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The 2013 Inter-sessional Science Board Meeting: A Note from the Science Board Chairman

This year is the 310th anniversary of Saint Petersburg after the great Russian city of culture and art was founded in 1703. It was also in this city where the 11th Inter-sessional Science Board meeting (ISB-2013) was held May 24–25, 2013. ISB-2013 took place back to back with a joint PICES/ICES Workshop on "*Global assessment of the implications of climate change on the spatial distribution of fish and fisheries*". I wish to thank the Russian Government for hosting these two events. I also welcome Mr. Chuanlin Huo, a new Chairman of the Marine Environmental Quality Committee (MEQ) to the Science Board.

I will start with what happened earlier this year. Unlike last year, PICES did not organize any big meetings in the first half of 2013 but PICES scientists convened and/or joined many international workshops and sessions. A PICES Workshop on "*Radionuclide science and environmental quality of radiation in the North Pacific*" was held March 14–15, 2013, in Xiamen, China. It was hosted by the Chinese Government and attended by 20 scientists from 5 PICES member countries and the International Atomic Energy Agency (IAEA). As you may recall, Governing Council approved a Study Group on *Radionuclide Science*

The Hermitage, St. Petersburg, Russia.

In This Issue

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Science Board members and guests. Back (L to R) Igor Shevchenko (Science Board, representing Russia), Gongke Tan (China), Thomas Therriault (AP-AICE Chairman, Science Board Chairman-elect), Kyung-Il Chang (POC Chairman), Yusheng Zhang (China), Elizabeth Logerwell (FIS Chairman), Phillip Mundy (AP-SOFE Chairman), Alexander Bychkov (PICES Secretariat), Atsushi Tsuda (BIO Chairman), Chuanlin Huo (MEQ Chairman), Hiroyuki Shimada (Japan), Dongho Youm (Korea). Front (L to R) Hiroya Sugisaki (MONITOR Chairman), Hiroaki Saito (AP-COVE Chairman), Jinqiu Du (China), Robin Brown (Governing Council member, Canada), Laura Richards (PICES Chairman), Sinjae Yoo (Science Board Chairman), John Stein (Governing Council member, USA), Toru Suzuki (TCODE Chairman), Skip McKinnell (PICES Secretariat), Naesun Park (Korea), and Heejin Kim (Korea).

and Environmental Quality of Radiation in the North Pacific at PICES-2012. Since then, the Study Group worked hard, under the leadership of Dr. Yusheng Zhang (Third Institute of Oceanography, SOA), to prepare for a new Working Group. During the workshop, attendees reviewed the status of radionuclide science in each PICES member country and discussed the direction of radionuclide science research in the future. You can read a detailed report on the workshop in this issue. The Study Group prepared the terms of reference and work plan and submitted a proposal for establishing a working group. Science Board was impressed by the Study Group's efficiency, eagerness and new research directions and unanimously endorsed the proposal. I would expect that the new working group will have its first meeting this fall at PICES-2013 in Nanaimo, Canada.

At ISB-2013, we started the meeting with business related to other international organizations and programs. We are witnessing ever-increasing PICES interactions with other international bodies. To name a few, we have many joint activities with ICES (International Council for the Exploration of the Sea), IOC (Intergovernmental Oceanographic Commission of UNESCO), NOWPAP (Northwest Pacific Action Plan), NPAFC (North Pacific Anadromous Fish Commission), SCOR (Scientific Committee on Oceanic Research), CLIVAR (Climate Variability and Predictability Program), GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms Program), IMBER (Integrated Marine Biogeochemistry and Ecosystem Research), and SOLAS (Surface Ocean - Lower Atmosphere Study), among others. Cooperative activities with these organizations and programs include co-sponsoring sessions at each other's annual meetings, symposia and workshops, summer schools, and joint activities of expert groups. There are too many activities to list here.

In 2008 and 2012, PICES, ICES and IOC organized the international symposium on the "*Effects of climate change on the world's oceans*". The first one was in Gijón, Spain, and the second one was in Yeosu, Korea. Following these two successful symposia on the continents of Europe and Asia, a third one is being planned for 2015 in Santos City, Brazil. Science Board invited Dr. Jacquelynne King (Canada) to serve as the PICES convener and Drs. Shoshiro Minobe (Japan), Fangli Qiao (China), and Angelica Peña (Canada) to serve as members of the Scientific Steering Committee.

The North Pacific Anadromous Fish Commission (NPAFC) was established one year after PICES. Its Contracting Parties include Canada, Japan, Republic of Korea, the Russian Federation, and the United States. The primary objective of the Commission is to promote the conservation of anadromous stocks in the Convention Area. NPAFC and PICES signed a Memorandum of Understanding (MOU) in 1998, and scientists involved in the two organizations have been working together on problems of mutual interest for the past 15 years, with a good record of joint activities. To further the cooperation, Science Board approved the establishment of a joint NPAFC/PICES Study Group on *Scientific Cooperation in*

Statue of Peter the Great.

the North Pacific Ocean. This Study Group will prepare a plan for a cooperative framework, aiming to finalize it at PICES-2014. The group will be led by Dr. Elizabeth Logerwell (FIS Chairman) on the PICES side and by Dr. James Irvine representing NPAFC.

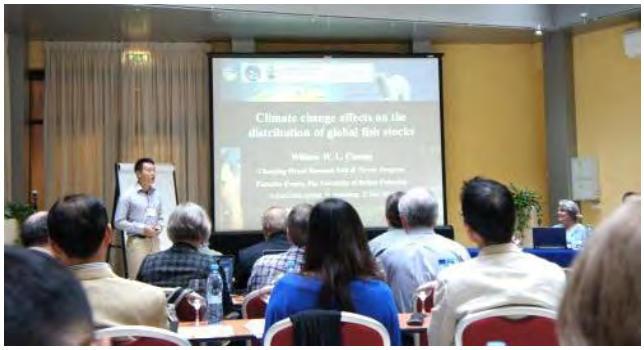
Capacity building has always been a high priority issue for PICES. Several events will be sponsored by PICES in 2013–2014, including a PICES Summer School on "*Ocean observing systems and ecosystem monitoring*" to be held August 19–23, 2013, in Newport, USA. The first PICES summer school in North America will include classroom lectures, laboratory demonstrations of interdisciplinary ocean sensors, an introduction to ocean observing platforms, and fieldwork on a research vessel to deploy ocean observing equipment at sea. Techniques of data quality control and data processing of time series will also be demonstrated. Besides its own summer school, PICES will support three early career scientists to attend the 6th SOLAS summer school in Xiamen, China (August 23–September 2, 2013). NOWPAP and PICES will co-sponsor a joint training course on "*Remote sensing data analysis*" on October 21–25, 2013, in Qingdao, China. This training course aims at providing opportunities for postgraduate students, young professional researchers and coastal managers (including local government officers) working in the fields of marine sciences and coastal-zone management in the Northwest Pacific Region and adjacent area. In 2014, the next PICES Summer School on "*Ecological modeling for marine resources management and research*" is slated for August 26–29, 2014, in Seoul, Korea. The purpose of this summer school is to review the end-to-end modeling techniques for ecological interactions and to show how these models can be applied to understand and predict change in ecosystem. The program, consisting of lectures and hands-on training, will be finalized at PICES-2013. The PICES/ICES Early Career Scientist Conference is a series of capacity building activities where early career scientists from the North Pacific and North Atlantic regions plan, prepare and run the conference by themselves. The previous conferences in 2007 and 2012 were a tremendous success. Talks are being initiated to hold the next conference in 2017, which will be the third in the series, possibly in Asia.

The PICES/FUTURE Open Science Meeting (OSM) will take place from April 15–18, 2014, on the Kohala Coast, Hawaii, USA. By 2014, the FUTURE integrative science program will be 5 years old so there will be a need to assess its progress and adjust the program's direction, if necessary. The FUTURE OSM is intended to provide an opportunity to evaluate what has been achieved and to make necessary course adjustments for the remaining years to achieve the objectives of FUTURE. The 4-day symposium will consist of morning plenary sessions and concurrent theme sessions. One-day workshops will precede the symposium. On the last day, the plenary session will focus on the integration of more general topics followed by a discussion on the evaluation of FUTURE progress, and to identify needed changes or adjustments to fulfill program objectives. After the OSM, an evaluation team will gather to make a formal assessment of FUTURE progress. Abstract submission deadline is December 15, 2013, and I encourage you to submit an abstract and attend. Please check the PICES website for further announcements.

An important agenda item at all ISB meetings is to decide who will be the recipients of PICES awards to be presented at the Annual Meeting. The Wooster Award is given annually to an individual who has made significant scientific contributions to North Pacific marine science. Likewise, the PICES Ocean Monitoring Service Award (POMA) acknowledges monitoring and data management activities that contribute to the progress of marine science in the North Pacific. The names will be kept secret until the Opening Session at PICES-2013.

The six Committees which form the core of the PICES Science Board described their activities since PICES-2012. We reviewed the status of each of their subsidiary bodies, the preparation of work plans and reports, planning of meetings, sending representatives to meetings of other organizations, and budgetary issues. I am pleased to say that all the Committees are on track and doing well.

The year 2016 will mark the 25th anniversary of PICES and Science Board discussed the ways to celebrate it. The objectives for the anniversary will not only include a celebration of achievements, but also finding ways to raise the profile of PICES with the public. Public communication can be made through various formats utilizing social media. National activities could also be used to enhance the awareness of the Organization. A planning committee is now in place and will meet at PICES-2013 to discuss tasks and brainstorm for more ideas. I encourage you to contact the Executive Secretary of PICES if you have any interesting suggestions to help celebrate this occasion.



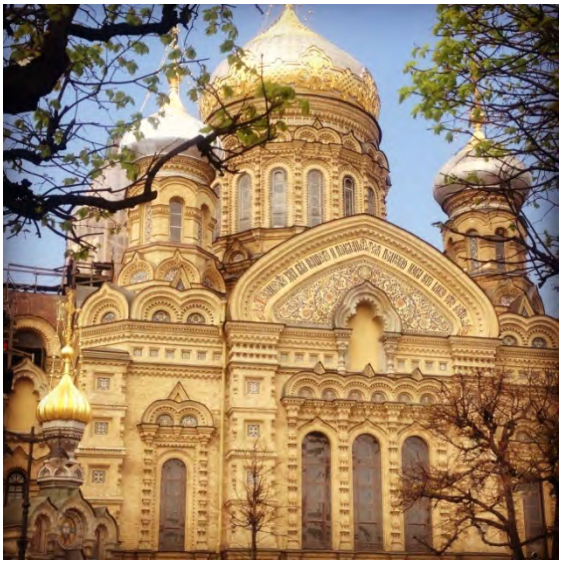
Dr. William Cheung (Canada) speaking at the PICES/ICES workshop in St. Petersburg.

As I mentioned earlier, the PICES/ICES workshop on "*Global assessment of the implications of climate change on the spatial distribution of fish and fisheries*" took place immediately after ISB-2013. The workshop was prepared by S-CCME [Section on *Climate Change and Marine Ecosystems* on the PICES side and SICCME (Strategic Initiative) on the ICES side]. The purpose of the workshop was to catalyse the development of an international interdisciplinary research effort focusing on understanding and projecting the implications of climate change on the spatial distribution and abundance of fish and fisheries in the northern hemisphere. The workshop discussed diverse issues ranging from analytical methods to detect changes in spatial distribution, and skill assessment and model inter-comparison, to quantifying uncertainty to communicating outcomes to inform on decisions regarding management of living marine resources under a changing climate. A detailed report on the workshop is included in this issue of PICES Press.

A second PICES/MAFF project on "*Marine ecosystem health and human well-being*" started last year. The objectives of the project include identifying the relationship between sustainable human communities and productive marine ecosystems in the North Pacific under the concept of fishery social-ecological systems. A project meeting recently took place in Honolulu, June 10–12, 2013. Taking advantage of the fact that many members of the project team are also active in the PICES Section on *Human Dimensions of Marine Systems*, a workshop on human dimensions indicators was held piggy-back with the project meeting. The purpose of the workshop was to assemble peer-reviewed information for developing socio-economic indices regarding the social and economic status of marine ecosystems in the North Pacific. The data will be a useful contribution to the next version of the North Pacific Ecosystem Status Report as well as to the World Ocean Assessment (UN Regular Process).

An International Workshop on "*Development and application of regional climate models-II*" co-sponsored by PICES will be held September 10–12, 2013, in Busan, Korea. This is a sequel to the successful first workshop held in 2011 in Seoul. The purpose of the workshop is to discuss the regional climate projections based on ocean or coupled models, novel downscaling techniques including implementation of surface and lateral boundary conditions, and existing roadblocks. The workshop will be chaired by four convenors, three of whom are Working Group on *Regional Climate Modeling* Co-Chairmen, Drs. Enrique Curchistser and Chan Joo Jang, and Physical Oceanography and Climate Chairman, Dr. Kyung-Il Chang. The deadline for abstract submission is August 15, 2013. Modeling studies using physics and biogeochemistry are welcome.

PICES-2014 will be hosted by Korea. Proposals for topic sessions and workshops will be processed through the new web-based submission system which we tested last year. It turned out to be a seamless, transparent, and comprehensive approach that improved the efficiency in evaluating and ranking the proposals. The session/workshop submission page for proposals for PICES-2014 and inter-sessional workshops in 2014 is now open and will close on September 7 to allow a period of about 3 weeks for Committee members and FUTURE Advisory Panels to evaluate the proposals. So anyone interested in submitting a proposal should prepare it and submit it using the submission system.



Finally, the next Annual Meeting, PICES-2013, will be held October 11–20, 2013, in Nanaimo, Canada. The theme of PICES-2013 is "*Communicating forecasts, uncertainty and consequences of ecosystem change*". Many interesting sessions and workshops, covering a wide range of topics, are planned. In addition to these scientific attractions, there are lots of interesting things to see in the region. Nanaimo is the third oldest city in British Columbia, and has a long and colourful history. I invite you all to this beautiful city!

