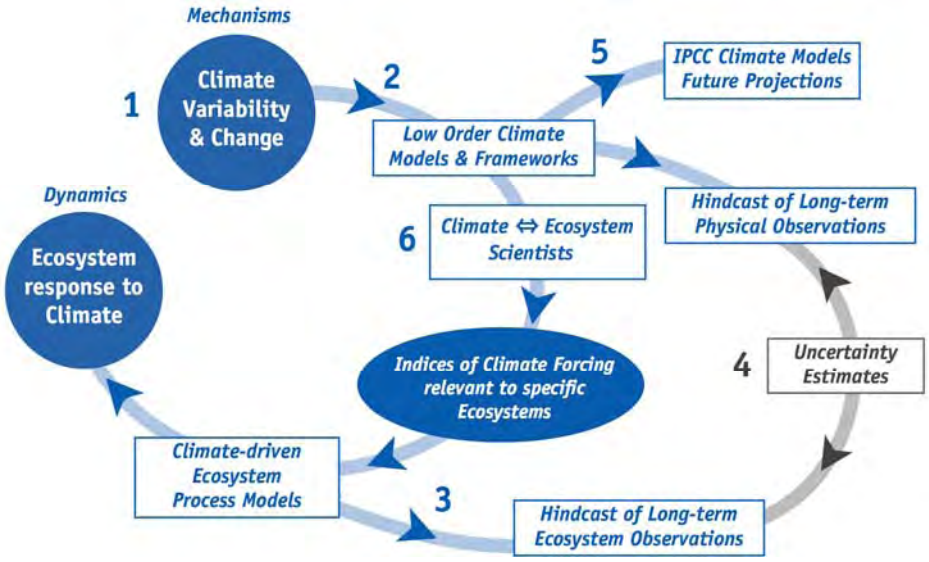


Fig. 2 WG 27 terms of reference schematics.

Terms of Reference (TOR)

The main objective of WG 27 is to improve our understanding of the mechanisms of Pacific climate variability and change to enable better diagnosing and predicting of the dynamics of marine ecosystem responses to climate forcing. In order to make the link between climate and ecosystem response, WG 27 will initially summarize the current understanding of the mechanisms of Pacific climate variability and change, and evaluate the strengths of the underlying hypotheses (*e.g.*, Fig. 1) with supporting evidence (TOR 1, Fig. 2). In particular, WG 27 will develop conceptual frameworks of Pacific climate variability and change, such as the schematic of Pacific climate variability (Fig. 1), which can serve as guidance to ecosystem scientists to better isolate and understand the essential physical processes that are relevant to specific ecosystem dynamics. Conceptual frameworks such as these will be synthesized in mathematical low-order process models of the climate system (TOR 2, Fig. 2). Low-order process models reduce the complex processes to their basic elements and dynamics and will be used to hindcast long-term physical observations. These low-order climate models will also serve as the basis for a scientific exchange between the climate and ecosystem scientists. Through this exchange, WG 27 will generate indices of climate forcing that are relevant to targeted ecosystem species in order to develop climate-driven ecosystem process models, which will be used to hindcast available long-term ecosystem observations (TOR 3, Fig. 2). This TOR 3 builds on the strengths of PICES, which provides an ideal community to use such quantitative models with long-term observations available from all PICES member countries. If these low-order process-based models of the ecosystem are successful in hindcasting available observations, we will be able to better isolate and quantify the dynamics of the ecosystem response to climate forcing (see Fig. 2).

The low-order climate models and the climate-driven ecosystem process models developed in TOR 2 and 3 will also be used statistically to provide uncertainty estimates of decadal variability in recent historical climate and ecosystem time series (TOR 4, Fig. 2). An important outcome of the development of the low-order climate models is that they provide improved metrics to test the mechanisms of climate variability and change in IPCC models (TOR 5, Fig. 2). The evaluation of the IPCC model is an activity that the PICES WG 20 on *Evaluations of Climate Change Projections* has conducted over the last three years. Although WG 27 will not directly evaluate the IPCC models, it will work in coordination with other PICES expert groups and FUTURE Advisory Panels to assist in evaluating those models and providing regional climate forecasts over the North Pacific.

The success of WG 27 relies on an active and efficient exchange between the climate and ecosystem scientists, which will allow the PICES community to understand and fill the gaps between what physical models can currently produce and what ecosystem scientists suggest are the important physical forcing factors required for predicting species and ecosystem responses to climate variability and change (TOR 6, Fig. 2).

Activities in 2011 and 2012

WG 27 has an ambitious working plan that will require coordination and planning among all group members, and with members of other PICES expert groups (*e.g.*, WG 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*), and joint activities with ICES. Although WG 27 had its first official business meeting only in October of 2011 (see below), several activities that advance WG 27 terms of reference have been planned for 2012. Below is a short overview.

Participants of the WG 27 meeting at PICES-2011 (Khabarovsk, Russia). Indicated by green, blue and red arrows are WG 27 Co-Chairmen and co-authors of this article, Drs. Shoshiro Minobe, Michael Foreman and Emanuele Di Lorenzo.

WG 27 had its first meeting on October 15, 2011, at the 2011 PICES Annual Meeting in Khabarovsk (Russia). Despite relatively short notice of this very first meeting, Working Group members showed their great enthusiasm, as 16 out of 19 members attended. After reviewing the terms of reference and the presentations from the members, it was decided that WG 27 would begin producing a simple mathematical framework or simple model to capture and quantify the known mechanisms of Pacific climate variability (Fig. 1), and that this model would be used to re-interpret an ecosystem dataset, such as the one used in Hare and Mantua (2000), in light of the recent advances in our understanding of Pacific climate variability. WG 27 will also establish a connection with the new PICES Section on *Climate Change Effects on Marine Ecosystems* (S-CCME) as a way to facilitate the exchange between ecosystem and climate scientists.

During the 2012 PICES Annual Meeting in Hiroshima (Japan), WG 27 will convene a Topic Session on "*Challenges in understanding Northern Hemisphere ocean climate variability and change*". Through collaboration between PICES, CLIVAR and ICES, this session invites contributions exploring important developments in the research field of North Pacific climate variability and change, including physical environmental variations and their predictability, teleconnection dynamics between oceanic basins, such as the Pacific and Atlantic Oceans, and linkages between physical conditions and marine ecosystems. The session also aims at bringing together climate and physical oceanography researchers with marine ecosystem scientists to share ideas about what physical parameters and processes are important in understanding and predicting the response of specific marine ecosystems to climate forcing.

In the summer of 2012, WG 27 is planning a 3-day workshop on "*Forecasting ecosystem indicators with climate-driven process models*", co-sponsored by U.S. GLOBEC, PICES and ICES, to be held in Friday Harbor (WA, U.S.A.). The goal of this workshop is to select a set of ecosystem indicators for both the North Pacific and North Atlantic large marine ecosystems and implement, through an interaction between physical/climate scientists and marine biologists, four examples of climate-driven process-based models that forecast ecosystem indicators. On Day 1, we will have a plenary session with review talks on (1) known physical mechanisms of variability in the North Pacific and North Atlantic, (2) the targeted ecosystem indicators, and (3) existing attempts to model the indicators. In the afternoon of Day 1 and the entire Day 2, four break-out groups will implement and test prototypes of climate-driven process models to hindcast and forecast the targeted indicators. On Day 3, the break-out groups will reconvene to present and discuss their findings, and plan future directions of research.

Dr. Emanuele (Manu) Di Lorenzo (edl@gatech.edu) is an Associate Professor at the School of Earth and Atmospheric Sciences, Georgia Institute of Technology, U.S.A. His research interests and experience span a wide range of topics from physical oceanography to ocean climate and marine ecosystems. More specific focus is on dynamics of basin and regional ocean circulation, inverse modeling, Pacific low-frequency variability, and impacts of large-scale climate variability on marine ecosystem dynamics. In PICES, he is Co-Chairman of the Working Group on North Pacific Climate Variability (WG 27) and a member of the FUTURE Advisory Panel on Climate, Oceanographic Variability and Ecosystems. He also serves on the U.S. Comparative Analysis of Marine Ecosystem Organization (CAMEO) Science Steering Committee.

Dr. Shoshiro Minobe (minobe@mail.sci.hokudai.ac.jp) is a Professor at the Graduate School of Sciences, Hokkaido University in Sapporo, Japan. His overall interest is to understand the ocean's role in the earth's climate system, and he is working on decadal climate variability over the North Pacific, ocean–atmosphere interactions, and recently, biogeochemistry data analysis. Shoshiro was a member of the Implementation Plan Writing Team for the PICES scientific program, FUTURE, and now co-chairs the Working Group on North Pacific Climate Variability (WG 27).

Dr. Michael (Mike) Foreman (mike.foreman@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada at the Institute of Ocean Sciences in Sidney, British Columbia. His primary research interests are coastal modelling and climate change. Mike is a former Chairman of the Physical Oceanography and Climate Committee and Co-Chairman of the Working Group on Evaluations of Climate Change Projections (WG 20). In addition to WG 27, is also a member of the new Working Group on Regional Climate Modeling (WG 29).

Final U.S. GLOBEC Symposium and Celebration

by Harold (Hal) Batchelder, Dale Haidvogel and David Mountain

More than 20 years ago, forward looking members of the U.S. ocean science community held a series of workshops to achieve a consensus on the core elements of a science plan for a U.S. Global Ocean Ecosystems Dynamics (hereafter U.S. GLOBEC or GLOBEC) program (http://www.usglobec.org). For additional history of the workshops leading to GLOBEC see the Appendix, "*History of Planning Efforts for GLOBEC*" in GLOBEC Report 1 (U.S. GLOBEC 1991; http://www.usglobec.org/reports/isp/isp.appendixa.html). It is clear from review of the early GLOBEC reports, that hints of the scale of the variability and the potential linkages between climate forcing, physical processes and population and ecosystem variations were there, but the magnitude of the variability, the existence of abrupt regime shifts (state transitions), and the complexity of the process linkages were unknown. Using the Northeast Pacific regional U.S. GLOBEC program as an example, the implementation plan (U.S. GLOBEC, 1996) identified four concrete benefits of U.S. GLOBEC:

(1) **improved knowledge of the impact of climate variability on marine ecosystems**;
(2) development and refinement of **coupled biophysical models** that would enable integration of biological, physical, and climate observations in coastal ecosystems;
(3) collection and analysis of **data sets** during the program that will provide the basis for future research activities;
(4) the generation of information to provide **a new basis for resource management** that will enable those responsible for managing living marine resources to move beyond the traditional fisheries management approach to a new paradigm that integrates environmental, fisheries and ecosystem data.

The context of ocean science in the early 1990s when U.S. GLOBEC was being created was one where large programs were being emphasized, developed mostly through bottom-up community initiatives. The World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JOGFS) had begun, focused on physical characterization and carbon dynamics at oceanic (global) scales, respectively. JGOFS was quantifying the vertical carbon flux that results from oceanic chemical and biological uptakes of CO_2, and determining how much of the production in the upper ocean was due to new nitrate *vs*. the magnitude of the total primary production and its role in the global carbon budget. GLOBEC's interest was to understand what controls the biotic (especially zooplankton) population dynamics in the sea. At the time, JGOFS was a balanced mix of process studies, large-scale ship and satellite surveys, time-series observations, models, and database activities predicated on improved documentation of the ocean carbon cycle and budget and predictive models to understand oceanic response to change. JGOFS' focus was on nutrient use, phytoplankton production and carbon transport and sequestration (mostly in oceanic regions); GLOBEC focused on zooplankton and fish in (mostly) coastal ecosystems.

On October 4–5, 2011, a Final U.S. GLOBEC Symposium was held at the American Association for the Advancement of Science Auditorium in Washington, D.C. to highlight and celebrate the scientific progress achieved by the program over the past two decades. Approximately 80 scientists, program managers and invited guests attended this event. The symposium consisted of invited talks, an evening reception and a poster session. Talks were intended to be retrospective views of the U.S. GLOBEC program and to synthesize results from the multiple GLOBEC regional scientific studies. Posters were shown from each of the ten Pan-Regional U.S. GLOBEC Synthesis projects which concluded this year. The talks given at the symposium are listed in Table 1, and the PDFs of these presentations will be available through the U.S. GLOBEC web site. In this article it is not possible to summarize all of the presentations; thus, below is a highly selective summary of some of the research done by U.S. GLOBEC as reported at the meeting. Many of the presentations highlighted attributes of the program that contributed to its success, and identified legacy products. These are summarized in Table 2 and Table 3.

While the presenters were proactive in coordinating their talks to avoid repeating similar messages or graphics in multiple presentations, a few graphics/publications got "lots of air time" at the symposium. This reflects how those papers were particularly successful in achieving a broader scale synthesis by focusing on larger-scales or mechanisms linking climate to ecosystem structure and function. Figures 1 and 2 show two such examples from the Georges Bank and Northeast Pacific systems, respectively. Both of these were considered by David Mountain as "fundamental discoveries" as they were integrative, big picture research that provided new insights on the coupling of climate to physics and ecosystems. Significantly, neither discovery would have been possible had not extensive pre-GLOBEC data existed for the regions. A lesson that emerged from the U.S. GLOBEC experience is that careful selection of study sites that had extensive prior sampling of the physical and ecosystem conditions (*e.g.*, time-series) was critical to the discoveries that link climate, physics and the ecosystem over large space and time scales. Investigations during the GLOBEC decades continued or expanded time-series measurements for *ca.* 7 years (more in some regions where NOAA or NPRB continued sampling programs after GLOBEC field work ended). Pre-existing data sets coupled with new data

Table 1 Talks given at the symposium.

Presentation Title	Presenter/Organization
Introduction and History of GLOBEC	Phillip Taylor/NSF and Elizabeth Turner/NOAA
The View from NOAA	Larry Robinson/NOAA
The View from NSF	Margaret Cavanaugh/NSF
Regional Perspectives in a Global Context	Thomas (Zack) Powell/University of California, Berkeley
Before and After	Eileen Hofmann/Old Dominion University
Fundamental Discoveries and Surprises	David Mountain/NOAA (retired)
Synthesis—Climate Impacts on Ecosystems	Frank Schwing/NOAA-OSTP
Two Decades of Progress in Physical-Biological Modeling and Prediction	Dennis McGillicuddy/WHOI
Synthesis—Population Dynamics in an Ecosystem Context	Jeffrey Runge/Gulf of Maine Research Institute
A View from the International Partners	Ian Perry/Fisheries and Oceans Canada
Contributions to Education and Training: Overview and Introduction	Dale Haidvogel/Rutgers University
Young Scientist—Confessions of a 'Young' Scientist: Krill Predator Ecology and the SO GLOBEC Experience	Ari Friedlaender/Duke University
A View from Ocean Leadership—Challenges Ahead in Washington	Robert Gagosian/The Consortium for Ocean Leadership
Young Scientist—What the Zooplankton Taught me about Climate	Julie Keister/University of Washington
Did US GLOBEC Meet the Tough Challenges and Promises on Climate and Ecosystems?	Ed Houde/University of Maryland
A Top-Down Perspective on Ecosystem Dynamics and Food Webs	Dan Costa/University of California, Santa Cruz
Young Scientist—The Odyssey of a GLOBEC-ian	Enrique Curchitser/Rutgers University
An Outsider's View of what GLOBEC Brought	Mimi Koehl/University of California, Berkeley
Taking the Legacy of US GLOBEC and Building Progress in Science and Management	Cisco Werner/NOAA and Steve Murawski/University of South Florida

Table 2 Attributes that enabled a successful U.S. GLOBEC program.

Consensus development of the initial science ideas through a series of workshops to achieve buy-in from ocean science community and federal funding agencies.
Multifaceted approach of complementary studies that included process-based, long-term observations, retrospective examinations, technology innovation, modeling, integration and synthesis.
Clear focus: few target species in specific regional ecosystems, but with considerations at larger (basin-to-global) scales; worked up and down the trophic levels only so far as needed (or could be afforded).
Long-term funding commitment: originally a 10 year program; eventually a 20 year program as different regions phased in sequentially.
Many partnerships: across scientific disciplines; across federal and academic sectors; across multiple federal agencies; internationally (SO was an international project, and the NEP and Georges Bank studies were U.S. contributions to PICES' Climate Change and Carrying Capacity and ICES' Cod and Climate Change regional programs, respectively).
Specific funding phases for regional synthesis AND pan-regional synthesis.

Table 3 The U.S. GLOBEC legacy.

Promoted a multi-, inter-disciplinary culture within the ocean sciences community that is needed to address big problems like the effects of climate change on marine ecosystems.
Documented and provided process-level understanding of ecosystem variability resulting from shifts in ocean physics driven by climate change.
Increased our understanding of the population dynamics and recruitment of zooplankton and fish populations.
Advanced the capabilities of coupled bio-physical modeling.
Fostered the development of new sampling and observing technologies.
Produced a new generation of interdisciplinary trained ocean scientists.
Generated and archived extensive, multi-disciplinary data sets and model outputs to support future investigations.
Developed integrated indices and model products in support of ecosystem-based management needs.

collected by U.S. GLOBEC, including spatial surveys, process studies and focused modeling, enabled these "fundamental discoveries".

Figure 1 summarizes one of these fundamental discoveries from the Georges Bank regional study. Time-series records show links between low salinity anomalies in the NW Atlantic, and phytoplankton production, zooplankton species composition and size structure, and survival of targeted larval fish species. The postulated mechanism for the link between climate and fish survival is described in the caption to Figure 1, but has not yet been examined through dynamical modeling (Mountain and Kane, 2010).

