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Newsletter of the North Pacific Marine Science Organization

2012 PICES Science: A Note from the Science Board Chairman

PICES has continued to mark another successful year in achievements through organizing and co-sponsoring meetings and symposia, through its integrative science program FUTURE (**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems), through the exchange of ideas and information among scientists, and through international collaborations across disciplines, institutions, and national boundaries.

International Conference Center located at the Hiroshima Peace Memorial Park.

Since our last Annual Meeting in 2011, logistical and financial arrangements have been made for more than 20 inter-sessional symposia, workshops and meetings convened at various locations around the North Pacific and beyond. PICES co-sponsored two landmark events in the first half of 2012. One was the PICES/ICES (International Council for the Exploration of the Sea) Early Career Scientist (ECS) Conference on "*Oceans of Change*" held in April, in Majorca, Spain. This conference provided an opportunity to foster a networking of future generations of ocean scientists working on the Northern Hemisphere early in their career. Only the second in what is anticipated to be a series of PICES/ICES ECS conferences, it was a tremendous success, with presentations from 130 participants selected from 550 applicants. We will soon start preparing a third conference, possibly in Asia, in 2017. The other major highlight, held less than a month later, was the 2nd International Symposium on the "*Effects of Climate Change on the World's Oceans*" held in Yeosu, Korea, in conjunction with Korea's hosting of the World Fair, Ocean Expo-2012, dedicated to the understanding the role of the ocean and its coasts and the challenge it faces through human development. Again, the major international co-sponsors were PICES and ICES, along with the IOC (Intergovernmental Oceanographic Commission of UNESCO). More than 300 scientists from 31 countries attended, and it is expected that a number of high-caliber papers will be published in various peer reviewed journals (for more information on the Symposium refer to the previous issue of PICES Press).

In This Issue

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Participants of the PICES-2012 Governing Council meeting (front row, from left): Darlene Smith (Canada), John Stein (USA), Lev Bocharov (Russia), Laura Richards (Canada), Yoshiaki Takahashi (Japan); (second row, from left) Guohui Cui (China), Chul Park (Korea), Hal Batchedler (USA), Tokio Wada (Japan), Ichiro Nakayama (Japan), Yukimasa Ishida (Japan); (third row, from left) Alexander Bychkov, Yong-Seok Kang (Korea), Vladimir Radchenko (Russia), Dosoo Jang (Korea), Hiroyuki Shimada (Japan), Igor Shevchenko (Russia); (fourth row, from left) Sinjae Yoo (Korea), Patricia Livingston (USA), Tatiana Semenova (Russia), Ningsheng Yang (China), Rui Zheng (China); (top) Kosuke Kiga (Japan).

A number of PICES-sponsored workshops and meetings were held throughout the summer. To name a couple, the GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) Open Science Meeting on "*Progress in Interpreting Life History and Growth Dynamics of Harmful Algal Blooms in Fjords and Coastal Environments*" was convened in May 2012 in Victoria, Canada, and co-sponsored by PICES, IOC and SCOR (Scientific Committee on Oceanic Research). In September, a GLOBEC/PICES/ICES workshop on "*Forecasting Ecosystem Indicators with Climate-driven Models*" led by PICES' Working Group on *North Pacific Climate Variability and Change* was held in Friday Harbor, USA (see a related article on pp. 10–15 in this issue).

High-quality publications are a standard way of documenting scientific progress. 2012 saw a number of special issues of peer-reviewed journals from meetings co-sponsored by PICES. Selected papers from the PICES-2010 Topic Session on "*Economic relation between marine aquaculture and wild capture fisheries*" were published in *Aquaculture Economic and Management* (Vol. 16, Is. 2). A May 2012 special issue of *ICES Journal of Marine Science* (Vol. 69, No. 3) contained papers from the 5th International Zooplankton Production Symposium on "*Population Connections, Community Dynamics, and Climate Variability*" (Pucón, Chile, March 2011), and a September 2012 special issue of this journal (Vol. 69, No.7) was based on papers presented at the 2nd ESSAS (Ecosystem Studies of Sub-Arctic Seas) Open Science Meeting on "*Comparative Studies of Climate Effects on Polar and Subpolar Ocean Ecosystems*" (Seattle, USA, May 2011). The 26th Lowell Wakefield Symposium on "*Ecosystems 2010: Global Progress on Ecosystem-Based Fisheries Management*" was held in Anchorage, Alaska, in November 2010, and proceedings of 18 peer-reviewed papers from the symposium that evaluated global progress towards ecosystem-based fisheries management were published by Alaska Sea Grant as an e-book. All these publications included PICES members as guest editors, and we are very grateful for their efforts.

Publications also came out in the PICES Scientific Report series. Our Study Group on *Human Dimensions* reviewed the role of social science practices applied in decision-making in marine sectors, namely in ecosystem-based fisheries management, around the world (PICES Sci. Rep. No. 39). The very successful Working Group (WG 20) on *Evaluations of Climate Change Projections* completed its term by accomplishing an evaluation of IPCC Global Climate Model projections (PICES Sci. Rep. No. 40). The PICES Advisory Report on the *Decline of Fraser River Sockeye Salmon in Relation to Marine Ecology*, prepared as a technical report for the federal government of Canada's Cohen's Commission of Enquiry, was published as PICES Sci. Rep. 41.

A major enterprise of PICES is its second integrative scientific program FUTURE, launched at the 2009 PICES Annual Meeting in Jeju, Korea. It is considered PICES' highest priority undertaking for the next decade. In May 2012, an inter-sessional workshop was held in Busan, Korea, to develop a roadmap for FUTURE. The workshop reviewed the terms of reference and activities of existing expert groups and discussed the gaps and needs for establishing new expert groups. It also considered

potential users and products, as directed in the FUTURE Implementation Plan. The workshop agreed to pursue an adaptive approach, with focus on products that can be made within two or three years. A draft FUTURE roadmap was put on the agenda for discussion at PICES-2012 and was tentatively approved. A FUTURE Open Science Meeting (OSM) was also discussed at the workshop, and later at the Annual Meeting. By 2014, FUTURE will be five years old, and there will be a need to assess where we stand and to adjust its direction at that time, if necessary. It has now been decided to hold the FUTURE OSM in the spring of 2014, in Hawaii. The first announcement of the meeting will be made soon, so stay tuned for the release.

PICES scientific events in 2012 culminated with the Annual Meeting, PICES-2012, held from October 12–21, in the peaceful city of Hiroshima, Japan. We thank Mr. Kenji Kagawa (Director-General, Resources Enhancement Promotion Department, Fisheries Agency of Japan) and Dr. Toshihiko Matsusato (President, Fisheries Research Agency of Japan) for giving opening remarks on behalf of the Japanese Government. PICES-2012 covered a broad range of timely and very relevant marine science issues. Almost 470 scientists and managers from 22 countries attended the meeting. A full-day Science Board Symposium on "*Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions*" was led by a keynote lecture entitled "*Resilience and sustainability of the human-ocean coupled system – Beyond the Great East Japan Earthquake*" given by Dr. Tokio Wada (Executive Director, Fisheries Research Agency of Japan), the previous Chairman of PICES. A total of 17 scientific sessions, 8 workshops and 25 business meetings of our committees and expert groups took place, and 263 talks and 150 posters were presented. Many of these presentations can be found on the PICES website.

A full house at the Opening Session (left) and joint FUTURE meeting (right) at PICES-2012.

As many of the scientific and capacity building issues addressed by PICES are not unique to the North Pacific, but concern the entire world, it is important to expand cooperation with other international scientific organizations and programs of regional and global scale, and with regional scientific and monitoring efforts in the North Pacific. At PICES-2012, four sessions and two workshops were co-sponsored by other international organizations or programs, such as CLIVAR (Climate Variability and Predictability Program), ESSAS, ICES, IMBER (Integrated Marine Biogeochemistry and Ecosystem Research), SCOR, and SOLAS (Surface Ocean - Lower Atmosphere Study). In addition, two sessions and one workshop were organized jointly with Japanese agencies and societies, such as FRA (Fisheries Research Agency of Japan), JSFO (Japanese Society of Fisheries Oceanography) and JSPS (Japanese Society for Promotion of Science). Thirty-four international and regional organizations and programs were present as observers at PICES-2012 and expressed their views on potential areas of collaboration with PICES (including specific proposals for 2013 and beyond) at the meetings of Science Board, Standing Committees and/or their subsidiary bodies. I expect that collaboration with these organizations and programs will continue to be strengthened. In particular, a decision was made to develop a framework for greater scientific links between PICES and NPAFC (North Pacific Anadromous Fish Commission) using an approach similar to the one used for expanding cooperation between PICES and ICES.

Two PICES awards are presented at every PICES Annual Meeting to recognize the contribution made not only to PICES-related activities, but to marine science in general. One of these awards, the Wooster Award, was given this year to Dr. Richard (Dick) Beamish (Canada) for his great contribution to marine science and PICES in particular. The 2012 PICES Ocean Monitoring Service Award (POMA) was presented to the long-term marine environmental monitoring program, the California Cooperative Fisheries Investigations (CalCOFI). For more on these two recipients, see the next article in this issue. We also awarded best papers and posters, and I encourage you to visit the PICES website and see who the worthy recipients were this year.

Robin Brown (left photo) and Mitsutaku Makino (right photo) accepting a PICES Certificate of Recognition for service as Chairs from Science Board Chairman, Sinjae Yoo.

PICES volunteer recruits being interviewed by a Fukuromachi Municipal Elementary School student (left photo) and learning the origami art of making cranes (right photo).

Capacity building with the school children of Fukuromachi Municipal Elementary School.

At PICES-2012, some changes were made in the leadership of Standing Committees and expert groups. Chuanlin Huo (China) was elected as the Chairman of the Marine Environmental Quality Committee (MEQ) to replace Steven Rumrill (USA), and Darlene Smith (Canada) was elected MEQ Vice-Chairman, replacing Matsutaku Makino (Japan). Phillip Mundy (USA) was appointed as the Chairman of the FUTURE Advisory Panel on *Status, Outlooks, Forecasts, and Engagement* (AP-SOFE), replacing Robin Brown (Canada). I thank the outgoing Chairmen and Vice-Chairmen for their past dedicated service and welcome the new Chairmen on board.

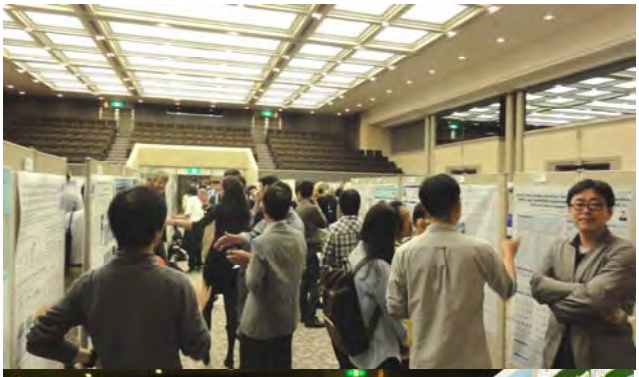
One of the final touches to a successful Annual Meeting was two public relations events that took place. One was a visit by a group of PICES scientists to the Fukuromachi Municipal Elementary School to learn first hand from the students their important message of world peace. The other was a public lecture on "The state of the marine ecosystem of the North Pacific" given by Dr. Michael Dagg, co-editor

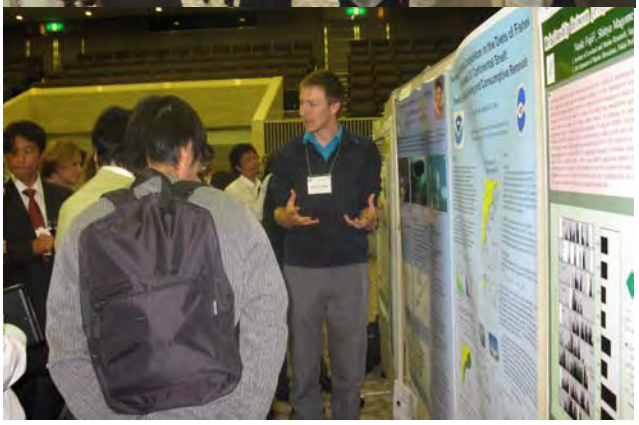
of PICES' second North Pacific Ecosystem Status Report. Both events provided an excellent opportunity for PICES scientists and the public to interact with each other.

Providing effective support and implementation for the goals of the Organization is one of PICES' strategies. This year, a new online system was introduced for submission and evaluation of topic sessions and workshop proposals. The system is intended to make the process more transparent and efficient by streamlining the procedures. As is usual with any new approach, there was a delay in acknowledging the new system by the community in the beginning. However, at the end of the day, it proved a procedural improvement which made evaluation and selection of the proposals for topic sessions and workshops much more efficient. I expect this system will work perfectly by next year.

Hoisting brews at a "pollock party" at the end of a busy topic session day.

Group picture at the end of lively team competitions in futsal (top). For those who did not want to follow a ball around a playing court, the other host country event PICES guests could play was Ken-dama.





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

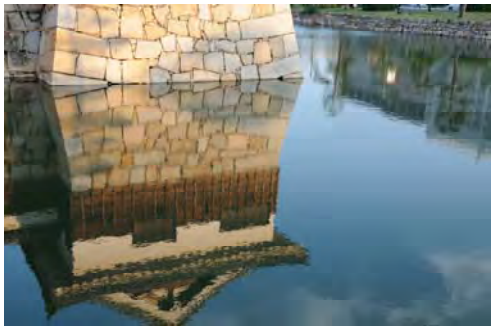
I already mentioned the PICES/ICES Early Career Scientists Conference held last April. PICES is very keen on capacity building: three PICES Summer Schools have been held since 2006, with the fourth PICES Summer School on "*Ocean observing systems and ecosystem monitoring*" slated from August 19–23, 2013, at the Hatfield Marine Science Center, Newport, USA. This summer school will teach many aspects related to ocean observing and monitoring, from lectures to field demonstration and data analysis. A wide range of sensors and sampling equipment to measure physical, biological and chemical properties of the ocean will be covered.

PICES is also a strong supporter of bi-annual summer schools organized by large-scale international ocean research projects, such as IMBER and SOLAS. In July 2012, PICES co-sponsored the IMBER ClimECO3 Summer School on "*A view towards Earth System models: Human-natural system interactions in the marine world*" in Ankara, Turkey, by providing travel funds and arranging additional support (through national programs/agencies) for 5 early career scientists from PICES member countries. This year, PICES will support a SOLAS Summer School to be held in August in Xiamen, China. We will also co-sponsor a training course on "*Remote sensing data analysis*" to be conducted in the autumn (dates to be determined) in Qingdao, China. This is a continuation of a training course series organized jointly by NOWPAP (Northwest Pacific Action Plan) and PICES.

Another component of capacity building for PICES is to share methodologies and information by organizing workshops and training courses in developing countries around the Pacific Rim. With generous funding from the Ministry of Agriculture, Forestry and Fisheries of Japan for a 5-year (2007–2012) PICES project on "*Development of the prevention systems for harmful organisms' expansion in the Pacific Rim*", three successful training courses led by PICES' Section on *Ecology of Harmful Algal Blooms in the North Pacific* have taken place, with the most recent in Indonesia (Jakarta and Lombok Island) in February 2012. The other sub-component of this project was conducted by Working Group 21 on *Non-indigenous Aquatic Species*, which organized three workshops on rapid assessment survey methodologies and collector surveys, with the most recent in Japan (Nagasaki), also in February 2012. With the successful completion of the project, two outreach brochures have been produced detailing its goals and accomplishments. In addition, we are proud to announce that WG 21 has completed the immense task of developing a database of marine non-indigenous species and Atlas of Marine and Estuarine Species in the North Pacific. Special thanks to Drs. Henry Lee and Deborah Ruesser for undertaking this important task.

Outreach brochure products resulting from the PICES/MAFF project.

To conclude, I will give a brief preview of two FUTURE-related workshops to be convened in 2013. On May 22–24, a PICES/ICES Workshop on "*Global assessment of the implications of climate change on the spatial distribution of fish and fisheries*" will be held in St. Petersburg, Russia. This workshop will be organized by the joint PICES/ICES Section (Strategic Initiative) on *Climate Change and Marine Ecosystems*, and will deal with one of the hot topics today – how will the distribution of marine species shift under the anticipated mode of climate change? The workshop will discuss many important issues related to this question, such as analytical methods for detecting changes in distributions, modeling approaches, uncertainty in projections, factors governing vulnerability to shifting distributions, and specifications for a global database. Products of this effort will be used to develop regional and latitudinal differences in the vulnerability of species or species groups to climate change induced shifts in ocean conditions. The synthesis will be used to inform future decisions regarding the governance and management of marine resources. In September, a workshop on "*Development and application of Regional Climate Models-II*" will be held in Busan, Korea. This event will be a follow-up of the meeting convened in October 2011, and will further stimulate activities of PICES Working Group 29 on *Regional Climate Modeling*, under the new framework for PICES-ICES scientific cooperation.



Reflections of Hiroshima Castle.

Finally, our next Annual Meeting, PICES-2013, will be held from October 11–20, 2013, in Nanaimo, Canada. The theme of the meeting is "*Communicating forecasts, uncertainty and consequences of ecosystem change*", and many interesting sessions and workshops, covering a wide range of topics, are planned. The theme is new to the PICES community, yet very relevant to FUTURE. It will be interesting to see how FUTURE will explore the uncharted sea.

Sinjae Yoo
Science Board Chairman

2012 PICES Awards

The presentation ceremony for two prestigious PICES awards took place on October 15, 2012, during the Opening Session at the 2012 PICES Annual Meeting in Hiroshima, Japan.

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), Jeffrey Polovina (2010) and Bernard Megrey (2011).

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

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. It is my great pleasure to announce that Dr. Richard Beamish is the recipient of the 2012 Wooster Award.

Dick was born and raised in Ontario, a region of Canada well known for its large number of lakes. Accordingly, he decided after his undergraduate degree in Biology, to undertake graduate studies in freshwater research at the University of Toronto. Dick started his career with the Department of Fisheries and Oceans in Winnipeg, where he studied the impacts of airborne pollution on fishes, before moving to the Pacific Biological Station in Nanaimo, British Columbia, to work in the Groundfish Section. There, he recognized the importance of accurate fish age estimates and set up an Ageing Lab at the Station. With his own research, he discovered that fish were much older than previously thought, and revolutionized the age determination methods of fish, resulting in a complete rethinking of stock assessment and management.