Sinjae Yoo
Science Board Chairman

ICES/PICES Workshop on Global Assessment of the Implications of Climate Change on the Spatial Distribution of Fish and Fisheries

by Myron A. Peck, Anne B. Hollowed and Suam Kim

St. Petersburg, Russia, one of the most important gateways where the East meets the West, was the perfect venue for PICES and ICES scientists to come together for three days to discuss climate-driven changes in the spatial distribution of living marine resources. The Strategic Initiative (Section) on Climate Change Impacts on Marine Ecosystems workshop on changes in spatial distribution (WKSICCME-Spatial) took place on the island district of Vasileostrovskiy from May 22 to 24, 2013, and was attended by 67 scientists from 13 countries as well as representatives from ICES, PICES and the FAO (Fig. 1). The workshop, co-convened by Anne Hollowed (USA, PICES), Suam Kim (Korea, PICES) and Myron Peck (Germany, ICES), was held to foster the development and testing of analytical methods for detecting changes in distribution, assessing the skill of different modeling approaches, and quantifying uncertainty in projected climate-driven changes. Other important questions addressed were: How do we best design a global database of marine observations and what are the strategies used to assess vulnerability (of resources and those that depend upon them) to shifts in distribution?

The workshop was organized around six theme sessions: (1) Analytical methods for detecting changes in spatial distribution, (2) Skill assessment and model inter-comparison, (3) Quantifying uncertainty, (4) Design specification for database of observations of distribution of living marine resources, (5) Vulnerability assessment, and (6) Communicating outcomes to inform decisions regarding management of living marine resources under changing climate. Each session had 1 or 2 keynote speakers (Fig. 2) and 3 breakout group leaders; the latter guided participants through a set of pre-defined discussion questions. The key points from each session were discussed in plenary, including consensus recommendation for future PICES/ICES activities on climate-driven changes in spatial distribution of living marine resources. The following provides a very brief overview of key discussion points and findings in each session.

Fig. 1 Group photo of participants of the ICES/PICES SICCME-Spatial workshop (top) as well as small breakout group discussions (bottom left and middle) A welcome address and wrap up summary of the workshop was provided by Anne Hollowed (bottom, right). Pictured in the bottom left photo (L to R: Chan Joo Jang (Korea), Michael Foreman (Canada) and William Sydeman (USA), Toru Suzuki (Japan), Naesun Park (Korea), John Stein (USA); bottom middle photo (L to R: Anne Britt Sandø (Norway), Jinqiu Du (China) Lorna Teal (Netherlands), Myron Peck (Germany) and David Reid (Ireland)).

Ten of the 11 keynote speakers at the ICES/PICES SICCME-Spatial workshop. From the top to the bottom (L to R): Session 1, William Cheung (Canada), Franz Mueter (USA); Session 2, Shin-ichi Ito (Japan), Miranda Jones (UK); Session 3, Grégoire Certain (Norway), Tatiana Pavlova (Russia); Session 4, William Sydeman (USA); Session 5, Gretta Pecl (Australia), Cassandra de Young (FAO); Session 6, Motomitsu Takahashi (Japan), and – not pictured – John Pinnegar (UK).

In session 1, William Cheung (Canada) and Franz Mueter (USA) gave presentations on different approaches to detect changes in the spatial distribution of living marine resources. They highlighted the different challenges faced when examining global changes based upon fisheries-dependent data *versus* examining historical changes in specific ecosystems based upon survey data (*e.g.*, 42 taxa in the Bering Sea). Changes in distribution have been assessed using a variety of approaches tailored to fit the scale of the question. Workshop participants agreed that comparisons of different approaches within the same system are needed. Moreover, examples highlighted how responses at the center, leading and trailing edges of a species' distribution may vary due to different processes. There was consensus that fisheries oceanographic (process) studies (including tagging and behavioral studies) along with laboratory studies (including physiological experiments) are needed to verify proposed mechanisms. Not only documenting historical shifts but also understanding the underlying mechanisms will be critical for making robust projections of future changes.

In session 2, Miranda Jones (UK) and Shin-ichi Ito (Japan) illustrated different modelling approaches (bioclimate envelope models constructed for many species *versus* coupled biophysical-ecosystem, full life cycle modeling of one species) and methods they used to examine the skill of models to reproduce historical distributions. These two talks highlighted the diversity of biological modelling tools available within the community and the different approaches taken (from pattern matching to quantitative statistical analyses) to assess how well models "perform". The breakout groups summarized previous efforts to examine the skill of a wide range of biological models applied around the globe (*e.g.*, what models have been used, where have they been applied, and how has model skill been appraised?). Discussions emphasized the close link between skill assessment and the *in situ* observations at appropriate temporal and spatial scales (*e.g.*, skill assessments of modelled responses at the base of the marine food web have been aided by the availability of satellite data, while those for upper trophic levels remain more challenging due to gaps in observations). There was consensus among workshop participants that it is important to identify life history bottlenecks to guide auxiliary surveys for model verification, and that the attribution of climate change impacts will be advanced by developing techniques to disentangle the effects of multiple drivers. To the extent practicable, participants suggested that biological modelers follow practices currently employed in climate modelling for evaluating hindcasts with contemporary observation. A key element includes assessing model skill in terms of both spatial and temporal patterns.

Within session 3, Tatiana Pavlova (Russia) provided an update on climate simulations and projections for Russia and its adjacent seas which featured variability in model projections of the seasonal changes in the extent of Arctic

Sea ice. This was followed by a presentation by Grégoire Certain (Norway) who provided an example of how to identify and address the cumulative error propagating through various steps of species distribution models (*e.g.*, from sampling error associated with the collection of species and environmental data, structural error associated with the formulation and selection of statistical models to examine those field data, the choice of climate model and ensembles of forecasts). Similar to session 2, workshop participants agreed that there is a need to identify regions where multiple modelling approaches have been developed and compare them after finding a "common currency". Short-term projections (nowcasts) available in various locations provide an opportunity to test assumptions behind links in changes in species distribution and environmental factors but it was important that users were informed about the uncertainty of projections. For biological models, both within (sensitivity analysis) and between (ensemble) model comparisons are needed.

Session 4 addressed data needs to better understand and project climate-driven changes in species distribution. William Sydeman (USA) gave a presentation summarizing the process of building the National Center for Ecological Analysis and Synthesis (NCEAS) "MarClim" database. The end product was a database that included information from studies on 857 species and species-assemblages, representing 1735 observations of marine biological responses to climate change (see www.nceas.ucsb.edu). The talk highlighted both the results of the meta-analysis as well as the challenges of compiling data from a variety of different sources. Workshop participants agreed that there is 1) an urgent need for an aggregated database of fishery-independent and fishery-dependent data collected at a higher spatio-temporal resolution than existing databases, and that such a database 2) is best supported by national or international institutions with 3) continued engagement from data collection experts because of the complicated nature of individual datasets (*e.g.*, non-standard, gear, region, design specificity).

Session 5 took a broader view of climate impacts by discussing the vulnerability of species (and the human communities that rely on those species) to climate-driven changes in distribution. From a human communities standpoint, Cassandra De Young (FAO) presented the generic model developed by the IPCC to assist in understanding vulnerability to climate change as a function of 1) the sensitivity of a system to changes in climate, 2) the adaptive capacity of practices, processes, or structures that can moderate or offset damage or that allow exploitation of new opportunities, and 3) the exposure of the system to climatic hazards. She provided global, regional (tuna fishing and 8 small Pacific island nations) and local (coral reef fishing and 10 communities in Kenya) examples of vulnerability assessments. From a living marine resources perspective, Gretta Pecl (Australia) summarized efforts taken in southeastern Australia to classify 150 species of invertebrates and fish into various risk categories (from very sensitive to insensitive) based on the potential for climate-driven changes distribution, abundance, productivity, and phenology. She also presented details on the "Redmap" (Range Extension Database and Mapping) project (www.redmap.org.au), an online database and mapping resource allowing the public to submit observations (including photographs) of marine species occurring outside their known distribution (*i.e.*, species that may be undergoing range shifts). Workshop participants agreed that ICES and PICES are uniquely placed to provide vulnerability assessments of climate change impacts on living marine resources. Discussions centered on the various pros and cons of performing quantitative *versus* qualitative assessments and the need to apply vulnerability, statistical and dynamic simulation modelling to the same problem when possible.

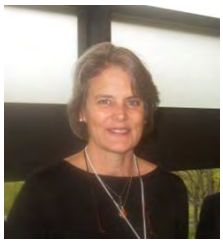
In session 6, the presentation by Motomitsu Takahashi (Japan) discussed both qualitative and quantitative methods used to provide information needed by policy makers regarding historical and projected environmental status. The presentation summarized ongoing activities in PICES Working Group 28 which focuses on the development of indicators to characterize the ecosystem responses to multiple stressors, including expert elicitation using stressors-habitats matrices. Based on published scientific reports, vulnerabilities were scored as spatial scale, frequency, functional impact, resistance, recovery time and certainty and identified most influential activities/stressors in the ecosystems. In a second talk, John Pinnegar (UK) reflected upon recent experience in the UK and European Union (EU) of communicating with policy makers, members of the public and the media using two key examples. The first example was a summary of the joint UK-Ireland Marine Climate Change Impacts Partnership (MCCIP) which was formed to transfer high quality evidence on marine climate change impacts from scientists to policy advisors and decision-makers. The 2010 Annual Report Card included contributions from 100+ scientists from 40 separate institutes. A very similar Annual Report Card was produced in 2009 by scientists in Australia and, together, these assessments have elicited considerable media interest all around the world. The presentation also summarized results from the EU CLAMER (Climate Change and Marine Ecosystem Research Results) project which hired a professional polling company to conduct a quantitative survey of 10,000 citizens within 10 European countries. The survey revealed that most European citizens obtain their information about marine climate change issues via television, but they do not necessarily trust this form of media. Scientific articles in journals were used less but were the most trusted, whereas newspapers and social-media websites were the least trusted. Workshop participants highlighted the importance of clearly communicating concise and reasonably accurate advice to managers. They agreed that there is a need to develop tools that include management strategy evaluations of the implications of policies and actions on the future

state of nature. When communicating with the public and/or policy advisors, clearly, a variety of fruitful pathways exist (from report cards and status reports to peer-reviewed publications) and evaluations that summarize suites of products for decision makers can be very effective.

Recommendations from the ICES/PICES WKSICCME-Spatial will improve methods used to assess regional and latitudinal differences in the vulnerability of species or species groups to climate change-induced shifts in ocean conditions. A series of manuscripts stemming from this workshop will form a special volume of a peer-reviewed journal, and it is hoped that a synthesis of climate-driven changes in distribution will be developed to inform future decisions regarding the governance and management of marine resources responding to changing ocean conditions.

The format of the workshop allowed ample time for discussion and debate and a considerable amount of information was exchanged within the three days. Despite the tight schedule and intense, small group discussions, workshop participants got the chance to enjoy the local sites (Fig. 3). The workshop conveners are grateful to our colleagues from the Pacific Research Institute of Fisheries and Oceanography (TINRO-Center, Vladivostok) and GOSNIORH (St. Petersburg) for taking care of all of the local arrangements (special thanks go to Ms. Tatiana Semenova, Ms. Ekaterina Kurilova and Dr. Andrey Pedchenko) as well as the PICES Secretariat for ensuring that the workshop ran smoothly. Further details regarding discussions and the keynote presentations can be found in the workshop report posted on both the ICES and PICES websites.

Fig. 3 Despite a very busy workshop schedule, participants still got to enjoy the waterfront and historical sites around St. Petersburg including an impromptu ICES-PICES-FAO bowling competition (luckily not pictured here); from left to right: Alan Haynie (USA), Cassandra de Young (FAO), Franz Mueter (USA), Myron Peck (Germany), Gretta Pecl (Australia), our helpful guide, Vladimir Kulik, Janet Nye (USA), and Mark Payne (Denmark).



Dr. Myron A. 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. Anne B. Hollowed (Anne.Hollowed@noaa.gov) is a Senior Scientist with the U.S. National Marine Fisheries Service's Alaska Fisheries Science Center. She conducts research on the effects of climate and ecosystem change on fish and fisheries and leads the Status of Stocks and Multispecies Assessment (SSMA) program (http://www.afsc.noaa.gov/REFM/Stocks/default.php). Anne serves as Co-Chairman of the joint PICES/ICES Section on Climate Change Effects on Marine Ecosystems. She is also a lead author of Chapter 28, Polar Regions, of the Working Group II contribution to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Anne is an Affiliate Professor with the School of Fisheries and Aquatic Sciences at the University of Washington. She is a member of the NPFMC Scientific and Statistical Committee and the Weather, Climate and Fisheries task team of the Joint Committee for Agriculture and Meteorology (CAgM) and the Joint Technical Committee for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organization.

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

PICES participates in a Convention on Biological Diversity Regional Workshop

by Thomas Therriault

The United Nations, through the Convention on Biological Diversity (CBD), is in the process of identifying/describing ecologically or biologically significant marine areas (EBSAs) around the world using a series of regional workshops. Scientific criteria agreed to by the Conference of the Parties (COP) to the Convention form the basis to describe the EBSAs (see Annex 1 of COP decision IX/20) and include: productivity, biodiversity, important areas for threatened and endangered species, life history criteria required for species to survive and thrive, unique and rare features, vulnerability and fragility, and naturalness. Identification of any area as an EBSA is a scientific process recognising and describing its importance to the ecological and/or biological defining criteria – the next step in the process (yet to be taken) is to discuss and identify any special management measures that may be recommended for any particular EBSA. A regional workshop for the North Pacific was held from February 25 to March 1, 2013, in Moscow, Russia. As a recognized organization with significant knowledge of the North Pacific, PICES was asked to officially nominate an expert to participate in this workshop. It was anticipated that PICES involvement would increase the awareness of the CBD and its EBSA process within PICES, assist in the nomination of relevant experts through PICES' scientific networks, help CBD identify other relevant organizations to be invited, facilitate the use of workshop products in future marine biodiversity conservation efforts in the North Pacific to ensure sustainable use, and work with the CBD Secretariat to conduct the workshop. The author of this article was nominated and served on the steering committee for this regional workshop and as rapporteur for one of the major elements of the final workshop report that will be posted on the CBD website.

The first day of the workshop focused on several housekeeping issues. The introductions identified participants from several member countries, including Canada, Democratic People's Republic of Korea, Japan, Mexico, Philippines, Republic of Korea, and Russian Federation (see the group photo, Fig. 1). The People's Republic of China had confirmed participation but visa difficulties precluded their involvement in Moscow. In addition, a representative from the National Oceanic and Atmospheric Administration of the United States and several international organizations, including NOWPAP, NPAFC, and PICES participated in the workshop. Workshop discussions and analyses were supported by a technical team from Duke University, USA.