Figure 2 illustrates the findings from spatiotemporal patterns of sea surface temperature anomaly and sea surface height anomaly in the Northeast Pacific (Di Lorenzo *et al*., 2008, 2009). As in the Georges Bank example, the availability of long-term observations of salinity, nutrient upwelling and chl-a from the repeated surveys done by CalCOFI (Southern California) and Fisheries and Oceans Canada (Line P) enabled the recognition of the NPGO as an important climate mode of the Pacific. Subsequently, Di Lorenzo and colleagues demonstrated connections between climate modes and western North Pacific ocean conditions, especially in the Kuroshio-Oyashio extension region.

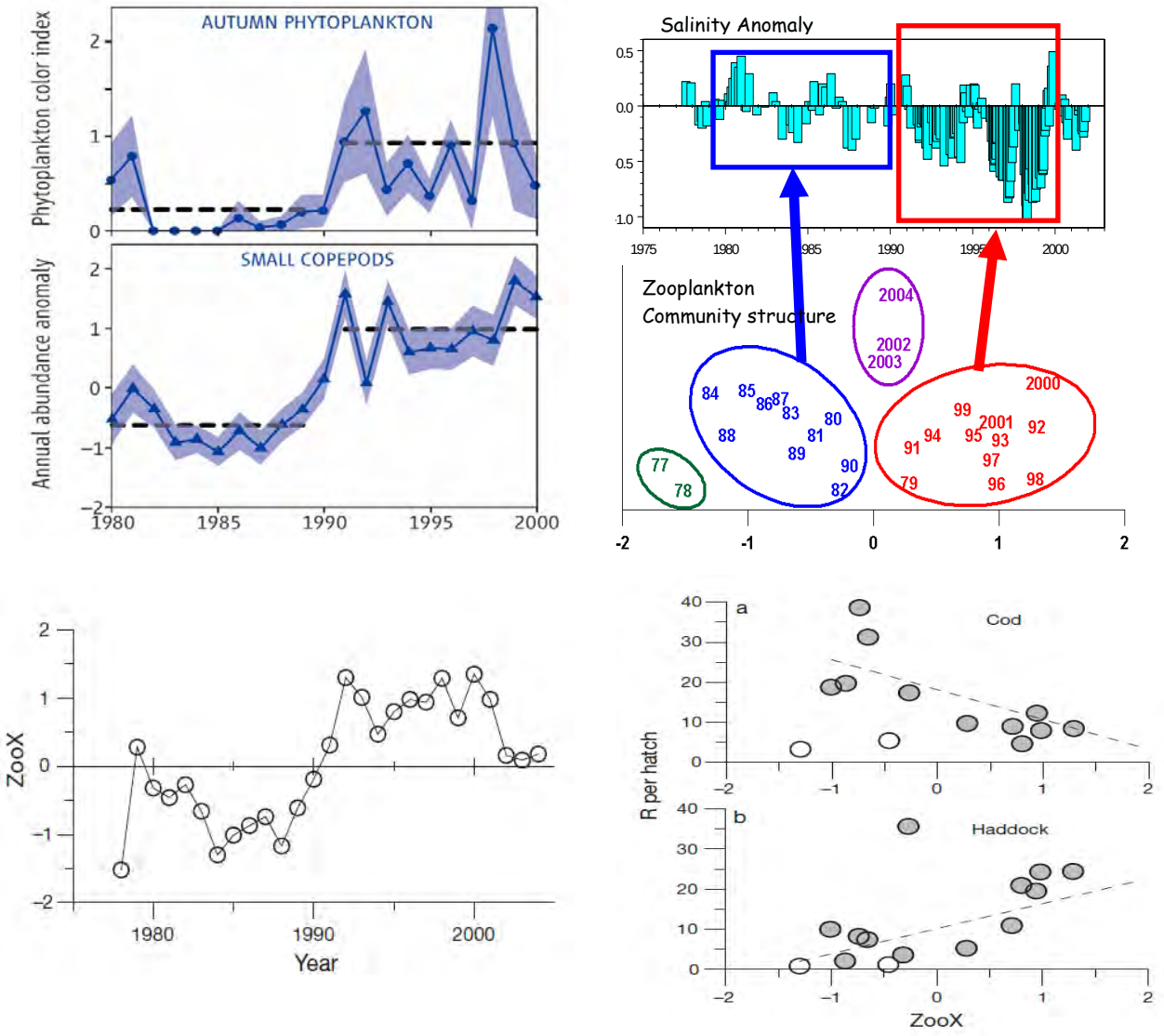


Fig. 1 Retrospective analysis of time-series (zooplankton size/species composition; cod and haddock recruitment; physical data) data collected prior (NEFSC MARMAP) and during GLOBEC on Georges Bank shows the following sequence of events from the late 1980s: Arctic Warming led to increased inflow of low salinity water (upper right) promoting enhanced stratification, allowing greater autumn and winter phytoplankton production (upper left) that altered the community structure of zooplankton, favoring small copepods (middle left, middle right) which increased (decreased) survival of haddock (cod) larvae on Georges Bank (lower right two panels). ZooX is an arbitrary index scaled from –2 to +2 on the x-coordinate axis of the non-metric multi-dimensional scaling of the zooplankton community composition (2nd panel down on right), and is used as an axis in the three lowermost panels. R per hatch in the lower right figures are the number of 1 yr old fish (recruits) per million hatched eggs. The above sequence is considered a plausible mechanism for the observed time-series data, but confirmation of the sequence requires additional sampling and especially dynamical modeling. From Durbin et al., 2003; Greene and Pershing, 2007; Kane, 2007; Mountain and Kane, 2010.

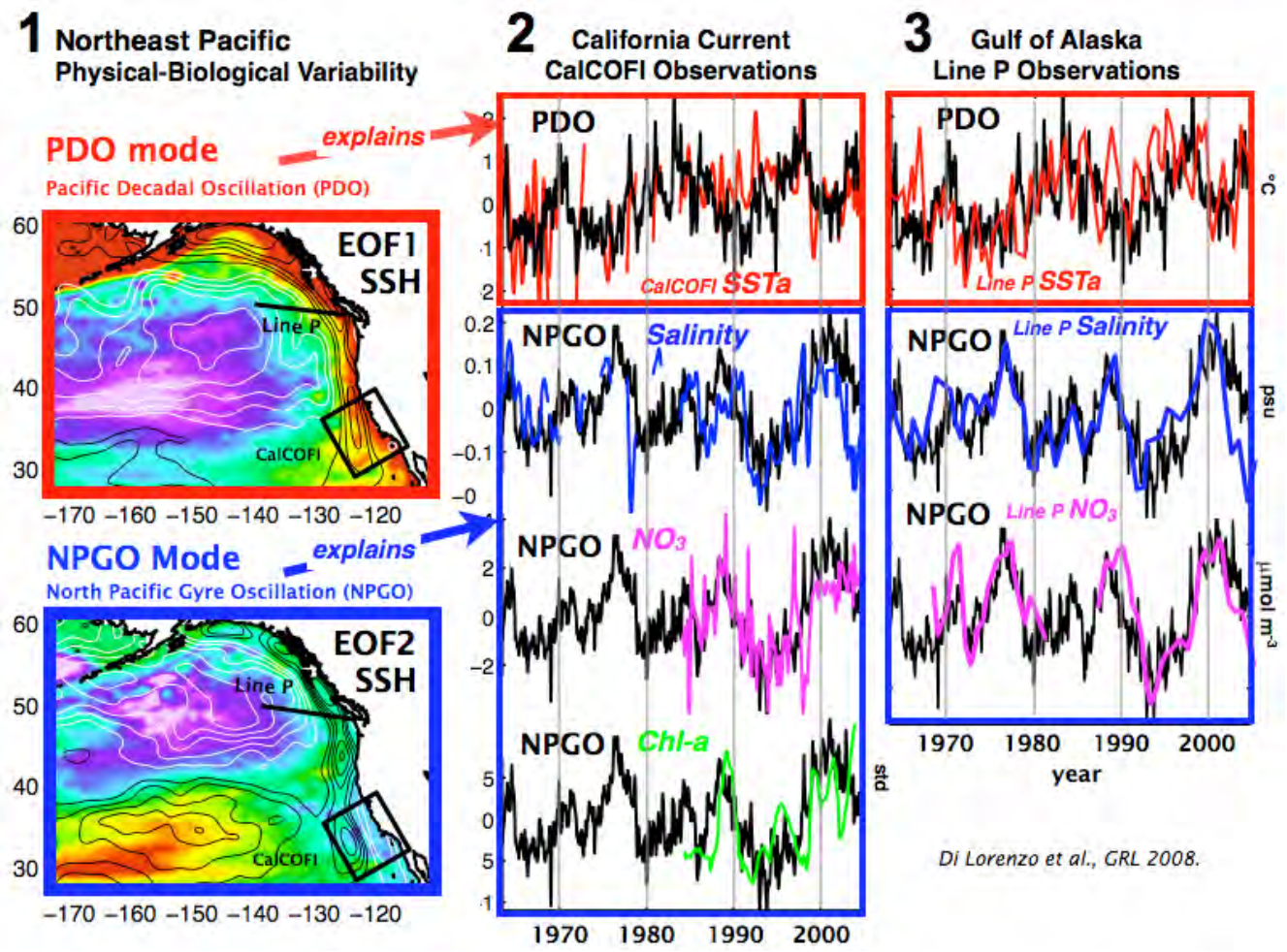


Fig. 2 Two dominant patterns of climate variability in the North Pacific are the Pacific Decadal Oscillation (PDO) and the North Pacific Gyre Oscillation (NPGO). The PDO emerges as the first EOF/PC of the spatiotemporal pattern of both sea surface temperature anomaly (SSTa) and sea surface height anomaly (SSHa). The NPGO index is the second EOF/PC of SSHa, and closely tracks the second EOF of the SSTa, which is known as the "Victoria Mode" (Bond et al., 2003). By definition of EOF analysis, the PDO and NPGO are statistically independent. Surface salinity, upper ocean nitrate concentration, and chlorophyll-a concentration in the California Current are strongly correlated with the strength of the NPGO.

Several talks emphasized that physical oceanography and biological oceanography prior to GLOBEC were done largely independently, which led to difficulties in attributing causation to observed patterns in biological populations/communities. Early programs that did conduct interdisciplinary science, such as Warm Core Rings and SUPER, were of limited duration (3–5 years), which made it difficult to examine even temporal variability at interannual scales. During GLOBEC, it was assumed that variability in population recruitment and marine ecosystems results from the integration of many processes across multiple scales and include both direct and indirect interactions. The idea of alternate regional food webs, structured either through physical (*e.g.*, advection) or food web interactions emerged from GLOBEC studies in the Southern Ocean (krill, salp and copepod pathways to higher trophic levels [HTL]), Northeast Pacific (nitrogen *vs.* iron-limited regions and subtropical *vs.* subarctic species dominance in lower trophic levels [LTL]), and NW Atlantic (*Calanus* to cod and haddock connections).

Population dynamics were a cornerstone of the GLOBEC program. The dynamics of zooplanktonic populations are controlled by physical processes (immigration and emigration) and biological processes (birth and death rates). For larger organisms with greater swimming ability, immigration and emigration are controlled also by animal behavior. Many observations of species abundance, variability, vital rates and ecosystem connections were made in U.S. GLOBEC regional studies. Direct observations of behavior were fewer, as behavior was often inferred from distributional changes in field observations.

Modeling in U.S. GLOBEC included conceptual studies (Steele *et al.*, 2007), prototype studies of biological processes in idealized flow fields (Batchelder *et al.*, 2002), and site-specific models with realism (*e.g.*, Dinniman *et al.*, 2011; Hermann *et al.*, 2009; Miller *et al.*, 1998). Coupled biophysical modeling advanced greatly as the realism of circulation models improved. Physical–biological models evolved to systems of inter-connected models that included

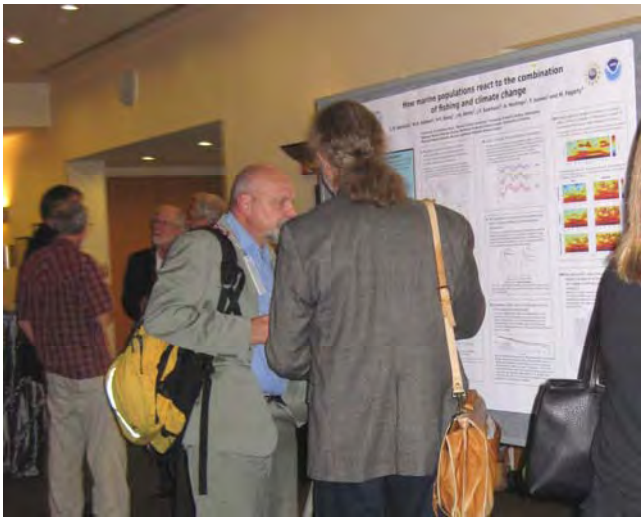
circulation, LTL dynamics, and individual HTL (especially fish) growth, and sometimes HTL population dynamics by inclusion of reproduction and recruitment. Transport pathways and controls on individual and population growth could be tracked, spawning areas identified, and spatial connectivity of populations estimated. For some of these (*e.g.*, connectivity), model-based estimates are difficult to validate because direct observations of connectivity are lacking.

The more powerful computers available during the GLOBEC decades had their most significant impact by enabling data-assimilative models of substantial complexity and high resolution. Data assimilation was greatly improved and applied to U.S. GLOBEC study regions to understand processes, to better estimate uncertain parameters, and to provide improved state estimates, particularly in regions subject to strong mesoscale variability. While to date the emphasis has been on assimilation of physical data, there is strong evidence that assimilation of physical data improves ecosystem state estimates in coupled bio-physical models (Fiechter *et al*., 2011).

U.S. GLOBEC significantly advanced the state of the field in linking regional ocean models with global climate models. Most global climate models do not represent continental shelves well, and the impact of continental shelf dynamics on the offshore regions, although important, is missing. Moreover, coastal regions are the sites of greatest anthropogenic change and greatest concern for the future. Climate-regional linking in the program was bidirectional, with both downscaling and upscaling. Accurate models of high resolution shelf dynamics, say in Eastern Boundary Current Regions, could have significant impacts on climate models both locally and remotely. Enrique Curchitser led this effort, working with the NCAR global climate model.

Just as important as the data sets and knowledge generated during the course of U.S. GLOBEC is the legacy of the next generation of scientists produced through their involvement in GLOBEC science. Hundreds of people participated as PIs, undergraduate and graduate students, postdoctoral investigators, technicians, program managers, and in many other ways. For many of them, the program was their introduction to science that was multi-disciplinary by design. Thus, these young scientists are trained in new ways that equip them to lead ocean and ecological investigations into new frontiers in the future. Many will have very successful careers and transmit the "GLOBEC way" to their own students, thus propagating the multi-disciplinary approach into the future. At the symposium three young scientists (two were graduate students and one a postdoc in GLOBEC) described their GLOBEC research and how it influenced their careers.

Dr. Ari Friedlaender did his doctoral research on the Western Antarctic Peninsula during the GLOBEC Southern Ocean program, receiving his Ph.D. in 2006 for his thesis,



Loo Botsford (back to camera) describing the significance of his salmon and cod research to Steve Murawski during the poster session (photo by Beth Turner).

Mark Ohman and Frank Schwing enjoying the poster session (photo by Ian Perry).

Jeff Runge, Beth Turner and Zack Powell enjoying tapas. Phil Taylor and Cisco Werner seated in background (photo by Ian Perry).

"*Spatial ecology of humpback and minke whales off the Western Antarctic Peninsula*". Before GLOBEC, Antarctic whale research was dominated by "whaling records" providing information on biology, life history and stock structure, and by coarse-scale surveys over broad regions. During Ari's research the emphasis shifted to quantitative studies of whales concurrent with their physical habitat and prey resources. This was feasible on Southern Ocean GLOBEC cruises because the large multi-disciplinary research teams provided environmental data to complement the whale studies. Dr. Friedlaender's work on cetaceans in the Southern Ocean continues with focused tagging of individuals to quantify underwater feeding behavior and prey patch selection.

Dr. Julie Keister received her Ph.D. from Oregon State University in 2008 for her dissertation, "*Variability in mesoscale circulation and its effects on zooplankton distribution in the Northern California Current*". Julie started with U.S. GLOBEC as a research technician working in the laboratory of William Peterson in Newport, Oregon, where she was responsible for sampling zooplankton during the Long-Term Observation Program and mesoscale survey cruises. Dr. Keister is now an Assistant Professor at the University of Washington, where she continues GLOBEC research as a co-PI with Dr. Manu Di Lorenzo and others in pan-regional synthesis.

Dr. Enrique Curchitser began working on GLOBEC physical modeling in the California Current System (CCS) and later the Coastal Gulf of Alaska (CGOA) as a postdoc. He produced the first GLOBEC physical model results in the CCS (*ca.* 2002), multi-decadal North Pacific Basin scale simulations and coupled biophysical models. Subsequently, Enrique linked high-resolution coastal ocean models to coarse-resolution climate models of the type used by the IPCC for long-range predictions of future conditions. Enrique is adding fish populations and fishing fleets, including behavior and economics into coupled ecosystem-circulation models. These three and others represent a new generation of GLOBEC trained scientists that not only links across disciplines within traditional natural sciences, oceanography and fisheries, but also links to social science (human activities).