In the 1990s, Dick decided to tackle research on Pacific salmon. He was the first to provide evidence of the synchrony between Pacific salmon production and climate, specifically atmospheric processes. In addition, he was one of the first scientists to write about North Pacific climate regimes and regime shifts. Recognizing a lifetime of outstanding achievement, dedication to the community and service to the nation, the Canadian Government awarded him with the prestigious Order of Canada in 1999, for his discovery of the effects of acid rain on fishes in Ontario lakes, his contributions to the age determination of fishes, and to the understanding of climate impacts on fishes.

Along with receiving other numerous national and provincial awards, Dick has also been recognized internationally, such as by the American Fisheries Society for the sustained excellence in marine fisheries biology, by the International Panel on Climate Change for his significant contributions that helped the Panel receive the Nobel Peace Prize for 2007, and by the Sea Fisheries Institute in Gdynia, Poland, for outstanding scientific achievements.

Dick has also made substantial contributions to the administration of science, both within Canada and in international committees. He served as Director of the Pacific Biological Station for 13 years, on the International North Pacific Fisheries Commission, was the Canadian Commissioner of the International Pacific Halibut Commission, and Chairman of the Scientific Research and Statistics in the North Pacific Anadromous Fish Commission.

In 1985, he was the President of IRIS, an organization that provided focus for international recruitment studies in the subarctic Pacific. In this capacity, he was instrumental in the formative meetings leading to the development of the North Pacific Marine Science Organization (PICES). In fact, the first formal PICES Annual Meeting (Victoria, B.C., 1992) was held in conjunction with the international symposium on "Climate Change and Northern Fish Populations" which was organized by Dick. All of us in the PICES community are aware of Dick's involvement with PICES. Dick has also brought enthusiasm and mentoring to academia. From 1996 until 2011, Dick was an Affiliate Professor at Vancouver Island University in Nanaimo. For recognition of his contribution to teaching and fundraising, and for his achievements in science, he was awarded an Honorary Doctorate of Science degree from Vancouver Island University in 2009.

Dick retired in 2011 but continues research on lampreys and the factors affecting Pacific salmon production, and is

currently editing a book on all aspects of the Strait of Georgia. He has had a career as a leader in marine research, with innovative approaches to ecosystem science, age determination, taxonomy, and climate change impacts on marine resources. He has published over 200 peer-reviewed journal papers, with senior authorship on 123 of these. From his publication list, there are 7 that are considered to be fisheries science 'citation classics'. It is no wonder that even in retirement he is still travelling the globe, giving keynote addresses, providing advice and winning awards.

Please join me in congratulating Dr. Dick Beamish!

Dr. Richard Beamish (right) posing with Dr. Sinjae Yoo (left, PICES Science Board Chairman) and Dr. Lev Bocharov (Chairman of PICES) after receiving the 2012 Wooster Award.

Reading of the Science Board citation was accompanied by a slide show dedicated to Dr. Beamish (http://www.pices.int/Wooster_Award/Wooster_recipients/2012_Beamish/Beamish-album.pdf). A commemorative plaque was presented to Dr. Beamish (a permanent plaque identifying all Wooster Award recipients resides at the PICES Secretariat), who accepted the award with the following remarks of thanks:

I very much appreciate receiving the Wooster Award from PICES because it is recognition from my colleagues and it is named after a person that I worked closely with for many years. I think that Warren Wooster first talked to me in the late 1970s about the need to relate fish population dynamics to climate and ocean conditions. This was a time when many in fisheries science considered that climate and the ocean effects on fish would be mostly random. For example, it was believed that fishing and freshwater habitat were the most important factors regulating the abundance of Pacific salmon. Warren had a friendly and unrelenting way of recruiting people into his way of thinking. This was not a problem for me as I found it refreshing that there was someone else who believed that trends in climate and the ocean strongly affected fish abundance. Together we ran an organization called IRIS, which was a "Woosterism" for "International Recruitment Studies in the Subarctic." IRIS was formed to demonstrate to Canada and the United States that a PICES-type of organization was an efficient way of improving the understanding of the mechanisms that regulated fish abundance. Warren Wooster was not as enthusiastic about fish as I was, but this never got in the way of our vision of PICES. Once PICES was formed, we continued to work together as he assigned me and colleagues to the various groups and tasks.

If Warren Wooster was still with us, I would try to talk him into supporting an "International Year of the Salmon." A few days ago, I was at the North Pacific Anadromous Fish Commission meeting in St. Petersburg, Russia, and presented a paper on the value of forming an integrated group of researchers to determine how Pacific salmon populations are regulated, and to develop models that will use climate and ocean parameters to forecast production trends of the various species of salmon. I think we are close to being able to do this if we can get the support to build teams of researchers. I suggested that participants in PICES would be essential to the success of the effort. I have the feeling that Warren Wooster would even be pleased with this idea.

I always tell people that there is very little that I do all by myself. There is a list of collaborators and people that influence what I do that is much too long to report. So let me simply say, "Colleagues, thank you for your help and thank you for all the years of fascinating science that I have enjoyed at PICES."

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). Prior recipients of the award were the training ship T/S *Oshoro-maru* (Japan) in 2008, Dr. Bernard Megrey and Mr. Allen Macklin (NOAA, USA) in 2009, the Station P/Line-P (Canada) monitoring program in 2010, and the Network of Serial Oceanographic Observations (Korea) in 2011.

Drs. Bocharov and Yoo conducted the POMA presentation ceremony. 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 2012 POMA goes to the California Cooperative Fisheries Investigations (CalCOFI).

CalCOFI can trace its origins to the pioneering work on fisheries oceanography by Harald Sverdrup and Oscar Sette in the 1930s. By the time the sardine fishery was rapidly declining in the late 1940s, it was well recognized that the population dynamics of pelagic fish could not be understood without considering the effects of their environment. When the sardine industry voluntarily imposed a tax on its landings in order to answer the immediate questions of where had the fish gone and when were they coming back, it also recognized that meaningful answers would depend on a broad set of ecological observations. Thus, CalCOFI was born as a unique partnership between the fishing industry, resource management agencies and academic institutions.

A grid of CalCOFI stations that encompasses the length and breadth of the California Current was established. The geographic extent and temporal density of observations has waxed and waned over the decades depending on resources, but the commitment to CalCOFI by participating institutions, particularly the US Government, has never wavered since 1949. CalCOFI researchers have described the bio-geographic patterns of a broad range of zooplankton and ichthyoplankton taxa, explored the effects of coastal upwelling and advection on biological productivity, described the coupling between the environment and survival of young fish, and advanced the field of fishery oceanography.

Over time, the length of CalCOFI data sets has allowed the resolution of ecological variability over a range of scales from seasonal to decadal to long-term secular change. CalCOFI has also evolved with the addition of new instrumentation and sampling protocols. Hundreds of student theses and thousands of scientific articles have used CalCOFI data sets and have built on the scientific foundation set by CalCOFI.

Over the years, other marine observation programs sponsored by the National Science Foundation, the Office of Naval Research, the Integrated Ocean Observation System, and private foundations have built on, and leveraged, the strength of the CalCOFI program. This has improved our ability to document processes in the California Current and has established the region as a model for assessing the health of marine ecosystems.

The CalCOFI Committee guides the fieldwork and publications of the program and is currently composed of representatives from Scripps Institution of Oceanography, Southwest Fisheries Science Center and California Department of Fish and Game. Please join me in congratulating Drs. Anthony Koslow and Steven Bograd, receiving the award on behalf of the hundreds of people, past and present, who have contributed to the CalCOFI for the past seven decades.

Reading of the Science Board citation was accompanied by a slide show dedicated to CalCOFI (http://www.pices.int/awards/POMA_award/2012-POMA/CalCOF-album.pdf). A commemorative plaque (a permanent plaque identifying all POMA recipients resides at the PICES Secretariat) and a certificate were presented to Drs. Anthony Koslow (Scripps Institution of Oceanography, UCSD, USA) and Steven Bograd (Southwest Fisheries Science Center, NMFS, USA).

Drs. Anthony Koslow (second from right) and Steven Bograd (right) posing with Dr. Sinjae Yoo (PICES Science Board Chairman) and Dr. Lev Bocharov (Chairman of PICES) after receiving the 2012 PICES Ocean Monitoring Service Award.

Dr. Koslow provided the following remarks of appreciation:

I am both proud and humble to accept the PICES Ocean Monitoring Service Award on behalf of Scripps Institution of Oceanography and NOAA. CalCOFI is a unique partnership of government and academic institutions: NOAA, the California Department of Fish and Game, and Scripps Institution of Oceanography. As such, its mission since its inception in 1949 has been to study and manage the living marine resources of the California Current within an ecosystem context. Key achievements of an earlier generation of CalCOFI scientists included development of the daily egg production to assess the northern anchovy and Pacific sardine fisheries, descriptions of the pelagic communities of the California Current, and the first understanding of the impact of ENSO on that ecosystem. The program continued to evolve through the years, adopting new instruments, and making new measurements as that became possible, while building on the old. Today, it is one of the few truly end-to-end observation programs in the world, carrying out observations from winds to whales on its quarterly cruises. In recent years, CalCOFI data have been instrumental in defining the impacts of decadal-scale Pacific variability and exploring the possible influence of climate change, developing new fishery-independent time series for key species, such as market squid and spiny lobster, and describing and modeling changes in deep-water oxygen concentrations and their impacts on mid-water fish communities.

CalCOFI is now more than 60 years old and is the fruit of several generations of scientists at Scripps Institution of Oceanography and NOAA. We are both humble and grateful to receive the award on behalf of all those, past and present, who built this program. If we see further than those who went before us, it is because (as Isaac Newton once said) we stand on the shoulders of giants.

GLOBEC/PICES/ICES ECOFOR Workshop

by Emanuele Di Lorenzo, Arthur Miller, Shoshiro Minobe, Jacquelynne King, Marc Hufnagl and Chuck Greene

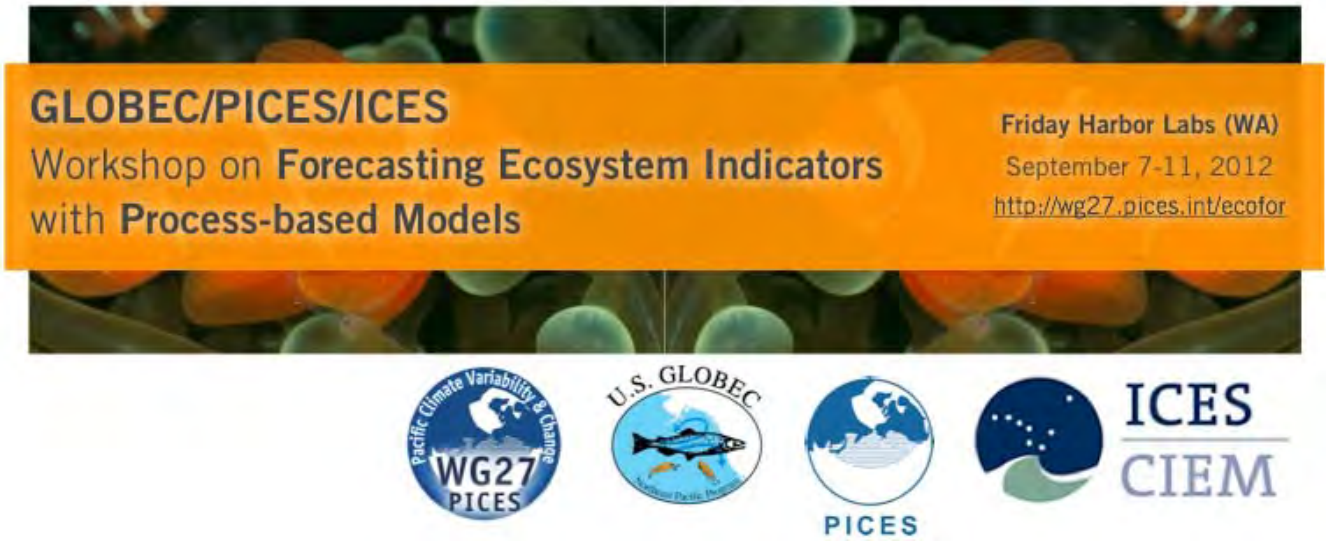
Motivations and goals

GLOBEC, PICES and ICES have advanced our understanding of the response mechanisms of the marine ecosystem lower trophic levels to climate variability. This improved knowledge allows us now to formulate climate-driven process models of low order (*e.g.*, low number of dimensions) to hindcast and forecast ecosystem species and indicators.

During 2011, PICES established two new working groups (WGs), WG 27 on *North Pacific Climate Variability and Change* and WG 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*. While WG 27 is developing quantitative approaches to evaluate how large-scale climate variability and change impacts physical and biogeochemical variables (*e.g.*, sea surface temperature, ocean circulation, seasonal timing, nutrient fluxes, acidification, hypoxia, upwelling and mixing), WG 28 is developing ecosystem indicators that best characterize the ecosystem responses to these multiple stressors.

Several workshops have been conducted in recent years to advance the scientific basis for implementing forecasting models for ecosystem indicators (*e.g.*, FUTURE Workshop on "*Indicators of status and change within North Pacific marine ecosystems*", Honolulu, 2011; CINAR Workshop on "*Climate and ecosystem change in the NW Atlantic*", Woods Hole, 2011). Also, efforts like the Indicator of the Seas Project (IndiSeas), which was launched in 2005 under the auspices of the EUR-OCEANS Scientific Programme as a follow-up to the SCOR/IOC Working Group 119 on *Quantitative Ecosystem Indicators*, now provide us with more robust frameworks for isolating and selecting ecosystem indicators. However, examples of low order climate-driven process models that forecast ecosystem indicators are still rare.

The goal of the 2012 GLOBEC/PICES/ICES ECOFOR workshop (see the workshop banner below) is to begin a more systematic application of the previous knowledge from the GLOBEC/PICES and ICES programs to move beyond the simple correlation analyses between physical and biological variability, and to identify key processes that enable us to succinctly and quantifiably model the mechanisms underlying the relationships observed in physical-biological datasets, both in the North Pacific and North Atlantic. The process models developed for this goal include as few degrees of freedom as possible (not full complexity) to sufficiently capture and test specific mechanisms of the ecosystem response to climate forcing and of the internal population dynamics. The process models are developed and tested within statistically based frameworks (*e.g.*, Bayesian hierarchical models, linear inverse models, *etc.*) that allow formal quantification of the uncertainties in historical reconstructions and future predictions of targeted ecosystem variables. Ecosystem process models complement full-ecosystem complex models (*e.g.*, End-To-End, Atlantis, ROMS-NPZD-NEMURO, IBM) by (1) directly testing the understanding and (2) quantifying the role of specific mechanisms underlying the physical-biological linkages. Although process models by definition do not include a complete description of ecosystem function and cannot account for the multi-dimensional interactions, they avoid magnifying uncertainty stemming from processes that are not well understood and modeled in full-ecosystem complex models.



Here we provide a short overview of some of the process models and new hypotheses of physical-biological interactions discussed at ECOFOR-2012.

The process models

Process models use few indices of environmental forcing that represent selected and relevant physical processes (*e.g.*, advection, mesoscale eddies) to reconstruct existing time series of marine populations in the lower and higher trophic levels. The opening session of the workshop was devoted to introducing examples of diagnostic and predictive ecosystem process models of different degrees of complexity. Ten examples that were presented and discussed are available in the workshop report and on the workshop website at http://wg27.pices.int/ecofor. Here we report on two of the examples presented by young scientists (a graduate and undergraduate student) attending the workshop. These examples elucidate the application of process models for diagnosing (Example #1) and predicting (Example #2) marine populations.

Example #1: Diagnosing North Atlantic Right Whales

by E. Meyer-Gutbrod, C. Greene and A. Pershing

Erin Meyer-Gutbrod (elg82@cornell.edu) is a third-year PhD student in the Earth and Atmospheric Sciences Department at Cornell University (USA) working with Dr. Charles Greene. She is interested in the population dynamics of endangered cetacean populations, with a special focus on the effects of environmental drivers on reproduction rates. She will use this research to define benchmarks in prey abundance that support the population growth of right whales in the North Atlantic and Southern Resident killer whales in the North Pacific. Erin is currently supported by the National Defense Science and Engineering Graduate fellowship.

The North Atlantic right whale, *Eubalaena glacialis*, has previously suffered declining populations due to the high rate of anthropogenic mortalities and low rate of reproduction. Numbering fewer than 500 individuals, the North Atlantic right whale is listed as critically endangered. The long calving intervals that hallmark low reproduction may be driven by nutritional deficiencies in adult females resulting from low prey availability. The abundance of *Calanus finmarchicus* in the Gulf of Maine and Western Scotian Shelf, a primary nutritional source for North Atlantic right whales, has been shown to respond to climate forcing from the Arctic as well as within the North Atlantic Basin. Given the critical state of the right whale population, it is vital to determine how changing climate and the corresponding changes in prey abundance will affect the future of the species.

A new demographic model has been built to incorporate changes in prey availability in the prediction of right whale calving intervals. Using a time series of calving events and viable cows from 1980–2005, we developed a deterministic matrix population model to estimate the distribution of cows among three reproductive stages: resting, pregnancy and nursing (Fig. 1). The probabilities of transitioning between reproductive stages are estimated as logistic functions of the *Calanus finmarchicus* abundance index as determined from 26 years of Continuous Plankton Recorder (CPR) survey data from the Gulf of Maine. The CPR data can be divided into separate indices representing a time series of bimonthly values in five key regions in the right whale feeding habitat: Gulf of Maine, Cape Cod Bay, Western Gulf of Maine, Eastern Gulf of Maine and Scotian Shelf. With this data resolution, we can determine the signature of the prey region and season that can be incorporated into the model to best fit the observed calving series. This exercise allows us to infer which feeding areas and times contribute significantly to successful right whale reproduction.

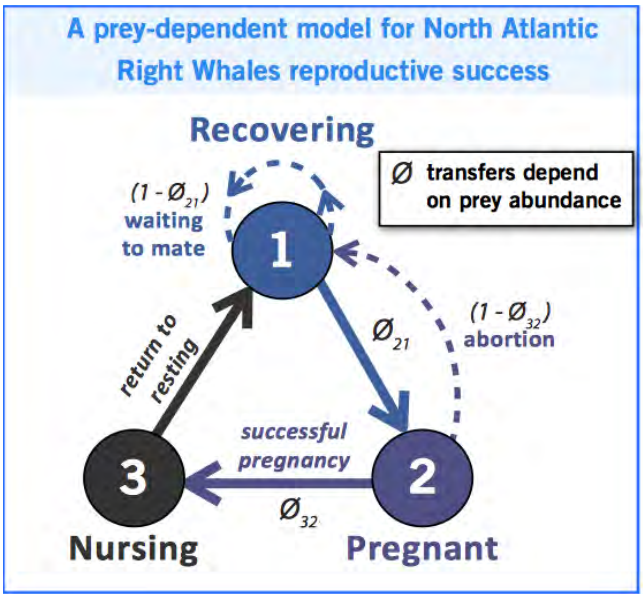


Fig. 1 A three-stage model of the right whale reproduction cycle. The recovery stage (1) is a period of time when a female is recuperating from previous pregnancies or waiting for ideal conditions for impregnation. The pregnant stage (2) lasts approximately one year, given that the pregnancy is not prematurely terminated. If an abortion occurs, the cow will return to the recovery stage (1). If the pregnancy is successful, the cow will move into the nursing stage (3). The nursing stage can last between 8 months and a year, after which the female enters the recovery stage (1) again.