Following UN procedures, Dr. Alexander Shestakov (Director, WWF Global Arctic Programme) and Dr. Jake Rice (Chief Scientist, Fisheries and Oceans Canada) were identified as workshop co-chairs. In addition, rapporteurs were selected for each of the major sections of the workshop report. Each international organization was then invited to provide a presentation to workshop participants.

Fig. 1. Participants at the CBD Workshop to identify EBSAs for the North Pacific (February 25 – March 1, 2013, Moscow, Russian Federation).

Fig. 2 Dr. Therriault provides an overview of PICES to workshop participants.

Dr. Therriault described the mandate and structure of PICES, efforts of its expert groups, and products (*e.g.*, North Pacific Ecosystem Status Reports) that would be of value to this CBD process, and an overview of the PICES FUTURE program (Fig. 2). This was followed by country presentations of national processes which apply EBSA criteria or similar national processes. The first day also included a review of the criteria that would be used to identify EBSAs for the North Pacific and the scope that workshop participants would consider. All countries other than Mexico and the Russian Federation requested that their national waters not be included in this meeting for identification of EBSAs, mostly because of national processes already underway. The workshop participants agreed on the following scope for the workshop: marine areas within national jurisdiction of Mexico and the Russian Federation, marine areas beyond national jurisdictions in this region, the northern limit identified at the Western South Pacific regional workshop on EBSAs, the northeastern tropical Pacific area, and the Bering Strait, including the Russian coastal area and "Donut Hole" in the Bering Sea, but excluding the marine areas within the national jurisdiction of the USA.

Following a preliminary scoping exercise on the start of Day 2, workshop participants spent the next three days identifying EBSAs in the North Pacific using the CBD criteria, including compiling the necessary supporting documentation. By the end of the workshop, participants had agreed upon 20 EBSA units (Table 1) that will be tabled for discussion at the next meeting of COP (winter 2013 or early 2014). The report from the meeting is expected to be available soon on CBD's website.

Table 1 EBSAs identified at the CBD workshop for the North Pacific.

Number	Areas meeting EBSA criteria
1	Peter the Great Bay, Russia
2	West Kamchatka shelf, Russia
3	South East Kamchatka coastal waters, Russia
4	Eastern shelf of Sakhalin island, Russia
5	Moneron Island shelf, Russia
6	Shantary Islands shelf, Amur and Tugur Bays, Russia
7	Commander Islands shelf and slope, Russia
8	East and South Chukotka coast, Russia
9	Yamskie Islands and western Shelikhov Bay, Russia
10	Alijos Islands, Mexico
11	Coronado Islands, Mexico
12	Guadalupe Island, Mexico
13	Upper Gulf of California region, Mexico
14	Midriff Islands region, Mexico
15	Coastal lagoons and islands off Baja California and Offshore Waters Complex, Mexico
16	Juan de Fuca Ridge Hydrothermal Vents
17	Northeast Pacific Ocean Seamounts
18	Emperor Seamount Chain and Northern Hawaiian Ridge
19	North Pacific Transition Zone and bordering currents
20	Albatross Arc

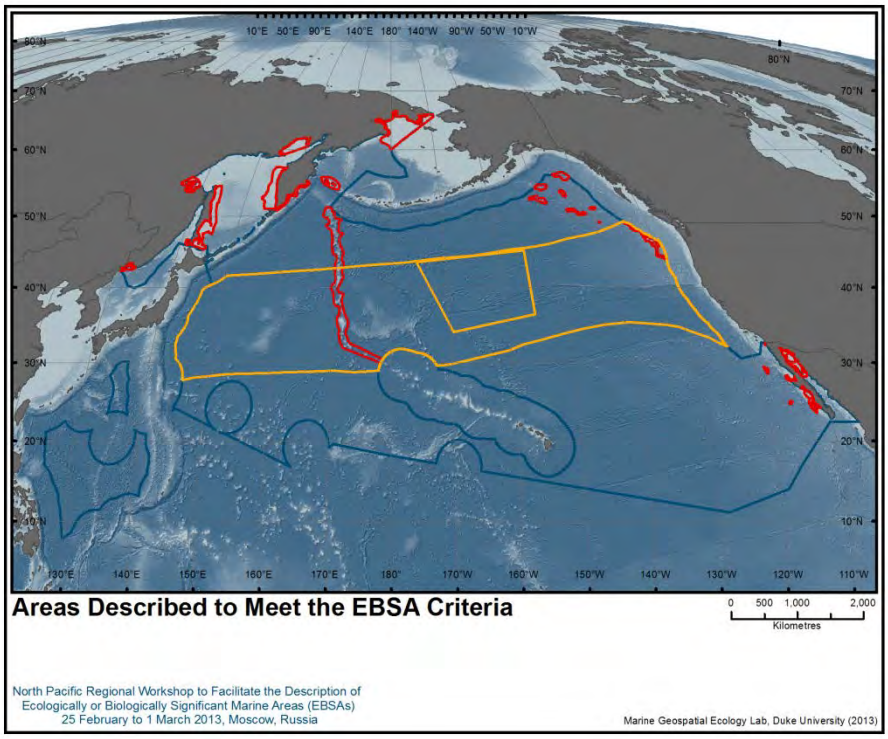


Fig. 3 Spatial extent of EBSAs developed at the CBD workshop for the North Pacific. Blue line indicates the boundary of the area considered by the workshop. Polygons in red indicate those areas described against EBSA criteria by the workshop. Polygons in orange indicate those features that are inherently not spatially fixed, and described against EBSA criteria by the workshop.

There was debate at the workshop about whether the eastern and western North Pacific gyres should be included as potential EBSAs, considering their importance for salmon populations. However, not enough information was available at the meeting to support including these regions as EBSAs at this time but participants recommended these regions should receive further consideration in future CBD processes. It is worth highlighting the area of the North Pacific Transition Zone (EBSA Number 19 identified by the large orange polygon in Fig. 3) is extraordinarily large for an EBSA, and was defined primarily on the basis of the northerly and southerly seasonal migrations of the Transition Zone chlorophyll frontal zone. The narrative describing this region notes that this is not a geographically fixed feature but one which is seasonally variable in its location. This is in contrast to the bathymetrically-fixed EBSAs proposed about the various seamount chains in the North Pacific.

PICES has considerable experience with identifying and describing ecologically and biologically important areas in the North Pacific, although it has not (yet) used the CBD EBSA terminology and criteria. Some examples include the two North Pacific Ecosystem Status Reports, topic sessions at PICES Annual Meetings (most recently in Portland in 2010), and WG 19's efforts on ecosystem-based management. The ever increasing international interest in EBSAs and current and planned global efforts to identify such areas both within and beyond country Exclusive Economic Zones (EEZs) represent an important opportunity for PICES. As an intergovernmental organization we have a wealth of science experts to consider these issues and to provide scientifically defensible recommendations not only for EBSAs but for other international initiatives currently underway in the North Pacific (*e.g.*, World Ocean Assessment; see page 12 in this issue).

Dr. Thomas Therriault (Thomas.Therriault@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada (DFO) at the Pacific Biological Station in Nanaimo, BC and currently is PICES Science Board Chairman-elect. Tom works on a variety of conservation biology issues including aquatic invasive species where he has an extensive research program both within DFO and through the second Canadian Aquatic Invasive Species Network (CAISN II) which includes collaborations with academia. Within PICES, Tom is the FUTURE Advisory Panel Chairman for AICE (Anthropogenic Influences on Coastal Ecosystems), a member of MEQ, a member of WG-21 on Non-indigenous marine species and most recently a member of the new NPAFC/PICES Study Group on Developing a Framework for Scientific Cooperation.

Social and Economic Indicators for Status and Change within North Pacific Ecosystems: A PICES Section on Human Dimensions of Marine Systems Workshop

by Keith Criddle and Mitsutaku Makino

PICES sponsored a 3-day workshop on the development of social and economic indicators for the upcoming North Pacific Ecosystem Status Report (NPESR) and the World Ocean Assessment (WOA). The workshop was held June 13–15, 2013, in Honolulu, USA. The convenors were Keith Criddle (USA), Mitsutaku Makino (Japan), Thomas Therriault (Canada) and Ian Perry (Canada). All six PICES member countries were represented by 21 participants (see group photo). In addition, Alan Simcock (UK, WOA Group of Experts) and Xiaodong Zhong (Northwest Pacific Action Plan (NOWPAP)) attended the meeting.

To date, the NPESR has highlighted climatic, oceanographic, and biological changes. The PICES Section on *Human Dimensions of Marine Systems* (S-HD) was formed, in part, to contribute social and economic – "human dimension" – indicators and changes to the upcoming NPESR. Separately, the United Nations has committed to the WOA, a regular process for global reporting and assessment of the state of the marine environment. The objectives of these two efforts are complementary, and the work of the WOA Group of Experts has benefited from information represented in the most recent NPESR, but this group is still in need of human dimensions indicators.

The purpose of this workshop was to share information on human dimension indicators for marine ecosystems in the North Pacific. After providing examples of the type of human dimension indicators regularly collected by their countries, workshop participants agreed on a common set of indicators to be compiled at the 2013 PICES Annual Meeting (PICES-2013) in Nanaimo. These indicators will serve as the base information for the S-HD contribution to the next NPESR. The workshop participants also identified aspects of the human dimensions of North Pacific ecosystems that are not yet well represented by indicators collected across the region. To begin to address an important gap, a 1-day joint Topic Session on "*Marine ecosystem services and the contribution from marine ecosystems to the economy and human well-being*", co-sponsored by PICES and IMBER (Integrated Marine Biogeochemisty and Ecosystems Research), will be convened at PICES-2013.

Representatives of each country filled Day 1 and the first half of Day 2 of the workshop with presentations of examples of regularly collected time series of human dimension indicators. The latter half of the second day and the beginning of Day 3 were devoted to a structured discussion that led to the identification of key human dimension indicators that can be compiled for all PICES member countries. Data series to be collated include time series of: (1) the quantity and value of catches and landings of seaweeds, fish, shellfish, and other invertebrates from inside and outside national Exclusive Economic Zones; (2) the quantity and value of mariculture of seaweeds, fish, shellfish, and other invertebrates; (3) the number and power of fishing vessels by gear type, length, and tonnage; (4) catch per unit effort by gear type and target fishery; (5) numbers of commercial fishers; (6) injury and mortality rates of commercial fishers (absolute and relative to

Fig. 1 The participants at the PICES North Pacific Ecosystem Status Report and World Ocean Assessment workshop, Honolulu, June 13-15, 2013. Left to right: Shang Chen, Ian Perry, Jung-Hee Cho, Ron Felthoven, Minling Pan, Sam Pooley, Rashid Sumaila, Ayeisha Brinson, Ningsheng Yang, Alan Simcock, Elena Anferova, Wenbo Yang, Yingren Li, Kyungjin Kim, Keith Criddle (co-author of this article), Kyoung Ju Cho, Xiaodong Zhong, Masahito Hirota, Juri Hori, Suam Kim, Thomas Therriault, Mitsutaku Makino (co-author of this article) and Jay Nam.

The overall objective, endorsed by the UN General Assembly in UNGA Resolution 64/71 (2009), paragraph 177, is that:

- "The regular process under the United Nations would be recognized as the global mechanism for reviewing the state of the marine environment, including socioeconomic aspects, on a continual and systematic basis by providing regular assessments at the global and supraregional levels and an integrated view of environmental, economic, and social aspects.
- Such assessments would support informed decision-making and thus contribute to managing in a sustainable manner human activities that affect the oceans and seas, in accordance with international law, including the United Nations Convention on the Law of the Sea and other applicable international instruments and initiatives.
- The regular process would facilitate the identification of trends and enable appropriate responses by States and competent regional and international organizations.
- The regular process would promote and facilitate the full participation of developing countries in all of its activities. Ecosystem approaches would be recognized as a useful framework for conducting fully integrated assessments.

national workforce averages); (7) income to fishers (absolute and relative to national workforce averages); (8) the number of fishing ports; (9) the number of fish processing plants; (10) the number of fishing villages or communities; (11) the number of fishing households; (12) per capita consumption of seaweeds, fish, shellfish, and other invertebrates; and (13) the amount and value of seafood (seaweeds, fish, shellfish, and other invertebrates) exports and imports. In addition, Rashid Sumaila (Fisheries Centre, University of British Columbia, Canada), has offered to query his database on global fisheries to derive North Pacific estimates of time series of: (1) the number of sport fishers and the quantity of their catches; (2) fishing costs as a percentage of revenues; (3) fishing subsidies; (4) fishing effort by gear type; (5) the number of commercial fisheries; and (6) value added multipliers for fishing and processing. One advantage of these data is that they are all collected using the same methods among countries, and so are directly comparable. Other time series of interest as indicators (*e.g.*, exvessel prices) can be derived from these data.

Having Alan Simcock as a representative of the WOA Group of Experts was extremely useful as it opened the dialogue between PICES and the UN Regular Process and allowed information to flow in both directions. The goals of the WOA (see box) were presented on Day 1. The selection of key indicators for the NPESR led naturally, on Day 3, to a focused discussion with Alan about WOA needs for human dimensions data that extend beyond the above listed key indicators. The timing of the first WOA (this assessment is to be completed in 2014) limits the extent to which PICES can offer specific scientific advice. Moreover, because the WOA is intended to provide a high-level overview, much of the detailed understanding we within PICES feel is important to capture will be lost to some extent in "global roll-ups". Nevertheless, through the NPESR as augmented by human dimensions indicators, PICES is well positioned to make valuable contributions to future iterations of the WOA. While PICES is not able to host formal UN meetings (that must be done by UN member states), other meetings such as this workshop provide critical information in support of UN processes (not only WOA but also the Convention on Biological Diversity Ecologically and Biologically Sensitive Areas process earlier this year; see the article by Thomas Therriault on this meeting elsewhere in this issue of PICES Press) and access to a network of scientific experts within PICES with unparalleled knowledge of North Pacific marine ecosystems. Nevertheless, some recognition of this by the UN might allow PICES to formally engage in these activities. For example, with sufficient lead-time, PICES could establish *ad-hoc* expert groups to review, compile, and synthesize key information/data. Due to the tight timelines and need to constrain its scope, our workshop focused primarily on fishing-related activities in the North Pacific. Clearly, however, within PICES we have considerable scientific understanding of other human activities that could be explored in future meetings.