As summarized by Ian Perry, the fundamental concepts of the GLOBEC way of doing science developed in the United States became a blueprint for other national GLOBEC studies undertaken worldwide. Moreover, U.S. GLOBEC approached SCOR, ICES, and IOC-UNESCO to develop an international program (IOC-SCOR Workshop, May 1991), which established the central themes of GLOBEC International. In 1995, the IGBP approved GLOBEC as a core project, with co-sponsorship by SCOR and IOC. As neither U.S. GLOBEC nor International GLOBEC were able to address all issues and provide answers to all questions, several challenges remain. A remaining task is to provide **meaningful** forecasts and projections of marine population variability and response to climate change and human influences. This will require continued sustained observations, large-scale meta-comparisons, improved integration of ocean observations and models, explicit inclusion of humans as drivers of change and recipients of ocean ecosystem services, better integrated scenario development and analysis that include uncertainty estimates, and improved communication of projections to policy makers and the public.

Final words

Although the October event was billed as the "Final GLOBEC Symposium and Celebration", we choose to believe that the event was not the final celebration of U.S. GLOBEC, but rather that 20 or 40 years hence a future generation of ocean scientists and managers, likely still confronting climate change and it impacts on coastal ecosystems, will be celebrating the foresight of NSF, NOAA and U.S. GLOBEC for having invested significant resources into the coupled physical, chemical and ecological investigations of the four target ecosystems: the Northwest Atlantic/Georges Bank, the Northern California Current, the Coastal Gulf of Alaska, and the Antarctic Peninsula.

Ed Houde concluded his talk on whether U.S. GLOBEC met the challenges and objectives it established in the early 1990s by posing the following question, *What are the three major contributions of U.S. GLOBEC that will insure the legacy of the program?* One is hard pressed to come up with only three major contributions (Table 3).

Postscript: One of us (HPB) as the coordinator for the GLOBEC Scientific Steering Committee (SSC) during 1992–1998 was responsible for recording the minutes of the SSC meetings, including notable quotes, the best of which became known as the Quote of the Meeting (QOTM). For the Final U.S. GLOBEC Symposium, the QOTM is from Loo Botsford for the statement, "*Dave Mountain is the George Carlin of GLOBEC*".

References

Batchelder, H.P., C.A. Edwards, and T.M. Powell. 2002. Individual based models of copepod populations in coastal upwelling regions: implications of physiologically and environmentally influenced diel vertical migration on demographic success and nearshore retention. *Prog. Oceanogr*., 53, 307–334.

Bond, N.A., J.E. Overland, M. Spillane, and P. Stabeno. 2003. Recent shifts in the state of the North Pacific. *Geophys. Res. Lett.*, 30, 2183, doi:10.1029/2003GL018597.

Di Lorenzo, E., J. Fiechter, N. Schneider, A. Bracco, A.J. Miller, P.J.S. Franks, S.J. Bograd, A.M. Moore, A.C. Thomas, W. Crawford, A. Peña, and A.J. Hermann. 2009. Nutrient and salinity decadal variations in the central and eastern North Pacific. *Geophys. Res. Lett.*, 36, L14601, doi:10.1029/2009GL038261.

Di Lorenzo, E., N. Schneider, K.M. Cobb, P.J.S. Franks, K. Chhak, A.J. Miller, J.C. McWilliams, S.J. Bograd, H. Arango,

E. Curchitser, T.M. Powell, and P. Rivière. 2008. North Pacific Gyre Oscillation links ocean climate and ecosystem change. *Geophys. Res. Lett.*, 35, L08607, doi:10.1029/2007GL032838.

Dinniman, M.S., J.M. Klinck, and W.O. Smith, Jr. 2011. A model study of Circumpolar Deep Water on the West Antarctic Peninsula and Ross Sea continental shelves. *Deep-Sea Res. II*, 58, 1508–1523.

Durbin, E.G., R.G. Campbell, M.C. Casas, J.D. Ohman, B. Niehoff, J. Runge, and M. Wagner. 2003. Interannual variation in phytoplankton blooms and zooplankton productivity and abundance in the Gulf of Maine during winter. *Mar. Ecol. Prog. Ser.*, 254, 81–100.

Fiechter, J., G. Broquet, A.M. Moore, and H.G. Arango. 2011. A data assimilative, coupled physical-biological model for the Coastal Gulf of Alaska. *Dyn. Atmos. Oceans*, 52, 95–118.

Greene, C.H. and A.J. Pershing. 2007. Climate drives sea change. *Science*, 315, 1084–1085.

Hermann, A.J., S. Hinckley, E.L. Dobbins, D.B. Haidvogel, N.A. Bond, C. Mordy, N. Kachel, and P.J. Stabeno. 2009. Quantifying cross-shelf and vertical nutrient flux in the Coastal Gulf of Alaska with a spatially nested, coupled biophysical model. *Deep-Sea Res. II*, 56, 2474–2486.

Kane, J. 2007. Zooplankton abundance trends on Georges Bank, 1977–2004. *ICES J. Mar. Sci*., 64, 909–919.

Miller, C.B., D.R. Lynch, F. Carlotti, W. Gentleman, and C.V.W. Lewis. 1998. Coupling an individual-based population dynamic model of *Calanus finmarchicus* to a circulation model for the Georges Bank region. *Fish. Oceanogr*., 7, 219–234.

Mountain, D.G., and J. Kane. 2010. Major changes in the Georges Bank ecosystem, 1980s to the 1990s. *Mar. Ecol. Prog. Ser*., 398, 81–91.

Steele, J., J. Collie, J. Bisagni, D. Gifford, M. Fogarty, J. Link, B. Sullivan, M. Sieracki, A. Beet, and D. Mountain. 2007. Balancing end-to-end budgets of the Georges Bank ecosystem. *Prog. Oceanogr*., 74, 423–448.

U.S. GLOBEC. 1991. Initial Science Plan. U.S. Global Ocean Ecosystems Dynamics Report Number 1. 93 pp.

U.S. GLOBEC. 1996. U.S. GLOBEC Northeast Pacific Implementation Plan. U.S. Global Ocean Ecosystems Dynamics Report Number 17. 60 pp.

From left to right, Dale Haidvogel, Art Miller, Hal Batchelder, Bob Beardsley and Dave Mountain enjoy some of the "celebration" portion of the symposium (photo courtesy of Ian Perry).

Dr. Harold (Hal) Batchelder (hbatchelder@coas.oregonstate.edu) is a Professor in the College of Oceanic and Atmospheric Sciences at Oregon State University, U.S.A. His present research focuses on individual based modeling the biological–physical coupling of marine environments and marine populations, including studies on Calanus finmarchicus in the North Atlantic, and krill and juvenile salmon in the Northeast Pacific. In PICES, Hal served as Co-Chairman of the Climate Change and Carrying Capacity (CCCC) program and as a Science Board member from 2001–2009, and presently as a member of the FUTURE Advisory Panel on Status, Outlooks, Forecasts and Engagement. He is active in the PICES Marine Ecosystem Model Intercomparison Project (MEMIP). He was a Coordinator of the U.S. GLOBEC National Program for 6 years, and Executive Director of the U.S. GLOBEC Northeast Pacific regional program for 12 years.

Dr. Dale Haidvogel (dale@marine.rutgers.edu) is a Professor in the Institute of Marine and Coastal Sciences (IMCS) at Rutgers University, U.S.A. His research interests include the modeling of regional climate impacts, numerical and laboratory studies of fundamental earth system processes, and the development of advanced algorithms for geophysical modeling. Dale founded the IMCS Ocean Modeling Group which has as one of it foremost goals the implementation and distribution of interdisciplinary ocean modeling systems, including coupled models for atmosphere/ocean, biogeochemical, and ecosystem responses. Modeling software developed by the Ocean Modeling Group, and its colleagues, is now in world-wide application (www.myroms.org). Dale has served as Director of the U.S. GLOBEC National Office for the past 8 years.

Dr. David Mountain (dmountain@capecod.net) is an oceanographer who worked at the NOAA Fisheries laboratory in Woods Hole, MA, U.S.A. for many years before retiring in 2007. He was a Principal Investigator in the U.S. GLOBEC Georges Bank study and a member of the U.S. GLOBEC Scientific Steering Committee. He currently is an Adjunct Scientist with both the Woods Hole Oceanographic Institution and the University of Arizona in Tucson.

2011 PICES Rapid Assessment Survey

by Vasily Radashevsky, John Chapman, Leslie Harris and Thomas Therriault

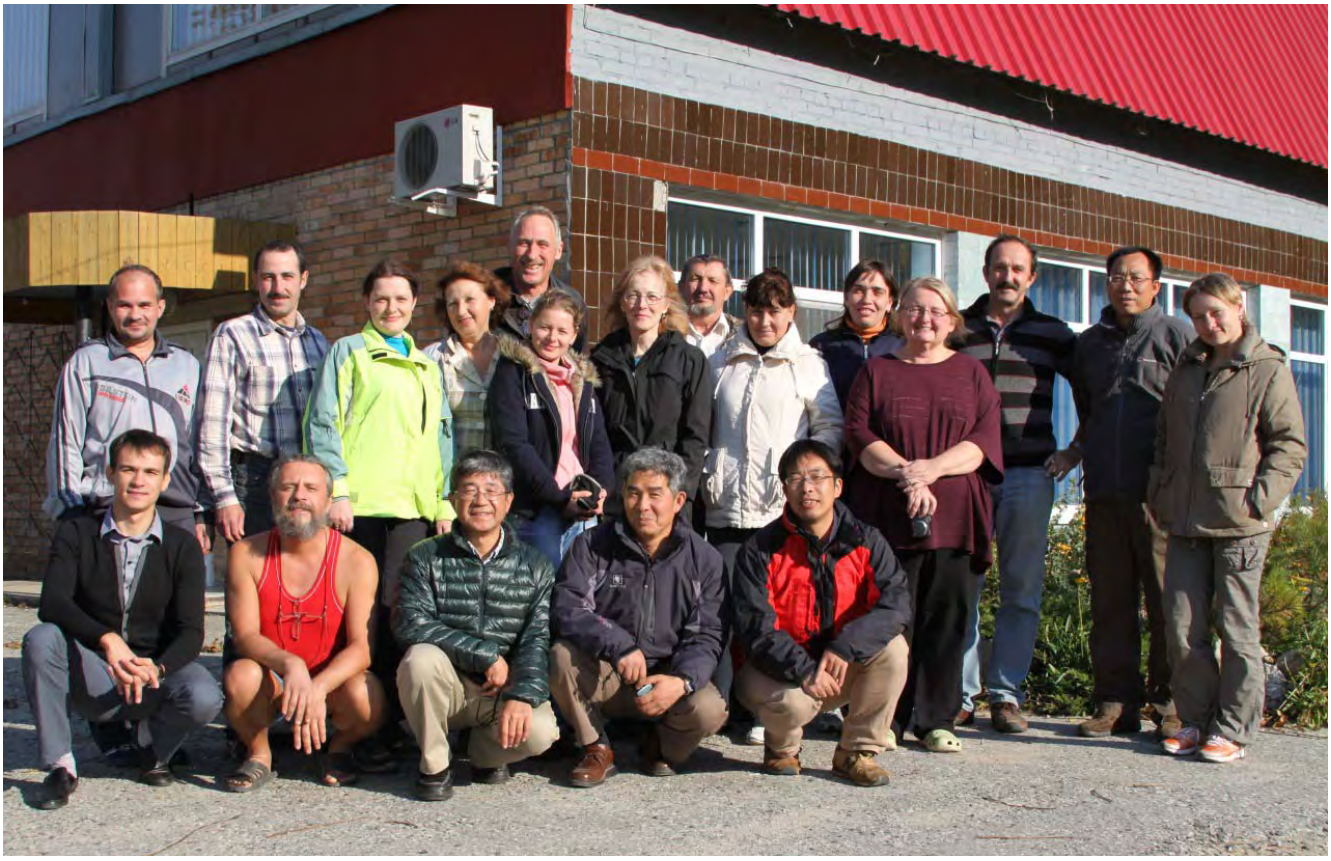
The central question to be answered by the PICES Working Group 21 (WG 21), since its formation in 2006, has been whether increasing invasions of non-indigenous species (NIS) threaten marine resources of North Pacific countries. In accordance with its mission to increase understanding of marine NIS in the PICES area, WG 21 began work in 2007 on the NIS component of a 5-year project on "*Development of the prevention systems for harmful organisms' expansion in the Pacific Rim*" supported by a voluntary contribution from the Ministry of Agriculture, Forestry and Fisheries of Japan, through the Fisheries Agency of Japan. This NIS component was further divided into two initiatives. Dr. Henry Lee II (U.S. Environmental Protection Agency; lee.henry@epa.gov) leads the first initiative, to develop a comprehensive database for non-indigenous North Pacific species. The second initiative, to conduct rapid assessment surveys (RAS) of PICES member countries, is being coordinated by Dr. Thomas Therriault (Fisheries and Oceans Canada; thomas.therriault@dfo-mpo.gc.ca). Both of these integrated initiatives have revealed: (1) significant and increasing threats to marine resources by NIS and (2) the critical importance of expanded international cooperation to resolve and manage them.

Responses to invasions are unlikely to be initiated or to be effective without understanding the problems they cause or collaborative efforts to manage them. Rapid assessment surveys are able to provide baseline data critical for measuring and limiting the rates and expansions of invasions among PICES member countries and are also indispensable for international calibration and standardization of both taxonomy and NIS detection. International ballast water traffic has been an especially important mechanism for transporting organisms into countries where high levels of secondary traffic (small craft and aquaculture) transfer these organisms to adjacent areas. The PICES surveys have been particularly useful for detecting and measuring invasions by all mechanisms.

The first PICES RAS was organized in Dalian, China, in 2008 (see PICES Press 17(1): 30–32). The second survey was conducted on Jeju Island, Korea, in 2009 (PICES Press 18(1): 38–40). The third one took place near Newport in central Oregon, U.S.A., in 2010 (PICES Press 19(1): 27–29). The 2011 survey described in this article was organized just prior to the 2011 PICES Annual Meeting in Khabarovsk, Russia.

The 2011 RAS was conducted in Peter the Great Bay, near Vladivostok and Nakhodka, the largest Far Eastern Region seaports of Russia. The survey was based at the *Vostok* Marine Biological Station of the A.V. Zhirmunsky Institute of Marine Biology (IMB) of the Far Eastern Branch of the Russian Academy of Sciences, which is located about 2 hours away in Vladivostok (see photo below). The *Vostok* Station, on the coast of Vostok Bay (an eastern extension of Peter the Great Bay), was established by the IMB in a comparatively clean area with diverse surrounding habitats to serve as an international base for marine studies. The biodiversity in the area has since become relatively well described due to continuous studies by scientists from all over the world.

Peter the Great Bay region, including Vladivostok, on the Muravyov-Amursky Peninsula and Vostok Bay to the east.



Participants in the 2011 PICES Rapid Assessment Survey of non-indigenous, cryptogenic and native species at the Vostok Marine Biological Station of the A.V. Zhirmunsky Institute of Marine Biology (taken by Leslie Harris). Front row (from left): Alexey Gorodkov, Alexander Rzhavsky, Hisashi Yokoyama, Jin-Woo Choi, Takeaki Hanyuda; back row: Evgeny Barabanshchikov, Ilia Korneichuk, Marina Nekrasova, Vera Radashevskaya, John Chapman, Oksana Belous, Gayle Hansen, Ivan Kashin Liudmila Budnikova, Natalia Demchenko Darlene Smith, Vasily Radashevsky, Xinzheng Li and Inna Alalykina (not in picture: Olga Golovan, Anastasia Mayorova and Leslie Harris).

As the previous year's RAS in Newport was particularly successful for polychaetes, small crustaceans, and marine algae, it was decided to focus on these groups again in 2011. A 7-member group, Leslie Harris (NHMLAC, U.S.A.), Vasily Radashevsky, Inna Alalykina and Marina Nekrasova (IMB), Alexander Rzhavsky (Severtsov Institute of Ecology and Evolution, RAS, Russia), Jin-Woo Choi (South Sea Research Institute, KORDI, Korea), and Hisashi Yokoyama (National Research Institute of Aquaculture, Japan), dealt with polychaetes. Another 7-member group, Liudmila Budnikova and, Evgeny Barabanshchikov and Ilia Korneichuk (TINRO-Center, Russia), John Chapman (Oregon State University, U.S.A.), Natalia Demchenko and Olga Golovan (IMB), and Xinzheng Li (Institute of Oceanology, CAS, China), surveyed crustaceans. Three participants, Oksana Belous (PIBOC, Russia), Gayle Hansen (Oregon State University, U.S.A.) and Takeaki Hanyuda (Kobe University Research Center for Inland Seas, Japan), worked with algae. Anastasia Mayorova (IMB) sampled for Sipunculida, and Evgeny Barabanshchikov did double duty, also surveying plankton. Alexey Gorodkov and Ivan Kashin (IMB) set the collector plates, and Darlene Smith (Fisheries and Oceans Canada) served as data manager. The entire survey was coordinated by Vasily Radashevsky.

The official survey took place from October 7–14. Several participants (Alalykina, Chapman, Demchenko, Hansen, Harris, Radashevsky and Rzhavsky) stayed on for another two weeks to maximize sampling efforts around the *Vostok* Station and to examine collections in Vladivostok. A seminar, with 10 reports on NIS research in the North Pacific, was organized at the station on October 13. Two additional lectures on introduced species issues were also delivered by Harris and Chapman at the Institute of Marine Biology in Vladivostok.

Most of the sampling was conducted in and around Vostok Bay in habitats that varied from small harbors to rocky points (see photo on next page) and mud flats. Collector plates (man-made attachment sites for species that prefer hard substrates) were deployed for about 5 months. Two sets of these plates were recovered from Vostok Bay harbors and one from the international harbor in Vladivostok.