The best fit prey-dependent reproduction model yields a significantly more precise calving time series than a prey-independent model, which strengthens the hypothesis that prey abundance drives reproduction. The prey-dependent model suggests that high winter prey levels in the Scotian Shelf and Cape Cod Bay may be especially good predictors of favorable breeding seasons.

Although the 1990s were characterised by long calving intervals and low reproduction rates which correspond with depressed copepod abundances, a regime shift occurring at the new millennium has led to increased abundances of *Calanus finmarchicus*, similar to the levels seen in the 1980s. Reflecting this increase in prey availability, the right whale calving rate experienced a sustained boom from

2001 to present. Although the inflated calving rate can be partially explained by an increase in viable cows attributed to slow population growth over the past two decades, it is likely that increased prey abundances are driving the shorter calving intervals for each cow and improving reproductive efficiency. Future work will be performed to determine whether the regions and seasons of copepod occurrence that drive right whale reproduction are distinct in the three decadal regimes recently witnessed in the North Atlantic.

Example #2: Predicting Alaskan sablefish recruitment

by A. Smith, K. Shotwell, M. Stachura and E. Di Lorenzo

Andrew Smith (andrewwsmith@gatech.edu) is a fourth-year undergraduate student majoring in Earth and Atmiospheric Sciences at the Georgia Institute of Technology (USA). He is currently conducting research on the topics of climate and marine ecosystem dynamics with Dr. Emanuele Di Lorenzo and of climate and monsoon variability with Dr. Peter Webster.

In the Gulf of Alaska, strong downwelling events (*e.g.*, the winter following the 1997 El Niño) drive high sea level along the coastal Gulf of Alaska. The high sea level and the resulting intensification of the Alaskan coastal current and Alaskan Stream excite the generation of strong anticyclonic eddies that entrain coastal waters rich in nutrients and iron. In the eastern Gulf, these eddies tend to generate at very predictable locations (*e.g.*, the Sitka and Haida eddies) and to persist for several years in the Gulf once they migrate away from the coastal waters.

Oceanographic surveys of these Alaskan large anticyclonic eddies have shown that the eddy regions are potentially very favorable environments for marine populations because of the richness in nutrients and because of the ability of these eddies to sustain secondary circulations that fuel primary production. Observations also suggest that these eddies have an impact on larval fish assemblages, which may change depending on the age and formation location of the eddy (Atwood *et al.* 2010). Alaska sablefish (*Anoplopoma fimbria*) is a commercially valuable slope-spawning groundfish species with highly variable recruitment (Hanselman *et al.* 2012). Larvae of these fish have also been observed in these eddy formation regions (Atwood *et al.* 2010), and it has been hypothesized that their cross-shelf transport may be influenced by the strength of the eddies (Shotwell *et al.* In press).

These concepts led a group of scientists from Georgia Tech and the Alaska Fisheries Science Center (Dr. Shotwell *et al.*, AFSC, NMFS, NOAA) to explore the hypothesis that higher sablefish recruitment is related to the strength of these large anticyclonic eddies. Although we do not have sufficient data to fully test this concept and understand the exact dynamics linking eddies to the sablefish life cycle, we have explored a simple predictive model of sablefish recruitment based on the intensity of the large Alaskan anticyclones. A regional eddy-resolving ocean model hindcast (ROMS) from 1950–2008 was used to generate an index of anticyclonic eddy strength. More specifically, because the dominant anticyclonic eddy in the northern Gulf is the Sitka Eddy, an index of its strength was produced by averaging the winter sea surface height anomaly (SSHa) from the ROMS eddy-resolving model in the formation region of the Sitka Eddy (see Fig. 2). The comparison of the Sitka Eddy index with the sablefish recruitment time series shows significant positive correlation (R = 0.45) and lends support to the hypothesis that sablefish recruitment is highest in years when Sitka eddies are stronger. Although further analysis and observations are required to develop and test the mechanistic link between this large anticyclone and sablefish recruitment dynamics, this work is an example of using data from an eddy-resolving model hindcast to generate a regional physical index to hindcast and forecast recruitment data, which is typically not available until several years later when young adult sablefish become vulnerable to surveys and the fishery.

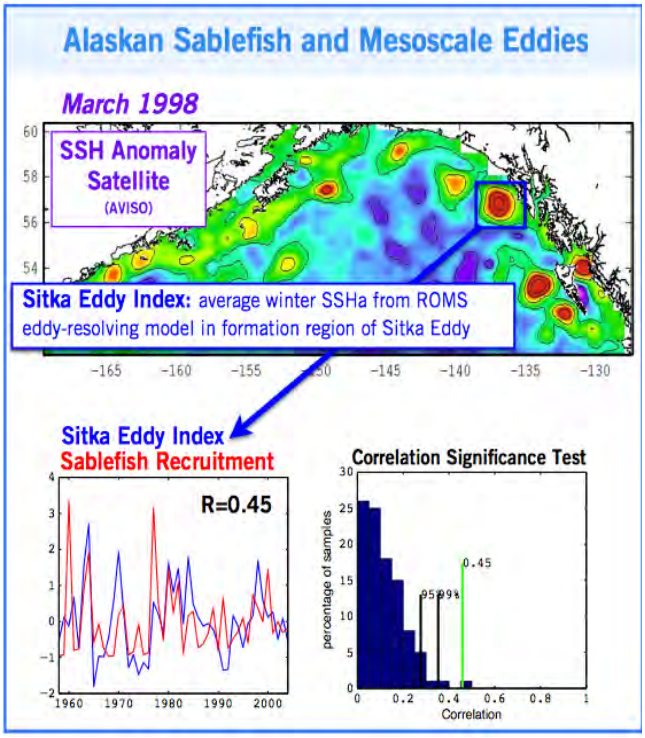


Fig. 2 Top panel shows large anticyclone eddies (e.g., Sitka Eddy) that follow the strong downwelling event associated with El Niño forcing in 1997–1998. A time series of the Sitka Eddy intensity reconstructed with high-resolution ocean model hindcast tracks correlating closely with the sablefish recruitment time series (bottom panel). Given that the recruitment data are not available in real time, the physically derived index could be exploited for prediction of sablefish recruits several years in advance.

New hypotheses linking climate modes to ecosystem response

Identifying large-scale climate patterns enables us to capture large fractions of the field variability (*e.g.*, sea surface temperature, sea level pressure) with a small number of

spatial patterns and associated time series – this is often done with data compression techniques like Empirical Orthogonal Function (EOF) and/or Principal Component Analysis (PC). Population dynamics are sometimes better correlated with large-scale climate indices rather than with local weather. This may be explained by the fact that one-dimensional views of the local climate (*e.g.*, temperature, rain-fall) are often too narrow to capture the climate impacts on ecosystems, which typically involve many dimensions.

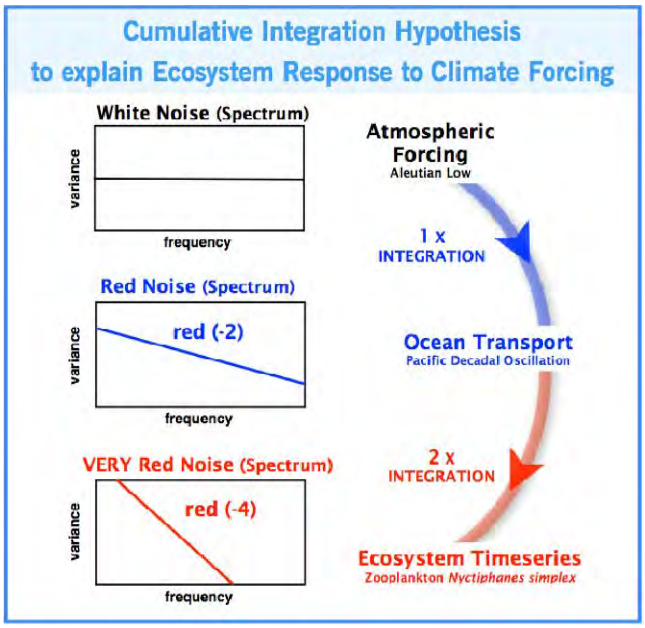


Fig. 3 Random white noise atmospheric variability (e.g., Aleutian Low) has been shown to drive oceanic responses (e.g., changes in ocean transport) that are captured by specific climate modes (e.g., PDO). The integration of the atmospheric forcing by the climate modes leads to a red noise ocean spectrum – that time series with enhanced low frequency variability compared to the high frequency. Marine populations (e.g., zooplankton in the California Current) that are forced by changes in ocean conditions can integrate the white noise atmospheric forcing a second time and lead to time series that exhibit even stronger low-frequency variability and apparent state changes – a very red noise spectrum. This cumulative integrations hypothesis of environmental forcing may explain the long-term regime-like transitions observed in marine populations and serve as a null-hypothesis to assess the level of significance in ocean ecosystems.

A new approach for exploring and explaining the relationship between climate modes and low-frequency changes in ecosystem time series was proposed by Di Lorenzo and Ohman (PNAS, in press) and discussed by the group. The underlying hypothesis behind this approach is based on cumulative integrations of white noise atmospheric forcing, which can generate marine population responses that are characterised by strong transitions and prolonged apparent state changes (see Fig. 3 and caption for a more detailed description). The applicability and success of this model was shown with a 60-year-long observed time series of zooplankton in the California Current, where changes in transport associated with the PDO (1x integration of atmospheric forcing) drive changes in zooplankton abundance (2x integration of atmospheric forcing). Although this approach and example for the California Current are promising, it is important (as noted by the group) that the magnitude of the forcing and response are tested more quantitatively using available observations. The effects of cumulative integrations of environmental and climate forcing on time series of marine populations (*e.g.*, zooplankton and fish) naturally lead to potentially strong and prolonged apparent state transitions that must be carefully considered when searching for apparent nonlinear responses and climate change signatures in marine ecosystems.

Recommendation for PICES and ICES

A major challenge towards developing and testing new hypotheses of the physical-biological linkages is the need to (1) identify/develop targeted observational and modelling datasets that can be used with process models and (2) better understand the regional physical forcing dynamics associated with the large-scale climate variability and change. To this end, the workshop recommended the development of a web-based repository of relevant climate forcing indices (from observations and models) along with a comprehensive explanation of their regional impacts and dynamics. This activity is already ongoing within PICES WG 27 but may also be considered within ICES for the activities of the new joint PICES/ICES Section (Strategic Initiative) on *Climate Change Effects on Marine Ecosystems* (http://www.pices.int/members/sections/CCME-S.aspx).

The workshop also identified two priorities for successfully developing hindcast/forecast ecosystem process-based models:

1. Maintain and improve the collaboration and exchange between marine ecosystem scientists, physical oceanographers, and climate scientists. This dialog is the foundation for developing better and new hypotheses linking ecosystem response to climate forcing.
2. Identify and develop targeted observational and modelling datasets that are required to test the new hypotheses using the process models.

All the material and documents of the ECOFOR workshop have been organised on the PICES WG 27 website at http://wg27.pices.int/ecofor/. The website also contains the presentation files and summary for each of the presenters.

The group and social events

A group of 28 international scientists and 5 graduate students attended the workshop. As in every good workshop, social events and team building activities are essential to develop the necessary trust that leads to successful collaborations. In this regard, the Friday Harbor setting was an ideal location to promote interactions among the participants. The evenings began with a wine reception at an ocean view dining terrace and ended at sundown with fireside chats. There was also a whale-watching excursion with sack lunch on the second day of the workshop (see photos).

People in order of appearance (top to bottom): Sanae Chiba, Julie Keister, Louis Botsford, Matt Newman, Michael Alexander, Shoshiro Minobe, Nick Bond, Tony Koslow, Mark Hufnagl, Ryan Rykaczewski and Steve Bograd.

Future activities in 2013

As an outcome of the 2012 ECOFOR workshop, a theme session at the 2013 ICES Annual Science Conference in Reykjavík, Iceland, and a workshop at the 2013 PICES Annual Meeting in Nanaimo, Canada, were proposed and accepted. These two events share the same scientific focus and title, "*Identifying mechanisms linking physical climate and ecosystem change: Observed indices, hypothesized processes, and "data dreams" for the future*", in order to collect inputs from both the PICES and ICES scientists. While the ICES session's goal is to collect information and

examples of relevant science ongoing in the ICES community on the topic of process modelling, the PICES workshop is aimed more at promoting and expanding the ECOFOR discussions. The PICES workshop format will be a mixture of talks and group discussions that aim at enriching the exchange of ideas and concepts between physical and biological ocean scientists. The ultimate goal of these events is to deliver (1) a set of new hypotheses of the mechanisms of marine ecosystem responses to climate forcing and (2) a description of the observational and modelling datasets required to test these hypotheses using process models.

Dr. Emanuele (Manu) Di Lorenzo (edl@gatech.edu) is an Associate Professor at the School of Earth and Atmospheric Sciences, Georgia Institute of Technology, USA. His research interests are climate dynamics, basin and regional ocean circulations, inverse modeling, and more recently, understanding the impacts of large-scale climate variability on marine ecosystem dynamics. In PICES, he co-chairs Working Group 27 on North Pacific Climate Variability and Change and is a member of the Advisory Panel on Climate Ocean Variability and Ecosystem (AP-COVE). Manu also serves on the US Comparative Analysis of Marine Ecosystem (CAMEO) Science Steering Committee and on CLIVAR Working Group on ENSO diversity.

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

Dr. Arthur (Art) Miller (ajmiller@ucsd.edu) is a Research Oceanographer, Senior Lecturer in Climate Sciences, and Director of the Climate, Atmospheric Science, and Physical Oceanography (CASPO) Division at the Scripps Institution of Oceanography, University of California, San Diego (USA). His research interests include ocean modeling, coupled ocean–atmosphere modeling, ocean data assimilation, and climate forcing of marine ecosystems.

Dr. Jacquelynne King (Jackie.King@dfo-mpo.gc.ca) is a Research Scientist at the Pacific Biological Station (Fisheries and Oceans Canada) and an Adjunct Professor at the University of British Columbia. She received her PhD in Limnology from the University of Toronto in 1997 and began her career in marine ecology as a Post Doctoral Fellow studying North Pacific regime shifts. Her current research includes climate change impacts on marine ecosystems and methods of incorporating climate variability into stock assessment advice. She is also Program Head of the Canadian Pacific Shark Research Lab. Within PICES, Jackie was the Chairman of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts, a member of the Climate Forcing and Marine Ecosystem Response Task Team and Working Group 16 on Climate Change, Shifts in Fish Production, and Fisheries Management. She is currently a member of the FIS Committee, the Section on Climate Change Effects on Marine Ecosystems, Working Group 27 on North Pacific Climate Variability and Change, and FUTURE AP-COVE.

Dr. Marc Hufnagl (Marc.Hufnagl@uni-hamburg.de) is a Junior Professor in Fisheries Science and Modelling, University of Hamburg, Germany. His research interests include modeling behaviour physiology and drift of marine invertebrates, ecosystem models, analyzing climate effects on ecosystems, fish and fisheries, life cycle modeling, population dynamics and lifecycle of the brown shrimp Crangon crangon, and selective Tidal Stream Transport (STT).

Dr. Chuck Greene (chg2@cornell.edu) is a Professor in the Department of Earth and Atmospheric Sciences and Director of the Ocean Resources and Ecosystems Program at Cornell University. He received his PhD in Oceanography from the University of Washington and spent a year as a postdoctoral fellow at the Woods Hole Oceanographic Institution prior to joining the faculty at Cornell. His research interests range from the ecological dynamics of marine animal populations to the effects of global climate change on ocean ecosystems. Chuck combines his research and educational interests in ocean science and technology by promoting innovative training opportunities for undergraduate and graduate students. Since 1993, he has organized 18 courses in marine bioacoustics that have trained over 250 students from 30 different countries. He also supervises the Cornell-WHOI Masters of Engineering Program in Ocean Science and Technology.

ICES/PICES Symposium on "*Forage Fish Interactions*"

by Myron Pack, Tim Essington and Stefan Neuenfeldt

Fig. 1 The participants of the ICES-PICES symposium on "Forage Fish Interactions", November 12–14, 2012, at the Citées Congrès in Nantes, France.

Forage fish are small, often pelagic and schooling fishes that are a main pathway for energy to flow from plankton to higher predators in marine ecosystems. Because they maintain this trophodynamic role throughout their life, their population fluctuations may produce notable ecological effects and, therefore, the sustainable management of forage fisheries is critical to maintaining ecosystem functioning. A group of 70 scientists from 16 nations (Fig. 1) gathered near the banks of the Loire River in the city of Nantes, France, from November 12–14, 2012, for an ICES/PICES Symposium on "*Forage fish interactions: Creating the tools for ecosystem-based management of marine resources*". The symposium was organized around three overarching themes and questions:

- (Drivers of change) – How do environmental factors and predator-prey interactions drive the productivity and distribution of forage fish stocks across ecosystems world-wide?
- (Management of resources) – What are the economic and ecological costs and benefits of different forage fish management strategies? and
- (Common traits) – Do commonalities exist across ecosystems in terms of the effective management of forage fish exploitation?

The symposium was kicked off with a keynote address by Jake Rice (Canada), who provided a retrospective of important achievements in both field and modelling research that have paved the way towards our current view of forage fish as central players in the trophodynamic structure and function of marine ecosystems. The talk also highlighted how historical achievements have led to the development of the different strategies employed today to manage the exploitation of forage fish stocks. That keynote address set the stage for a series of oral and electronic poster (Fig. 2) presentations that were given within five theme sessions over the following three days.

Session 1 on "Climatic and biotic mechanisms and forage fish recruitment": Within this session, Akinori Takasuka (Japan) gave a keynote address that reviewed the various recruitment hypotheses that have been offered to explain world-wide, synchronous fluctuations in anchovy-sardine species pairs. Using different examples, he highlighted how subtle changes in mean growth rates and stage durations of early life stages may lead to dramatic consequences for survival and year-class success. Following that presentation, a number of talks illustrated how changes in the distribution and productivity of key forage fishes were associated with climate-driven changes in bottom-up processes (changes in physical forcing, zooplankton community dynamics, *etc.*). An emerging theme was the role of intra-guild predation and competition in population dynamics, particularly how intra-guild dynamics can amplify impacts of external drivers (*e.g.*, environment and fishing). Forage fish recruitment dynamics from a diverse array of habitats (from the Mediterranean and North Seas to the Seto Inland Sea of Japan) were discussed.