The North Pacific region includes global leaders in the production and consumption of seafoods. While important strides have been made in assuring that North Pacific capture fisheries do not exceed sustainable levels and that growth in aquaculture is guided by principles of sustainability, by themselves, these accomplishments do not ensure the sustainability of the human side of the North Pacific marine social-ecological system. The indicators identified during this workshop will help provide a synopsis of the status and trends in human dimensions of the North Pacific ecosystem.

Dr. Keith Criddle (keith.criddle@alaska.edu; see group photo on p. 12) 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 of Marine Systems.

Dr. Mitsutaku Makino (mmakino@affrc.go.jp; see group photo on p. 12) co-chairs the Section on Human Dimensions of Marine Systems (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 p. 18 for details).

The Fourth International Jellyfish Bloom Symposium

by Shin-ichi Uye and Richard Brodeur

The participants of the 4th International Jellyfish Bloom Symposium (June 5–7, 2013, Hiroshima, Japan).

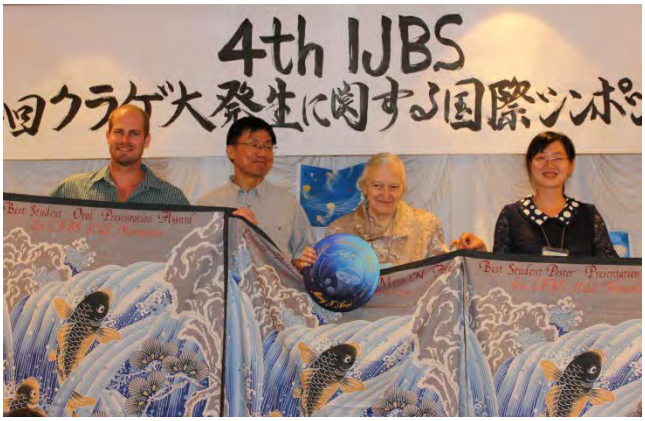
Following the initial meeting in Alabama (U.S.A.) in 2000, and subsequent meetings in Gold Coast (Australia) in 2008 and Mar del Plata (Argentina) in 2010, the 4th International Jellyfish Bloom Symposium was held June 5–7, 2013, in Hiroshima, Japan. Given the importance of jellyfish blooms to the North Pacific, PICES served as a co-sponsor of this event through its established Working Group on *Jellyfish Blooms around the North Pacific Rim: Causes and Consequence* (WG 26) and provided logistical and financial support for the symposium.

The symposium was a great success, attracting over 120 scientists from 29 countries and 5 continents. Following opening remarks by the symposium organizer and WG 26 Co-Chairman, Dr. Shin-ichi Uye (Hiroshima University, Japan), Dr. Larry Madin (Woods Hole Oceanographic Institution, U.S.A.) presented a comprehensive overview of the major taxonomic groups comprising this diverse group, along with a history of the sampling and utilization of jellyfish over time. He noted the importance of understanding the beneficial services that jellyfish provide to humans that are often overlooked in the media.

A second keynote talk given by Dr. Rob Condon (Dauphin Island Sea Laboratory, University of South Alabama, U.S.A.) described some of the progress achieved by the international Global Jellyfish Group sponsored by the National Center for Ecological Synthesis (NCEAS, U.S.A.) which completed its formal activities this past year. A key product of this working group was the establishment of the Jellyfish Data Initiative (JEDI), which provides a repository for most of the jellyfish historical abundance and distribution time series worldwide. Using this database, Rob led several studies examining the long-term trends in jellyfish blooms around the globe which not only indicate some recent increases in many regions, but also an underlying multi-decadal oscillation which inhibits drawing firm conclusions until the time series are suitably extended.

A final invited talk was provided by Dr. José Acuna (Oveido University, Spain) on the adaptations that jellyfish have evolved to make them efficient consumers in the marine environment on a similar scale as the fishes, despite being greater than 95% body water content. He also stressed the diversity of feeding modes in the gelatinous zooplankton that have allowed them to be so successful over time.

Plenary talk on gelatinous zooplankton by Larry Madin (Woods Hole Oceanographic Institute, U.S.A.).



At the Award Presentation Ceremony (from left to right): Christopher Mooney (Best Student Oral Presentation Award), Dr. Shin-ichi Uye, a grandmother of jellyfish study, Dr. Mary Arai (Lifetime Achievement Award), and Zhilu Fu (Best Student Poster Presentation Award).

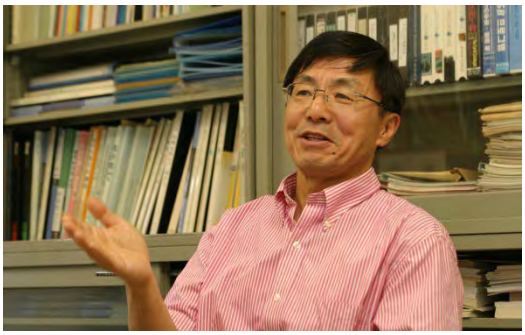
The symposium also consisted of nine sessions dealing with such diverse topics as physiology, production, growth, reproduction, and feeding dynamics (http://home.hiroshima-u.ac.jp/ijfs/program.html). It culminated in a series of presentations highlighting the impacts that jellyfish blooms have on human enterprises including not only the negative aspects of preying on or competing with fish of ecological or commercial importance, but also stressing their beneficial aspects including their role in sequestering CO_2 to the deep ocean and provisioning of food resources to humans, especially within many PICES member countries.

In addition to the scientific accomplishment of the symposium, the participants were able to enjoy the many local Japanese cultural and culinary delights of the Hiroshima region, including a post-meeting excursion to Miyajima, a World Heritage site located nearby.

The Award Presentation Ceremony took place during the symposium reception which followed the field trip. A Lifetime Achievement Award was presented to Dr. Mary Arai (Department of Fisheries and Oceans, Canada; retired) for her outstanding contributions to the taxonomic and ecological body of knowledge available for the gelatinous taxa. Two Best Student Presentation Awards were given to Christopher Mooney (James Cook University, Australia) for his talk on "Experimental calibration of elemental incorporation into *Chironex fleckeri* statoliths resulting from changes in salinity" and to Zhilu Fu (Hiroshima University, Japan) for her poster on "Point-of-no-return in ephyrae of the moon jellyfish *Aurelia aurita*".

The meeting was a complete success and the participants are already looking forward to the 5th International Jellyfish Bloom Symposium slated to be held in 2016, in Barcelona, Spain.

The symposium elevated the status of the PICES WG 26 worldwide. The Working Group also held a 1-day inter-sessional meeting in advance of the symposium (on June 4) to take advantage of the expertise coming to the meeting, to present reports on new topics and achievements in jellyfish bloom research in PICES member countries, and also move forward on the WG 26 final report. The draft of this report is expected to be completed by the end of this year.



Dr. Shin-ichi Uye (suye@hiroshima-u.ac.jp) is a Professor of biological oceanography at Hiroshima University. Shin-ichi is currently involved in two Japanese jellyfish research projects: Studies on Prediction and Control of Jellyfish Outbreak (STOPJELLY) and the China-Japan-Korea International Project on the Giant Jellyfish Bloom. He was former President of the Plankton Society of Japan (2001–2004) and former President of the World Association of Copepodologists (2005–2008). Shin-ichi was awarded the Oceanographic Society of Japan Prize in 2010 for his advancement of zooplankton research, particularly on their functional roles in coastal marine ecosystems. Shin-ichi now serves as a Co-Chairman of the PICES Working Group on Jellyfish Blooms around the North Pacific Rim: Causes and Consequence.

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

Workshop on Radionuclide Science and Environmental Quality in the North Pacific

by Yusheng Zhang, Wen Yu and Hongzhi Li

The participants of the PICES/SOA workshop on "Radionuclide science and environmental quality of radiation in the North Pacific" (March 14–15, 2013, Xiamen, People's Republic of China).

This was the first opportunity for the PICES Study Group on *Radionuclide Science and Environmental Quality of Radiation in the North Pacific* (SG-RS) to meet. The workshop was jointly sponsored by PICES and the State Oceanic Administration (SOA) of China and organized by the Third Institute of Oceanography (TIO/SOA) from March 14–15, 2013, in Xiamen. It was led by Dr. Yusheng Zhang (SG-RS Chairman), Mr. Chuanlin Huo (Marine Environmental Quality (MEQ) Committee Chairman), and Dr. Sinjae Yoo (Science Board Chairman). A total of 20 participants attended the workshop, including 8 SG-RS members from 5 PICES member countries: Canada, China, Japan, Korea and the United States. The International Atomic Energy Agency (IAEA) was represented by the IAEA/RCA project leading country coordinator, Dr. Ronald Szymczak (Australia).

The objectives of the workshop were:

- to review research on marine radiation in each PICES member country;
- to exchange views on how to develop a scientific focus within PICES to understand the quantities and distributions of radionuclides in the North Pacific, and
- to refine the Terms of Reference (TORs) and work plan for a new PICES Working Group on *Assessment of Marine Environmental Quality of Radiation around the North Pacific* (WG-AMR), under MEQ as Parent Committee.

The outcome from this workshop is intended to provide a sound foundation for the establishment of WG-AMR in the near future.

In his introductory remarks, Dr. Yusheng Zhang pointed out that the widespread application of nuclear science and technology as well as a recent nuclear power plant accident had led to increasing amounts of radionuclides released into the North Pacific. Radionuclides with long half-lives could potentially endanger the marine ecosystem and human health through exposures *via* the food chain. Consequently, it is important to monitor the radiation exposure level and to assess the effects of radioactive substances on marine ecosystems in the North Pacific waters. This was the rationale behind China's proposal at the 2012 PICES Annual Meeting (Hiroshima, Japan) to establish the SG-RS that would make preparations for the future establishment of the WG-AMR. The envisioned working group aims to exchange technologies and share experiences in monitoring radioactive contaminants in North Pacific waters, to assess the radiation effects and radiological risks in these waters and to promote the public understanding of radiation effects. The proposal to form the SG-RS garnered positive support from all PICES member countries and was approved by the Science Board and the Governing Council of PICES.

Dr. Sinjae Yoo and Mr. Chuanlin Huo were invited to make a presentation about the current PICES integrative science program, FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) and the MEQ Action Plan. Thereafter, the participants discussed and refined the Terms of Reference for the proposed WG-AMR, including their relevance to FUTURE.

The workshop in session.

Facing from left: Mr. Chuanlin Huo (MEQ Chairman), Dr. Sinjae Yoo (Science Board Chairman), Dr. Yusheng Zhang (SG-RS Chairman), and Dr. Jian Chen (Director of Division of International Cooperation, TIO).

Following an active discussion, the TORs for the proposed WG-AMR were refined and agreed upon by all the members as follows:

1. To compare and analyze radiological doses to North Pacific marine organisms from natural and anthropogenic radionuclides in a post-Fukushima world.
2. To examine the utility of applying natural and artificial (from Fukushima and other sources) radionuclides as tracers of circulation, ecological transfers and biogeo-chemical cycling in the North Pacific (and downstream, *e.g.*, Arctic) environments undergoing modification by climate change.
3. To determine the state of the science with respect to the assessment and mitigation of radiological impacts to marine organisms from natural and anthropogenic releases of radionuclides into the marine environment.
4. To contribute to FUTURE by producing status reports for items 1–3 above, management related guidelines and/or technical manuals.
5. To foster collaboration with other expert groups to achieve the goals of items 1–3.
6. To identify priority research requirements for knowledge gaps identified in items 1–3, the planned expansion of nuclear facilities and other emerging issues in the PICES region.
7. To promote collaboration among PICES member countries and international organizations in the exchange of information on environmental radioactivity and encourage joint surveys/research among PICES member countries.

Participants discussed a 3-year work plan for the proposed working group and explored possible ways to fund the activities. A detailed work plan will be included in the 2013 Annual Report.

A list of the possible WG-AMR members developed in two weeks after the workshop includes the following scientists: John N. Smith (Canada), Hongzhi Li, Wen Yu and Yusheng Zhang (China), Takami Morita, Tsuneo Ono and Tomowo Watanabe (Japan), Gi-Hoon Hong and Suk Hyun Kim (Korea), Vladimir Goryachev (Russia) and Kathryn A. Higley (USA).

The SG-RS report and the proposal to establish WG-AMR, including the Terms of Reference, the work plan and potential members were presented and reviewed at the 2013 inter-sessional Science Board meeting held May 20–21 in St. Petersburg, Russia.

Dr. Yusheng Zhang (ys.zhang@163.com), a senior scientist from the Third Institute of Oceanography, State Oceanic Administration (SOA) of China, has been interested in radioecology and biological effects of marine pollutants on marine organisms and ecosystems. Since 2007, he has been working as a National Project Coordinator of IAEA/RCA projects. Within PICES, Dr. Zhang has been serving as the SG-RS chairman since January 2013.

Dr. Wen Yu (yuwen2001@gmail.com) is a scientific researcher at the Third Institute of Oceanography, State Oceanic Administration of China. She has a broad range of research interests related to marine biota radiation dosimetry, the destiny of radionuclides in marine species and radio-isotope application. Dr. Yu is a National Project Coordinator of the IAEA Fukushima marine impact program. She has been a member of the SG-RS since January 2013,

Mr. Hongzhi Li (lihongzhi6535@126.com) is the Director of the Department of Marine Measurement Sensor Technology at the National Oceanic Technology Center, State Oceanic Administration of China. His research focuses on marine sensor technology, model and application for monitoring of marine pollutants, as well as data processing. He has been a SG-RS member since January 2013.

PICES-MAFF Project on Marine Ecosystem Health and Human Well-Being: Indonesia Workshop

by Mitsutaku Makino

Background

In April 2012, PICES began a 5-year project on *Marine Ecosystem Health and Human Well-Being* funded by the Ministry of Agriculture Forestry and Fisheries of Japan (MAFF). The goal of the project is to identify relationships between sustainable human communities and productive marine ecosystems in the North Pacific under the concept of fishery social-ecological systems. In Japan, this concept is known as the *sato-umi* fisheries management system. It recognizes that global changes are affecting both climate and human social and economic conditions. Key questions of the project are: a) How do marine ecosystems support human well-being? and b) How do human communities support sustainable and productive marine ecosystems? The project will be directed by a Project Team, co-chaired by Drs. Mitsutaku Makino (Fisheries Research Agency, Japan) and Ian Perry (Fisheries and Oceans Canada).