The value of the PICES surveys depends on whether biological invasions affect marine ecosystems or human welfare, and whether managing or preventing these invasions can be cost effective. The surveys therefore focused on three relevant questions:

Participants of the PICES Rapid Assessment Survey on the rocky shore of Anna Bight, Anna Lighthouse Resort Point, near Vostok Bay, October 9, 2011.

(1) What are the patterns, magnitudes and processes of biological invasions?
(2) Can these invasions reduce food security, economic development or alter the ecological dynamics of natural ecosystems?
(3) Can biological invasions be managed or prevented?

All PICES member countries appear to be addressing *Question 3* but are hindered by the absence of quantitative measures or rigorous theory for measuring effects or designing and testing responses. International efforts depend on close collaborations such as those that the PICES surveys have produced. The accumulating discoveries of the PICES surveys have addressed *Questions 1* and *2* in particular, and thus *Question 3* as well. A sampling of PICES discoveries follows.

The most fundamental parameters of invasion ecology, the origins of species (native, ***N*** or introduced, ***I***) and their relative abundances (***R*** = ***I***/***N***) have proven elusive to measure in nearly all marine systems due to the large proportions of "cryptogenic species" (***C***), that cannot be confidently classified as ***I*** or ***N***. The unmeasured dependence of ***I*** and ***N*** on ***C*** has prevented confident measures of ***R***. Correlations between cryptogenic species with introductions but not with native species among sites and phyla were discovered in the PICES surveys. The majority of cryptogenic species are likely to be introduced and therefore, can be included among introduced species for estimates of ***R***. Preliminary analyses of other surveys around the world indicate a nearly universal association of cryptogenic species with introductions.

Another fundamental question has been whether the recently found invasions are due predominantly to rapidly increasing new mechanisms or to long-standing gradual increases only recently discovered. Comparisons of the dates of species descriptions with their dates of discovery in Peter the Great Bay revealed that most introduced species of the region were known more than 100 years before they were discovered in the bay. The majority of native macroscopic invertebrates, algae and plants recovered in recent surveys of Peter the Great Bay were also previously known. These discoveries of introduced species were therefore, not likely to have been overlooked among previously unreported species. More probable, these invasions are due to recent arrivals rather than to increases in research.

The PICES surveys permit analyses of climate effects on the rates and patterns of invasions. Nearly all of the introduced species discovered in Peter the Great Bay since 2009 were previously known from southern East Asian countries (Zvyagintsev *et al*. 2009, 2011). The restricted ranges and summer occurrences for most of these species are consistent with expanding southern populations or northern migration (Zvyagintsev *et al*. 2009, 2011). The recent invasions of Russia found in the PICES survey appear also to be northern shifts or expanding ranges of warm water species. The introduced and cryptogenic species found in the relatively pristine Vostok Bay area also indicate that they are not restricted to harbors and thus have broad distributions on the Russian coast, with significant potential to interact with valuable native populations.

Relative to whether marine invasions can threaten human welfare: none of the human-borne introduced species found in the October 2011 and earlier surveys (Zvyagintsev *et al*. 2009, 2011) are of economic value to Russia. Since all of these species have the potential to displace or replace economically valuable native species, the common introduced species to Russia thus appear more likely to be harmful than useful and also unlikely to make positive contributions to the native biota.

Population extinctions and displacement of native species coincident with introduced biological invasions are occurring in North America (Chapman *et al*., in press), as species equilibrium models have predicted. Although invasions of the Russian coasts seem to be less intense than in North America, their rapid increases appear likely to soon bring them to North American intensities. The PICES surveys provide critical information and a mechanism to foster the international cooperation needed for each member country to detect and manage introduced species. International collaborations through PICES are thus

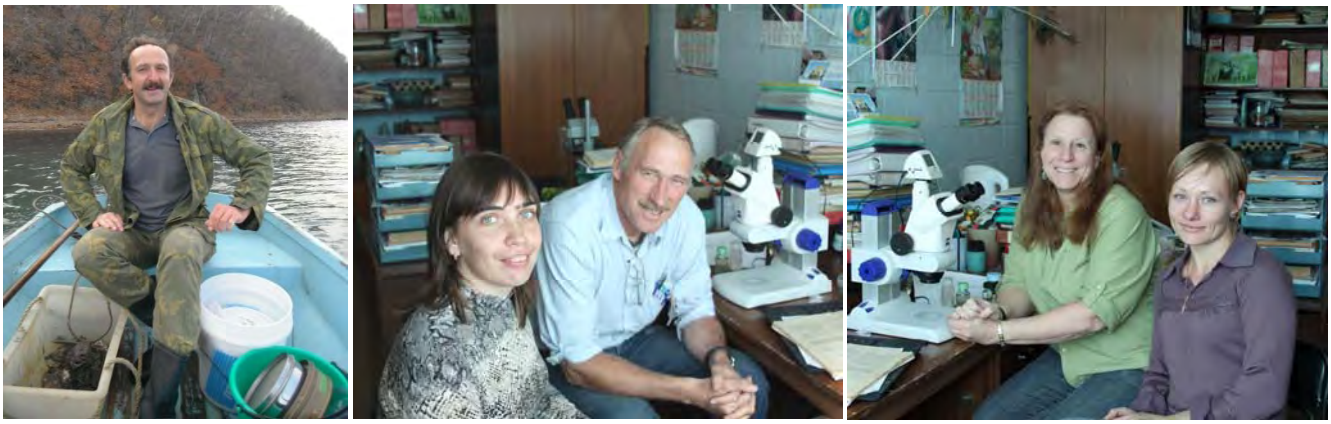
increasing the quality and resolution of taxonomic research on Asian coasts, increasing the resolution of invasion patterns and opening communications needed to permit relevant, cooperative responses to begin.

References

Chapman, J.W., Dumbauld, B.R., Itani, G. and Markham, J.C. (In press). An introduced Asian parasite threatens northeastern Pacific estuarine ecosystems. *Biological Invasions*. BINV2594R2.

Zvyagintsev, A.Yu., Ivin, V.V., Kashin, I.A., Orlova, T.Yu., Selina, M.S., Kasyan, V.V., Korn, O.M., Kornienko, E.S., Kulikova, V.A., Bezverbnaya, I.P., Zvereva, L.V., Radashevsky, V.I., Belogurova, L.S., Begun, A.A. and Gorodkov, A.N. Ships' ballast water organisms in the port of Vladivostok. *Russian Journal of Marine Biology*, 2009, vol. 35, no. 1, pp. 29–40.

Zvyagintsev A.Yu., Radashevsky V.I., Ivin V.V., Kashin I.A. and Gorodkov A.N. Non-indigenous species in the Far-Eastern seas of Russia. *Russian Journal of Biological Invasions*, 2011, vol. 2, no. 2–3, pp. 44–73.



Dr. Vasily Radashevsky (radashevsky@gmail.com; left photo) is a Research Scientist at the A.V. Zhirmunsky Institute of Marine Biology (IMB) of the Far Eastern Branch of the Russian Academy of Sciences in Vladivostok, Russia. Vasily studies the morphology, ecology, reproductive biology and phylogeny of marine worms of the family Spionidae (Annelida) which easily survive in ballast waters and are transported worldwide. He co-chairs PICES Working Group 21 on Non-indigenous Aquatic Species.

Dr. John Chapman (John.Chapman@oregonstate.edu; center photo, with Natalia Demchenko [amphipod taxonomist and ecologist at IMB]) is the Head of the Marine Biological Invasions Laboratory at the Hatfield Marine Science Center, in Newport, Oregon, U.S.A. In addition to the PICES rapid assessment surveys in 2009, 2010 and 2011, his research includes shallow water amphipod crustacean systematics and the parasite-host ecology of introduced and native bopyrid isopods and their host shrimps. John also teaches lower and upper division Aquatic Biological Invasions through the Departments of Biology and Fisheries and Wildlife at Oregon State University.

Leslie Harris (exogone@hotmail.com; left in right photo, reviewing North Pacific polychaete taxonomy with Inna Alalykina [polychaete taxonomist and ecologist at IMB]) is the Polychaete Collection Manager at the Natural History Museum of Los Angeles County, U.S.A. She has over 30 years of experience in identifying polychaetes from the Arctic to the Antarctic and points in between, with particular emphasis on the North Pacific fauna. A veteran of non-indigenous species surveys since 1998, Leslie was also a participant in the 2010 PICES rapid assessment survey. Her research focuses on taxonomic issues, distribution patterns, and resolution of introduction status of marine organisms, in general, and polychaete worms, in particular.

Dr. Thomas Therriault (Tom's photo can be seen in the next article; Thomas.Therriault@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station in Nanaimo, British Columbia. Tom is working on a number of aquatic invasive species research questions both within DFO and through the second Canadian Aquatic Invasive Species Network (CAISN II). He is the Principal Investigator for the Taxonomy Initiative of PICES Working Group 21 on Non-indigenous Aquatic Species (under the project on "Development of the prevention systems for harmful organisms' expansion in the Pacific Rim" supported by the Ministry of Agriculture, Forestry and Fisheries of Japan) that includes rapid assessment surveys for non-indigenous species. Within PICES, Tom serves as Vice-Chairman of Science Board and Chairman of the FUTURE Advisory Panel on Anthropogenic Influences on Coastal Ecosystems. He is a member of the Marine Environmental Quality Committee and the PICES/ICES Study Group on Developing a Framework for Scientific Cooperation in the Northern Hemisphere Marine Science.

Introduction to Rapid Assessment Survey Methodologies for Detecting Non-indigenous Marine Species

by Thomas Therriault

Thanks to a contribution from the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), funding for a PICES project entitled "*Development of the prevention systems for harmful organisms' expansion in the Pacific Rim*" has allowed Working Group 21 (http://www.pices.int/members/working_groups/wg21.aspx) to advance its understanding of non-indigenous marine species in the North Pacific. As highlighted in previous PICES Press articles, WG 21 has employed Rapid Assessment Surveys (RAS) to quickly characterize the native, non-native, and cryptogenic species present in coastal areas of different PICES member countries. To date, RAS have been conducted in 2008 in Dalian (People's Republic of China), in 2009 in Jeju (Republic of Korea), in 2010 in Newport (U.S.A.), and most recently near Vladivostok, Russia, in 2011 (*see related PICES Press article in this issue*). In addition, this funding has allowed for capacity building in non-PICES member countries. In July 2010, a pilot workshop was held at the Marine Station of Kobe University's Center for Inland Seas (Awaji Island, Japan) to provide participants from developing countries with the tools to conduct RAS in their own waters (PICES Press, 2011, Vol. 19, No. 1, pp. 30–31).

The positive feedback from workshop participants was so overwhelming that Drs. Thomas Therriault (Pacific Biological Station, Fisheries and Oceans Canada) and Hiroshi Kawai (Kobe University, Japan) started planning for a larger RAS demonstration workshop for 2011. Given the global nature of biological invasions, it was critical to engage researchers working on this important topic outside the six PICES member countries, especially those locations adjacent to the PICES region where the potential transport of non-indigenous species is expected to be high. The Intergovernmental Oceanographic Commission's Sub-Commission for the Western Pacific (WESTPAC) has been assisting their member countries in studying marine non-indigenous species since 2009, with a focus in Southeast Asia, and the shared interests of the two organizations represented an excellent opportunity to collaborate on marine non-indigenous species issues. Dr. Apple Chavanich offered to host the joint workshop in Thailand, given its logistical benefits.

Although specific methods vary slightly, based on habitats being sampled or taxonomic groups being characterized, WG 21 has developed methodologies that have been used within PICES member countries to identify non-indigenous species in both intertidal and subtidal habitats. In addition, data from each of these surveys have been archived in the WG 21 database, thereby making it more broadly available. Thus, the objectives of the demonstration workshop on "*Rapid Assessment Survey methodologies for detecting non-indigenous marine species*" were to:

(1) provide hands-on training to researchers from developing Southeast Asian countries concerned about the potential introduction of non-indigenous marine species;
(2) introduce the PICES WG 21 database on non-indigenous marine species; and
(3) foster collaboration between PICES and WESTPAC.

Workshop participants explore the intertidal zone near the Phuket Marine Biological Center.

Workshop participants engaged in sample processing and species identifications.

The workshop was held July 19–21, 2011, at the Marine Biological Center, Phuket, Thailand, with more than 25 participants from the People's Republic of China, Hong Kong, Indonesia, Malaysia, the Philippines, Republic of Korea, Singapore, Thailand, and Vietnam. The workshop was supported by PICES, WESTPAC and the Phuket Marine Biological Center, and co-convened by Drs. Apple Chavanich (WESTPAC), Hiroshi Kawai (PICES), and Thomas Therriault (PICES).

The workshop kicked off on Day 1 with a warm welcome from the Director of the Phuket Marine Biological Center, Mr. Wannakiat Thubthimsang. Following an introduction from the co-convenors and with participants providing a bit of background about themselves, information about PICES and WESTPAC initiatives on non-indigenous marine species were discussed. However, with the Marine Biological Center positioned right on the Andaman Sea, it did not take long to get to the hands-on part of the workshop, and participants visited a number of intertidal sites around the Center and the dock where a Thai research vessel was tied up. Thus, participants were exposed to techniques for sampling a variety of different habitats and organisms. Dr. Kawai supplemented algal collections by snorkelling in the warm (but murky) nearshore waters. Loaded down with bags full of live samples, participants returned to the Marine Biological Center where they spent time identifying the various organisms they had collected. On the second day the workshop shifted towards data collection and data sharing. Dr. Therriault introduced the PICES WG 21 database on non-indigenous marine species developed by Drs. Henry Lee and Debbie Reusser. This hierarchical database, based on marine eco-regions of the world, will allow participants from developing countries to archive their data in a systematic way that is then directly available both to them and to scientists from PICES member countries. The afternoon saw a bit of free time emerge, and most participants visited the nearby Phuket Aquarium before regrouping for a wonderful all-you-can-eat seafood buffet. The last day included a special lecture on how genetic techniques can be used to resolve invasion patterns in marine systems, and workshop attendees each provided an overview of the types of research they are conducting with respect to non-indigenous species.

Overall, this workshop exposed participants to a background about marine non-indigenous species and why vigilance is required, using a series of short lectures, hands-on experience in making field collections in a variety of coastal environments, and laboratory experience using keys and reference material to identify organisms collected. Since this workshop focused on background and techniques, actual taxonomic experts were not utilized in this demonstration but would play a critical role in actual RAS. Taxonomic experts have a broad knowledge of their taxonomic group amassed over time spent studying thousands of individuals from different geographical areas to resolve identifications – skills taxonomic generalists must develop to confidently resolve identifications (and potential invasion status). Further, given that taxonomy for some species will be controversial and that reference collections are important to document the occurrence of non-indigenous species, it is imperative that voucher specimens be maintained for future reference.

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, British Columbia. Tom is working on a number of aquatic invasive species research questions both within DFO and through the second Canadian Aquatic Invasive Species Network (CAISN II). He is the Principal Investigator for the Taxonomy Initiative of PICES Working Group 21 on Non-indigenous Aquatic Species that includes rapid assessment surveys (RAS) for non-indigenous species. Within PICES, Tom serves as Vice-Chairman of Science Board and Chairman of the FUTURE Advisory Panel on Anthropogenic Influences on Coastal Ecosystems. He is a member of the Marine Environmental Quality Committee and the PICES/ICES Study Group on Developing a Framework for Scientific Cooperation in Northern Hemisphere Marine Science.

The 7th International Conference on Marine Bioinvasions

by Lisa Drake and Thomas Therriault

From August 23–25, 2011, the 7th International Conference on Marine Bioinvasions—the first held in Europe—was convened in Barcelona, Spain. Approximately 150 scientists, policy makers, and regulators from 20 countries in North America, Europe, Africa, Asia, and Australia and New Zealand arrived in Barcelona to exchange ideas and discuss the latest findings and progress in the global effort to understand and reduce the delivery, establishment, and spread of marine invasive species.

The Scientific Steering Committee (SSC) for the conference was composed of researchers from the international community: Jeb Byers (University of Georgia, U.S.A.), Jeff Crooks (Tijuana River NERR, U.S.A.), Lisa Drake (SSC Co-Chair; Naval Research Laboratory, U.S.A.), Graeme Inglis (National Institute of Water and Atmospheric Research, New Zealand), Anders Jelmert (Institute of Marine Research, Norway), Emma Johnston (University of New South Wales, Australia), Whitman Miller (Smithsonian Institution, U.S.A.), Henn Ojaveer (Estonian Marine Institute, Estonia), Gil Rilov (National Institute of Oceanography, Israel Oceanographic and Limnological Research, Israel), Gemma Quílez-Badia (SSC Co-Chair and local host; World Wildlife Fund, Spain), Thomas Therriault (Fisheries and Oceans Canada), and Chela Zabin (Smithsonian Institution and University of California-Davis, U.S.A.). Also, two technical advisors provided helpful input in preparing the conference: Jim Carlton (Williams College, U.S.A.) and Judith Pederson (MIT Sea Grant College Program, U.S.A.).

The SSC benefited greatly from the work of the Local Organizing Committee, which was very capably led by Gemma Quílez-Badia and included: Ernesto Azzurro and Pep Gasol (Marine Science Institute of Barcelona, Spanish Council for Scientific Research), Xavier Turon (Centre for Advanced Studies of Blanes, Spanish Council for Scientific Research), and Luis Valdés (Intergovernmental Oceanographic Commission of UNESCO, Paris).

In addition to the efforts by the SSC and its advisors, the Local Organizing Committee, and three student interns, the conference received generous support from the North Pacific Marine Science Organization (PICES), the National Oceanic and Atmospheric Administration (NOAA), CosmoCaixa (Barcelona) and "La Caixa" (Barcelona). Fittingly, the conference was held at the sleek and modern CosmoCaixa, a state-of-the art science museum.