Session 2 on "Post recruitment predator-prey dynamics in ecosystems world-wide": In this theme session, Geir Huse (Norway) provided a keynote presentation that reviewed how swimming behaviour, which modifies the spatial overlap of forage fishes and their predators, has been utilized within biophysical food web models developed for the Barents and Norwegian Seas. The important tropho-dynamic role of forage fish as prey was highlighted in presentations that spanned a wide range of ecosystems (from sub-tropical seas to sub-Arctic habitats). Several talks emphasized the impacts that local changes in forage fish availability had to central-based predators such as marine mammals and seabirds. These presentations and discussions highlighted, in some cases, our lack of knowledge on the diet preferences and requirements of the predators of forage fish such as "charismatic mega-fauna" within complex food webs such as shelf sea ecosystems.

Fig. 2 Marisa Litz (USA) describes the electronic version of her poster on spatial and temporal influences of the Columbia River plume on the community structure of forage fish and other nekton over the Washington and Oregon shelf. Some of the onlookers include (from right to left) Myron Peck (Germany), Richard Nash (Norway), Maria Røjbek (Denmark), Geir Huse (Norway), Keith Farnsworth (UK), Ignacio Catalán (Spain), Lars Ravn-Jonsen (Denmark), Eckhard Bethke (Germany), Barbara Schoute (ICES) and (in profile) Georg Engelhard (UK).

Session 3 on "Linking biology and economics": An important element of the symposium was to bring together (and bridge any potential gaps between) biologists and economists. This represents a critical step towards advancing knowledge and tools useful in the management of forage (and other) fishes. The state of the art in coupling biology and economics was provided in a keynote address by Røgnvaldur Hanesson (Norway), who emphasized the need to more fully appreciate the economic role played by forage fishes. This includes estimates of their direct value not only in landings, but in associated industries and as products such as fish meal and forage. Forage fish also provide several ecosystem services (*e.g.*, supporting ecosystem and food web structure and maintaining healthy populations of other commercially exploited stocks) which are difficult to valuate but, nonetheless, need to be considered and compared when exploring the economic consequences of various management options.

Session 4 on "Ecosystem-based management": This session offered presentations that highlighted the role of forage fish within current ecosystem-based approaches to managing marine systems and included a keynote address by Jason Link (USA). Presentations stemmed from the recent Lenfest Forage Fish Task Force report, a comprehensive, global analysis of forage fish and their management. A reoccurring theme in many talks was that managing forage fish fisheries broadly hinges on striking a balance between utilizing different parts of the system and balancing biological and economic tradeoffs. These various management options must also be considered within the context of the large fluctuations in biomass typically observed in many forage fish stocks. It was discussed whether, in some cases, forage fish could be managed as one portfolio (as a single component). "How much forage fish should be left in the water for predators?" was a hotly contested question although it was clear from many talks that mortality due to predators is often (much) higher than the removal of forage fish due to fisheries.

Session 5 on "Direct comparisons between ecosystems and generic properties": This session explored whether commonalities existed among ecosystems and the role of forage fish in ecosystem structure and function. Jeremy Collie (USA) provided a keynote address that explored forage fish dynamics among various shelf sea ecosystems across the northern hemisphere. That presentation echoed the message within a variety of talks on the key role of forage fishes as planktivores and the common (and sometimes striking) community shifts that have been observed in the last decades as revealed in size-based ecosystem indicators (*e.g.*, mean ratio of "small" to "large" or "pelagic" to "demersal" species). Presentations explored and critically evaluated different approaches to model the effects of forage fish removals on food web dynamics. For example, generic, size-based (size spectrum) approaches are being used to explore how different harvest strategies of forage fish may impact upper and lower trophic levels and the contrasting responses of relatively "small" and "large" species to fishing mortality. A second presentation critically examined the design and performance of 18 existing ecosystem-based models in terms of their suitability to make projections regarding the potential consequences of changes in forage fish stocks on marine food webs.

Fig. 3 The final event of the symposium was a panel discussion of keynote speakers which helped synthesize the take-home messages from the symposium. From left to right: Gier Huse (Norway), Jeremy Collie (USA), Jake Rice (Canada), Røgnvaldur Hanesson (Denmark), Akinori Takasuka (Japan) and Jason Link (USA).

The final event of the symposium was a Panel Discussion on "*What exactly is a healthy ecosystem? Managing forage fish: What do we want and why?"* The six keynote speakers (Fig. 3) fielded questions from the audience and offered their own opinions about remaining questions, the hot topics addressed in presentations, and future research needs concerning the effective management of forage fish within an ecosystem context. A special volume of the *ICES Journal of Marine Science* has been set to publish the results presented at this symposium.

The symposium was convened by Stefan Neuenfeldt (Denmark), Myron Peck (Germany), Tim Essington (USA), Niels Vestergaard (Denmark) and Vladimir Radchenko (Russia). A long list of people made the symposium run smoothly, including Olivier Berthéle, Mareike Volkenandt and Sophie Pilven. Special thanks are given to Verena Trenkel and Helle Sørensen who (similar to forage fish in many ecosystems) formed the essential "wasp-waist" by effectively channelling substantial amounts of local energy to the symposium's participants. Additional funding for the symposium was obtained from the EU project "FACTS".

Dr. Myron Peck (myron.peck@uni-hamburg.de) is an Associate Professor of Biological Oceanography at the University of Hamburg, Institute of Hydrobiology and Fisheries Science (Hamburg, Germany). He has a broad range of research interests related to physical and biological processes governing marine and estuarine species and food webs, including coupling species life history and physiology and translating that knowledge to models to advance predictive capacity.

Dr. Tim Essington (essing@uw.edu) is an Associate Professor of Aquatic and Fishers Sciences at the University of Washington (Seattle, Washington, USA). His research examines food web interactions within a wide range of marine, estuarine and freshwater habitats. A primary consideration is the structuring role played by fisheries and other anthropogenic effects. His research attempts to understand the potential conflicts between fisheries targeting species that occupy distinct positions in food webs.

Dr. Stefan Neuenfeldt (stn@aqua.dtu.dk) is a Senior Researcher at the Danish Technical University, Division of Aquatic Resources (DTU-Aqua) in Charlottenlund, Denmark. His research interests include multi-species interactions in marine systems, particularly predator-prey dynamics operating at different temporal and spatial scales. He also uses biotelemetry to explore various facets of fish behaviour. Stefan is the coordinator of the EU FACTS forage fish program.

The Yeosu Declaration, the Yeosu Declaration Forum and the Yeosu Project: We Look to the Oceans as a New Engine for Green Growth

by Dosoo Jang

Yeosu Declaration Roundtable Discussion participants.

Background

The International Exposition Yeosu Korea 2012 (Expo 2012 Yeosu Korea) is a monumental event for the global ocean community, focusing on "The Living Ocean and Coast" which drew more than 8.2 million people over the course of 93 days. In the spirit of progress and innovation, as reflected in the exhibitions of the Expo 2012 Yeosu Korea, the Yeosu Declaration and the Yeosu Declaration Forum sought to catalyze international action in pursuit of the new vision of "*green growth from the sea*", which looks to the ocean as a new engine of sustainable economic growth, while keeping the ocean healthy and ensuring harmony of the sea and humankind.

The Yeosu Declaration

The Yeosu Declaration builds on the efforts of the Expo 2012 Yeosu Korea, as well as the international framework for the ocean and the outcomes of major conferences on sustainable development. It recognizes the ocean as a critical part of the Earth's life supporting system and a valuable source of food, livelihood, and culture to billions around the world. Marine ecosystem services and a rich diversity of marine resources are essential to human survival, civilization, and prosperity. This is especially important in light of the growing global population and the many pressures facing the ocean.

The Declaration aims to elevate ocean issues to the top of the global policy agenda and empower all stakeholders to have greater stewardship and take up their unique roles in ensuring the well-being of the ocean for future generations. It seeks to mobilize the global community in all sectors, including governments, civil society, and the private sector, to support the ocean as an important source of prosperity and development, strengthening social and economic linkages of the global community.

The Declaration also intends to catalyze tangible action for the protection of marine ecosystems and the use of innovative and environmentally-friendly technologies to realize the many opportunities of the ocean. It supports an improved understanding of the ocean through science and observation in order to better manage ocean resources and more effectively respond to major threats and natural disasters.

As the well-being of the entire world is inextricably connected to the ocean, the Yeosu Declaration emphasizes the importance of collaborative international action, involving all nations. In this respect, the Declaration highlights the importance of assisting developing nations, including small island developing states, to better manage their marine resources and address ocean-related challenges.

The Declaration also highlights the Yeosu Project, as a legacy of the Expo 2012 Yeosu Korea, which focuses on building the capacity of developing nations, and calls for translating the spirit of the Declaration into action. The text of the Declaration is posted at http://eng.expo2012.kr/is/ps/unitybbs/bbs/selectBbsDetail.html?ispsBbsId=BBS001&ispsNttId=0000060031.

The Yeosu Declaration Forum and Roundtable

The Yeosu Declaration Forum and Roundtable outlined the vision of the ocean as a new engine of sustainable economic growth, combined with sustainable management and stewardship of ocean resources. These two events provided a key opportunity to build on the political momentum of Rio+20, with the heightened awareness of the general public on oceans illustrated by the more than 8 million Expo visitors.

Presentations at the Yeosu Declaration Forum by UN Secretary General, Ban Ki-moon (top), Prime Minister of Korea, Hwang-sik Kim (middle) and Prime Minister of Tuvalu, Willy Telavi (bottom), August 12, 2012.

Throughout the discussions at the Forum and Roundtable, many innovative and forward-looking ideas emerged for mobilizing various stakeholders in the ocean community to implement the Yeosu Declaration and to advance a new paradigm of "*green growth from the sea*". Global ocean leaders highlighted the Expo 2012 Yeosu Korea and Declaration as signaling a change in our relationship with the ocean, shifting from unsustainable resource-use and ecosystem degradation to a society that utilizes new opportunities of the ocean, driving sustainable economies, while reducing impacts on the marine environment and ensuring that ecosystems remain healthy and productive.

The main points and actionable items that emerged in the day's discussions can be organized into three main thematic areas: (1) Green growth from the sea to support the ocean as a new engine of sustainable economic growth; (2) Supporting ocean stewardship throughout the global community; and (3) Supporting developing countries in achieving green growth from the sea:

1. Green Growth from the Sea

Equity and Transparency

- Ensure that the principles of equity and transparency are central in the transition to green growth from the sea.

Science and Technology

- Develop new technological approaches to shift towards more sustainable practices in both new and traditional uses of the ocean;
- Increase investment and policy support for new technologies to ensure that new and emerging opportunities in the ocean can be explored while mitigating impacts on the marine environment, and reducing the costs of technologies and making them accessible to all nations;
- Develop viable policy and regulatory frameworks, underpinned by sound data and research, for new and emerging technologies.

Ocean Observation and Data to Support Improved Management

- Expand and support comprehensive and sustained observation and monitoring of the marine environment as contributions to the Global Ocean Observing System (GOOS), including through increased institutional capacity and funding;
- Support developing countries, through technology transfer and other types of capacity development, in observing and monitoring the marine environment, and foster data exchange across nations and the international community;
- Support the role of the private sector in ocean observation and monitoring;
- Support the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socio-economic Aspects (Regular Process) and other types of reporting mechanisms to strengthen the science-policy interface;
- Improve the consistency in the type of the data collected on natural and non-natural science areas to support effective and coherent policy development for ocean management;
- Improve understanding of, and methodologies to analyze the value of, both the market and non-market values of the ocean.

Fisheries and Aquaculture

- Phase out harmful subsidies that drive overexploitation and harmful practices and support subsidies that encourage sustainable use and environmentally-friendly practices;
- Support coastal fishing communities in taking up sustainable practices or switching to alternative livelihoods;
- Sustainably expand aquaculture to meet the food demands of the rising global population.

Integrated Governance

- Develop synergistic approaches to the use of ocean resources and space to reduce user conflicts, costs, and cumulative impacts;
- Improve integrated ocean governance at the national level through the strengthening of integrated institutions and decision-making processes for the coast and ocean
- Accelerate the development and implementation of integrated ocean governance in regional and transboundary areas, encouraging the adoption of regional protocols on integrated ocean governance to guide action at regional and national levels;
- Move toward ecosystem-based management of areas beyond national jurisdiction to address multiple use conflicts, manage new uses, and protect vulnerable ecosystems and marine biodiversity;
- Implement the integrated approach at the UN level, supporting the UN Secretary General's Oceans Compact, to enable a crosscutting approach and appropriate and timely response to major threats and opportunities related to the ocean;
- Build upon and expand the use of marine spatial planning (MSP) in different areas, relying on useful guidelines that have been put forth, including the IOC/UNESCO MSP guidelines;
- Improve governance, including through partnerships and sharing experiences, to improve the health and productivity of marine ecosystems and shore up much needed financing for coastal communities.

Climate Change

- Integrate the use of both new scientific information and local knowledge in devising solutions to climate change;
- Protect and preserve ocean and coastal ecosystems to support climate change mitigation, ecosystem-based climate change adaptation, and the long-term well-being and productivity of marine ecosystems;
- Explore new and innovative options to reduce atmospheric carbon dioxide levels, such as storage of CO_2 in phytoplankton via bioreactors;
- Build upon and coordinate ongoing efforts for ecosystem-based climate change adaptation in coastal and ocean areas, including through the utilization of existing funds for climate change adaptation (*e.g.*, GEF Least Developed Countries Fund and Special Climate Change Fund).

Participants of the Yeosu Declaration Roundtable (top to bottom): Arni Mathiesen (Assistant Director General, FAO), Patricio Bernal (Project Coordinator, IUCN), Biliana Cicin-Sain (President, GOF) and Alexander Bychkov (Executive Secretary, PICES).

2. Supporting Ocean Stewardship throughout the Global Community

- Better engage governments, especially at the local level, to build their understanding of the value and range of services provided by the ocean and capacitate them to effectively implement policies in support of "*green growth from the sea*";
- Support collaboration among scientists, policy experts, and decision-makers to strengthen the science-policy interface, and develop and implement policies for "*green growth from the sea*";
- Foster "ocean champions" by engaging high-level and high profile policy-makers on the importance of the ocean and the need to take urgent action;
- Expand public education and outreach, including ocean literacy, ocean education, social media, and other tools, to empower the public to make behavioral changes and push policymakers and resource managers to responsibly manage ocean resources;
- Engage youth at an early age, through better integration of ocean literacy in curriculum, to cultivate tomorrow's ocean leaders;
- Provide increased support to schools and organizations undertaking education and outreach efforts;
- Encourage and support ocean stewardship in various industries and commercial activities, including through guidelines for sustainable practices and public-private partnerships;
- Support collaboration among governments, the private sector, scientists, and environmental interests to ensure that robust and efficient regulatory frameworks are in place for new and emerging activities;
- Support eco-labeling (which indicates if a product has been produced in an environmentally-friendly manner which has been proven to be relatively effective in assisting consumers in supporting responsible companies).

3. Supporting Developing Countries in Achieving Green Growth from the Sea

- Enhance the capacity of developing countries, including Small Islands Developing States, to effectively manage and sustainably benefit from their ocean resources, and to cope with major ocean-related challenges, including climate change, using the full range of capacity development (financing, training, technology transfer, knowledge sharing, and institutional development);
- Develop a more strategic approach to ocean-related capacity development to ensure the effectiveness and sustainability of capacity efforts;
- Link capacity efforts in various forms to leverage resources and catalyze further capacity support;
- Use official development assistance (ODA), including allocating a certain percentage of ODA to science and technology development;
- Encourage North-South and South-South collaboration in ocean-related capacity development;
- Utilize the political and financial power and intellectual capacity of urban areas in capacity development.

The Yeosu Project

The Yeosu Project is an international cooperation program designed to strengthen the capacity of developing countries in meeting the challenges related to the ocean and the environment. The Project is intended to be the practical element that translates the spirit of the Yeosu Declaration and the theme of Expo 2012 Yeosu Korea into action.

A total of ten billion won (approximately ten million US dollars) is being invested in projects as a pilot program by the Korean government from 2009 through 2012 to assist coastal and island communities in coping with ocean-related challenges.

Participants of the Yeosu Declaration Roundtable (left to right): Zhanhai Zhang (Director General, International Cooperation Department, SOA), Susan Avery (President, WHOI) and Jacqueline Alder (Coordinator, UNEP).

The focal areas of support were identified as follows:

- *Improvement of the marine environment*: management and conservation of marine resources, response to marine pollution, marine environment exploration, marine safety measures;
- *Development of new marine technologies*: practical use of fisheries resources, development of marine biological resources, utilization of marine mineral resources;
- *Conservation and utilization of marine resources*: conservation of fisheries resources.

For the implementation of the pilot stage of the Yeosu Project, the Korea International Cooperation Agency (KOICA) was designated as the execution agency. The following projects were launched:

- *First-Year (2009)*: 12 assignments in 7 countries including Fiji, Indonesia, Tuvalu, and Vietnam;
- *Second-Year (2010)*: 3 assignments in Grenada, Sri Lanka, and Tanzania;
- *Third-Year (2011)*: 6 assignments with 6 international and intergovernmental organizations such as FAO (Food and Agriculture Organization of the United Nations), IMO (International Maritime Organization), IOC (Intergovernmental Oceanographic Commission of UNESCO), PEMSEA (Partnership in Environmental Management for the Seas of East Asia), COBSEA (Coordinating Body on the Seas of East Asia), and WCPFC (Western and Central Pacific Fisheries Commission).

The results of the pilot stage are being evaluated, and the design for the next stage is in progress. In 2012, after the Yeosu Expo was successfully completed, the Korean government made a decision to advance the three-year pilot stage of the Yeosu Project for the main program in the near future in an effort to raise, if successful, a total of one hundred billion won (approximately one hundred million US dollars) as a seed fund.

Ensuring the legacy of the Yeosu Declaration

The Yeosu Declaration represents an important milestone in articulating the collective recognition of the global community on the importance of the ocean to our survival, development, and prosperity. It notably voices the concerns of the global community on the pressing threats facing the oceans, and also signals a new paradigm where the ocean is more than just a resource base. We look to the ocean as a source of opportunity that, if utilized responsibly, will yield limitless possibilities for humankind.