At its first meeting (October 11, 2012, in Hiroshima, Japan), the Project Team decided to conduct two workshops in developing countries in each of three regions of the North Pacific (Southeast Asia, Pacific oceanic islands, and Central America). Indonesia was selected because of its large population and aquaculture-intensive industry. Palau was chosen because of its focus on finfish capture fisheries and its existing networks of community-based fisheries. Finally, Guatemala was selected because its coastline features an upwelling system favourable for finfish fisheries and aquaculture.

GEMPITA-SPL concept in Indonesia

The Indonesian Agency for the Assessment and Application of Technology (BPPT) has developed a concept of managing coastal and marine resources in a balanced, harmonious, integrated, and productive environment by actively involving the community. Their concept is called GEMPITA-SPL (Gerakkan Masyarakat Peduli Kelestarian Sumberdaya Perikanan, Pesisir dan Laut) or in the English language version as SFiCoMS (Sustainable Utilization of Fisheries, Coastal and Marine Resources for the Society). The GEMPITA-SPL concept has been implemented in the northern coastal area of West Java by BPPT and the local Department of Fisheries and Marine Affairs. It fosters the development and promotion of environmentally friendly aquaculture technology using Integrated Multi-Trophic Aquaculture (IMTA). This approach features concepts of bio-recycling in idle and/or marginal brackish water ponds in the northern part of western Java. Coastal areas that had been damaged by shrimp monoculture are being transformed into productive systems that feature a balanced and harmonious approach and greater biodiversity to improve the welfare of local communities. This concept fits very well within the framework of fishery social-ecological systems in the PICES-MAFF project.

Indonesia workshop

The first PICES-MAFF project workshop was held on March 13–14, 2013, with a total of 93 participants from Indonesia, Japan, and the United States of America. Indonesia was represented by the Ministry of Marine Affairs and Fisheries, Ministry of Research and Technology, Ministry of Environment, Ministry of Public Works, Coordinating Ministry for the Economy, Finance and Industry, Coordinating Ministry for People's Welfare, Ministry of Development of Disadvantaged Areas, Ministry for National Development Planning, Food Security Agency of the Ministry of Agriculture, Bandung Institute of Technology, Bogor Agriculture University, and local governments. The objectives of the workshop were:

- To develop the contents of a manual that will describe GEMPITA-SPL experiences in Java province according to local conditions in some candidate sites;
- To assess the utility of PICES' scientific tools for enhancing the human well-being of local communities and for rehabilitating coastal ecosystems in some candidate sites.

The first day of the workshop was spent at the Main Commission Hall of BPPT headquarters in Jakarta. It started with a welcome by Ms. Nenie Yustiningsih (Director of the Center for Agricultural Production Technology of BPPT),

Dr. Mitsutaku Makino (mmakino@affrc.go.jp) co-chairs the PICES Section on Human Dimensions of Marine Ecosystems and co-leads the PICES-MAFF project on "Marine ecosystem health and human well-being". His major scientific interests are 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 the IUCN Commission of Ecosystem Management (CEM) Fisheries Expert Group (FEG), IMBER Human Dimension Working Group, United Nations 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.

Fig. 1 Dr. Mitsutaku Makino giving opening remarks and introduction at the PICES-MAFF workshop in Jakarta, Indonesia.

Fig. 2 Panel discussion including participation by Drs. Masahito Hirota (far left) and Mark Wells (center).

followed by opening remarks and introduction by Dr. Makino (Fig. 1). The keynote speech was made by Professor Tetsuo Yanagi from Kyushu University, Japan. The opening of the workshop was declared by Dr. Listyani Wijayanti (Deputy Chairman of BPPT). A total of 10 presentations were given on this day. A Project Team member, Dr. Mark Wells (University of Maine, U.S.A.; Fig. 2) described previous activities of PICES in Indonesia and suggested ways that PICES science can support GEMPITA-SPL. Another member of the Project Team, Dr. Masahito Hirota (National Research Institute of Fisheries Science, Fisheries Research Agency, Japan) talked about how PICES scientific tools can support the analysis of well-being in the coastal societies (Fig. 2).

The second day featured a field trip to the Karawan area of West Java, where the BPPT has developed GEMPITA-SPL. Participants visited the Center for Brackishwater and Marine Culture of West Java Province and the National Center for Brackishwater Aquaculture to observe aquaculture ponds that applied the GEMPITA-SPL approach, and had discussions with local stakeholders (fishers, managers, *etc*.).

The workshop attracted serious attention from the Indonesian media, with many reports appearing in newspapers, on TV and web news (Fig. 3).

Results and next steps

Discussions following the workshop led to the idea of a Letter of Intent (LOI) between PICES and BPPT to recognize the benefits to their respective institutions of establishing international links (Fig. 3). The second output was a draft list of parameters to assess GEMPITA-SPL performance. In close coordination with Indonesian scientists, PICES scientists will support the assessment of these parameters in sample ponds where GEMPITA-SPL has been implemented. A table of contents for a GEMPITA-SPL manual was drafted to facilitate the dissemination of GEMPITA-SPL activities in Indonesia. These will be discussed at the second meeting of the PICES-MAFF Project Team to be held June 11–12, 2013, in Honolulu. Based on the advice and comments from this meeting, a second Indonesian workshop will be held around March 2014.

Fig. 3 Media report about the LOI signing ceremony involving Dr. Makino and Dr. Listyani (BPPT Vice Chairman).

Socioeconomic Indicators for United States Fisheries and Fishing Communities

by Ronald Felthoven and Stephen Kasperski

Introduction

Over the past decade, the Fisheries Division of the U.S. National Oceanic and Atmospheric Administration (NOAA Fisheries) has prioritized the need to collect and compile information on the fisheries it manages and the communities that are engaged in or dependent upon those fisheries. Social scientists within NOAA Fisheries have been working with regional fishery management councils (Councils) to institutionalize cost and earnings data collections for fishery participants using primary data collections, and to better inform trends in social well-being in relevant communities by conducting field work to gather primary data and better utilize existing secondary data gathered by other agencies. Nascent efforts in each region have varied according to the degree of funding, personnel, and industry cooperation available, and have often worked to characterize populations and issues most germane to their particular fishery management questions. As the data needed to support more complete and sophisticated social science have improved, so have the analytical techniques utilized by researchers within the agency.

In the past few years, NOAA leadership has made it a priority to coordinate with regional scientists to define the most practical and useful indicators that can be developed for the bulk of our fisheries and associated communities, with an eye toward a national status report. Ideally, we could define baseline levels for these indicators and examine how they respond to future perturbations in management, markets, and the environment. The impetus for defining baseline social indicators for fisheries stems not only from improvements in data availability, but also from our desire to better understand the ways in which our policies are affecting stakeholders. In particular, the formal adoption of a policy to implement catch-share management in many of our fisheries, and the requirements of federal laws such as the re-authorized Magnuson-Stevens Fishery Management and Conservation Act (MSA) to assess the impacts of those policies, makes the construction of metrics to track socioeconomic impacts over time more important and timely than ever. This article briefly describes the metrics NOAA Fisheries has constructed, and is planning to construct in coming years, to characterize changes in the socioeconomic health of fisheries and well-being of fishing communities.

Fishery performance indicators

NOAA Fisheries' Office of Science and Technology initiated development of a national set of fishery performance indicators by convening workshops that included economists, anthropologists, and sociologists from each region of the country. The initial scope of the workshops was to identify changes in performance in fisheries managed by catch shares, although the indicators have also been computed for several non-catch share fisheries and will be expanded to nearly all federally managed fisheries in the future. Regional experts identified a substantial number of potential indicators characterizing many aspects of fishery performance that were subsequently classified as being Tier 1, Tier 2, or Tier 3 metrics based on data availability, usefulness, and relative ease in quantifying each indicator. *Tier 1* indicators were defined as metrics for which data were readily available, could be routinely produced and updated, and could be provided for most catch share programs. *Tier 2* indicators were defined as metrics that could be produced using available data, but required additional research before they could be routinely produced. *Tier 3* indicators were determined to be measures that would require large investments in research or new data collection programs. As research and data collection progresses, performance indicators in Tier 2 and Tier 3 will be moved up to Tier 1. To date we have produced a set of Tier 1 performance indicators for all catch share fisheries, which include metrics for catch and landings, fishing effort, and revenue (Table 1).

Tier 1 catch and landings indicators include the quota allocated to the program or Annual Catch Limit (ACL), landings, whether the quota allocated to the program or ACL has been exceeded, and the percentage of the available quota that has been utilized. Although changes in quota or ACL are used as an indicator, quotas are based on biological conditions that may be increased or reduced independent of any particular management program (*e.g.*, catch shares). However, catch share programs are typically accompanied by increased monitoring of catches at the vessel or shareholder level. This improvement in catch accounting means that ACLs may be less likely to be exceeded under a catch share program. Similarly, the percent of ACL used may increase under catch share programs, particularly if the fishery had been closed due to bycatch limits and the catch share program includes bycatch allocations or reduction incentives.

Fishing effort indicators include the number of entities that hold shares, the number of active vessels, season length, number of trips, and time spent at sea. Some of the effort data are used to convey information on changes in fishing capacity. Councils frequently note the need to reduce capacity and end the race to fish when implementing catch share programs. Two dimensions that often change drastically after introducing catch share management are

the number of active vessels and season length. However, Councils may also be concerned with accumulation of quota shares among fewer owners or geographic consolidation, which can lead to social dislocation and changes in the vocational structure and opportunities of a community. Tier 1 indicators also include information on whether excessive share accumulation limits have been set, and report the amount of fees collected for cost recovery purposes. Quantifying the number of entities holding shares, as well as noting the presence or absence of an accumulation cap, is a useful step toward examining the degree of ownership accumulation in catch share programs.

The effort indicators also describe the size of the temporal window in which the fishery is prosecuted, which can generate both biological and market repercussions. Extending the length of the fishing season is often cited as a Council objective associated with the transition to catch shares; longer seasons often imply improved timing on the marketing and sale of seafood products as well as improving vessel safety, as fishermen may choose when and where to fish as weather conditions allow. In this regard, season length needs to be interpreted in conjunction with other indicators of improved economic performance or vessel safety and not necessarily as a stand-alone indicator. Although the current set of catch share indicators does not include any specific measure for vessel safety, an in-depth study of changes in accident rates was conducted as part of the 5-year review undertaken by the North Pacific Fishery Management Council for the Bering Sea and Aleutian Islands Crab IFQ Program. That study found that the longer fishing season resulted in a number of changes to the operational manner in which the fishery was prosecuted, leading to safer working conditions for crew and participating vessels (https://alaskafisheries.noaa.gov/npfmc/PDFdocuments/catch_shares/Crab/5YearRev1210.pdf).

A set of landings revenue indicators is also computed to convey changes in the economic returns of the fishery. Revenue indicators include total annual revenues from all species in the catch share program, aggregate revenues received from non-catch share program species while on a fishing trip where catch share species were landed, as well as aggregate revenues derived from non-catch share program species on all other trips. Although profit or "net revenues" is a more desirable metric, data limitations preclude computing this in most federally managed fisheries. Interpreting revenue trends without knowing how costs have changed can be a bit dicey, and since fishing revenues are the joint realization of both landed quantity and market

Table 1 Definitions for Tier 1 performance indicators of catch share programs.

Indicators	Definitions
Catch and Landings	
Allocated quota	Annual quota of combined catch share program species, in terms of weight
Aggregate landings	Annual total weight of combined catch share program species generated by vessels that fish quota
ACL exceeded (Y/N)	Was the ACL exceeded for any species/stock within the catch share program? (Y/N)
% Utilization	Portion of target species TAC that is caught and retained within a fishing year; aggregate landings/quota allocated to catch share program
Fishing effort	
Entities holding share	Annual total number of entities/individuals/vessel owners/permit holders receiving quota share at the beginning of the year
Active vessels	Annual number of vessels that fish quota and landing one or more pounds of any catch share program species
Season length	Number of days per calendar year or fishing year, as defined above, that the catch share program fishery is open
Trips	Annual total number of trips taken by vessels fishing quota on which one or more pounds of any catch share program species were landed
Days at sea	Annual total number of days absent on trips taken by vessels fishing quota on which one or more pounds of any catch share program species were landed
Landing revenue	
Aggregate revenue from catch share species	Annual total ex-vessel revenue of combined catch share program species generated by vessels that fish quota
Aggregate revenue from non-catch share species	Aggregate ex-vessel revenue from non-catch share species caught on catch share program trips
Non-catch share revenue	Aggregate ex-vessel revenue from non-catch share species on all non-catch share program trips
Average price	Aggregate ex-vessel revenue from catch share species/aggregate landings
Revenue per active vessel	Aggregate ex-vessel revenue/active vessels
Revenue per trip	Aggregate ex-vessel revenue/trip
Revenue per day at sea	Aggregate ex-vessel revenue/day at sea
Other	
Cost recovery fee	Amount collected for cost recovery
Share cap in place (Y/N)	An ownership share and/or allocation cap is any measure consistent with the MSA LAPP purpose and intent whether or not the catch share program is required to have an excessive share cap (Y/N)

demand, some counterintuitive patterns can arise in the indicators without a clear reason for the trend. If the market price were only affected by harvested quantities of catch share species, then price changes would be a consistent inverse indicator of catch share landings; prices would increase as catch share landings decline and prices would decrease as catch share landings increase. However, prices are affected not only by factors attributable to catch shares, but are also affected by external factors such as changing supplies of species that may be market substitutes for catch share species, international markets, changes in consumer preferences, and income.

In addition to the direct computation of revenues, we also calculate a set of derived indicators such as revenue per vessel, revenue per trip, and revenue per day. Each of these indicators combines two indicators to calculate an average. In each case the numerator is total revenue which may be subject to the same uncertainties noted above for price. The denominator of each of these indicators is a measure of input required (boats, trips, days) to produce total catch share revenues. As such, they are each proxies for economic efficiency or productivity, albeit crude. A more direct indicator of efficiency would require information on input use and/or operating costs.

One of the primary difficulties in interpreting nearly the all of the indicators in the context of "catch share performance" is that many changes have occurred in fisheries aside from the introduction of catch shares. Lacking a natural experiment, sophisticated models are often required to effectively isolate the impact of catch shares programs in any given fishery. Many of the performance indictors we are developing reflect influences beyond those attributable to a catch share program. In most cases, one must have some basic understanding of the fishery and related markets in order to properly interpret and source observed trends. As such, although the indicators present a reduced form presentation of a lot of information, appropriate use and understanding of the indicators necessitates a careful read of the narrative accompanying the indicators. This makes the production of annual reports relatively time consuming, as the supporting narrative benefits from input and information gathered from a broad swath of scientists and fishery management staff who understand the different dimensions reflected in the suite of indicators.