The three invited plenary speakers began each day with timely and novel approaches to issues of invasive species research. Bella Galil (National Institute of Oceanography, Israel Oceanographic and Limnological Research, Israel) opened the conference by discussing the history of invasions to the Mediterranean Sea as well as gaps in our knowledge in this region. Fabio Bulleri (Dipartimento di Scienze Botaniche Ecologiche e Geologiche, Università di Sassari, Italy) gave a thought-provoking talk suggesting that invasive species researchers should consider potential positive species interactions that can occur due to some invasions and how these relationships might be included in invasion models. Lastly, Graeme Inglis (National Institute of Water and Atmospheric Research, New Zealand) provided insight into the dynamics of transporting species by shipping and the role of initial population size in successful colonization. All plenary presentations were well received and became a starting point for continued discussion during coffee breaks, meals and especially over drinks.

The Marine Bioinvasions Conference series continues to grow in popularity. This year's conference theme was "*Advances and gaps in understanding marine bioinvasions*" and, due to the many submissions for oral presentations (almost all of which were accommodated), the days were long with talks organized in two concurrent sessions. Oral presentations were 15 minutes followed by five minutes for questions, which delegates felt was a good format, as it allowed conference participants to actively interact with speakers during the sessions. In addition to general sessions, several special topic sessions were organized including: region-specific invasion research (this year, the Mediterranean Sea), application of new genetic tools for reconstructing invasion histories, ship biofouling as an understudied invasion vector, factors promoting the establishment and spread of invasive species, and management and eradication efforts. In addition, a poster session that included approximately 40 posters was held at the museum on the first evening, and allowed presenters and attendees to mingle and learn about the latest findings in a relaxed atmosphere that included food and drinks (always a good motivator for discussions).

An important part of conferences is the opportunity to informally discuss presentations, meet new colleagues, and forge new collaborations. The breakfasts, coffee breaks, and lunches (held on site and consisting of traditional Spanish foods), allowed these happy interactions to proceed. On the second evening of the conference, a reception was held on the museum grounds as the sun was setting. Conference delegates were free to explore the museum during the day and were able to sightsee or go clubbing around the fabulous city of Barcelona at night.

The input and participation of early-career scientists historically has been an important aspect of the Marine

Recipients of PICES travel grants for the 7th International Conference on Marine Bioinvasions, left to right: Amy Fowler (U.S.A.), April Blakeslee (U.S.A.), Joao Canning Clode (U.S.A.), Paul Edwards (Canada), Sam Collin (Canada), Catherine Clarke Murray (Canada), Gail Ashton (U.S.A.) and Francis Choi (Canada). Missing from photo: Michael MacGillvary and Anais Lacousière-Roussel (Canada); Max Castorani and Annick Drouin (U.S.A.).

Bioinvasions Conferences. Indeed, this conference was no different. Thanks to contributions from the sponsoring organizations, it was possible to provide travel support to 22 graduate students and postdoctoral fellows who applied. PICES supported the travel of eight graduate students (Max Castorani, Francis Choi, Catherine Clarke Murray, Samuel Collin, Annick Drouin, Paul Edwards, Anais Lacousière-Roussel and Michael MacGillivary) and four postdoctoral fellows (Gail Ashton, April Blakeslee, Joao Canning Clode and Amy Fowler).

In summary, the plenary talks, along with all of the presentations—approximately 140 papers and posters—engendered lively discussions during the sessions, the breaks, and the social events. The topics of the presentations were impressive: new ideas and approaches to invasion biology, clever field studies to address emerging hypotheses, and research results used to inform international policy. This clearly illustrates how the field of invasion biology has advanced since the first conference in 1999, owing largely to the researchers and policy makers who attend these conferences!

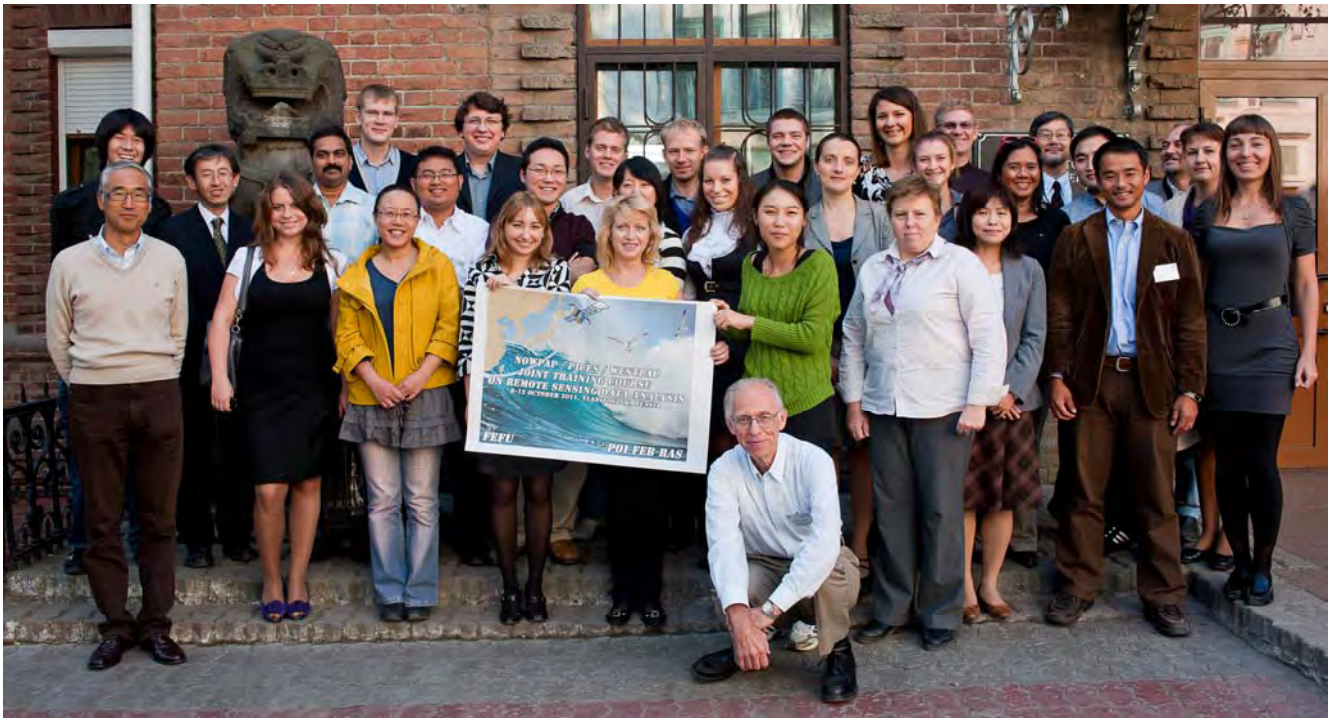
In Barcelona, the SSC members developed a strategic plan for future conferences. Our goals are to increase the geographic breadth of these meetings (since all but two of seven conferences have been held in the United States) and to encourage participation by researchers and decision makers from areas typically underrepresented at this forum: Asia, Central America, South America and Africa. To that end, we devised the following schedule of conference locations: 2013 – Canada, 2015 – Australia, and 2017 – South America. We are excited about the upcoming conferences and are confident they will strengthen existing collaborations and promote new ones. In fact, planning has begun for the 8th International Conference on Marine Bioinvasions, tentatively scheduled for the summer of 2013 in Vancouver, Canada, so feel free to contact any of the SSC members, especially your PICES representatives, and keep an eye out for further details in future issues of PICES Press.

Dr. Lisa Drake is a Physical Scientist at the U.S. Naval Research Laboratory in Key West, Florida. She is a biological oceanographer and leads a team of biological and physical scientists, engineers, and a statistician who develop procedures and methods used in testing ballast water management systems. Specifically, the biology group is developing robust, automated analyses to determine protist and zooplankton viability.

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, British Columbia. Tom is working on a number of aquatic invasive species research questions both within DFO and through the second Canadian Aquatic Invasive Species Network (CAISN II). He is the Principal Investigator for the Taxonomy Initiative of PICES Working Group 21 on Non-indigenous Aquatic Species that includes rapid assessment surveys (RAS) for non-indigenous species. Within PICES, Tom serves as Vice-Chairman of Science Board and Chairman of the FUTURE Advisory Panel on Anthropogenic Influences on Coastal Ecosystems. He is a member of the Marine Environmental Quality Committee and the PICES/ICES Study Group on Developing a Framework for Scientific Cooperation in Northern Hemisphere Marine Science.

NOWPAP/PICES/WESTPAC Training Course on Remote Sensing Data Analysis

by Leonid Mitnik, Genki Terauchi and Vyacheslav Lobanov



A training course on "*Remote sensing data analysis*" was organized by the Special Monitoring and Coastal Environmental Assessment Regional Activity Centre (CEARAC) of the Northwest Pacific Action Plan (NOWPAP), co-sponsored by the North Pacific Marine Science Organization (PICES) and the Intergovernmental Oceanographic Commission's Sub-Commission for the Western Pacific (WESTPAC), supported by the International Ocean Color Coordinating Group (IOCCG), and carried out by the V.I. Il'ichev Pacific Oceanological Institute (POI) of the Far Eastern Branch of the Russian Academy of Sciences (FEB RAS) and the Far Eastern Federal University (FEFU) from October 8–12, 2011, in Vladivostok, Russia.

The goal of the course was to provide an opportunity for students, early career scientists and coastal managers to obtain useful skills and knowledge on utilizing remote sensing data to monitor and assess the coastal and marine environment. This is especially timely and important for the Russian Far East, where huge investments have been recently put by the Russian government into the development of the region, including the establishment of FEFU, with a capacity of 50,000 students.

POI and the Institute of Automation and Control Processes (IACP) of FEB RAS have good experience in satellite data analysis for marine research. POI's main focus is on passive and active microwave sensing of the sea surface that allows retrieval of the oceanic and atmospheric parameters independently on sun illumination and cloudiness. The applications of microwave sensing include oil spill detection and monitoring as well as monitoring of severe marine weather conditions and sea ice. POI scientists emphasize the necessity of a multi-sensor approach to study various oceanic phenomena including harmful algal blooms. To do this they process and analyze Landsat visible and infrared images together with Envisat ASAR and ALOS PALSAR radar images that have a spatial resolution of several tenths meters. A regional monitoring center established at IACP provides operational data received from various satellites. POI and IACP specialists have also developed original algorithms for satellite data processing that are used for efficient monitoring of the Far Eastern Seas.

The training course was organized immediately prior to the 2011 PICES Annual Meeting held in Khabarovsk, the nearest major city to Vladivostok, to allow participants to attend the Meeting after the course was finished.

The CEARAC Secretariat, along with members of the Organizing Committee, Drs. Leonid Mitnik (POI, Russia; representing NOWPAP), Rafael Kudela (University of California Santa Cruz, U.S.A.; representing PICES) and

Teruhisa Komatsu (University of Tokyo, Japan; representing WESTPAC), prepared a course program and selected 22 trainees from 58 applicants. Participants from China, India, Indonesia, Japan, Korea, Russia and the Philippines were made up of postgraduate students, professional researchers and local government officers working in the field of marine sciences. The sponsoring organizations and FEFU were able to cover the costs of the course, so training was provided free of charge.

The course consisted of lectures and practical training, and included themes of satellite oceanography, global ocean observing systems, new satellites, software for data processing and new available products, problems of data analysis for remote sensing of ocean color, calibration and validation of satellite data, estimation of chlorophyll-*a* concentration and primary production, levels of eutrophication, red tides, estimation and monitoring of oil pollution, and mapping of marine habitats. As well as receiving theory through lectures, participants had the opportunity to practice with new software for satellite data analysis. Ten lecturers from China, Germany, Japan, Korea, Russia and the United States delivered lectures on remote sensing applications for monitoring and assessment of the marine and coastal environment in the Northwest Pacific Region.

Dr. Leonid Mitnik introduced the participants to satellite oceanography, focusing on the physical basis of remote sensing of the ocean and atmosphere in visual, infrared and microwave bands, recent advances in observing system capabilities and application of remote sensing data in marine sciences.

Lectures by Dr. Roland Doerffer (Helmgholts Center, Germany) were related to remote sensing of the coastal ocean, which is the most complicated aspect of ocean remote sensing. He explained the factors that influence the retrieval of chlorophyll-*a* and suspended matter concentrations in the water, and reviewed existing algorithms providing their assessment and conditions needed for their application. Then he discussed the problem of atmospheric correction and presented a new software, BEAM, designed by Brockmann Consult (Germany) for MERIS (MEdium Resolution Imaging Spectrometer), and gave detailed instructions on how to use it for satellite data processing. This software can be downloaded free of charge from http://www.brockmann-consult.de/cms/web/ beam/.

Dr. Vyacheslav Lobanov (POI, Russia) reviewed the current status of the Global Ocean Observing System (GOOS), its component in North East Asia (NEAR-GOOS), and various kinds of oceanographic data and products available through GOOS in real-time and delayed modes.

Presentations by Dr. Matti Kahru (Scripps Institution of Oceanography, U.S.A.) provided a detailed description of WIM software for processing, visualizing and verifying satellite data. The trainees were able to make practical use of the software on their computers, working on a few examples prepared by the lecturer. Dr. Karhu also discussed the problem of time series analysis and introduced a method to detect changes using ocean color and other satellite data, which is especially interesting for understanding climate change impacts on the global ocean.

Drs. Raphael Kudela and Joji Ishizaka (Nagoya University, Japan) talked about the estimation of primary production and level of eutrophication in marine and coastal waters using satellite remote sensing. They highlighted the basics of the primary production process, and reviewed current methods and problems of its quantitative estimation.

Dr. Yu-Hwan Ahn (Korea Ocean Research and Development Institute, Korea) introduced the potential of GOCI (Geostationary Ocean Color Imager), onboard the recently launched new Korean Communication, Ocean and Meteorological Satellite (COMS). He reported on the work being done on radiometric calibration and development of algorithms for data processing and the availability of a new source of ocean color data from geostationary satellites.

Dr. Teruhisa Komatsu presented an application of remote sensing to map marine habitats such as coral reefs, mangroves and marine algae, and to estimate their status

In the class (left photo) and during a coffee break (right photo).

and dynamics, which is especially important under current global changes and response of marine ecosystems.

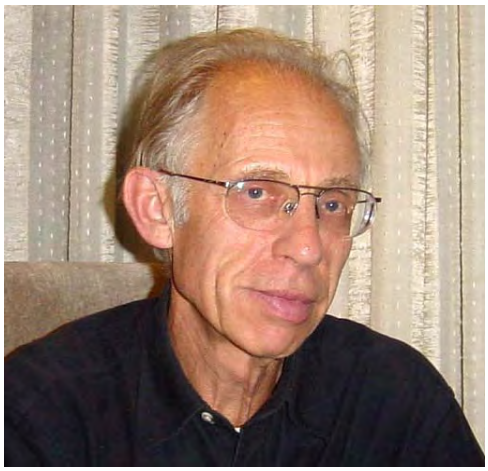
Dr. Sung Ling (National Satellite Meteorological Center, China Meteorological Administration, China) introduced Chinese activities on radiometric calibration of satellite solar reflective bands. She considered an absolute onboard calibration and vicarious calibration based on *in-situ* measurements, invariant target tracking and inter-calibration for satellites without onboard calibration. She presented information about new sensors, in particular MERSI (MEdium Resolution Spectral Imager), which is a MODIS-like sensor with 20 bands covering a VNIR/SWIR/TIR spectral region onboard the second generation Chinese polar-orbit meteorological satellite, FengYun-3.

Dr. Natalia Evtushenko (ScanEx Center, Russia) presented lectures on the application of high resolution optical and radar satellite information to monitor the state of the marine coastal area, focusing on methods for detecting and estimating oil pollution. She also demonstrated software for satellite data analysis developed by ScanEx Center (Moscow), and 25 sets of the ScanMagic software were presented to the trainees.

A problem of oil pollution detection was also discussed in another lecture by Dr. Mitnik. He reported on the results of oil spill monitoring by POI over the northwestern Pacific based on SAR (Synthetic Aperture Radar) images of Envisat and ALOS satellites, in particular recent identification of oil leakages from a platform in the Bohai Sea, and presented various examples of case studies collected at the special internet site http://cearac.poi.dvo.ru. Then he talked about the possibility of using widely optical sensor data observed by Landsat satellite for coastal zone monitoring. Although the information with high spatial resolution (30–60 m) used to be expensive in the past, it may be obtained free of charge at http://landsat.usgs.gov/ or http://earthexplorer.usgs.gov. Dr. Mitnik also lectured on the problem of operational monitoring and estimation of parameters of tropical storms and typhoons such as wind speed, vapor and heat content and other parameters which could be done using a multisensory approach based on microwave and optical bands satellite data.

On the last day, the effectiveness of the training course was tested using practical assignments developed by Mr. Genki Terauchi of CEARAC. He gave two tasks to the class: (1) determine the variation of plankton bloom magnitude and (2) estimate its trends in the northwest Pacific during the period 1997–2011. All participants were requested to select satellite data from a region of their interest and to prepare time series data with WIM software for their individual presentations. The tasks were successfully fulfilled. At the closing of the course program, each trainee received a certificate from NOWPAP, PICES and WESTPAC.

After a farewell party, some of the participants took a train from Vladivostok to Khabarovsk to attend the 2011 PICES Annual Meeting, and enjoyed a night ride along the famous Trans-Siberian railroad.