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2013 PICES Calendar

- International Symposium on "*Climate variability and change on marine resources and fisheries: Toward a South Pacific Integrated Ecosystem Studies Program (SPICES)*", January 7–10, 2013, Concepción, Chile (co-sponsored by PICES);
- IMBER IMBIZO III on "*The future of marine biogeochemistry, ecosystems and societies: Multi-dimensional approaches to the challenges of global change in continental margins and open ocean systems*", January 28–31, 2013, Goa, India (co-sponsored by PICES);
- 4th International Jellyfish Bloom Symposium, June 5–7, 2013, Hiroshima, Japan (co-sponsored by PICES);
- CLIVAR/PICES Theme Session on "*Biophysical interactions*" at the 2nd international Symposium on "*Boundary Current dynamics: Its connection with open-ocean, coastal processes, biophysical interactions and responses to global climate change*", July 8-13, 2013, Lijiang, China;
- PICES Summer School on "*Ocean observing systems and ecosystem monitoring*", August 19–23, 2013, Hatfield Marine Science Center, Newport, U.S.A.;
- 8th International Conference on Marine Bioinvasions, August 20–22, 2013, Vancouver, Canada (co-sponsored by PICES)
- Workshop on "*Development and application of Regional Climate Models-II*", September 2013, Busan, Korea;
- 6th SOLAS Summer School, August 23 – September 2, 2013, Xiamen, China (co-sponsored by PICES);
- PICES-2013 on "*Communicating forecasts, uncertainty and consequences of ecosystem change*", October 11-20, 2013, Nanaimo, BC, Canada;
- NOWPAP/PICES training course on "*Remote sensing data analysis*", fall 2013, Qingdao, China.

Why Do We Need Human Dimensions for the FUTURE Program?

By Mitsutaku Makino and Keith Criddle

Introduction

Good scientific (biophysical or ecological) arguments for management actions are sometimes not accepted or implemented because of the perceived socio-economic or cultural costs. An integrated understanding of how ecosystem changes affect human social systems, and *vice versa*, is necessary to improve the stewardship of marine ecosystems. Therefore, increased attention must be paid to human dimensions and the integration of social science into marine ecosystem research, that is, recognition that marine systems are social-ecological systems (SES). In other words, recognition that ecological (or 'natural') systems and human (cultural, social, economic, socio-political, ethical, and management) systems are simply dimensions of a greater whole (Perry *et al.* 2010, Ommer *et al.* 2011).

The key questions in the second PICES integrative scientific program, FUTURE, also reflect this recognition. For example, FUTURE Research Theme 3 "How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?" is about anthropogenic pressures on marine ecosystems (questions 3.1, 3.2 and 3.3), and the impacts of ecosystem change on dependent human populations and the development of social strategies to cope with those changes (question 3.5). FUTURE Objective 2 is to convey research findings to society and to foster the engagement. To support these goals, the Study Group on *Human Dimensions* (SG-HD) was established in 2009 (and completed in 2011), and the Section on *Human Dimensions of Marine Systems* (S-HD) was formed in 2012. This article briefly explains two important factors which necessitate the integrations of human dimensions into FUTURE (governance effectiveness and the value system at the objective setting process) and presents, based on the results of SG-HD, examples of how social science works in PICES member countries.

Effectiveness of governance

Recent studies have begun to identify human dimension factors which contribute to the effectiveness of ecosystem governance. For example, strong community leadership, robust social capital, and well-designed incentive structures such as individual or community quotas play major roles in determining the success of fisheries management (Gutierrez *et al*. 2011). On the other hand, these incentive structures can have undesirable effects, depending on their specific design characteristics and the social conditions of people and communities (Allison *et al.* 2012). Human factors are key sources of uncertainty in ecosystem governance.

Stakeholder participation is an indispensable part of effective governance. For example, fisheries co-management studies often emphasize the importance of resource users' participation in the decision making process. When making decisions on marine ecosystem governance, in which the recipients of marine ecosystem services are very widely distributed in the society, enhancement of public understanding of science or outreach of marine ecosystem research is highly important.

Value system and conservation objectives

When selecting objectives for marine ecosystem or resource governance, human dimensions matter. Each marine sector views ecosystems in terms of its own economic, cultural and societal needs. Consequently, ecosystem conservation is "a societal choice" (Convention on Biological Diversity's Ecosystem Approach Principle 1), and that choice requires balancing diverse and conflicting interests. The value system encompasses the diversity of culture and the full range of economic, intellectual, emotional, moral, and spiritual satisfaction.

Natural resources are not fixed things. Their meaning and value evolves as humans develop the scientific and technical knowledge to transform them into useful commodities in the society and as humans ascribe intrinsic value to them (Zimmermann 1933). This is also true of the services we receive from the marine ecosystems. The famous drawing of Tokyo Bay (Japan) in the early 19th century (Fig. 1) depicts fishing as an integral part of daily life in a coastal community. This image accurately portrays widespread agreement that marine social-ecological systems ought to integrate human activities, but that the footprint of those activities should not compromise ecosystem function or the stream of ecosystem services.

Fig. 1 Fishing in Tokyo Bay, Japan.

Studies on human dimensions in PICES member countries

There are many social science methodologies which can contribute to understanding human dimensions of marine ecosystems. SG-HD conducted an initial review of social science applications to marine resources and ecosystem

governance in the North Pacific area. In this section, we introduce a sample of the results presented in the PICES SG-HD final report (PICES Scientific Report No. 39).

Marine Use Analysis based on anthropology, economics, and policy science is being conducted to develop the conservation objectives for the Pacific North Coast Integrated Management Area (PNCIMA), Canada. Similarly, Integrated Ecosystem Assessment (IEA), which models the linkages among ecosystem threats, management activities, and social and economic goals, has been adopted as a central tool for management in Puget Sound, USA.

In Japan, social surveys have been conducted to identify objectives and public policy demands, and to prioritize various uses of the Japanese Exclusive Economic Zone. Of all respondents, 83.3% chose "food production by fisheries," 54.4% – "generation of energy from tidal power or offshore wind power", 21.0% – "transportation", 8.2% – "recreational use" and 1.9% – "creation of space by land reclamation".

In China, MEGA-MES (Marine EcoloGical Assessment Group – Marine Ecosystem Service Evaluation Software) was developed to model the determinants of the nonmarket value of ecosystem services. The tool has been applied to regional studies of the Yellow Sea, the South China Sea, the East China Sea, and the Bohai Sea. Similar studies of Peter the Great Bay in Primorsky Kray, Russia, were used to estimate the potential lost value of ecosystem services as a result of the construction of bridges, *etc*.

In Korea, socio-economic attributes (including economic revenue, the structure of seafood markets, employment, *etc*.) and ecological attributes were integrated into a fisheries risk assessment framework, IFRAME (Integrated Fisheries Risk Assessment Forecasting and Management for Ecosystems), and used to model the social benefits of the large purse seine fishery and other fisheries. In Canada, the Environmental Accounting concepts are being applied to monitor and assess the economic importance, impacts, full costs and full benefits of governance.

Conclusions

The social sciences provide tools and concepts for approaching aspects of marine SES which are not addressed by the natural sciences. These methodologies and tools are just now beginning to be applied to marine SES in a variety of locations and at a variety of scales. We believe that the academic environment is ripe for the integrated social-ecological research needed to address the challenges of rapidly changing environments and evolving social and economic demands on ecological resources.

The social sciences have developed qualitative and quantitative analytic methods that can be used to examine what has occurred and to develop conditional predictions of what is likely to occur under anticipated future conditions and given alternative policy choices. With careful planning on both sides, these approaches and tools can be compatible with models developed for the natural sciences and *vice versa*. In that sense, social sciences can contribute to assessment of the social and economic performances of actual and contemplated governance measures. In particular, analytical tools developed in economics and environmental accounting can be used to quantify the "efficiency" and distributional consequences of specific management actions. In addition, tools in sociology, anthropology, psychology, *etc.* can be used to conduct analyses on social criteria such as "sufficiency", "fairness", and "appropriateness".

When implementing governance measures, scale is an important and non-trivial issue. Just as particular scales are appropriate for representing particular natural science processes, so too particular spatial, temporal, and organizational scales are most appropriate for reflecting the operation of governance institutions and stakeholder impacts and inputs. Upscaling and downscaling human systems is every bit as challenging as upscaling and downscaling natural systems, and integrating SES across scales will be especially challenging. Doing so will require the coming together of social scientists and natural scientists envisioned in FUTURE. Social science can improve the value of the information produced by the natural sciences, and natural science can improve the value of information produced by the social sciences for decision making, better management, and better understanding.

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Dr. Mitsutaku Makino (mmakino@affrc.go.jp; see group photo on p. 27) co-chairs the Section on Human Dimensions (he was a former Chairman of the Study Group on Human Dimensions) and co-leads the new PICES project on "Marine ecosystem health and human well-being" (see pp. 26–28 for details).

Dr. Keith Criddle (keith.criddle@alaska.edu; see group photo on p. 27) is a bioeconomist at the Juneau Fisheries Center of the University of Alaska Fairbanks. His research explores the intersection between the natural sciences, economics, and public policy and is driven by an interest in the sustainable management of marine resources of the North Pacific. He directs graduate projects in bioeconomics, statistical inference, and policy analysis and teaches courses in resource and environmental economics, econometrics and time series analysis, operations research and decision theory, fisheries law, and policy analysis. In PICES, Keith was a member of the Study Group on Human Dimensions and now co-chairs the Section on Human Dimensions.

New PICES MAFF-Sponsored Project on "*Marine Ecosystem Health and Human Well-Being*"

by R. Ian Perry and Mitsutaku Makino

Progress is being made internationally on an ecosystem approach to the management of marine systems, in particular as applied to ecosystem-based fisheries management (EBFM; FAO 2003; Hollowed *et al.* 2011). PICES has contributed to this progress and explored regional applications to the North Pacific, through the activities of the ecosystem-based management Study Group and Working Group reports (Jamieson *et al*. 2005, 2010). Recent initiatives at the global level have expanded the concept of ecosystem approaches to include people in what have been called coupled marine social-ecological systems (*e.g*., De Young *et al*. 2008; Ommer *et al*. 2011). PICES has also contributed to these initiatives (Makino and Fluharty 2011) and has recently formed an expert group to develop the human dimensions of marine ecosystems (Section on *Human Dimensions*, http://www.pices.int/members/sections/S-HD.aspx). The second PICES integrative program, FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems), also has significant activities and strong linkages with ecosystems and people, through its Advisory Panels on *Anthropogenic Influences on Coastal Ecosystems* (AP-AICE; http://www.pices.int/members/advisory_panels/AICE-AP.aspx) and on *Status, Outlooks, Forecasts and Engagement* (AP-SOFE; http://www.pices.int/members/advisory_panels/SOFE-AP.aspx).

Very recently, the concept of human well-being within marine social-ecological systems has become recognized as an important step forward (Coulthard *et al*. 2011; Charles 2012). Well-being shifts the perspective from objective measures of sustainable livelihoods (comprised of the physical, social, human, natural, and financial resources available to a community or country) to include the subjective or perceived well-being of individuals and communities. This represents a shift from people as exploiters of the ocean to people as integral components of resource sustainability and ecosystem health (Coulthard *et al*. 2011; Charles 2012). Therefore, taking account of the dynamics of livelihoods and the concept of well-being can help with the development of policies supporting sustainable and resilient marine social-ecological systems (Charles 2012).

The Japanese concept of *sato-umi* represents one version of this humans-in-nature approach, in which a healthy ecosystem is seen to nourish human well-being, but human activities are seen as necessary for sustaining ecosystem health (Fig. 1). *Sato* means community or village, and *umi* means sea. Therefore, *sato-umi* refers to marine environments that have long-standing relationships with human communities, and in which human interactions have resulted in high marine productivity and biodiversity (Makino 2011, p. 126; Makino and Fluharty 2011). The activities to re-establish and promote the recovery of sea grass beds that have been undertaken by local community members near Yokohama are one example. Comparable types of sea grass and kelp restoration activities have been proposed by local communities in the Strait of Georgia, Canada. The Japanese government has undertaken integrated studies to assess the contributions of social, cultural, economic, and ecological aspects in *sato-umi* type projects in Japan (Yanagi 2012).

Fig. 1 Image of sato-umi (coastal village and sea): fishing villages, fisheries operations, aquaculture, swimming, shellfish gathering, sport fishing (angling), nature observation, urban area, etc. (source: United Nation University (2010), Japan Satoyama Satoumi Assessment).

As a result of generous funding provided by the government of Japan, through its Ministry of Agriculture, Forestry and Fisheries (MAFF), PICES has developed a new project to explore these issues of marine social-ecological systems and *sato-umi* in the North Pacific. The goal of this PICES project on "*Marine ecosystem health and human well-being*" is to identify the relationships between sustainable human communities and sustainable marine ecosystems in the North Pacific, under the concept of fishery social-ecological systems. Specifically, considering the global changes in climate and human social and economic conditions, the project is expected to answer the following questions: (a) how do marine ecosystems support human well-being? and (b) how do human communities support sustainable and productive marine ecosystems?

This goal links directly with the PICES FUTURE Research Theme 3 on "How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?", specifically questions 3.1 (*What are*

the dominant anthropogenic pressures in coastal marine ecosystems and how are they changing?) and 3.3 (*How do multiple anthropogenic stressors interact to alter the structure and function of these systems, and what are the cumulate effects?*). In addition, the project will integrate, support, and expand on the activities of several PICES expert groups, including the new Section on *Human Dimensions*, and Working Group 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*.

A Task Team was established for the project, which had its first meeting at the 2012 PICES Annual Meeting in Hiroshima, Japan (Fig. 2). The meeting reviewed the outputs of this project that are expected by the government of Japan, and outlined the approach and a broad plan for implementation of the project over the next 5 years. The expected outputs include: selection of study sites in Southeast Asia, oceanic Pacific islands, and Central America (3 sites in total); research on ecosystem health and human well-being; workshops at each site; and construction of a database, for example, of case studies of where and how a social-ecological (*sato-umi*) systems approach may be applied. Workshops will be held in three developing countries around the North Pacific to explore their use of marine social-ecological (*sato-umi*) concepts in marine activities, and to develop training manuals for the application of such concepts to help improve the sustainability of both natural marine ecosystems and their dependent human communities. The three countries proposed as main case studies are Indonesia (large population, aquaculture-intensive), Palau (finfish capture fishery focus; existing networks of community-based fisheries) and Guatemala (upwelling system; finfish and aquaculture). The main question to be asked is what tools can PICES provide these countries with respect to developing a social-ecological (*sato-umi*) approach to marine systems. The key outcome will be to provide an approach and tools that advance the following types of 'integrated social-ecological assessments':

- What are the general concepts leading to sustainable human communities and productive marine ecosystems?
- Where does each country and local community 'want' to be within these concepts?
- Where are they now?
- What are the major stresses, for example climate change, and how might these affect the current state and the transitions to the desired state?
- How does human well-being relate to ecosystem services in these countries and locations?

One tool, from psychological research, that will be explored is called the "well-being cube". At the meeting in Hiroshima, Drs. Juri Hori and Mitsutaku Makino presented definitions for human well-being from psychological research, and described the concept of the "well-being cube". In this approach, a person's (or community, region, or country) perception of their well-being can be located in one or more of 27 cells defined by three axes, each with

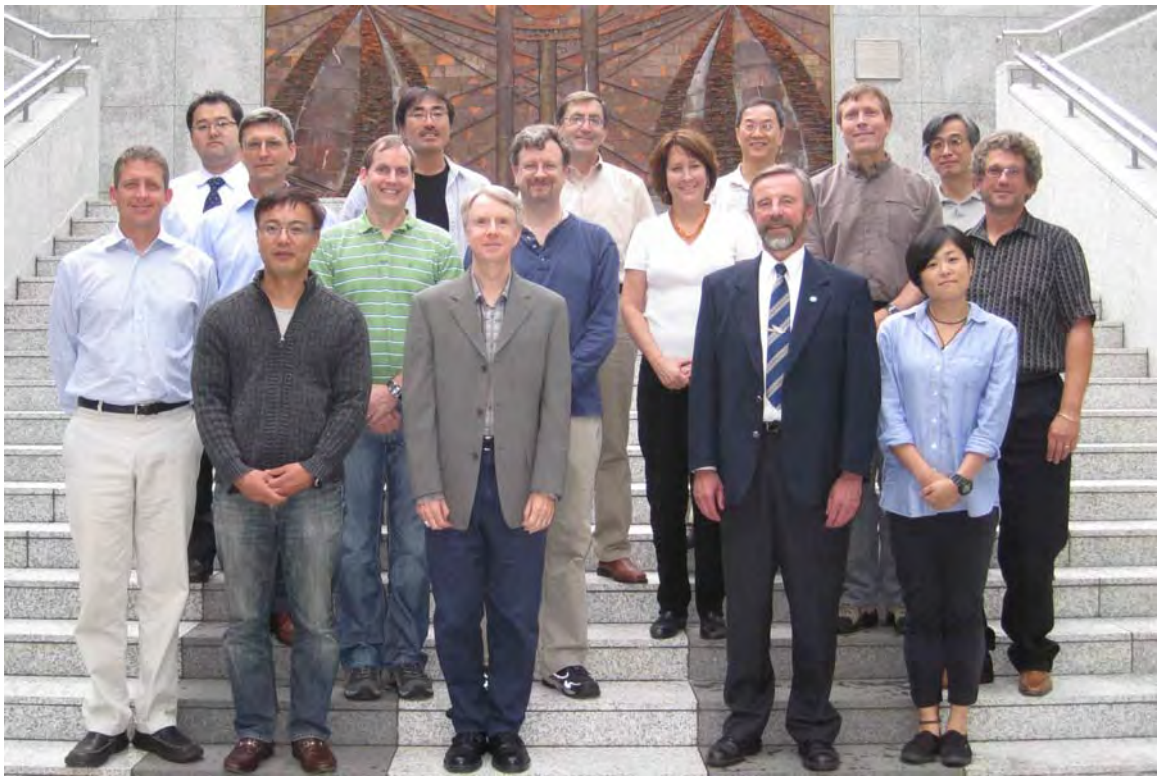

Fig. 2 Participants and Task Team members at the first meeting of the PICES MAFF-sponsored project on "Marine ecosystem health and human well-being", October 11, 2012, Hiroshima, Japan. From left to right, front row: Grant Murray, Mitsutaku Makino, Ian Perry, Skip McKinnell and Juri Hori; middle row: Igor Trofimov, Thomas Therriault, Harold (Hal) Batchelder, Vera Trainer, Keith Criddle and Mark Wells; back row: Takaomi Kaneko, Masahito Hirota, Alexander Bychkov, Suam Kim and Sinjae Yoo.

three categories: the extent of conscious interpretation of their situation, their level of active response to their situation, and their view of how they fit into their world (Fig. 3).