Community vulnerability and resiliency indicators

In addition to the fishery-based indicators discussed above, social scientists within NOAA Fisheries are developing community-based indicators of vulnerability and resiliency. Vulnerability is generally defined as a community's exposure to experience impacts from a hazard event or other disturbance, and the sensitivity of the community to that type of hazard event or other disturbance. Resiliency refers to the capacity for communities to adapt successfully to changes caused by a disturbance, but not necessarily returning to their pre-disturbance characteristics. By classifying the type of vulnerability and resiliency exhibited by communities, scientists can give better advice on coping or mitigation strategies to alter a community's risk or exposure profile.

These community-based indicators provide a pragmatic approach toward standardization of data and analysis for assessment of some of the long–term effects of management actions on fishing communities. Historically, the ability to conduct such analysis has been limited due to the lack of quantitative social data. The use of indicators to monitor sustainability and other measures of well-being within marine fisheries has been promoted within international fisheries management (Garcia and Staples, 2000) and there have been some cases of its use within U.S. fisheries, mainly in the Southeast (Jepson and Jacob, 2007; Jacob and Jepson, 2009; Jacob *et al.*, 2010; 2013). These social indices are intended to improve the analytical rigor of fisheries Social Impact Assessments (SIA), through analysis of adherence to National Standard 8 of the MSA and Executive Order 12898 on Environmental Justice in components of Environmental Impact Statements. Given the short time frame in which such analyses are often conducted, an advantage to this approach is that the majority of the data used to construct these indices is readily accessible secondary data and can be compiled quickly to create measures of social vulnerability and to update community profiles.

Following the SIA work of Pollnac *et al*. (2006), NOAA social scientists have jointly developed these vulnerability and resiliency indicators for the Southeast and Northeast regions of the U.S. The Pacific Islands, Pacific, and North Pacific regions of the U.S. are now conducting similar work, albeit with slightly different data that are unique to their particular region. Once all of the regions around the U.S. have produced their regional indicators, national-level indicators of community vulnerability and resiliency will be developed to explore general characteristics of a community that make it more or less vulnerable and resilient. As this is an evolving process, once the national or regional vulnerability and resiliency indicators are developed, it is important to incorporate community stakeholder feedback through a ground-truthing exercise, as in Smith *et al*. (2011), where researchers visit a selection of communities to assess the appropriateness and adequacy the current set of vulnerability indicators. This ground-truthing process serves as a test of the external validity of the results through in-community education and outreach.

It would be ideal to be able to recreate these indicators annually so that changes in fisheries, fisheries management, and other factors that affect communities are taken into account. However, non-fisheries secondary data used to create the social indicators primarily come from the American Community Survey (ACS) of the U.S. Census Bureau. The ACS does not provide annual statistics for communities with populations less than 65,000, which eliminates many fishing communities in the U.S., but does

provide annual 3-year estimates of places with populations greater than 20,000, and annual 5-year estimates for all areas. Therefore, to incorporate the same data for all communities, the 5-year estimates of secondary data (from 2005–2009) are used to create the social indicators. As the multi-year averages should not be compared from one year to the next due to 4 years of data overlapping between the annual 5-year estimates, the second observation that can be used to compare with the original social indicators under development will be the 2010–2014 5-year estimates from the ACS.

Next steps

A national report defining and summarizing fishery performance indicators has been drafted by the Office of Science and Technology and is currently undergoing internal review prior to publication. As we begin to construct the Tier 1 indicators for a greater number of non-catch share fisheries, we anticipate developing a report summarizing those trends as well. NOAA Fisheries social scientists will continue to conduct vulnerability and resiliency studies in a greater number of regions, and will begin ground-truthing those indicators with input from community members in regions where work has already been undertaken. We also plan to add new metrics to the suite of performance indicators in the next year, including Gini coefficients to convey information about the distribution and concentration of revenues, and productivity measures that were recommended by a productivity measurement working group (Mamula and Walden, 2013). Some researchers such as Himes-Cornell and Kasperski (in prep.) are also working to extend the community vulnerability and resiliency framework to incorporate other sources of change that affect communities, such as impacts from climate change in Alaska. Working groups have also been established to improve and better utilize the information currently gathered on quota leases and sales. Such data can be very informative regarding trends in overall fishery profitability, as long as the reported prices control for in-kind compensation or other factors that must be considered along with the reported prices. Many of the catch share programs allocate quota directly to cooperatives which can freely trade quotas among members without requirements to report pricing to NOAA. While this eases the administrative burden on industry, we lose the potential to observe a summary statistic representing fishery profitability and its trends.

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Dr. Ronald Felthoven (Ron.Felthoven@noaa.gov, left) is an economist and program manager for the Economic and Social Sciences Research group at the Alaska Fisheries Science Center (National Marine Fisheries Service) in Seattle, WA. His research focuses on the measurement of economic performance in commercial fisheries. In particular, Ron has evaluated changes in fishing capacity, efficiency and productivity following the transition of the pollock and crab fisheries to catch share programs. He has been involved extensively in developing new data collections to support fishery evaluation and is currently serving on the newly formed PICES Section on Human Dimensions as well as other national working groups that are developing fishery performance metrics.

Dr. Stephen Kasperski (Stephen.Kasperski@noaa.gov, right) is an industry economist at the Alaska Fisheries Science Center of the National Marine Fisheries Service (NMFS). His research explores the economics of ecosystem-based management, the economic and social impacts of fisheries management decisions, and risk management strategies for fishermen and fishing communities. Stephen currently serves on six NMFS working groups, including integrated ecosystem assessments, social indicators of community well-being, dealer and processor information, and three related to U.S. catch share policies.

Harmful Algal Blooms in a Changing World

by Mark Wells

There are projections that climate change will lead to increases in the frequency and severity of harmful algal blooms (HABs). Indeed, there is evidence that climate change already may be causing shifts in phytoplankton community composition, but the projections of a climate-increasing HAB impact remain speculative. Although there are many intuitive linkages, these scenarios are founded on limited and often conflicting experimental data. Moreover, the few longer-term datasets that exist on HAB events in almost all cases lack the oceanographic data essential for statistical assessment. So scientific debate cannot establish a link between HABs and climate change at this time, let alone forecast regional HAB changes in the future. It is critical that HAB scientists proactively identify the fundamental parameters and research infrastructure required to effectively address this important question if we are to inform when called upon to forecast or explain changing HAB patterns.

PICES, ICES (International Council for the Exploration of the Sea; http://www.ices.dk), GEOHAB (IOC/SCOR Global Ecology and Oceanography of Harmful Algal Blooms Research Program; http://www.geohab.info/) and NOAA (U.S. National Oceanic and Atmospheric Administration), with funding provided through PICES, GEOHAB and NOAA, convened a workshop of invited international experts (11 participants from 5 countries; Fig. 1) to develop an assessment of where the field of HAB research stands in terms of addressing HAB/climate change linkages, and what research is needed to move forward on these questions over the next decade. This workshop was held on March 18–22, 2013, at the Whiteley Center, Friday Harbor Laboratories, University of Washington (Figs. 2 and 3), and co-chaired by Mark Wells (PICES), Bengt Karlson (ICES) and Raphael Kudela (GEOHAB).

Three broad classes of HABs were considered: *toxic* HABs that impact human health, *fish-killing* HABs where the causative organisms affect both wild and aquaculture fish populations, and *high-biomass* HABs, whether derived by natural or anthropogenic processes leading to hypoxia, foam causing bird deaths, and other negative impacts. The key underlying consideration surrounding changes in the distribution of HABs is three-pronged: HAB species "getting there", being adapted well enough to "remain there" over the course of the season, and ultimately "staying there" for multiple seasons.

The deliberations focused on the observed and predicted climate changes in the physical and chemical conditions in aquatic systems identified in the AR4 IPCC Synthesis Report on climate change, and what is known about these effects on the physiology of HAB species as well as general phytoplankton. The core questions were:

- What do we know about how the given parameter affects HAB species?
- What do we not know of importance in terms of these parameters impacts? and
- Which of these unknowns are the most pressing questions and how should we go about addressing them?

The factors considered included: temperature, with its effects on cellular growth rates, nutrient uptake rates, toxin production and cellular lipid compositions, and stratification, with its impact on vertical nutrient flux, physical and chemical stability of the system, and the prolonging of HAB windows of opportunity. Similarly, the effect of ocean acidification was examined in terms of success of HAB species and cellular toxin synthesis and accumulation, as well as consideration of the effects from altered nutrient inputs associated with changing precipitation characteristics (*e.g.*, pulsed terrestrial riverine flows) and facilitated transport of culturally-derived nutrients. While each of these four broad parameters have known impacts on HAB species, it will be the synergistic interactions among these drivers that will determine the overall impact on HAB species success in phytoplankton communities.

The participants felt that there was insufficient current insight on how climate change may influence grazing and light effects on HAB species. Many HABs species are both grazers and prey, but there is very limited information on how the balance of these processes might deviate as the ocean environment changes. The second factor is the effect of changing light fields resulting from broad-scale alterations in cloud cover. While light is a key environmental parameter affecting phytoplankton communities, and different species are known to be better light- or shade-adapted candidates, there is little indication so far that HAB species will be affected differently than non-HAB species.

An important aspect of the deliberations was consideration of how HAB science has progressed over the last few decades. The participants recognized that much of the research to date has focused on two fronts: observations of HAB events and the study of HAB organisms. Although when combined, these approaches provide some understanding of the ecophysiology of HAB organisms, but there is only limited insight on how HAB organisms interact within the broader phytoplankton communities. One of key findings of the workshop was that HAB research needs to move towards more comparative investigations that inform on

the thresholds for shifting balance among HAB and non-HAB species in the context of climatically-driven changes in coastal and oceanic environments.

The participants contemplated what new research tools would help move the science forward most quickly. The primary need at this time is initiating the long-term collection of HAB-relevant datasets across diverse geographical and oceanographic regimes. While there exists numerous long-term HAB monitoring efforts, none are sufficient to provide the data streams required to assess climate-related changes in HABs. It was agreed that the most productive means to initiate these data collection streams is to collaborate with existing coastal and offshore oceanographic and climate-based monitoring sites to add a limited list of parameters (*e.g.*, phytoplankton speciation, toxins, *etc.*) to establish HAB "observer sites". Recognizing that there are very limited laboratory facilities and expertise in many areas of interest, a shorter list of key parameters that are easily obtained with simple sampling approaches was developed to facilitate new monitoring sites in waters where HABs are not a persistent problem.

Fig. 1 The participants of the PICES/ICES/GEOHAB/NOAA workshop on "Harmful algal blooms in a changing world", March 18–22, 2013, at the Whiteley Center, Friday Harbor Laboratories, University of Washington. Left to right: Stuart Benard (South Africa), Donald Anderson (U.S.A.), Vera Trainer (U.S.A.), Angela Wulff (Germany), Charles Trick (Canada), Bengt Karlson (Co-Chairman, ICES/Sweden), Ted Smayda (U.S.A.), Raphael Kudela (Co-Chairman, GEOHAB/U.S.A.), Mark Wells (Co-Chairman, PICES/U.S.A.; author of this article), Akira Ishikawa (Japan) and William Cochlan (U.S.A.).

Fig. 2 Friday Harbor Laboratories, San Juan Island, Washington State, U.S.A.

Fig. 3 One of the group dinners prepared by participants in the Whiteley Center, Friday Harbor Laboratories.

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Enhancing Scientific Cooperation between PICES and NPAFC

by Skip McKinnell

The 3rd International Workshop on "Migration and survival mechanisms of juvenile salmon and steelhead in ocean ecosystems" (April 25–26, 2013, Honolulu, Hawaii, U.S.A.) in session. The photo was provided by the NPAFC Secretariat.

The North Pacific Anadromous Fish Commission (NPAFC) and PICES are taking steps to foster greater scientific cooperation between the two organizations. During their spring meetings in 2013, the PICES Science Board and the NPAFC Committee on Scientific Research and Statistics endorsed the creation of a joint Study Group on *Scientific Cooperation in the North Pacific Ocean* to develop a framework of enhanced collaboration between the two organizations in order to achieve more rapid gains in understanding how natural and anthropogenic forces affect variability in marine ecosystems inhabited by salmonids. The main tasks of the Study Group are: (1) to identify areas of marine science that are of common interest to both organizations, (2) to describe a framework for scientific cooperation, and (3) to make recommendations on how to implement the framework. Members nominated by NPAFC include Drs. James Irvine, Shigehiko Urawa, Alexander Zavolokin, and Nancy Davis (Deputy Executive Director, NPAFC). Members recommended by PICES include Drs. Elizabeth Logerwell, Thomas Therriault, Hiroaki Saito, and Skip McKinnell (Deputy Executive Secretary, PICES). The proposed chairmanship of the Study Group is shared equally by Dr. Logerwell (Chairperson of the Fishery Science Committee) and Dr. Irvine (Chairperson of the Working Group on Stock Assessment). Establishment of the joint Study Group awaits formal approval by the PICES Governing Council and by the NPAFC Commission.

Dr. Vladimir Radchenko (Pacific Research Institute of Fisheries and Oceanography, Russia) will take a new position as the Executive Director of NPAFC in July 2013. He has been involved with PICES since its first scientific workshop held in December of 1991, in Seattle, U.S.A. Dr. Radchenko served as a member of several PICES expert groups and the Biological Oceanography Committee, and chaired this Committee from 2001–2004. He also represented Russia on the PICES Governing Council.

On April 25–26, 2013, NPAFC was in Honolulu, Hawaii for a workshop on "*Migration and survival mechanisms of juvenile salmon and steelhead in ocean ecosystems*". This was the third time since 1993 that NPAFC had focused on this topic. Regular readers of PICES Press will recall that since 1999, annual workshops on the ecology of juvenile salmon in the eastern North Pacific have been reported in PICES Press. The 2013 incarnation of this workshop had the added cachet of a noteworthy international sponsor, an exotic location, and the inclusion of participants from the western North Pacific. These factors combined to make the workshop, with 33 oral presentations and 40 posters, a great success. Dr. Radchenko gave an invited review talk on juvenile Pacific salmon studies in Asia and Dr. Marc Trudel (Fisheries and Oceans Canada) gave a similar talk on North American studies. Session topics during the workshop included:

1. Seasonal distribution and migration route/timing,
2. Hydrological characteristics, primary production, and prey resources,
3. Trophic linkages, growth rates, and predation rates,
4. Ecological interactions among species and populations,
5. Survival rate and survival mechanisms,
6. Survival and salmonid ecology during the first winter at sea.