Dr. Leonid Mitnik (mitnik@poi.dvo.ru) is Head of the Department of Satellite Oceanography of the V.I. Il'ichev Pacific Oceanological Institute (POI) of the Far Eastern Branch of Russian Academy of Sciences. He is a specialist in satellite remote sensing with extensive experience in leading research projects for the Russian Academy of Sciences, European Space Agency, JAXA, NOWPAP and other programs.

Mr. Genki Terauchi (terauchi@npec.or.jp) is a Senior Researcher at the Special Monitoring and Coastal Environmental Assessment Regional Activity Centre of the Northwest Pacific Action Plan (NOWPAP) in Japan. His research interests include the assessment of eutrophication status with ocean color remote sensing data and mapping seagrass species with hyperspectral sensors.

Dr. Vyacheslav Lobanov (lobanov@poi.dvo.ru) is Deputy Director of the V.I. Il'ichev Pacific Oceanological Institute (POI) of the Far Eastern Branch of Russian Academy of Sciences. One of his responsibilities is to develop international collaboration in marine sciences and support activities of regional internationals programs and organizations like NOWPAP, PICES and WESTPAC.

PICES-2011 Workshop on "Trends in Marine Contaminants and their Effects in a Changing Ocean"

by Peter S. Ross and Olga Lukyanova

The sheer number of contaminants entering the North Pacific Ocean from a combination of point and non-point sources provides a daunting backdrop to those concerned with the protection of aquatic biota. However, this did not deter the 16 participants at the workshop on "*Trends in marine contaminants and their effects in a changing ocean: Refining indicator approaches in support of coastal management*", who spent a productive day discussing topics related to the workshop theme, and a day sampling for microplastics on the Amur River. This workshop, co-sponsored by GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) and ICES (International Council for the Exploration of the Sea), was held on October 14, 2011, in conjunction with the 2011 PICES Annual Meeting in Khabarovsk, Russia.

The workshop agenda included four invited presentations. Representatives from GESAMP and ICES delivered concise insight into their concerns, priorities, and activities. Dr. Peter Kershaw (Centre for Environment, Fisheries and Aquaculture Science, UK) described the mandate and activities of the UN-sponsored GESAMP, which is also supported by IMO, FAO, IOC-UNESCO, WMO, IAEA, UNEP and UNIDO. GESAMP provides expert advice on priority topics, as well as assessments of regional and global environmental concerns. One major activity of relevance to PICES is reflected in GESAMP efforts to identify and apply pollution indicators for the UN Transboundary Waters Assessment Programme (TWAP) in five categories: groundwater, rivers, lakes, Large Marine Ecosystems (LMEs) and open oceans. GESAMP currently has a number of Working Groups that are active in such areas as "mercury, cadmium and lead" (WG 37), "the historical inputs of contaminants into coastal ecosystems" (WG 39), and "source, fate and effects of microplastics in the marine environment" (WG 40). In addition, a new Correspondence Group is being established to evaluate the "biomagnification of pollutants in top predators". This concern for the scale of pollution impacts on the marine environment is shared by the general public (Fig. 1).

Dr. Kris Cooreman (Institute for Agricultural and Fisheries Research, Belgium) described the aim within the ICES realm for integrated science in support of management. He stressed that fisheries regulations were ineffectual when the root causes of reduced fish stocks are unrelated to fishing, and presented one case study on the decades-long decline in the abundance of shrimp (*Crangon crangon*) which had been attributed to overfishing. However, recent research suggests that the extensive contamination of coastal sediments in Europe by the antifoulant chemical tributyltin

Fig. 1 Over 10,000 people respond: "When you are thinking about the coastline or the sea, what are the three most important matters that come to mind?" (http://www.CLAMER.eu).

(TBT) historically used on vessel hulls caused reduced growth and survival of shrimp. In addition to this example of a population-level impact related to a single chemical, other European examples include the effects of PCBs (poly-chlorinated biphenyls) and DDT (dichlorodiphenyl-trichloroethane) on reproduction and health of seabirds and marine mammals. A long history of interest in the area of marine pollution positions ICES extremely well to partner with PICES on subjects of mutual interest into the future.

Dr. Joel Baker (Center for Urban Waters, University of Washington, U.S.A.) presented an overview on the emerging microplastics concern, which provided a basis for the field trip on the Amur River the next day (see photos). This one pollutant category encompasses a very wide variety of types, sizes, shapes, colours and origins for this "structural pollutant", highlighting the need for standardized assessment methods. "Microplastics" may be defined as any solid material < 5 mm that is primarily composed of synthetic polymers, but may also be considered from a practical perspective to be larger than 330 µm so as to be compatible with ichthyoplanktonic surveys. Microplastics include both primary (produced intentionally for consumer products) and secondary (generated by disintegration of larger materials) materials. Major challenges, and hence opportunities for collaboration in the North Pacific, are: methods to detect and quantify, distribution over space, and effects on biota (including invertebrates, fish, turtles, seabirds and marine mammals). Evidence of impact today is largely limited to the visually obvious macroplastics which have caused mortality in some stranded turtles, seabirds, and marine mammals.

Dr. Annamalai Subramanian (Ehime University, Japan) delivered an overview of persistent organic pollutants (POPs) and metals in the Asia-Pacific region. Dedicated sampling from multiple species over the past three decades has been carried out through the Environmental Specimen Bank for Global Monitoring at his university. Contaminants

A field trip to the Amur River near Khabarovsk on October 15, 2011, provided an opportunity for some of the workshop participants to conduct surface tows for microplastics from a small craft. Shown here clockwise, starting at top is the sampling platform, participants decanting microplastic samples from the plankton net on shore, workshop members examining samples using a dissecting microscope in the laboratory of the Khabarovsk Branch of Pacific Research Fisheries Centre, Russian Federal Agency on Fisheries, and Drs. Joel Baker and Olga Lukyanova with 330 µm mesh plankton net prior to deployment. Photos by A. Subramanian, P.S. Ross and O. Lukyanova.

have been determined for some of the many hundreds of invertebrate, fish, seabird and marine mammal species for which samples have been collected and preserved over time and space. Results reveal widespread environmental responses to the use, disposal and subsequent regulation of many of the POPs. Mussels have been utilized as sessile indicators of coastal pollution by POPs and metals throughout Asia. Albatross have been used to provide an integrated measure of POPs along their migratory corridor. Northern fur seals reveal improvements in the way of reductions in the concentrations of some POPs over time.

Russian scientists, including Olga Lukyanova, Mikhail Simokon and Vasiliy Tsygankov, provided insight into some of the priority concerns along the coastline of the Russian Far East and adjacent waters. While human population density is relatively low in this region, there exist concerns about offshore oil and gas exploration and development in the Sea of Okhotsk, metals related to local industrial activity, radioactive releases, and POPs and biological pollutants from global sources.

Because of the complexity of marine pollution issues in the North Pacific Ocean, workshop participants were focussed on defining concepts and strategies that would lead to pragmatic indicators. It was agreed that a series of basic concepts should be used to identify contaminant indicators that could be shared among PICES member countries. In

this way, the indicator must:

- involve a species (*e.g.*, mussels) or matrix (*e.g.*, sediment) which is well understood;
- involve a pollutant or class of pollutants for which analytical methods are available;
- provide the best available science to management;
- provide insight into spatial and temporal changes;
- have linkages to a risk of adverse effects;
- be responsive to regulations;
- be able to identify emerging contaminant concerns;
- be cost-effective.

Since there exists no single indicator which can adequately capture all contaminant concerns, workshop participants acknowledged the need for a suite of indicators which could capture different contaminant types including, for example, persistent, bioaccumulative contaminants (*e.g.*, POPs) in seabird eggs or marine mammals, metals and radionuclides in mussels, hydrocarbons in flatfish, and plastics in seawater. Several regional examples from researchers in different PICES member countries were cited as examples to build on, where opportunities to improve analytical techniques, exchange samples, collect new samples, and/or exchange expertise were considered.

During the next year, a new PICES Study Group on *Marine Pollutants* (SG-MP) will operate under the aegis of the Marine Environmental Quality (MEQ) Committee to identify novel approaches to operational marine pollution assessment with the aim of: establishing a list of priority pollutants; identifying indicators of status, trends and effects; harmonizing methods to evaluate impacts on biota; and describing case studies which demonstrate the effectiveness of indicators to inform the success of remedial actions. This effort will create opportunities for PICES scientists to participate in a renewal of the pollution topic and to identify emerging concerns, technologies and concepts into the FUTURE.

Following the workshop on marine pollution indicators, some workshop participants went on an excursion on the Amur River to collect microplastics under the guidance of Dr. Joel Baker (third from the left). Photo by O. Lukyanova

Dr. Peter S. Ross (peter.s.ross@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada (DFO) at the Institute of Ocean Sciences in Sidney, British Columbia, and Adjunct Professor at Simon Fraser University and the University of Victoria. Peter is an ecotoxicologist specializing in marine mammals. He conducts research on source, transport, fate and effects of environmental contaminants in Canada and internationally. Within PICES, Peter serves on the Advisory Panel on Marine Birds and Mammals and the Study Group on Maine Pollutants. He is also frequent participant at the meetings of the Marine Environmental Quality Committee.

Dr. Olga Lukyanova (onlukyanova@tinro.ru) is a Research Bbiologist at the Pacific Research Fisheries Centre (TINRO-Centre) in Vladivostok, Russia. Olga conducts research on marine pollution and its effects on biota in the Russian zone of Far Eastern seas in the North Pacific. She is wearing multiple hats within PICES being a member of the Section on Harmful Algal Blooms, Section on Human Dimensions of Marine Systems, Working Group on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors and Study Group on Marine Pollutants.

The State of the Western North Pacific in the First Half of 2011

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 2011, 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, MetOp/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, positive SST anomalies exceeding +1°C prevailed in the seas between 35°N and 50°N east of 155°E. These anomalies gradually decreased and turned negative in June. In February, positive SST anomalies exceeding +1°C appeared southeast of the Philippines. In April, negative SST anomalies exceeding –1°C were found in the South China Sea and east of the Philippines, and positive SST anomalies exceeding +1°C prevailed from 10°N, 150°E to 20°N, 180°E. SSTs were below normal in the seas around Japan from January to June. After February, negative SST anomalies exceeding –2°C were found in the seas east of Japan around 40°N, 145°E and in the East China Sea.

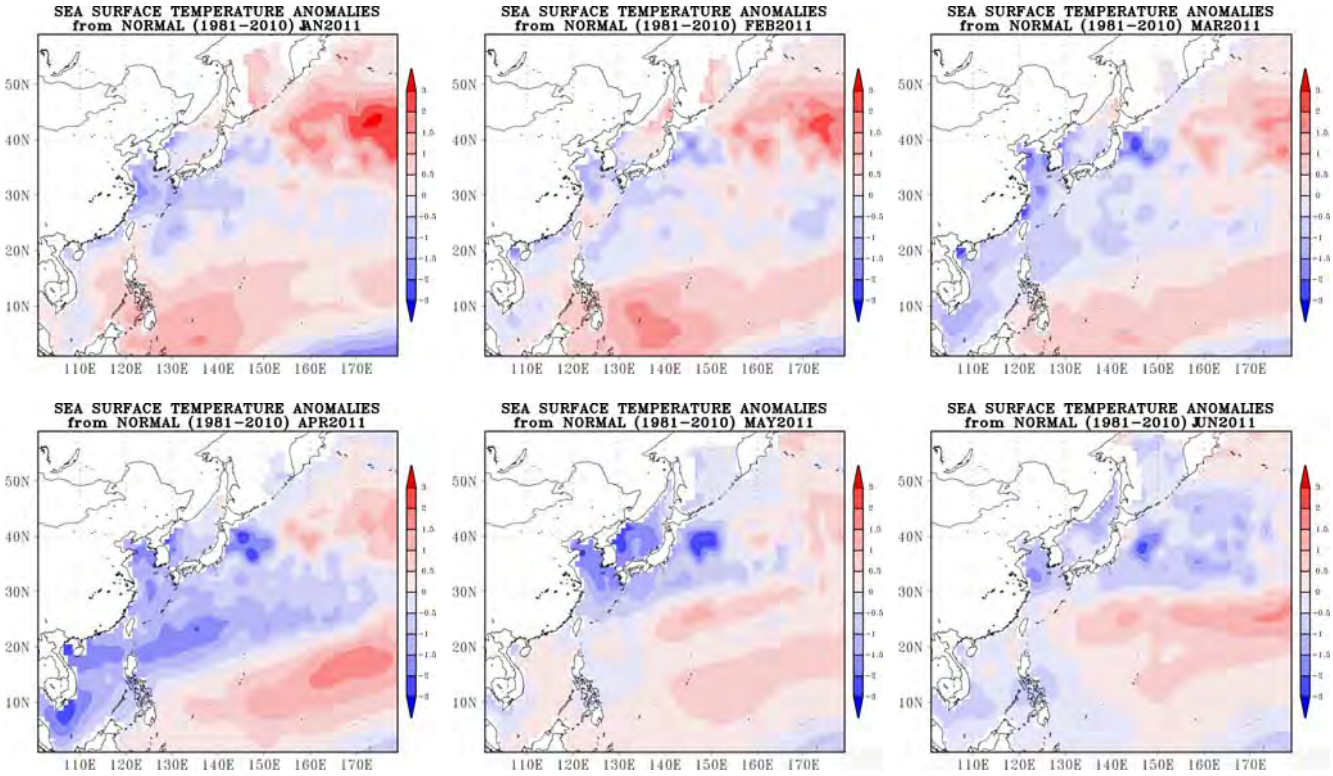


Fig. 1 Monthly mean sea surface temperature anomalies (°C) from January to June 2011. Anomalies are deviations from JMA's 1971–2000 climatology.

Shiro Ishizaki (s_ishizaki@met.kishou.go.jp) is a Scientific Officer of the Office of Marine Prediction at the Japan Meteorological Agency. 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.

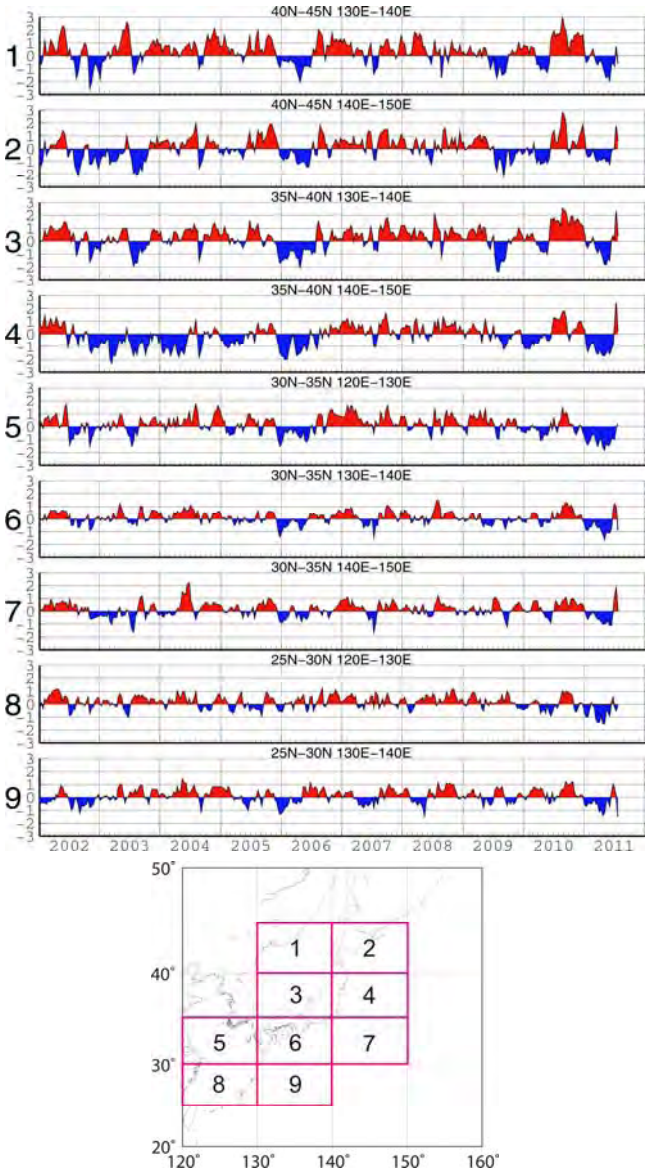


Fig. 2 Time series of 10-day mean sea surface temperature anomalies (°C) averaged for the sub-areas shown in the bottom panel. Anomalies are deviations from JMA's 1971–2000 climatology.

Kuroshio and Oyashio

Figure 3 shows a time series outlining the location of the Kuroshio path from January to June of 2011, at intervals of 10 days. The current took a non-large-meander path off the coast to the south of Honshu Island (between 135°E and 140°E). East of 135°E, several small perturbations propagated eastward along the Kuroshio. Corresponding to the passage of each perturbation, the latitude of the Kuroshio axis over the Izu Ridge (around 140°E) moved north and south. From March to April, the Kuroshio flowed south of Hachijo Island (33°N, 140°E). Figure 4 presents the mean subsurface temperature at a depth of 100 m in the seas east of Japan for April 2011 generated using the numerical ocean data assimilation system (MOVE/MRI.COM-WNP).