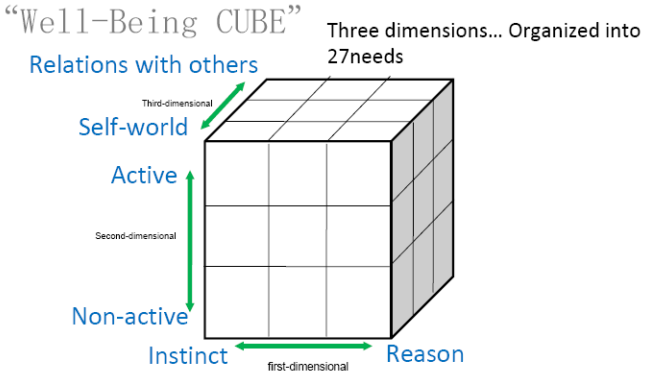

Fig. 3 Example of the "well-being cube" concept for human interactions with their environment.

The first workshop is being organized for Indonesia in March of 2013. Indonesia already has some knowledge and experience with the *sato-umi* concept as applied to coastal aquaculture and local community systems. The goal of this first workshop will be to use broad scientific and local knowledge to develop the contents of a manual on this approach for use in other coastal communities of Indonesia, and to assess the applicability of scientific tools for describing and applying these concepts in real situations. The results of this experience will be presented and discussed at the second meeting of the project Task Team, scheduled for June 2013.

This 5-year MAFF-sponsored PICES project is planned to provide many opportunities to test and support the activities and contributions of several PICES expert groups and the FUTURE program.

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Dr. Mitsutaku Makino (mmakino@affrc.go.jp; see group photo) co-chairs the new PICES project on "Marine ecosystem health and human well-being" and PICES Section on Human Dimensions (he was a former Chairman of PICES Study Group on Human Dimensions). His major is institutional and economic analysis of marine policies, including fisheries management and ecosystem-based management. He is currently the Head of the Fisheries Management Group at the National Research Institute of Fisheries Science, Fisheries Research Agency of Japan, and a member of many international research activities such as IUCN Commission of Ecosystem Management (CEM) Fisheries Expert Group (FEG), IMBER Human Dimension Working Group, United Nation University Sustainable Ocean Initiative. Also, he is now serving as an editor of ICES Journal of Marine Science as well as a Scientific Committee member of the Japanese Society of Ocean Policy. He teaches several courses at Japanese universities (Hokkaido University, Yokohama National University, Nagasaki University, Tokyo Agricultural University, etc.) as an Associate Professor. One of his major publications in recent years is "Fisheries Management in Japan", which was published by Springer in autumn 2011.

Dr. Ian Perry (Ian.Perry@dfo-mpo.gc.ca; see group photo) co-chairs the new PICES project on "Marine ecosystem health and human well-being" and PICES Working Group on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors. He is a research scientist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station (PBS) in Nanaimo, BC. In addition, Ian is an Adjunct Professor at the Fisheries Centre of the University of British Columbia, and has taught courses on fisheries oceanography at universities in Canada, Chile, and Portugal. He currently heads the Ecosystem Approaches Program at PBS, and is one of two leaders for the DFO Strait of Georgia Ecosystem Research Initiative. His research expertise includes the effects of the environment on finfish and invertebrates; the structure and function of marine ecosystems; ecosystem-based approaches to the management of marine resources; the human dimensions of marine ecosystem changes; and scientific leadership of international and inter-governmental programs on marine ecosystems and global change. Ian is a former Chairman of the international Global Ocean Ecosystem Dynamics (GLOBEC) program, whose goal was to understand how global changes affect the abundance, diversity and productivity of marine populations, and a former Chairman of the Science Board for PICES. He is a past Editor for the scientific journal Fisheries Oceanography, and is presently an Associate Editor for the journal Ecology and Society, and a member of the Editorial Boards for Fisheries Oceanography and Current Opinion in Environmental Sustainability.

The Bering Sea: Current Status and Recent Trends

by Lisa Eisner

Climate and oceanography

In the Bering Sea, winter–spring ocean temperatures in 2012 remained cold with lots of sea ice, similar to 2008 and 2010. This created the most extensive cold pool of the recent decade for summer 2012 (Fig. 1). Unlike a year ago, the summer of 2012 was relatively calm, and this resulted in a rather thin (~10 m) mixed layer that rapidly warmed in June through July, especially in the north, producing near-normal sea surface temperatures in summer (Fig. 2). Given the relatively low heat content on the Bering Sea shelf at present, we are probably looking at a moderate to heavy ice year for 2013, although weather in late winter and early spring can change this prediction.

In the Arctic, summer sea ice cover continued its downward trend into 2012, with a new record low, since records began in 1979, in September 2012. However, the distribution of the Arctic sea ice in early August differed somewhat from recent years, with high ice concentrations persisting in the Chukchi Sea and in the western portion of the Beaufort Sea.

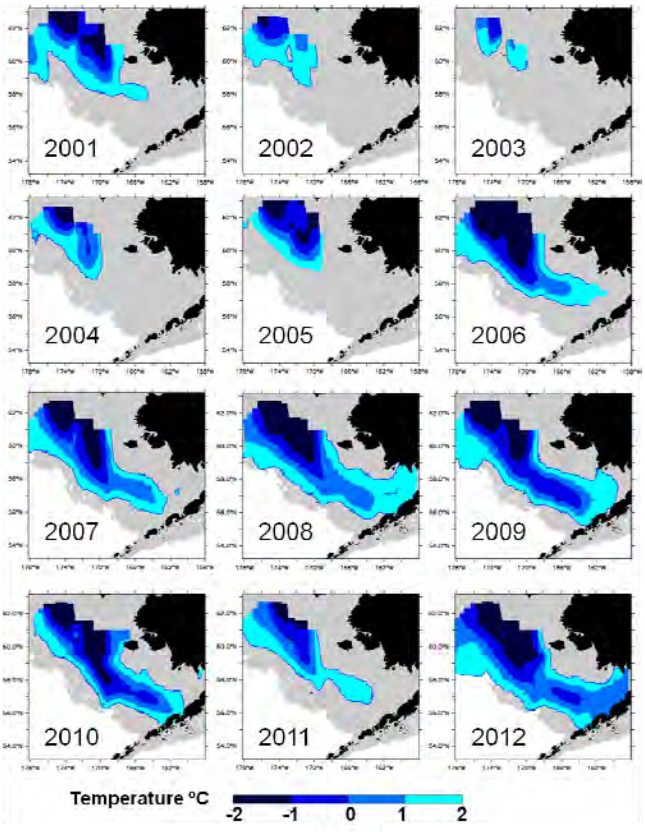

Fig. 1 Summer cold pool locations on the eastern Bering Sea shelf from bottom trawl surveys, 2001–2012. Figure courtesy of J. Overland.

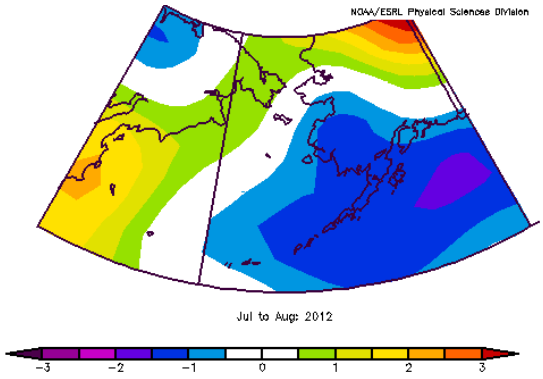

Fig. 2 NOAA sea surface temperature anomalies (deviations from 1981–2010 climatology) for July–August 2012. Figure courtesy of J. Overland.

Bering Sea and Chukchi Sea surveys in 2012

Several fisheries oceanography surveys took place during summer and early fall 2012 in the Bering Sea. Hokkaido University's T/S *Oshoro Maru* conducted a survey in the Aleutian Islands and eastern Bering Sea shelf. NOAA's Alaska Fisheries Science Center carried out a summer shelf bottom trawl survey, a summer shelf midwater trawl survey, a summer Aleutian Island bottom trawl survey, and a late summer ecosystem survey. The Russian Pacific Federal Fisheries Research Institute's (TINRO) R/V *Professor Kaganovsky* conducted a bottom survey, benthic micro survey, an acoustic and trawl survey (pollock) in August, and a pelagic survey (salmon) September to October, in the western Bering Sea.

One interesting result from the NOAA summer bottom trawl survey was that pollock (*Theragra chalcogramma*) were aggregated inside the cold pool within the 0ºC temperature contour (Fig. 3). This was unusual since pollock were found outside the 1ºC contour in past years.

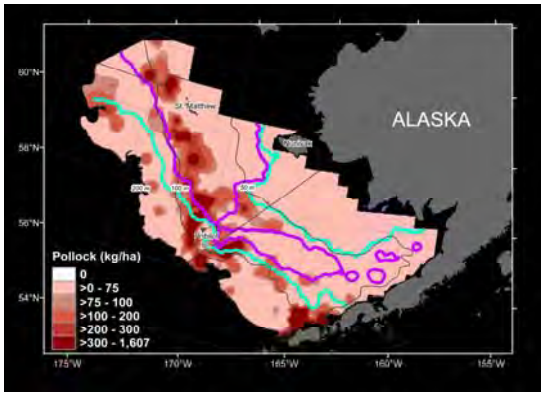

Fig. 3 Walleye pollock distribution in relation to 0ºC (purple) and 1ºC (aqua) temperature contours from NOAA bottom trawl surveys in the summer of 2012. Figure courtesy of R. Lauth.

Bottom trawl survey biomass estimates of pollock were similar or slightly up compared to 2011, at 3.49 million mt (Fig. 4, top), but average pollock size was smaller. The survey biomass of Pacific cod (*Gadus macrocephalus*) remained strong (0.9 million mt for the third consecutive year (Fig. 4, bottom), with multiple year classes present.

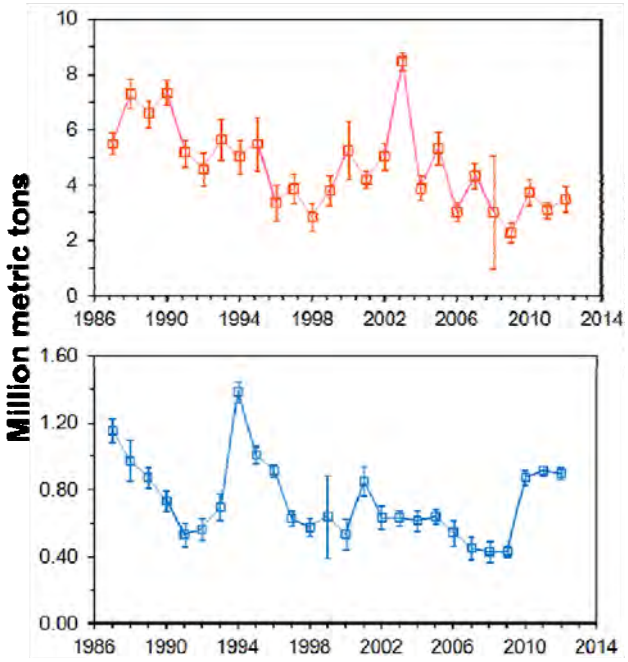

Fig. 4 NOAA bottom trawl survey biomass estimates of pollock (top) and Pacific cod (bottom) in the eastern Bering Sea, 1987–2012. Figures courtesy of R. Lauth.

In the Chukchi Sea, a myriad of surveys were conducted by the U.S., Japan, Russian Federation, China and Korea (see http://data.aoos.org/maps/arctic_assets/). Here we focus on fisheries data collected by two ecosystem sampling programs: the Arctic Ecosystem Integrated Survey (Arctic EIS) and the Russian–American Long-Term Census of the Arctic (RUSALCA), a joint U.S.–Russia research program in the Bering and Chukchi Seas.

NOAA and the University of Alaska Fairbanks, with support from the U.S. Bureau of Ocean Energy Management (BOEM) carried out Arctic EIS surveys on the U.S. side of the Chukchi Sea in August–September 2012. Oceanography and plankton, surface and acoustic midwater trawls, and seabird observations in the north Bering Sea and Chukchi Sea were conducted on the F/V *Bristol Explorer*. Bottom trawls were deployed over the same time period in the Chukchi Sea on the F/V *Aquila*.

Age-0 Arctic cod (*Boreogadus saida*), a key ecologically important species in the Arctic, were concentrated in the northern Chukchi Sea in surface waters (Fig. 5). Acoustic backscatter data also indicated that aggregations of age-0 Arctic cod dominated the backscatter from 69–71°N, while Pacific herring (*Clupea pallasi*) were dominant from 66–67.5°N. The highest fish biomass from bottom trawl surveys in the Chukchi Sea were Arctic cod, saffron cod (*Eleginus gracilis*) and Pacific herring (Fig. 6, top). Adult herring had the highest overall biomass in the surface trawls. Invertebrates were abundant in the Chukchi Sea shelf ecosystem, with 336 taxa caught in bottom trawls (Fig. 6, bottom), far outweighing total fish biomass. Arctic EIS surveys (oceanography, plankton, surface trawls and midwater acoustics) will be repeated in August 2013.

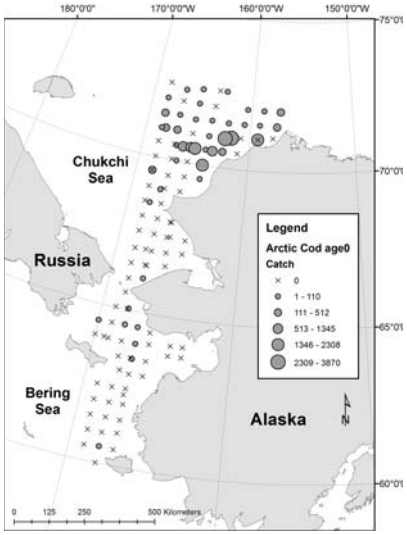

Fig. 5 Number of age-0 Arctic cod caught in Arctic Eis surface trawls, August to September, 2012. Figure courtesy of E. Farley.

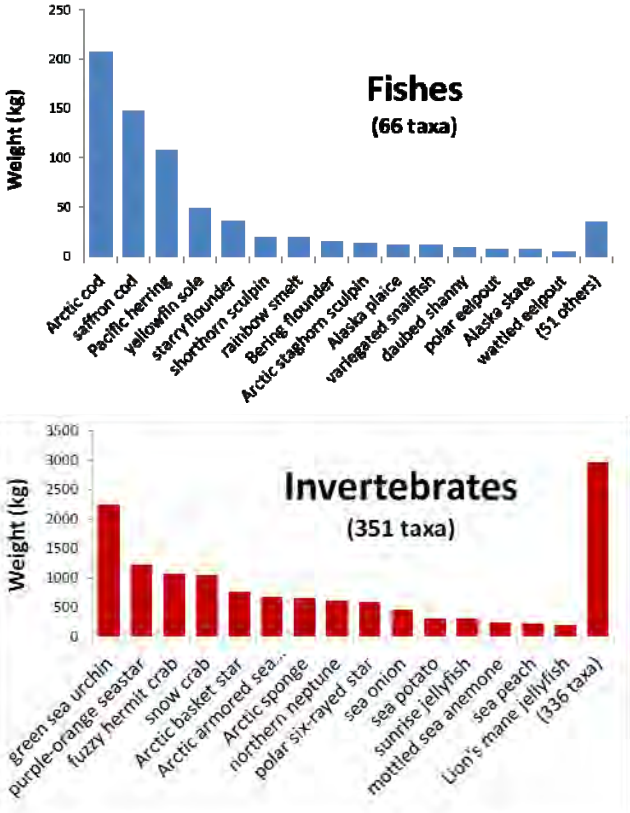

Fig. 6 Bottom trawl fish (top) and invertebrate (bottom) catches in the Chukchi Sea, August to September 2012. Figures courtesy of R. Lauth and F. Mueter.

RUSALCA conducted ecosystem surveys collecting a suite of oceanographic parameters, plankton, fish and invertebrates in the Chukchi Sea aboard the R/V *Khromov* in August–September 2012. Bottom otter trawls were deployed at 16 stations in Russian and U.S. waters in September 2012 (Fig. 7). Bottom depths were in a range from 39–97 m. The catch included at least 31 species, but fewer species were caught and fewer tissue samples and photographs were taken in 2012 than in 2009 because of foul weather and ice. The ship did not reach the northern continental slope stations where several first and rare records of species were found in 2009. However, having draft pages from the new identification guide, *Pacific-Arctic Marine Fishes* (Mecklenburg and others, due out in 2014), enabled relatively rapid and more accurate identification of fishes by RUSALCA program scientists.

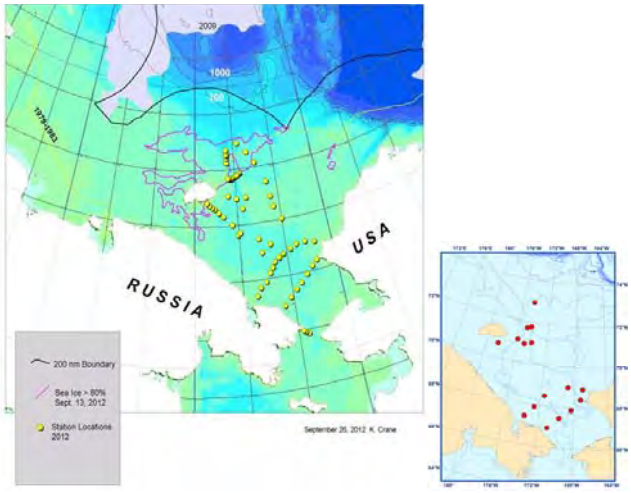

Fig. 7 2012 RUSALCA leg 2 ecosystem stations. Small map shows locations of fish collections. Maps courtesy of K. Crane and C. Mecklenburg.

Fig. 8 Liparis tunicatus (top) and Myoxocephalus scorpius (bottom) from 2012 RUSALCA surveys. Photos by C. Mecklenburg.

Two of the most striking highlights of the RUSALCA 2012 otter trawl catch were: (1) unusually large numbers of postlarval juvenile kelp snailfish, *Liparis tunicatus* (Fig. 8, top), with the greatest numbers at stations in the southwestern Chukchi Sea off the Chukotka Peninsula (in 2004 and 2009, few were caught despite sampling at more stations), and (2) unusually low numbers of shorthorn sculpin *Myoxocephalus scorpius* (Fig. 8, bottom) of any age at any station. In 2004 and 2009, this climate sentinel species was widespread and one of the three most abundant species in RUSALCA bottom trawls on the continental shelf. In 2012, however, it dropped to 11th place, even though the stations sampled included some of the most productive locations sampled in the previous years. Research over the coming months will focus on these and other observations from the RUSALCA 2012 data.