Dr. William (Bill) Heard, NOAA emeritus scientist, was invited to offer his views on what had been presented at the workshop, and he pointed out five noteworthy advances. The first was that there are continuing improvements in the capacity to identify stock-specific migration routes of juvenile salmon based on progress in stock identification technologies. The second was the growing body of evidence for the role of early marine growth and size-selective mortality as an important factor for overall survival. Special notice was made of Strahan Tucker's presentation on salmon predation by Rhinoceros auklets, *Cerorhinca monocerata*, showing that this predator selected smaller individuals. Bill summarized the concept as "getting bigger quicker is better". He was also struck by the potential for phenological mismatches to develop between salmon migration timing and the availability of their prey resources because of differential changes in freshwater and marine waters due to global warming and climate change. Fourthly, Bill noted that new insight into homing migratory behaviour was arising from empirical evidence of geomagnetic imprinting. Finally, he made a point of highlighting Kate Myers' talk on the potential for marine debris, particularly persistent plastics, to have deleterious impacts on salmon ecology and survival. Many of the presentations from the workshop can be found at www.npafc.org/new/events/workshops/workshop2013/workshop_presentations.html.

Dr. Skip McKinnell (mckinnell@pices.int) is the Deputy Executive Secretary of PICES. He served recently as author and Editor-in-Chief of the PICES North Pacific Ecosystem Status Report and of the PICES Advisory Report to the Cohen Commission on the Decline of Fraser River Sockeye Salmon Oncorhynchus nerka (Steller, 1743) in Relation to Marine Ecology (PICES Scientific Report No. 41).

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A second class of sentinel sites was envisioned, termed "super sites", that though limited in number would be equipped with sophisticated monitoring equipment that would enable high-frequency sampling of phytoplankton species composition along with a wide range of environmental parameters. Their purpose would be to enable *in-situ* investigations of the ecology of HABs in relation to non-HAB species. The goal of both "observer" and "super" sites is to ensure adequate datasets for statistical assessment of change across multiple coastal and oceanic regimes.

New investigative approaches also will be required to address the HAB/climate change issue. It is recognized that isolates of given phytoplankton species differ in their growth responses to different stimuli, so there is a strong need to understand these localized differences among isolates in projecting climate change effects. One novel approach is using "common garden" style culture experiments, where many laboratories situated around the globe conduct identical experiments using precise established procedures to test the effects of one or more parameters on a single species isolated from their local waters. This approach provides the ideal mechanism for evaluating species response as well as characterizing their inter-strain variability. Other methods included cross-sectional research programs such as mesocosms and other enclosures using standardized methods, design, analysis, and assessment. The participants also identified a strong need to develop measures for dealing with HAB outbreaks, including proactive (avoidance), abatement (halting) and mitigation (reduced impact) strategies. In addition, there is a need for virtual assessment approaches to understand past outbreaks and forecasting future outbreaks built upon detailed conceptual or heuristic models.

One of the main outcomes of the workshop discussions was identifying the need for a focused Open Science Meeting on global change impacts on marine and freshwater HABs, to be held in 2014/2015. The goals of this meeting will be to promote research in the topics discussed in this workshop over the next decade, to bring new scientists into the field (*i.e.*, to make climate change researchers aware of the HAB issue and how their expertise and methods may find rich ground for research), and to focus community efforts towards identifying the datasets required to unequivocally test the hypothesis of a linkage between HABs and climate change.

The workshop findings are now being integrated into a manuscript intended for publication in the international journal *Harmful Algae*. The findings will provide guidance to the HAB research community on some of the key gaps in our understanding to help focus global research efforts on addressing HABs and climate change.

Dr. Mark Wells (mlwells@maine.edu) is a Professor in the School of Marine Sciences, University of Maine, U.S.A. His research interests span chemical oceanography and its influence on carbon cycling, trace metal chemistry, and the dynamics of marine phytoplankton communities. He is a founding member of the PICES Section on Ecology of Harmful Algal Blooms in the North Pacific and has served as the PICES representative at the UNESCO IOC International Panel on Harmful Algal Blooms.

Workshop on Marine Biodiversity Conservation and Marine Protected Areas in the Northwest Pacific

by Vladimir Kulik

Fig. 1 The participants of the NOWPAP/NEASPEC workshop on "Marine biodiversity conservation and marine protected areas in the Northwest Pacific", March 13–14, 2013, in Toyama, Japan. The photo was provided by the Special Monitoring and Coastal Environmental Assessment Regional Activity Centre (CEARAC) of NOWPAP.

The beautiful city of Toyama, Japan, 300 km northeast of Tokyo, was the setting on March 13–14, 2013, for a workshop on "*Marine biodiversity conservation and marine protected areas in the Northwest Pacific*". The workshop was convened by NOWPAP (Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region; part of the Regional Seas Program of the United Nations Environment Program; http://www.nowpap.org/) and NEASPEC (North-east Asian Sub-program for Environmental Cooperation; http://www.neaspec.org/). The objectives of the workshop were: (1) to share information on methodologies for marine environment assessment and the current status of Marine Protected Areas (MPAs) in member states of NOWPAP, and (2) to discuss the programs and operations of the proposed North-east Asian MPA network. PICES was invited to participate in this workshop, and was represented by Dr. Vladimir Kulik, a member of the PICES Working Group 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*. In addition to PICES, other participants at the workshop included experts from all NOWPAP member states (Japan, People's Republic of China, Republic of Korea and the Russian Federation) and from international organizations such as the Helsinki Commission (HELCOM; http://www.helcom.fi/) and the IOC Sub-Commission for the Western Pacific (IOC/WESTPAC; http://www.unescobkk.org/westpac). In total, more than 20 people attended the workshop (Fig. 1).

The motivation for the workshop was responsibilities to contribute to marine biodiversity conservation and sustainable use of marine ecosystem services in the NOWPAP region. The meeting had presentations and shared information on details of MPAs in the region, including definition, categories and monitoring/management status in each member state of NOWPAP. An information sheet was developed and will be finalized based on additional information provided after the workshop. The meeting discussed the similarities and differences in the definitions of MPAs among the member states and recognized the usefulness of such information for future considerations to improve the management of MPAs. Information was also shared on the challenges of

maintaining and managing MPAs, as well as future plans to design and expand these areas, including the possible application of the Ecologically or Biologically Significant Sea Area (EBSA) concept developed by the United Nations (UN) Convention on Biological Diversity (CBD; http://www.cbd.int) and other organizations.

The meeting learned about ongoing related activities for assessing the marine environment being conducted by PICES, HELCOM and IOC/WESTPAC, which were recognized as being useful for the conservation of marine biodiversity in the NOWPAP region. The necessity of Ecological Quality Objectives for the NOWPAP region was stressed as a basis for setting targets for assessment and appropriate management. Collaborations among the NOWPAP member states and other regional organizations such as PICES towards the conservation of marine biodiversity were acknowledged as being crucial. Of special interest to PICES was a presentation by Dr. Maria Laamanenof (HELCOM) on "*Comprehensive ecosystem assessment for marine biodiversity conservation*". She noted that they have reached the 10 % target set by the UN CBD for a regional network of MPAs in the Baltic Sea. However, the present network may not be entirely ecologically coherent if adequacy, representativity, replication and connectivity are the primary criteria used for its assessment. The most important problems they have encountered in evaluating the effectiveness of this network of MPAs are nonlinearities and thresholds in the ecosystem recovery process. Therefore, reaching some of the targets did not lead to convergence with other targets from the same domain. As a result, widely used simplifications in the models of ecosystem assessment such as linearity and additivity must be reconsidered. HELCOM member states are in the process of summarizing their achievements in assessing the progress towards reaching HELCOM objectives for a healthy Baltic Sea, which are available at http://www.helcom.fi/BSAP_assessment/en_GB/main.

At its conclusion, the NOWPAP/NEASPEC workshop recommended the following:

- The regional monitoring centre for NOWPAP to assess the availability of data and to consider the collection of metadata and the development of assessment tools based on the available data for marine biodiversity conservation in the NOWPAP region;
- Recognizing that the indicators employed by HELCOM and those being studied by PICES are useful references for the NOWPAP region, to consider the availability of data and different conditions in the marine environment in the NOWPAP region when selecting indicators;
- Strengthen collaboration with relevant partners, for example, PICES, HELCOM and IOC/WESTPAC, when conducting the above tasks.

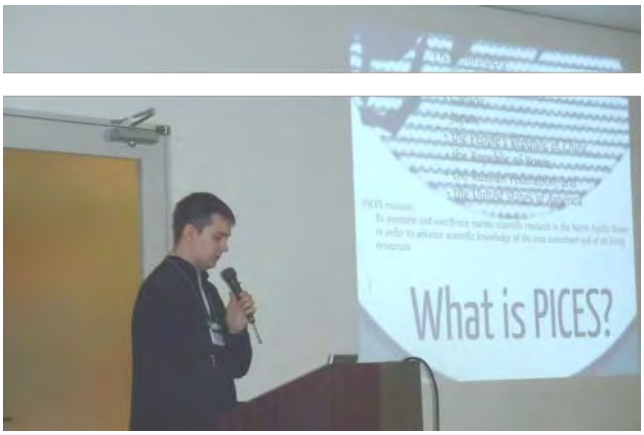


Fig. 2 PICES WG 28 presentation at the NOWPAP/NEASPEC workshop.

The full meeting report, with details from each NOWPAP member state, and all presentations (including that given by the author of this article (Fig. 2) on behalf of PICES WG 28) are available on the workshop website at http://www.cearac-project.org/NOWPAP_NEASPEC_Workshop/NOWPAP_NEASPEC_Joint_Workshop.htm.

Dr. Vladimir Kulik (vladimir.kulik@tinro-center.ru) is the Leading Research Scientist at the Regional Data Center of the Pacific Research Institute of Fisheries and Oceanography (TINRO-Centre) in Vladivostok, Russia. His research focuses on the fluctuation of abundance of species which are caught by pelagic and bottom trawls with 1 cm mesh during scientific surveys in the Russian part of the Northwestern Pacific Ocean since 1979. Within PICES, Vladimir is a member of the Technical Committee on Monitoring, the Working Group on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors (WG 28), and the FUTURE Advisory Panel on Anthropogenic Influences on Coastal Ecosystems.

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

by Shiro Ishizaki

Sea surface temperature

Figure 1 shows the monthly mean sea surface temperature (SST) anomalies in the western North Pacific from July to December 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, and *in-situ* observations for the period since 1985. Time series of 10-day mean SST anomalies are presented in Figure 2 for 9 regions indicated in the bottom panel. In July, SSTs were above normal around 40ºN and east of 150ºE. The positive SST anomalies extended westward, and anomalies exceeding +1ºC prevailed east of 135ºE in September. These anomalies shrunk after September and were observed only east of 160ºE in December. From August to September, SSTs were above normal in the eastern part of the Sea of Japan and in the seas east of Japan. In particular, positive anomalies exceeding +2ºC were observed in September (regions 1, 2, 3 and 4 in Fig. 2), and the averaged SST in region 2 was the highest recorded since 1985. From October to December, SSTs were below normal in the seas south of Japan (regions 6 and 9 in Fig. 2).

Kuroshio path

Figure 3 shows time series of the location of the Kuroshio path. During the reviewed period, the Kuroshio took a non-large-meandering path off the coast to the south of Honshu Island (between 135ºE and 140ºE). East of 135 ºE, several small perturbations propagated eastward along it. Corresponding to the passage of each perturbation, the latitude of the current's axis over the Izu Ridge (around 140ºE) moved north and south. In December, the Kuroshio flowed south of Hachijo Island (33ºN, 140ºE).

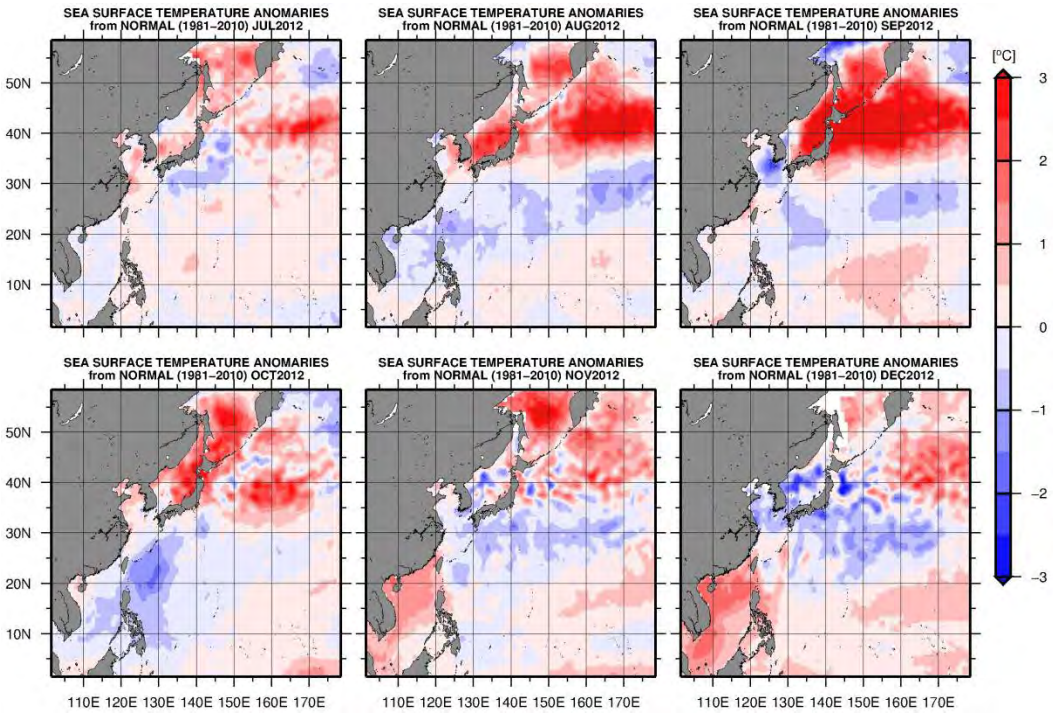


Fig. 1 Monthly mean SST anomalies (°C) from July to December 2012. Anomalies are deviations from JMA's 1971–2000 climatology.

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.