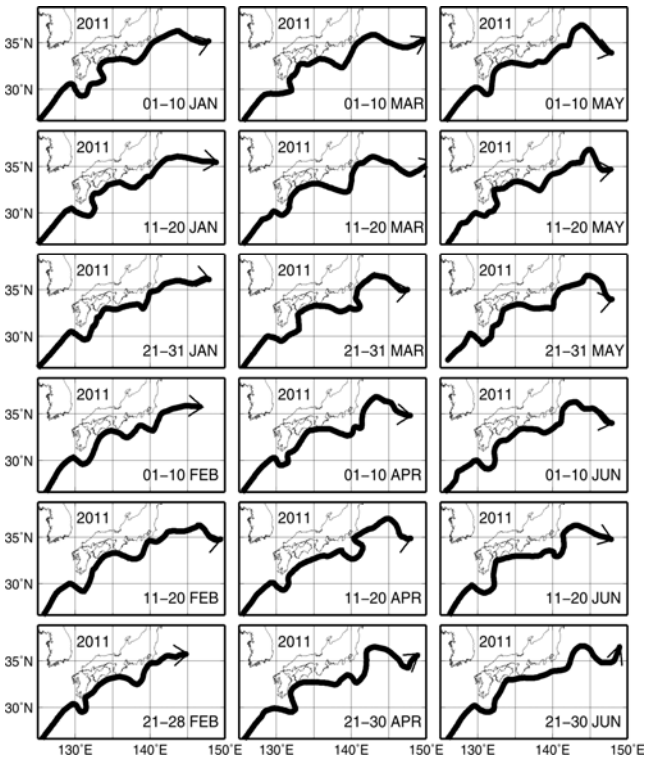


Fig. 3 Location of the Kuroshio path from January to June 2011.

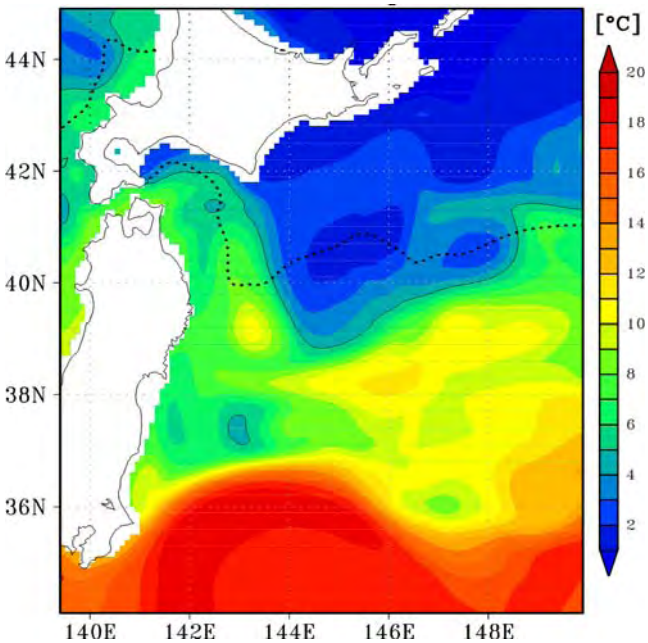


Fig. 4 Subsurface temperatures (°C) at a depth of 100 m east of Japan for April 2011. The solid line denotes the 5°C isotherm, while the dotted line is its climatology (26-year average values from 1985 to 2010).

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). During almost the entire period, the coastal branch of the Oyashio was located in its normal range (Fig. 5).

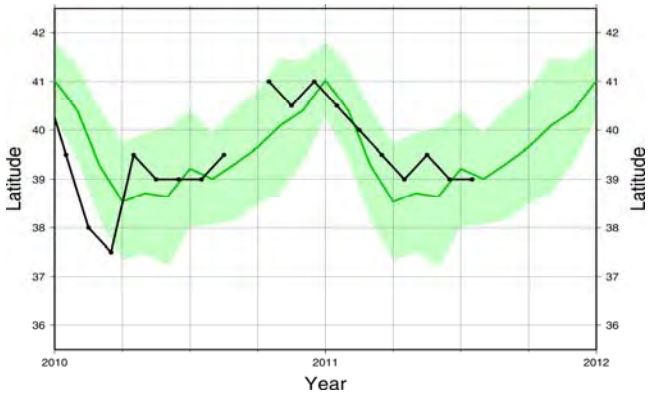


Fig. 5 The southernmost position of the coastal branch of the Oyashio cold water from January 2010 to July 2011 (black line), and the 26-year average values (green line), with a range of one standard deviation (green shading) from 1985 to 2010.

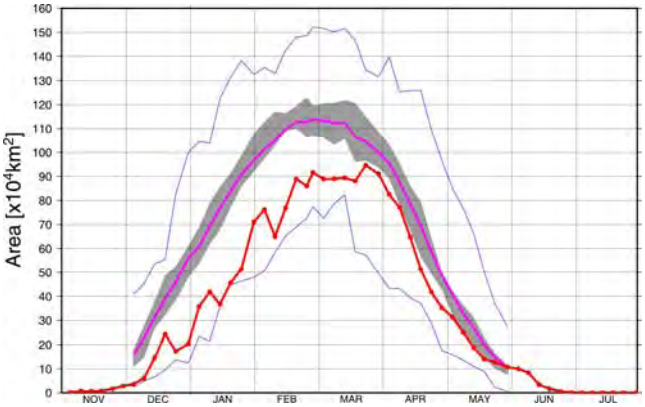


Fig. 6 Time series of the sea ice extent in the Sea of Okhotsk from November to July (red line: 2010–2011 analysis; pink line: JMA's 1981—2010 climatology; blue lines: maximum/minimum sea ice extent since 1971; gray area: normal range).

Sea ice in the Sea of Okhotsk

For the almost entire 2011 sea ice season (defined as the period from December 2010 to May 2011), the sea ice extent in the Sea of Okhotsk was below normal (Fig. 6), and reached its seasonal maximum coverage of 94.54 × 10^4 km^2 on March 25.

Figure 7 presents interannual variations in the maximum sea ice extent (red line) and accumulated sea ice extent (green line) in the Sea of Okhotsk from 1971 to 2011. Although the sea ice extent in the Sea of Okhotsk shows large interannual variations, there are decreasing trends of 184 [70–298] × 10^4 km^2 per decade (the numbers in square brackets indicating the two-sided 95% confidence interval) in the accumulated sea ice extent, and 6.0 [2.0–10.0] × 10^4 km^2 (equivalent to 3.8% of the total area of the Sea of Okhotsk) per decade in the maximum extent.

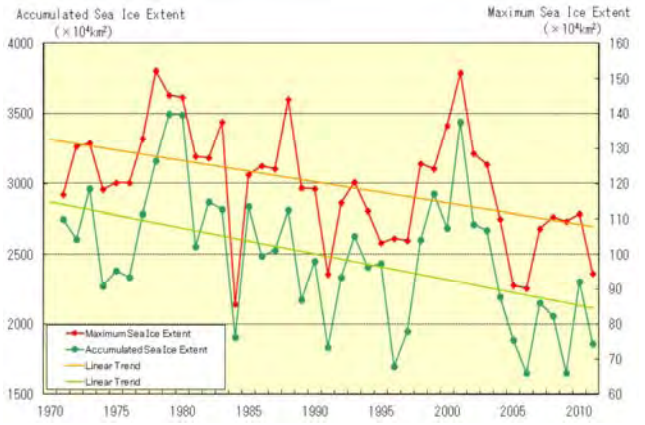
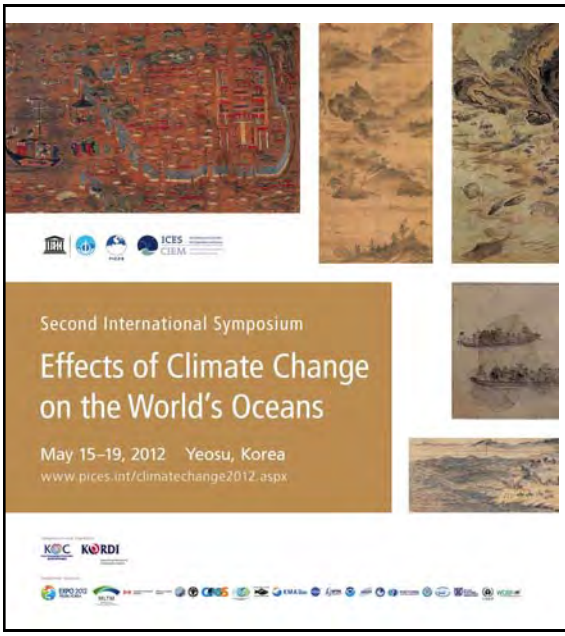


Fig. 7 Interannual variations in the maximum sea ice extent (red line) and accumulated sea ice extent (green line) in the Sea of Okhotsk from 1971 to 2011. The accumulated sea ice extent is defined as the sum of 5-day sea ice extents from December to May.



Yeosu symposium theme sessions

- S1: Climate variability versus anthropogenic impacts; analysing their separate and combined effects on long-term physical, biogeochemical and ecological patterns
- S2: Systematic, sustained and integrated global ocean observations
- S3: Projections of climate change impacts on marine ecosystems and their uncertainty
- S4: Climate change effects on living marine resources: From physics to fish, marine mammals, and seabirds, to fishermen and fishery-dependent communities
- S5: From genes to ecosystems: Genetic and physiological responses to climate change
- S6: Marine spatial planning and risk management in the context of climate change: The living ocean and coast under changing climate
- S7: Coastal and low-lying areas
- S8: Trend and impacts of de-oxygenation in oceanic and coastal ecosystems
- S9: Marine tipping points in the earth system
- S10: Changes in the marine carbon cycle

The Bering Sea: Current Status and Recent Events

by Jeffrey Napp

Current status of the Bering Sea ecosystem

We are still waiting to learn if the signs of moderation in Bering Sea climate observed last year will result in a break in the string of cold years experienced from 2007 to 2011. So far all bets are off. Winter temperatures in the southeastern Bering Sea were considered "near normal" or average as observed at the mooring M2 site (Fig. 1). However, summer was unusually cold so that the water remained cold through the summer and fall, comparable to the recent string of cold years. Thus, this winter started with cold water in the Bering Sea making it less difficult for the formation of sea ice.

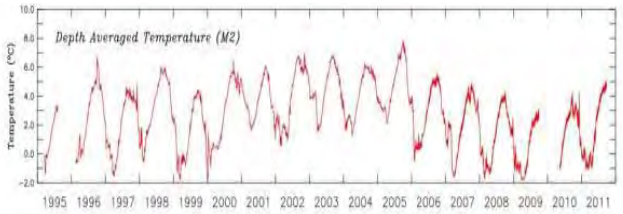


Fig. 1 Time series of water temperatures at the Bering Sea mooring M2 site (56.87°N, 164.03°W). Daily depth averaged water column temperatures. Figure courtesy of P. Stabeno, NOAA.

Coastal residents of Alaska also complained about the lack of a warm, calm summer season. For example, small gold dredging platforms (comparable to a raft, Fig. 2) were not able to prospect off Nome until mid August due to stormy weather.

Fig. 2 Small dredging vessels near Belmont Point, Nome, Alaska. Photo courtesy of the Nome Nugget (http://www.nomenugget.net/archives/2011/8.11.11%20nn.pdf).

During the fall, the resupply of Nome with heating and transportation fuel was prevented by a large mid November storm. The customary fall resupply by a barge (1.6 million gallons of gasoline and diesel) was not possible and, as this article is being written, an international effort between a Russian Federation ice-strengthened tanker and a U.S. Coast Guard ice breaker is unfolding in an attempt to resupply Nome before they run out of fuel. Due to the presence of sea ice and the configuration of the harbour, the tanker may not be able to reach the harbour and will have to string its resupply hoses across the ice to the shoreline to make its delivery. Note that one forecast of climate change is that the weather patterns will become less predictable with more extreme weather events. Whether or not the fall storm experienced by the Bering Sea is just such an extreme event is open to debate. However, the consequences of this event directly impact the people living around the margins of the Bering Sea. Had the storm arrived earlier, it could also have seriously impacted those fishers engaged in the fall fishing season.

In early January, the southerly ice extent in the eastern Bering Sea reached past Nunivak Island (60°N) and into Bristol Bay, but is well short of the Pribilof Islands (Fig. 3). In the next 5 days the ice front is not expected to move very far.

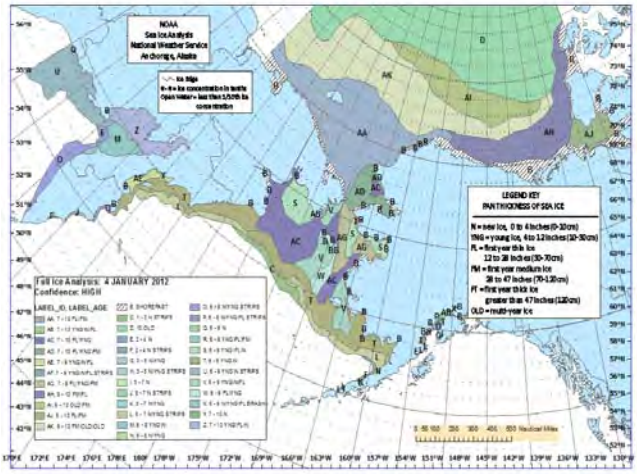
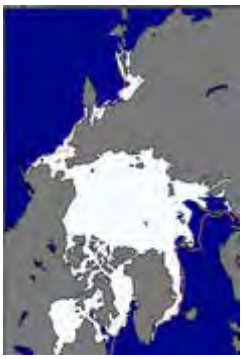


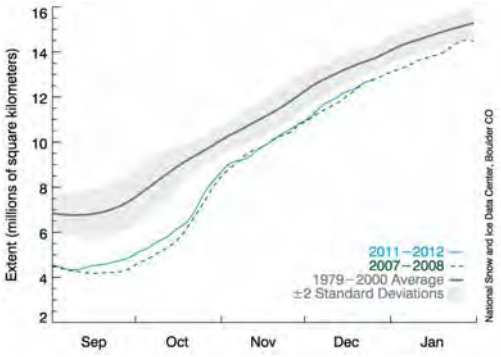
Fig. 3 Position and areal coverage of sea ice in the Bering Sea and western Arctic Ocean (4 January 2012). Source: U.S. National Weather Service (http://pafc.arh.noaa.gov/ice.php?img=fullice).

On the equator

Based on October/November 2011 events at the equator, NOAA is predicting that the present La Niña conditions will continue to at least early spring and have a 40% chance of continuing until 2012–2013 based on past events sometimes lasting 3 years (http://www.esrl.noaa.gov/psd/enso/mei). In the past, cold winters and extensive sea ice conditions in the eastern Being Sea have been associated with La Niña conditions at the equator.

Other non-marine signs of a potentially cold winter include the irruption of arctic bird species in the Pacific Northwest corner of North America. For instance, snowy owls (*Bubo scandiacus*) have been seen more frequently this winter, and the sighting of rare Ross' gull (*Rhodostethia rosea*) was recently reported.





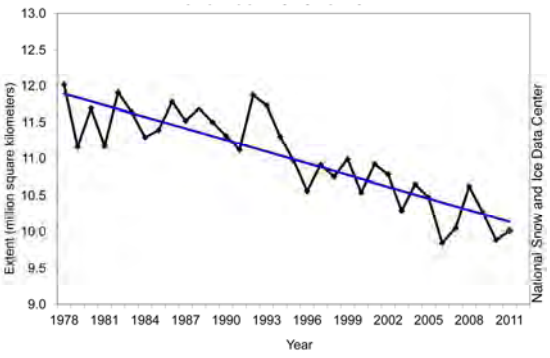


Fig. 4 (left) Ice edge extent for December 5, 2011 compared to median extent (orange line). Source: http://nsidc.org/arcticseaicenews/.
Fig. 5 (center) Ice edge extent for fall 2011 compared to average extent 1979 – 2000. Source: http://nsidc.org/arcticseaicenews/.
Fig. 6 (right) Monthly ice extent for November 1979 to 2011. Source: http://nsidc.org/arcticseaicenews/.

Arctic conditions

In December, the sea ice in the western Arctic (Bering, Chukchi and Beaufort Seas) was at or beyond the median ice extent for 1979–2000, while the ice extent in the eastern Arctic (Labrador, Greenland, Barents and Kara Seas) was somewhat less than the recent median extent (Fig. 4). The trajectory for the fall/winter of 2011/2012 was following that of 2007/2008 where the summer ice extent was well below the recent average, but the winter ice extent was just below the 95% confidence interval for the time series mean (Fig 5).

The Arctic sea ice extent in November was the third lowest in the satellite record for the month, behind 2006 and 2010. If one fits a linear regression to the November data from 1979 to the present, the areal sea ice extent for the month appears to be decreasing at a rate of 4.7% per decade (Fig. 6). The Arctic Oscillation Index which was strongly negative last winter (–2.6 in December 2010, –1.68 in January 2011) was strongly positive through most of November and December 2011.

2011/2012 Bering Sea field season

The number of observation days in the eastern Bering Sea was dramatically reduced last year. This was due, in part, to the end of the field component of the recent U.S. Bering Sea ecosystem programs BEST and BSIERP. A NOAA spring cruise to survey larval pollock and cod was cancelled because of mechanical issues with the FSV *Oscar Dyson*. The NOAA summer acoustics survey was situated in the Gulf of Alaska, and the T/S *Oshoro Maru* did not visit the eastern Bering Sea shelf. The NOAA mid summer bottom trawl survey and the late summer BASIS surveys both occurred as planned. Details of the 2012 observation program for the Bering Sea are forthcoming.

Science meetings and special journal issue

Meetings in 2012 that may host sessions or talks of interest to scientists working in the Bering Sea include:

- Alaska Marine Science Symposium, January 16–20, 2012, Anchorage, Alaska, U.S.A.;
- AGU/Ocean Sciences Meeting, February 20–24 2012, Salt Lake City, Utah, U.S.A.;
- PICES/ICES Conference for Early Career Scientists, April 24–27, 2012, Majorca, Spain;
- Second PICES/ICES/IOC Symposium on "Effects of climate change on the world's oceans", May 15–19, 2012, Yeosu, Korea.