Upcoming science meetings

Meetings in the first half of 2013 of interest to scientists working in the Bering Sea include:

- ESSAS (Ecosystem Studies of Subarctic Seas) Annual Science Meeting on "*Spatial dynamics of subarctic marine ecosystems*", January 7–9, Hakodate, Japan;
- Alaska Marine Science Symposium, January 21–25, Anchorage, U.S.A.;
- Lowell Wakefield Symposium on "*Responses of Arctic marine ecosystems to climate change*", March 26–29, Anchorage, U.S.A.;
- The North Pacific Anadromous Fish Commission workshop on "*Migration and survival mechanisms of juvenile salmon and steelhead in ocean ecosystems*" April 25–26, Honolulu, HI, U.S.A.

Acknowledgements: Many thanks to the following scientists who helped create this report: Drs. Nicholas Bond, Kathleen Crane, Ed Farley, Robert Lauth, Jim Overland, Catherine Mecklenburg, Franz Mueter and Olga Temnykh.

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Continuing Cool in the Northeast Pacific Ocean

by William Crawford and Skip McKinnell

The past few years have brought high temperatures to many regions of the globe, including record highs across the contiguous United States in 2011 to 2012, and extreme warm temperature in March 2012 in Canada and the USA. In contrast, the Northeast Pacific Ocean surface temperature has remained relatively cool for the past seven years or so. Cooler temperatures have dominated in all four seasons, and were interrupted only briefly in the winter of 2010 when an El Niño warmed the region for one season.

The negative (cool) temperature anomaly (Fig. 1a) extends along the west coast from southern Alaska to Baja California, and then sweeps southward to spread along the central Pacific Equator. Positive (warm) anomalies are found in the central North Pacific Ocean. This pattern is typical for La Niña events and the negative phase of the Pacific Decadal Oscillation. The relative cooling is most intense in the central and eastern Gulf of Alaska.

The spatial pattern of the sea surface temperature anomalies (Fig. 1a) is consistent with the sea level pressure anomalies over the same period (Fig. 1b). The positive (high pressure) anomaly is south of the Aleutian Islands and relatively low pressure lies over western Canada. The thick arrow (Fig. 1b) shows the direction of the average wind anomaly through these years.

For comparison, the average sea surface temperature and sea level pressure for 1981–2010 are shown in Figures 1c and 1d, respectively. The north–south temperature gradient of Figure 1c is much stronger in the western Pacific near 40°N than in the eastern Pacific. The Aleutian Low Pressure system lies near 55°N and 180°W in Figure 1d, with the North Pacific High situated to the southeast at 30°N, 140°W. Average geostrophic winds generally blow along isobars with high air pressure to their right side. Average winds of 1981–2010 between 40°N and 50°N were generally blowing from the west southwest, with the Aleutian Low to their left and North Pacific High on the right. The effect of the persistent pressure anomaly from 2006 to 2012 was to shift the average wind direction to blow more from the west, or even west northwest, bringing cooler air to the eastern Gulf of Alaska. A second effect of this change in wind direction is toward stronger upwelling along the west coast of Alaska to Baja California, which also contributes to cooler sea surface temperature.

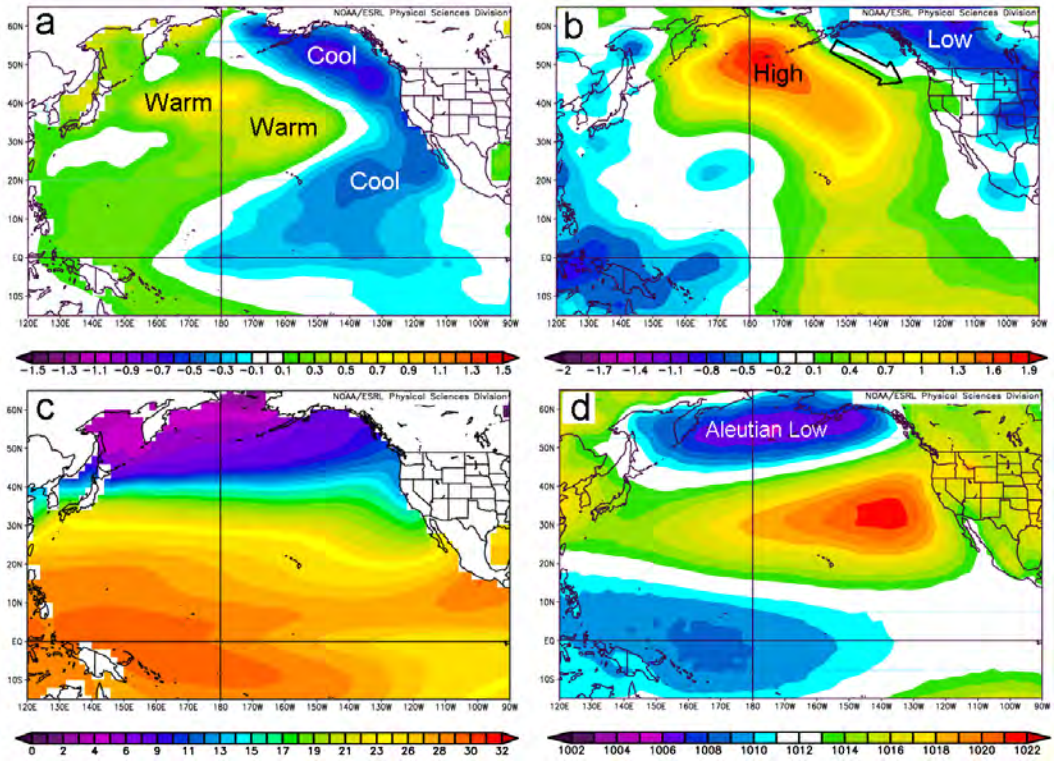


Fig. 1 December 2005 to November 2012 averages (lower panels) and anomalies (upper panels) from the 1981–2010 mean temperature and sea level pressure in the North Pacific Ocean. (a) sea surface temperature anomaly (SSTA, °C); (b) sea level pressure anomaly (SLPA, mbar); (c) sea surface temperature (SST, °C); (d) sea level pressure (SLP, mbar). Images provided by NOAA Earth System Research Laboratory, Physical Sciences Division.

(*continued on page 35*)

The State of the Western North Pacific in the First Half of 2012

by Shiro Ishizaki

Sea surface temperature

Figure 1 shows monthly mean sea surface temperature (SST) anomalies in the western North Pacific from January to June 2012, 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. From January to April, SSTs were above normal from 15°N, 155°E to 25°N, 180°E. In the seas around 25°N, 180°E, positive SST anomalies remained until the end of the period. From January to March, positive anomalies dominated in the western equatorial Pacific (west of 150°E), while negative anomalies prevailed east of 160°E along the equator. In March, positive anomalies exceeding +1°C were seen in the South China Sea. In May, positive anomalies were found in the seas from the area east of the Philippines to the area around the Mariana Islands. Negative anomalies exceeding –1°C appeared in the seas east of Japan during the entire period except in May. In April, negative anomalies prevailed in the seas adjacent to Japan. In June, negative anomalies exceeding –1°C existed in the seas south of Japan.

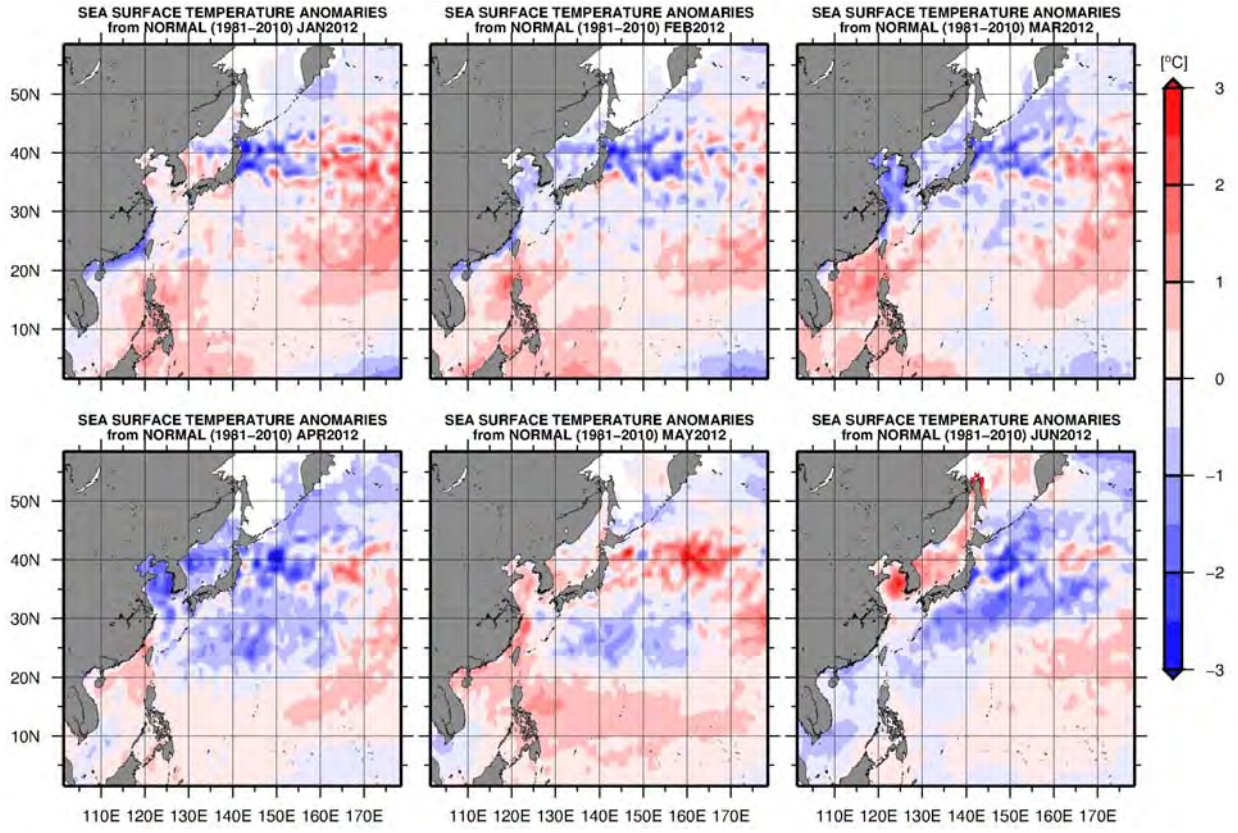


Fig. 1 Monthly mean sea surface temperature anomalies (°C) from January to June 2012. Anomalies are deviations from JMA's 1971–2000 climatology.

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.

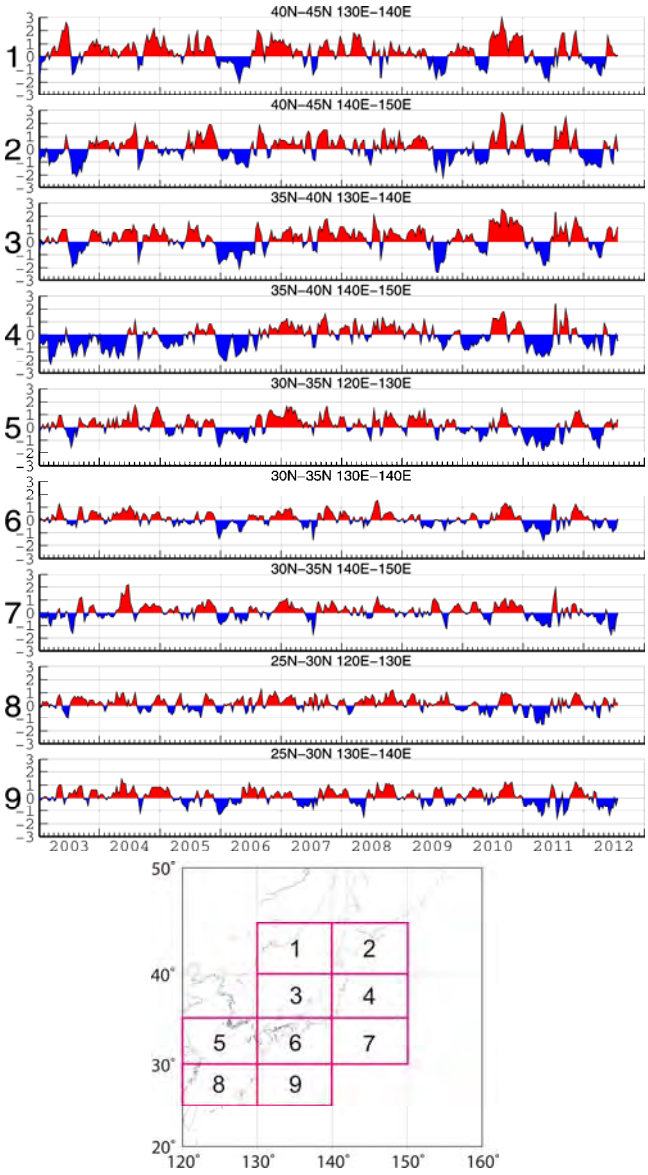


Fig. 2 Time series of 10-day mean sea surface temperature anomalies (°C) averaged for the sub-areas shown in the bottom panel. Anomalies are deviations from JMA's 1971–2000 climatology.

Kuroshio and Oyashio

A time series outlining the location of the Kuroshio's path from January to June 2012, at intervals of 10 days, is presented in Figure 3. The current took a non-large-meandering path off the southern coast 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 current's axis over the Izu Ridge (around 140°E) moved north and south. In March, May and most of June, the Kuroshio flowed south of Hachijo Island (33°N, 140°E). Figure 4 shows monthly mean subsurface temperature at a depth of 100 m in the seas east of Japan for April 2012 generated using a numerical ocean data assimilation system (MOVE/MRI.COM-WNP).

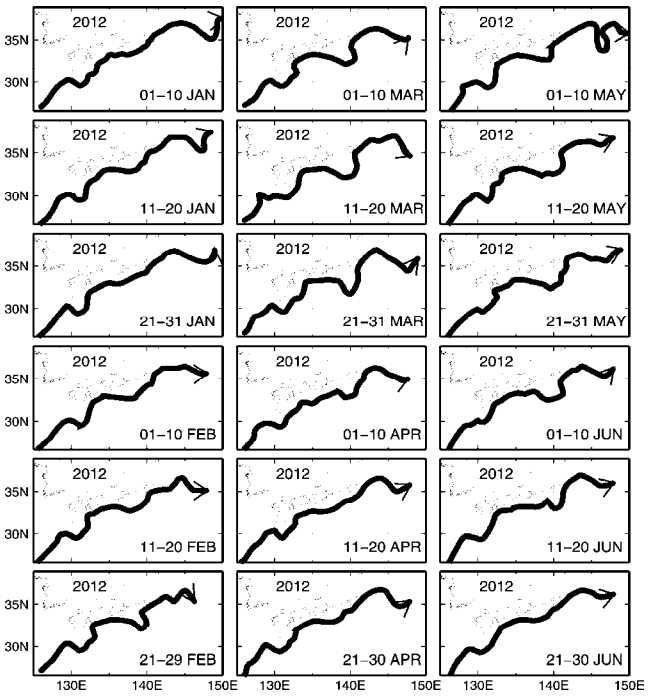


Fig. 3 Location of the Kuroshio path from January to June 2012.

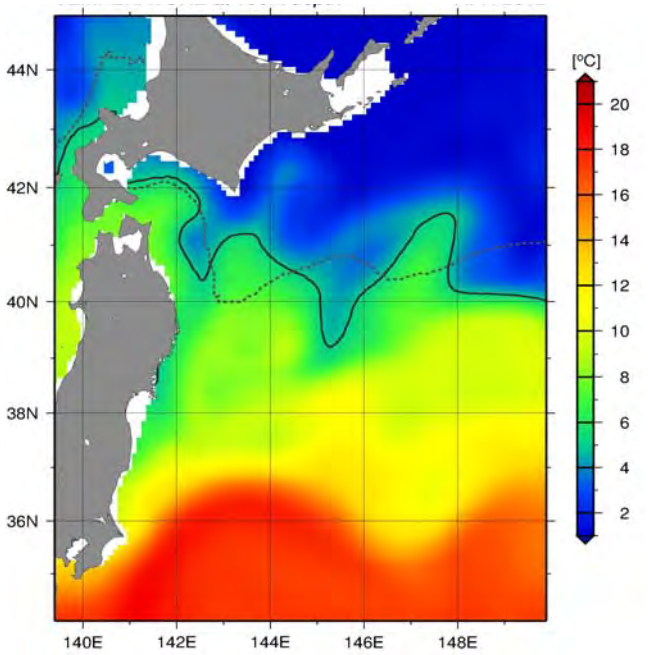


Fig. 4 Subsurface temperatures (°C) at a depth of 100 m east of Japan for April 2012. The solid line denotes the 5°C isotherm, while the dotted line is its climatology (26-year average values from 1985 to 2010).

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). From January to February, the coastal branch of the Oyashio cold water was located south of its normal position. From March to April, however, it moved significantly northward and stayed north of its normal position after April (Fig. 5).

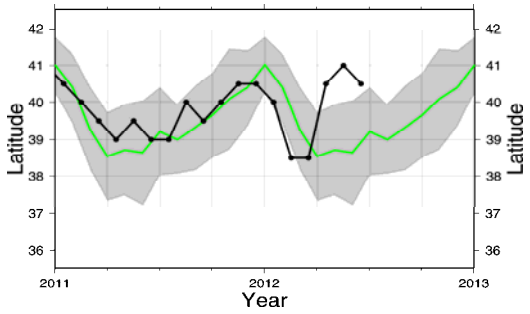


Fig. 5 The monthly southernmost position of the coastal branch of the Oyashio cold water from January 2011 to July 2012 (black line), and the 26-year average values (green line), with a range of one standard deviation (grey shading) from 1985 to 2010.

Sea ice in the Sea of Okhotsk

The sea ice extent in the Sea of Okhotsk was near normal from December 2011 to May 2012 (Fig. 6), and reached its season maximum of 112.26 × 10^4km^2 (slightly below the normal of 116.92 × 10^4km^2) on March 31, 2012. Figure 7 presents interannual variations in the maximum sea ice extent and accumulated sea ice extent in the Sea of Okhotsk for the period from 1971 to 2012. Although both parameters show large interannual variations, there are long-term decreasing trends of 173 [63–282] × 10^4 km^2 per decade (the number in square brackets indicate the two-sided 95% confidence interval) in the accumulated sea ice extent, and 5.8 [2.0–9.6] × 10^4km^2 (equivalent to 3.7% of the Sea of Okhotsk's total area) per decade in the maximum extent.

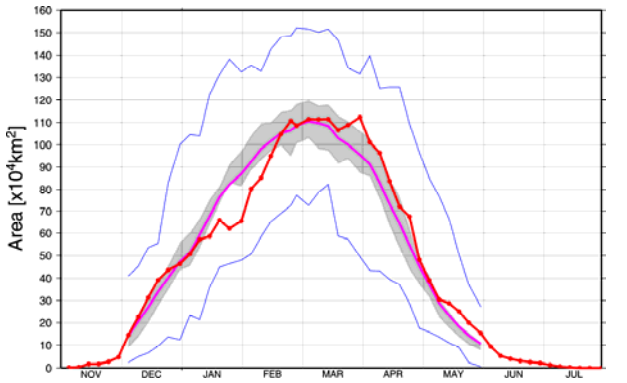


Fig. 6 Time series of the sea ice extent in the Sea of Okhotsk from November to July (red line: 2011–2012 analysis; pink line: JMA's 1981—2010 climatology; blue lines: maximum/minimum sea ice extent since 1971; grey area: normal range).

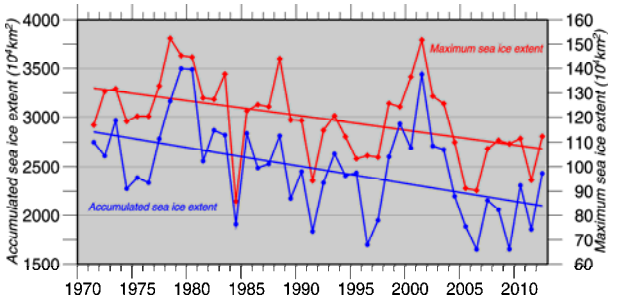


Fig. 7 Interannual variations in the maximum sea ice extent (red line) and accumulated sea ice extent (blue line) in the Sea of Okhotsk from 1971 to 2012. The accumulated sea ice extent is defined as the sum of 5-day sea ice extents from December to May.

(*continued from page 32*)

Fisheries and Oceans Canada maintains an observation program along Line P that extends 1400 km west from Juan de Fuca Strait. Since 2006, temperature anomalies along Line P have been cool, with 2008 being the second coolest in a time series that extends to the 1950s (Fig. 2). One must look back to the early 1970s to find a similar period of persistent cool ocean temperature.

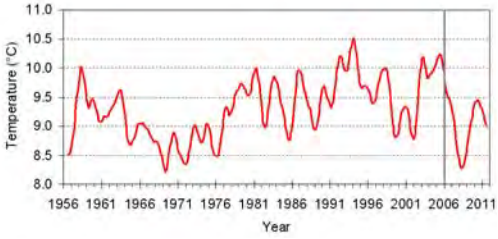


Fig. 2 Average temperature from 10 and 50 m depth along Line P. A 12-month running-mean filter has been applied. A grey vertical bar marks the beginning on the year 2006.

Marine ecosystems along the North American west coast have been affected by the drop in temperature from highs in 2002 to 2005. Many of the warm-water species that extended their range northward along the coast in 2005 have retreated to more southern waters. Cold water species off the British Columbia coast have increased in numbers. As shown in Figure 1a, the pattern of warm and cold anomalies extends across the North Pacific Ocean.

Most boreal regions have ecosystem changes that are associated with shifts in temperature. Forecasting these persistent changes in temperature provides an opportunity for economic advantage should the predictions of temperature changes be accurate. Unfortunately, there has been little success in predicting shifts in the Pacific Decadal Oscillation and other climate patterns. The exceptions are the ENSO events, which provide some predictability in North Pacific ocean temperature for six months or so, but accurate multi-year predictions remain elusive.

Dr. William (Bill) Crawford (bill. Crawford @dfo-mpo.gc.ca) is a Research Scientist Emeritus 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. He served recently as an author and Editor-in-Chief of the PICES North Pacific Ecosystem Status Report and of the PICES Advisory Report to the Cohen Commission (PICES Scientific Report No. 41).

New Leadership in PICES

Governing Council

At PICES-2012, Dr. Laura Richards (Canada) was elected Chairman and Dr. Chul Park (Korea) was elected Vice-Chairman of PICES. PICES is grateful to Dr. Lev Bocharov (Russia) for this dedicated service as Chairman of the Organization since October 2010. He will continue serving PICES as the Russian national delegate.

Laura Richards was born in Halifax, Nova Scotia, on the east coast of Canada. As a child, she spent her summers around water – swimming in lakes and beachcombing along the seashore. She became fascinated by marine life. By the age of 12, she decided to make marine biology her career. She completed a B.Sc. in Biology at Dalhousie University and then went on to complete M.Sc. and Ph.D. degrees in Zoology at the University of British Columbia. Laura managed to combine her love of beaches with science. Her Ph.D. research focused on a sandy beach amphipod and its beetle predator. All the action was nocturnal, and she became locally known for wandering along beaches at night.

Laura was fortunate to find a post-doctoral position at the Pacific Biological Station (PBS) in Nanaimo, British Columbia, where she was hired by Dr. Glen Jamieson (former Chairman of the PICES Marine Environmental Quality Committee) to work on Dungeness crabs. A year later in 1983, she started her career as a groundfish scientist for Fisheries and Oceans Canada at PBS. She was tasked with conducting assessments of various species of rockfish (*Sebastes*), groundfish and salmon. Much of her research focused on the development of quantitative methods for stock assessment.

In 1998, Laura shifted to managing research when she was appointed as the Acting Regional Director Science for Fisheries and Oceans Canada in British Columbia and the Yukon. She was confirmed as Regional Director Science in 2002 and continues to hold that position.

Laura was Vice-Chairman of PICES for one term (2010 to 2012). She has been a Canadian delegate to the PICES Governing Council since 2000, and a member of the Fisheries Science Committee and the Finance and Administration Committee (F&A). She held two terms as Chairman of F&A (2004 to 2008) and participated in several study groups. Laura also plays lead roles in other international organizations. Since 2001, she has been the Chairman or Co-Chairman of the Committee on Scientific Cooperation under the Pacific Salmon Commission (Chairman/Co-Chairman alternates annually between Canada and the United States). In addition, from 2005 to 2012, she was Canada's lead Commissioner at the International Pacific Halibut Commission. In that role, she worked with different harvest sectors to apply science advice to make decisions on fishery quotas.

Laura enjoys keeping physically active through walking, hiking and nature watching (when it is not raining in British Columbia). Yoga and pilates also help her stay focused. Whenever possible, she travels to see research in action, and was fortunate to transit the Northwest Passage in both 2008 and 2011.

Chul Park was born in a small town in the southern part of the Korean peninsula in 1956, as the youngest child of a relatively big family with five sisters and one brother. When he was a child, his mom kept him away from wheels and water. He had never been at the beach until the age of 19. He lived in a rural area until the age of 12 with his parents. Then, he moved to Seoul with his youngest sister to obtain a better education.

In 1974, Chul entered Seoul National University (SNU) where he began to study Oceanography. Completing his compulsory service in the army for 27 months, Chul received his B.Sc. degree in 1980, and began to study Fisheries Oceanography in graduate school, SNU. However, his mentor emigrated from Korea to the United States one year after, so Chul switched his major to zooplankton ecology. Getting a M.Sc. degree in 1982, he moved to Texas A&M University in 1983 and graduated in 1987 with a Ph.D., under the supervision of Dr. John Wormuth. His thesis was on the fine scale patchiness of zooplankton. It was a more or less statistical approach.

Chul was fortunate to find a job right after graduation at Chungnam National University (CNU), where he is now. During his early career, he participated in the Antarctic Cruise in 1988, 1989 and 1990 for the Antarctic Marine Living Resources program of the National Marine Fisheries Services (USA). He spent one year as a post-doctoral student at the University of Hawaii, Manoa, in 1991, studying egg production and feeding of copepods under the guidance of Dr. Michael Landry. Since then, he has been working on zooplankton ecology in relatively small bays in the western part of the Korean peninsula.

In 2004, Chul was invited to work as the Head of the Marine Environment Division at the National Fisheries Research and Development Institute, which made him get involved with PICES as a Korean national delegate to Governing Council (GC) and the Finance and Administration Committee (F&A). But he returned to CNU just one year after and stepped down from GC and F&A. From February 2006 till January 2008, he served as Dean of College of Natural Sciences at CNU, which was composed of 11 departments. During this time he learned a lot on how to compromise and intervene. In 2009, Chul joined GC and F&A again. He also served as the President of the Korean Society of Oceanography for two years, 2010–2011. Now he is also a member of Group of Experts for UN World Ocean Assessment.

In his private life, Chul is a devoted and happy family man. His wife Hyunsoon provides support to her beloved husband. They have two sons, Juweon who is a Dentist and Jaehyun who is a Neurosurgeon (both married), and are waiting to become grandparents.

Finance and Administration Committee

At PICES-2012, Dr. John Stein (USA) was elected Chairman of the Finance and Administration Committee (F&A). PICES is grateful to Ms. Patricia Livingston (USA) for her dedicated service as Chairman of F&A since October 2008. She will continue serving PICES as a member of F&A.

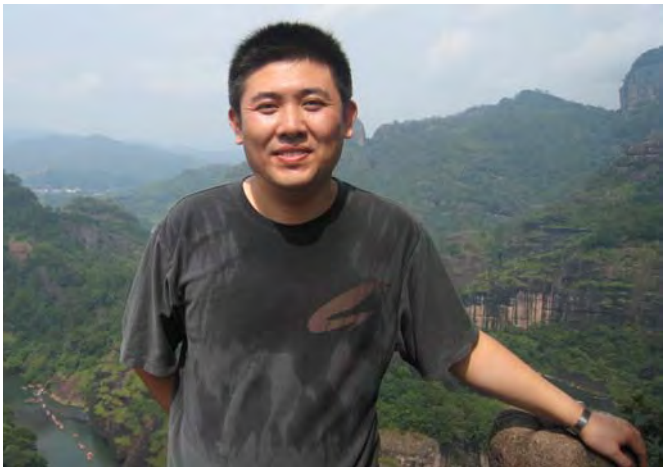
John Stein is the Science and Research Director of the Northwest Fisheries Science Center (NWFSC), NOAA Fisheries Service, USA. He also serves as the Lead for NOAA's Western Regional Collaboration Team and as a member of the Science Panel for the Puget Sound Partnership, a state agency leading an ecosystem approach to the recovery of Puget Sound. Previously, John served as the NWFSC's Deputy Science and Research Director, Pacific Salmon Science Coordinator and Director of the Environmental Conservation Division, and as current Program Manager for NOAA Fisheries Seafood Safety Program in response to the Deepwater Horizon incident in the Gulf of Mexico. He recently completed his term as the Chairman of the Science Board of PICES, and was then appointed US national delegate to Governing Council.

John is an Affiliate Professor at the University of Washington in the Department of Environmental and Occupational Health Sciences. Throughout his science career in NOAA Fisheries, John has focused on the impacts of anthropogenic and natural toxic compounds (*e.g.*, chemical contaminants and marine biotoxins) on fishery resources and protected marine species, the development and application of biological markers of chemical contaminant exposure and effects in fishes and marine mammals, and the application of these techniques in delineating relationships between chemical contaminant exposure and effects in fishes and marine mammals. In addition, he served as Director for NOAA's West Coast Center for Oceans and Human Health at NWFSC, leading research on the effects of the state of the ocean on the health of humans, health benefits and disease risk, and as a member of a NOAA team developing and implementing a science plan on ocean acidification.

John is married and has three wonderful children; girl, boy, girl; and three beautiful grandchildren. His wife Christie runs her own organic farm and a 50-member CSA (Community Supported Agriculture). During the summer, John's hobby is manual farm labor helping Christie on the weekends; a good change of pace from NOAA duties, and a good exercise program. When he is not working to stay ahead of prolific and tenacious weeds, John enjoys fishing on Pacific Northwest rivers.

Marine Environmental Quality Committee

At PICES-2012, Mr. Chuanlin Huo (China) was elected as Chairman and Ms. Darlene Smith (Canada) was elected Vice-Chairman of the Marine Environmental Quality Committee (MEQ). PICES thanks Dr. Mitsutaku Makino (Japan) for his dedicated service as Acting Chairman of MEQ since April 2012. He will continue to contribute to activities of the Organization as a member of MEQ and Co-Chairman of the Section on Human Dimensions



Chuanlin Huo is a research scientist with the National Marine Environmental Monitoring Center (NMEMC) of the State Oceanic Administration (SOA) and is based in Dalian, China, where the 2008 PICES Annual Meeting was held. Chuanlin has both scientific background and experience in administrative affairs and in international collaboration, and knows PICES well, as he used to be a PICES intern from 2003–2004.

Chuanlin received his B.Sc. in Biochemistry from the Jilin University, and his M.Sc. in Environmental Science and Engineering from Dalian University of Technology. His scientific interests include marine environmental toxicology, marine environmental monitoring and evaluation, operational oceanography, carbon dioxide storage and ocean dumping. He has authored more than 20 scientific publications, including research papers and books, and serves on the Advisory Committee for the SOA Science and Engineering Foundation.

Chuanlin has been involved in many research projects, national and sectional (departmental), fundamental and high-tech, bilateral and regional, including the UNDP/GEF Yellow Sea Large Marine Ecosystem (YSLME) project. Being a Chinese member of the YSLME Regional Working Group-Pollution, he participated in the compilation of the document titled "Environmental State of the Yellow Sea".

Since 2005, Chuanlin has been serving as a Chinese member of the Scientific Groups under the London Convention and London Protocol. In this capacity, he has attended numerous scientific and technical meetings, participating in discussions of the Risk Assessment and Management Framework and compilation of the draft Specific Guidelines for the Assessment of Carbon Dioxide Streams for Disposal into Sub-seabed Geological Formations. He also represents China on the experts' pool on ocean dumping and marine environmental protection for International Maritime Organization (IMO).

Chuanlin is a member of the Technical Panel responsible for organizing marine environmental monitoring and assessment in Chinese waters, training courses, and quality control and quality assurance. In addition, he serves as the executive editor/author of a crucial white-paper "Bulletin of Marine Environmental Status of China" (former "Bulletin of Marine Environmental Quality of China") from SOA, since he started as Chief of Planning and management Department of NMEMC in 2007.

Chuanlin has a beautiful wife and similarly beautiful daughter who make his heart swell with pride. His daughter, 4-years old, is a lovely kid, and the most favourite thing the little girl likes is to walk holding his father and mother's hands.

Darlene Smith was born and raised in Nova Scotia, Canada, and has always had an affinity for the sea which has not been dampened by her 25 years in Ottawa working for Fisheries and Oceans Canada. She received her B.Sc. degree in Biology and Geology and a M.Sc. of Environmental Studies from Dalhousie University. Her graduate research focused on post-glacial paleoecology of Maritime lakes. Following graduation in 1984, Darlene worked for the Geological Survey of Canada on Arctic diatoms prior to joining Fisheries and Oceans Canada where she has been involved in fisheries management, habitat management and science, with focus on biodiversity, aquatic invasive species and aquaculture. Currently, Darlene is the Director of the Canadian Science Advisory Secretariat.

Darlene's association with PICES began at the 2005 Annual Meeting in Vladivostok, Russia. Since 2006, she has served as a member of MEQ and the Co-Chairman of Working Group on *Non-indigenous Aquatic Species* (WG 21), and subsequently as an advisor to the Canadian members of the Finance and Administration Committee and Governing Council. Darlene looks forward to her continued involvement with MEQ.

FUTURE Advisory Panel on *Status, Outlooks, Forecasts, and Engagement*

At PICES-2012, Dr. Phillip Mundy (USA) was appointed as Chairman of the FUTURE Advisory Panel on Status, Outlooks, Forecasts, and Engagement (AP-SOFE). In this capacity, he will also serve as a member of Science Board. PICES is grateful to Mr. Robin Brown (Canada) for his dedicated service as Chairman of AP-SOFE since October 2009. Robin will continue serving PICES as a member of this expert group and as a member of TCODE (Technical Committee on Data Exchange).

Phil grew up in the eastern United States, including Florida, where many hours of snorkeling and diving turned him toward his life-long avocation. Trawling for hogchokers with Dr. Eugenia Clark in the Chesapeake Bay provided an inspiring start for fish studies (B.Sc. UMD 1970). Helping build and curate the University of Alabama Ichthyologic Collection (M.Sc. Biology 1973) taught him the necessity of taking computer science. Solving the educational equation, fish plus computers equals where, put him in Seattle (Ph.D. UW 1979). At the University of Washington, Dr. Ole A. Mathisen entrained him in the salmon vortex which led to Iceland, then Alaska, and then Puget Sound, where Phil wrote the first salmon fishing regulations on Hood Canal for the treaty fishing tribes in 1976. At Old Dominion University, Phil was fortunate to be major professor to Dr. Anne Hollowed, among other oceanography graduates who later came to the North Pacific. At the Exxon Valdez Oil Spill Trustee Council (1999), Phil led the development of the Gulf [of Alaska] Ecosystem Monitoring (GEM) program, now known as GulfWatch. During this time, as a member of the U.S. Steering Committee of the U.S. Global Ocean Observing System, Phil helped start the Alaska Ocean Observing System and U.S. IOOS, and served as a charter member of the North Pacific Research Board (NPRB). Ocean observing led Phil to PICES (the first Annual Meeting he attended was PICES-2000 in Hakodate, Japan), where he later became a member (now Co-Chairman) of the Technical Committee on *Monitoring* (MONITOR), and a member (now Chairman) of the Advisory Panel on *Continuous Plankton Recorder Survey in the North Pacific* (AP-CPR).

In 2009, following the adoption of the Implementation Plan for the second PICES integrative science program on "Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems" (FUTURE), three Advisory Panels were established to provide continuing direction, leadership, coordination, and synthesis within PICES toward attaining the FUTURE goal. Phil became a member (now Chairman) for one of these Advisory Panels on *Status*, *Outlooks*, *Forecasts*, *and Engagement* (AP-SOFE), which is focused on identifying major sources of uncertainty and impediments to improving the skill of assessments and forecasts, suggesting research areas for priority development, providing coordination of potential PICES products, and engaging potential users of North Pacific ecosystem and climate information.

Phil has been the director of the Auke Bay Laboratories (ABL) Division, Alaska Fisheries Science Center, Juneau, since 2005. ABL is home base for observing programs in the Gulf of Alaska, Bering Sea and the Arctic, including the BASIS fisheries oceanography survey, the Gulf of Alaska Integrated Ecosystem Research Program, and the Alaska longline survey.

Juneau's outdoor habitat provides Phil ample opportunities for hiking and whale watching, and the weather often sends him indoors for music and books.

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