A collection of Bering Sea papers will be published in a special issue of *Deep-Sea Research II* in mid 2012. The issue is sponsored by the BEST and BSIERP programs.

Acknowledgements: Many thanks to the following PICESans who helped create this report: Drs. James Overland, and Phyllis Stabeno.

Dr. Jeffrey (Jeff) Napp 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. He 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 Monitoring Technical Committee.

News of the Northeast Pacific Ocean

by William Crawford, Skip McKinnell and Howard Freeland

Surface temperature of the Northeast Pacific Ocean is still in a cool era that began in 2006 and was interrupted only briefly in 2010. Lower temperatures over the past six years are coincident with mostly La Niña conditions in the tropical Pacific Ocean. Figure 1 shows the anomaly of sea surface temperature for the Pacific Ocean for the months of August and September of 2006 to 2011. This pattern of temperature is a feature of the negative phase of the Pacific Decadal Oscillation (PDO) that dominates North Pacific climate variability (Mantua *et al*., 1997). The main PDO characteristics are: negative anomalies (cool) in the eastern North Pacific that form a crescent around a mid-Pacific pool of positive anomalies (warm) centred between 30°N and 40°N. The dominant La Niña pattern is revealed by negative temperature anomalies along the central Pacific equator. A search of temperature anomalies in August and September of the past two decades indicates a general sequence of positive and negative versions of the patterns of Figure 1. In general, the eastern side of the North Pacific was cool in 1998 to 2001, whereas warmer waters dominated in 1992 to 1998 and in 2001 to 2005. Although the features are not a perfect fit to PDO variability, they do follow it, and the ENSO variability, rather closely.

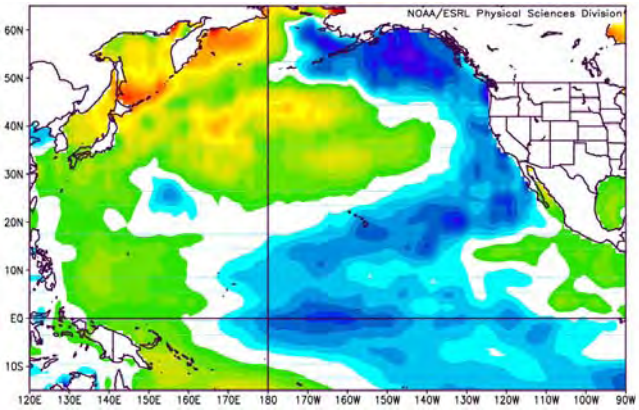


Fig. 1 Anomalies of sea surface temperature for the Pacific Ocean north of 15°S, for the months of August and September of 2006 to 2011. Blue regions reveal negative anomalies; red denotes positive anomalies, with a range of ± 1.5°C. Images provided by NOAA (http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/printpage.pl).

The PDO time series and spatial pattern are calculated as the first mode of an empirical orthogonal function of ocean temperature anomalies of the Pacific Ocean north of 20°N, (Davis, 1976). It is based on time series over the Pacific Ocean at resolution of 2° in latitude and longitude. Since 1982, with better satellite observations, ship-based reporting and Argo floats, the accuracy and spatial resolution has improved. To take advantage of these improved measurements, we have calculated a high-resolution PDO for the years since 1982, with its time series shown in Figure 2. Years of positive PDO and relatively warm ocean waters of the Northeast Pacific dominate the PDO prior to 1998; negative PDO and relatively cool Northeast Pacific Ocean waters dominate after 1998. Although both patterns are briefly interrupted, we do see mostly red at the left and mostly blue at the right. Each phase is attributed to persistent anomalies of winds over the Pacific. This pattern of decadal variability extends back to at least the 1900s, with distinct positive and negative phases each covering periods of more than a decade. Although the PDO spatial stability broke down briefly in the late 1990s and early 2000s when its normally smaller second mode dominated (Bond *et al*., 2003), the PDO mode has generally dominated from 1982 to present, except for a couple of years after the 2002/03 El Niño when North Pacific anomalies shared a common positive sign.

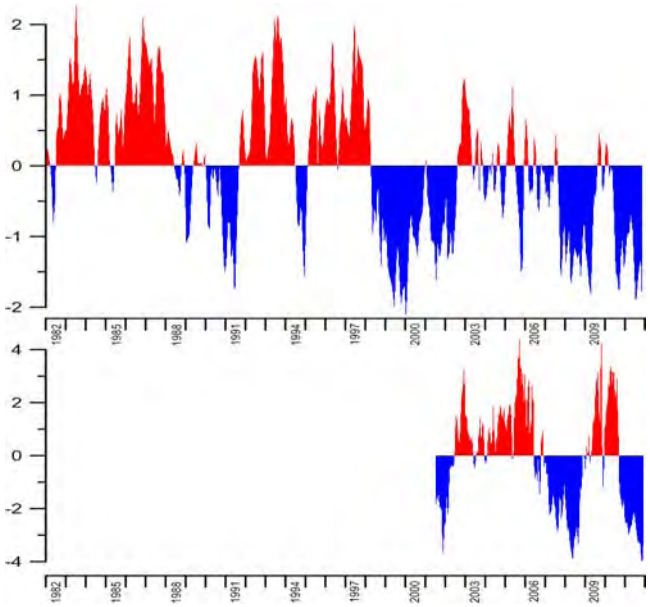


Fig. 2 Upper panel: time series of a high-resolution PDO (standard deviations) computed from monthly time series of Pacific Ocean surface temperature anomalies on a 1° latitude and longitude grid. Lower panel: time series of anomalies of oceanic heat content (10^8 joules/m^2) in the upper 700 m at Ocean Station P (50°N, 145°W), calculated from Argo floats.

The lower panel of Figure 2 reveals anomalies of heat content in the Gulf of Alaska in the upper 700 m, computed from measurements made by Project Argo's profiling floats. There are now more than 3000 active Argo floats scattered across all the oceans, whose measurements have provided high spatial and temporal resolution globally for almost a decade. We note that the time series of heat content at Ocean Station P generally matches the PDO, although their zero crossings on the *y*-axes are offset, likely due to the different periods used to compute long-term average values.

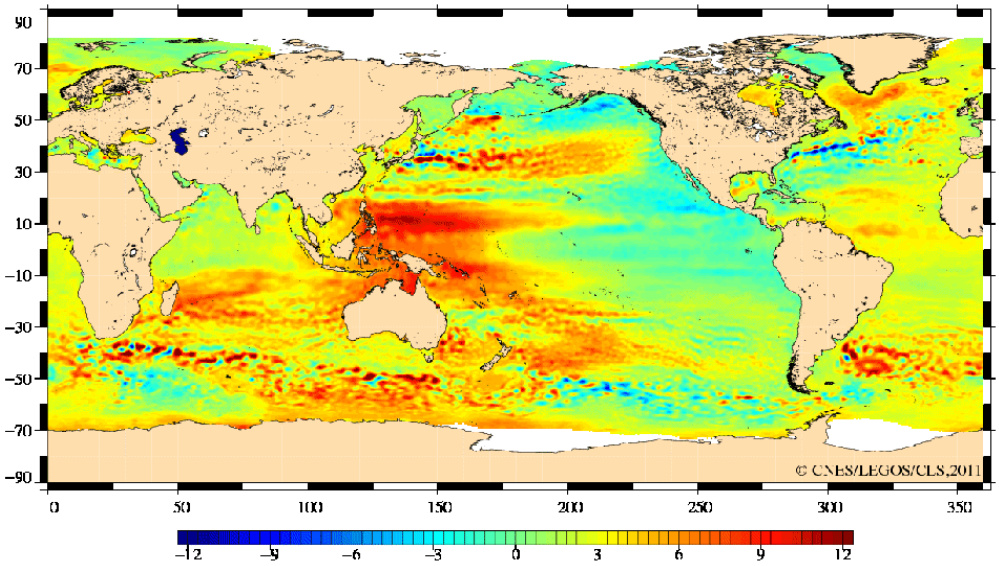


Fig. 3 Sea level rise from October 1992 to December 2010, as measured by satellites. Image provided by AVISO: http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/.

For marine life along the west coast of Canada and the United States, some species have surged and retreated northward along the coast in association with changes between warm and cool waters. For example, sardines returned to west coast Canadian waters in 1992 from more southern regions during a warm period. Through the next decade of mostly warm waters, their numbers increased but since the start of the present cooling in 2006, the biomass of sardine in Canadian waters has declined. The numbers of Pacific hake and Humboldt squid have declined off western Canada in the past few years. Both are warm-water species whose "home" waters are on the continental shelf far to the south.

The shifting PDO phase is itself part of a Pacific-wide signal that extends far into the South Pacific Ocean. Cool phases in the eastern North Pacific are dominated by stronger westerly winds at mid latitudes, and stronger trade winds in the tropics, part of negative PDO and La Niña respectively. Reversals of these winds set up warm phases, associated with positive PDO and El Niño. These persistent anomalies in winds even alter sea levels across the Pacific, which is not too surprising since the temperature anomalies at Ocean Station P extend down to 700 metres, a feature likely common to much of the Pacific. We can observe this Pacific-wide pattern, in Figure 3, of regional sea level rise measured by satellites since 1992.

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 in Sidney, British Columbia. He is co-editor of Canada's annual State of the Pacific Ocean Report for Canada's Pacific coast, and is fascinated with changes in ocean climate and its impact on ecosystems.

Dr. Skip McKinnell (mckinnell@pices.int) is the Deputy Executive Secretary of PICES. For two years (2008–2010) he served as an author and Editor-in-Chief of the PICES North Pacific Ecosystem Status Report.

Dr. Howard Freeland (howard.freeland@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada, at the Institute of Ocean Sciences, in Sidney, British Columbia. Howard has conducted research on the changing circulation of the Northeast Pacific and the climatic status of the oceans. His overwhelming interest over that last 12 years has been the steady development of the international Argo project. Howard is shown visiting an old friend, Baba Yaga, in Khabarovsk.

The time trend in Figure 3 began with the launch of TOPEX/Poseidon by CNES and NASA in September 1992, and has continued with ERS and ENVISAT satellites of the European Space Agency, and Jason-1 and -2 of the CNES-NASA partnership. The time series of sea level rise since 1992 is calculated by averaging the measurements over all oceans and calibrating sea level measurements among the satellites and with accurate sea level gauges on isolated islands. It indicates a global-average rise of 3 mm/yr over this period. The colours in Figure 3 reveal that this global average has significant variability in the Pacific Ocean. Over much of the Pacific coast of the Americas there has been no sea level rise since 1992. The entire coast north of 20°S is mostly shaded blue, representing sea level fall from 1992 to 2010. On the other hand, the western tropical Pacific has experienced a much greater rise, with some regions surpassing 10 mm/yr.

We attribute this east–west difference to the same wind anomalies that set up the PDO and ENSO patterns since 1992. The 1990s were dominated by El Niño and positive PDO, but since 1998 La Niña and negative PDO have prevailed. To some extent, the figures above reveal that both global warming and its associated sea level rise have been "on hold", or even reversed for the past decade or so in the Northeast Pacific Ocean. Recent winter-averaged sea levels (the season of highest sea level) have not matched the high extreme of the winter of 1997/98. The present era of cooler seawater along Line P (a line of sampling stations between Canada and Ocean Station P) has persisted longer than in any decade back to the early 1970s (DFO, 2011).

Although we do not offer a prediction on when the present cool PDO phase will end, when it does end there could be a relatively rapid rise in sea level along the Central and North American coast and warmer waters, accompanied by poleward movement of warm-water marine species.

References

Bond, N.A., Overland, J.E., Spillane, M. and Stabeno, P. 2003. Recent shifts in the state of the North Pacific. *Geophys. Res. Lett*. 30(23), 2183, doi:10.1029/2003GL018597.

Davis, R.E. 1976. Predictability of sea surface temperature and sea level pressure anomalies over the North Pacific Ocean. *J. Phys. Oceanogr*. 6, 249–266.

DFO 2011. State of the Pacific Ocean 2010. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/032.

Mantua, N., Hare, S.R., Zhang, Z., Wallace, J.M. and Francis, R.C. 1997. A Pacific decadal oscillation with impacts on salmon production. *Bull. Am. Meteorol. Soc.* 78: 1069–1079.

Recent and Upcoming PICES Publications

Special Issues in primary journals

- Proceedings of the ICES/PICES/FAO symposium on "Climate change effects on fish and fisheries: Forecasting impacts, assessing ecosystem responses, and evaluating management strategies" in *ICES Journal of Marine Science*, July 2011, Vol. 68, Is. 6 (Guest Editors: A. Hollowed, S.-I. Ito, S. Kim, H. Loeng and M. Peck);
- Special Issue of *Fisheries Research* based on selected papers from the PICES-2009 Topic Session on "*Ecosystem-based approaches for the assessment of fisheries under data-limited situations*", December 2011, Vol. 122, Is. 3 (Guest Editors: P. Livingston, G. Kruse and L. Richards);
- Special issue of *Aquaculture Economics and Management* based on selected papers from the PICES-2010 Topic Session on "*Economic relation between marine aquaculture and wild capture fisheries*" (Guest Editor: M. Pang), spring 2012;
- Special issue of *ICES Journal of Marine Science* based on selected papers from the 2011 PICES/ICES Zooplankton Production Symposium on "*Population connections, community dynamics and climate variability*" (Guest Editors: J. Keister, C. Johnson and D. Bonnet), summer 2012;
- Review paper on Fraser River sockeye salmon and their marine environment in *Reviews in Fish Biology and Fisheries* (Lead Author: S. McKinnell), 2012.

PICES Scientific Report series

- Report of the Study Group on *Human Dimensions* (Editors: M. Makino and D.L. Fluharty), 2011, PICES Scientific Report No. 39;
- Final Report of Working Group 20 on Evaluations of Climate Change Projections (Editors: M. Foreman and Y. Yamanaka), 2011, PICES Scientific Report No. 40;
- Final report of the Working Group on *Iron Supply and its Impact on Biogeochemistry and Ecosystems in the North Pacific Ocean* (Editors: F. Chai and S. Takeda);
- Final report of the Working Group on *Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim* (Editor: W. Peterson);
- Final report of the Working Group on *Environmental Interactions of Marine Aquaculture* (Editors: K. Abo, I. Burgetz, B. Dumbauld and S. Johnson);
- Final report of the Working Group on *Forecasting Climate Change Impacts on Fish and Shellfish* (Editors: A. Hollowed and S. Kim);
- PICES Advisory Report to the Cohen Commission on "*The decline of Fraser River sockeye salmon in relation to marine ecology*" (Editor: S. McKinnell) – reproduction of the web-based Cohen Commission Technical Report No. 4;
- Final report for the Climate Change and Carrying Capacity Program (Editor: H. Batchelder)

New leadership for the PICES Fishery Science Committee

Drs. Elizabeth (Libby) Logerwell (U.S.A.) and Xianshi Jin (China) were elected Chairman and Vice-Chairman of the Fishery Science Committee (FIS) in October 2011, at the 2011 PICES Annual Meeting in Khabarovsk, Russia.

Libby was raised in Seattle, Washington. She spent many memorable summer days in the forests, mountains and beaches of the Pacific Northwest, and turned her love of the outdoors into a career in biology. She completed a B.Sc. in Biological Sciences at Stanford University in 1988. After several years of temporary field work that ranged from the study of tropical rainforests of Hawaii to saltgrasses of Louisiana to seabirds of the Eastern Tropical Pacific, she began a Ph.D. program at the University of California Irvine. Her dissertation research, chaired by George Hunt, Jr., was on the at-sea foraging distribution of seabirds in Alaska and British Columbia, and she earned her degree in 1997. Libby then did post-doctoral research on sardine physiology and ecology (with Paul Smith at the Southwest Fisheries Science Center, La Jolla) and on juvenile salmon survival dynamics (with Bob Francis and others at the University of Washington). In 2001, she was hired by Anne Hollowed to be a Research Fishery Biologist in the Resource Ecology and Fisheries Management Division at the Alaska Fisheries Science Center (AFSC) in Seattle.

Libby is currently lead of the Fisheries Interaction Team at AFSC, a small field-oriented team that studies the ecological consequences of commercial fishing, with particular emphasis on the local impacts of groundfish harvest on endangered Steller sea lions in Alaska. Her own research interests also include the influence of oceanographic dynamics on the behavior, distribution and abundance of marine life. She has recently developed keen interest and some expertise in Arctic ecosystems and the potential ecosystem impacts of oil and gas industry development in the Arctic.

Libby has been participating in PICES Annual Meetings since graduate school and was selected to be the U.S. member of FIS in 2003.

Libby is an avid runner, cyclist and skier. She practices yoga several times each week. She also very much enjoys sharing Seattle's vibrant music culture and excellent dining with her husband, friends and family.

PICES thanks Drs. Mikhail Stepanenko (TINRO-Center, Vladivostok, Russia) and Gordon Kruse (University of Alaska, Fairbanks, U.S.A.) for their leadership of FIS over the last several years. Drs. Stepanenko and Kruse led the Committee's activities as FIS Chairman and Vice-Chairman, respectively, since 2008. Dr. Kruse served as FIS Chairman from 2005–2008. They both will continue to contribute to PICES as members of FIS.

Dr. Mikhail Stepanenko, outgoing FIS Chairman, posing with Dr. Sinjae Yoo, Science Board Chairman, after receiving a PICES Service Award at the PICES-2011 Closing Session.

PICES Press
Produced and published by the PICES Secretariat
P.O. Box 6000
9860 West Saanich Road
Sidney, British Columbia V8L 4B2, Canada
E-mail: secretariat@pices.int http://www.pices.int