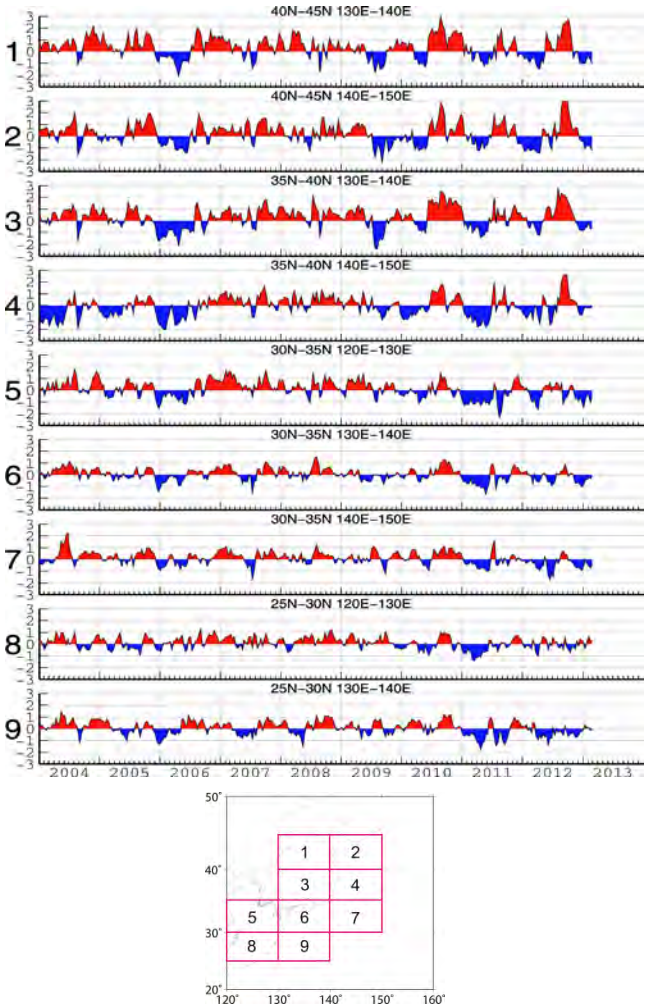


Fig. 2 Time series of 10-day mean SST anomalies (°C) averaged for the sub-areas shown in the bottom panel. Anomalies are deviations from JMA's 1971–2000 climatology.

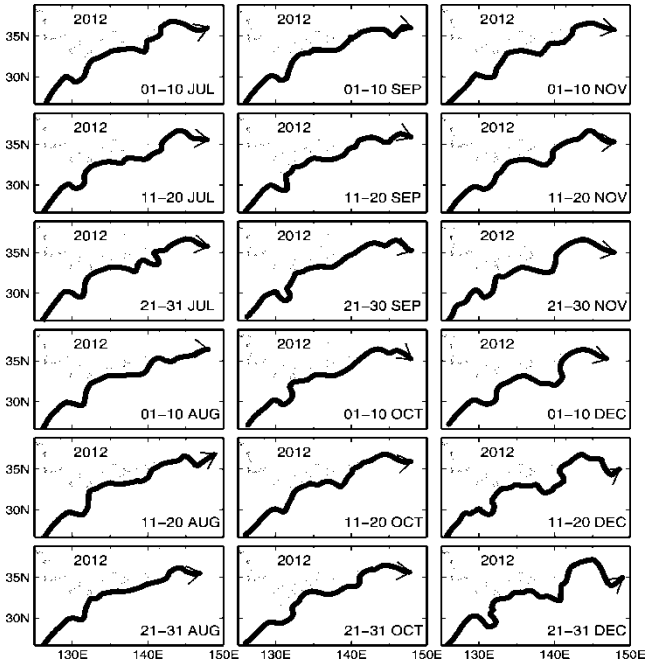


Fig. 3 Location of the Kuroshio path from July to December 2012.

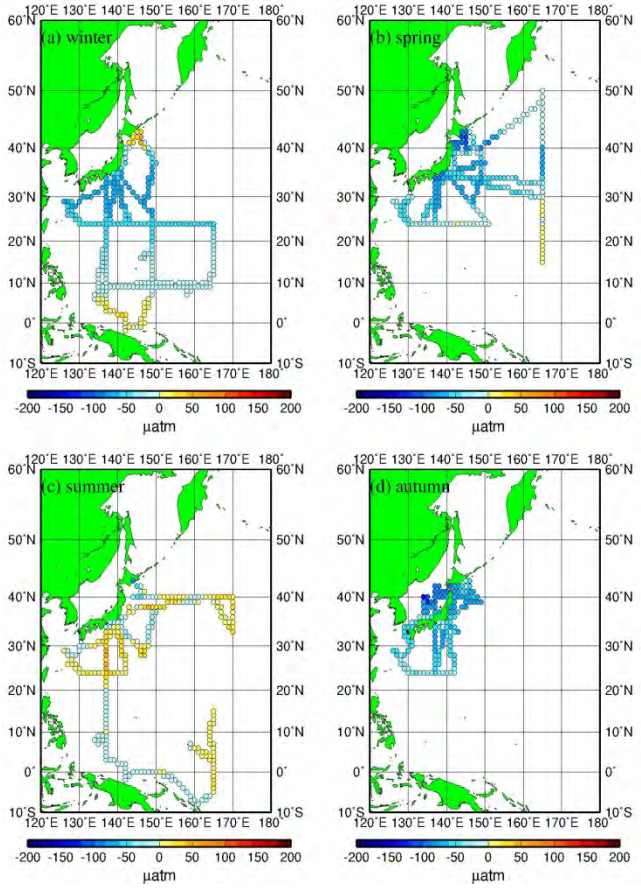


Fig. 4 Difference in CO_2 partial pressure between the ocean and the atmosphere in the western North Pacific in 2012: (a) winter (January–March), (b) spring (April–June), (c) summer (July–September) and (d) autumn (October –December).

Carbon dioxide

JMA has been conducting observations for carbon dioxide (CO_2) in the ocean and atmosphere in the western North Pacific on board the R/V *Ryofu Maru* and R/V *Keifu Maru*. Figure 4 illustrates the distribution of the difference in CO_2 partial pressure (pCO_2) between the surface seawater and the overlying air (denoted as ΔpCO_2) observed in the western North Pacific for each season of 2012. The sign of ΔpCO_2 determines the direction of CO_2 gas exchange across the air–sea interface, indicating that the ocean is a source (or sink) for atmospheric CO_2 in the case of positive (or negative) values of ΔpCO_2.

In the winter of 2012, the ocean widely acted as a CO_2 sink in subtropical regions and as a source in subarctic regions north of 40ºN and in equatorial regions. In the spring, it acted as a sink in the region between 24ºN and 50ºN. Late in June and in the summer, the ocean turned into a CO_2 source due to thermodynamically increased pCO_2 in seasonally warmed seawater in subtropical regions south of 30ºN. In the autumn, subtropical regions north of 24ºN, and the Sea of Japan acted as a CO_2 sink.

Stuck in Neutral in the Northeast Pacific Ocean

by Skip McKinnell

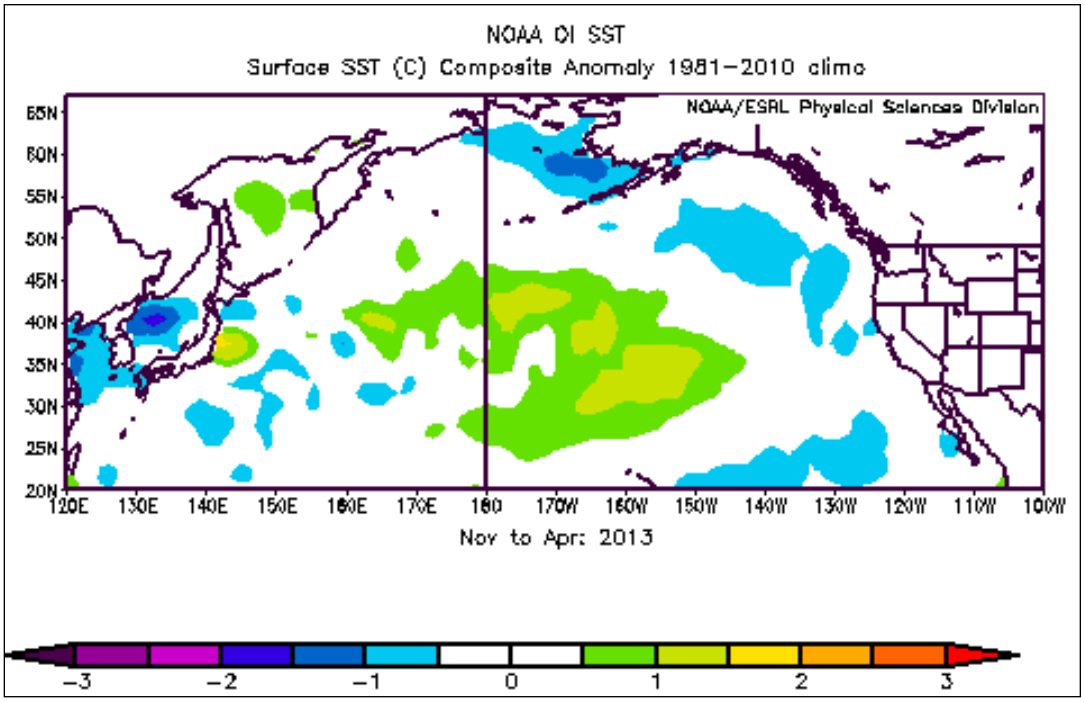


Fig. 1 Winter sea surface temperature anomalies (°C) in the North Pacific in 2013. The colour legend indicates the magnitude of the anomalies.

The surface temperature of the Northeast Pacific Ocean has remained relatively cool since 2006, interrupted briefly during the winter of 2010 by an El Niño that warmed the coastal region for a few months. The perimeter of the North Pacific was cooler than average during the winter of 2013, while the central part was warmer than average, but the anomalies were generally less than |0.5|°C (Fig. 1). This pattern reflects a negative/neutral PDO (Pacific Decadal Oscillation) phase that has been relatively persistent since early 1998 (Fig. 2).

Teleconnections between the tropics and the Northeast Pacific imply that aspects of the state of the Northeast Pacific can be found in the state of the tropical Pacific Ocean and atmosphere. The El Niño–Southern Oscillation (ENSO) has been relatively neutral since the middle of 2012. This can also be seen in the dominant EOF (empirical orthogonal function) of weekly equatorial sea surface temperature from 5°S to 5°N (Fig. 1). Climate models suggest a persistence of ENSO-neutral conditions through the boreal summer.

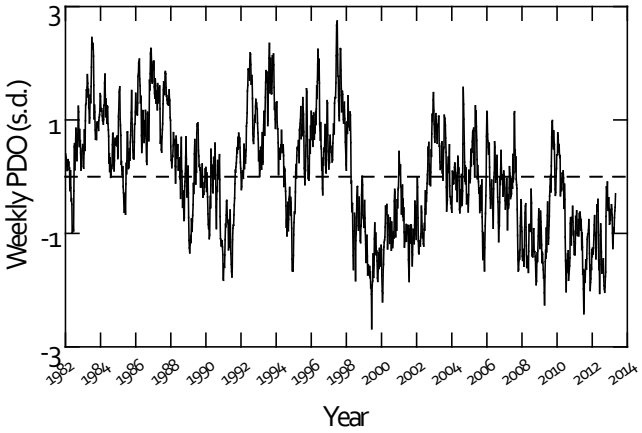


Fig. 2 Temporal index of the dominant EOF of sea surface temperature in the PDO region calculated from weekly NOAA/OIv2SST data from 1982–2013.

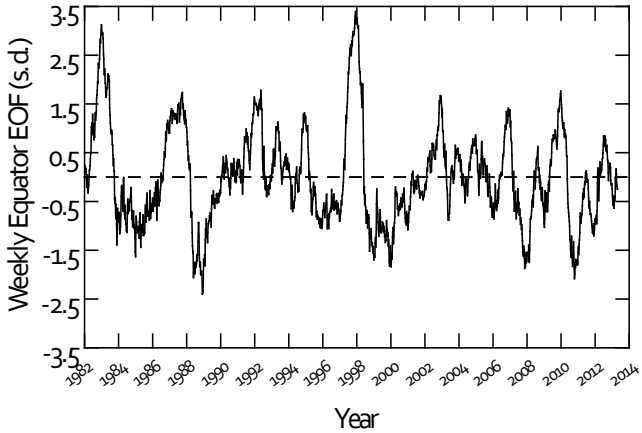


Fig. 3 Temporal index of the dominant EOF of sea surface temperature at the equator calculated from weekly NOAA/OIv2SST data from 1982–2013.

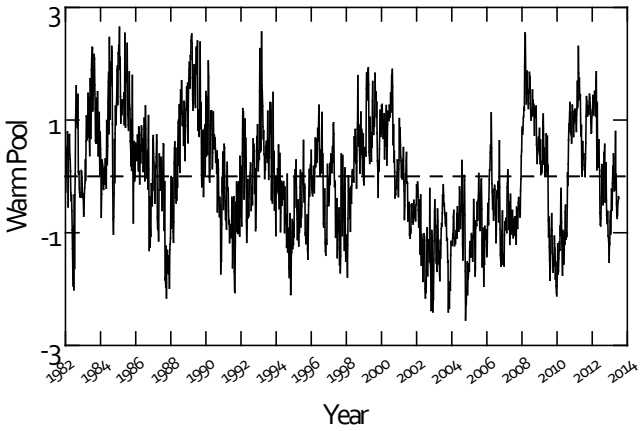


Fig. 4 An index of the weekly extent of the Western Tropical Warm Pool from 1982–2013 (May), measured as the number of 1° x 1° grid points exceeding 29°C at the ocean surface. OIv2SST data provided by NOAA Earth System Research Laboratory, Physical Sciences Division.

Low frequency variation is a characteristic of the spatial extent of the western tropical Pacific warm pool (region with surface temperatures greater than 29°C). The extent of the warm pool during the winter of 2013 was about average (Fig. 4), which reflects other climate indices for the region.

Winter storms are responsible for the decay of the summer seasonal pycnocline. The number and intensity of the storms is a factor that determines the depth of the winter mixed layer and the extent to which nutrients are resupplied to the surface waters. An index of winter (DJF) sea level atmospheric pressure in the Northeast Pacific Ocean indicates that the winter of 2013 was near the long-term average (Fig. 5).

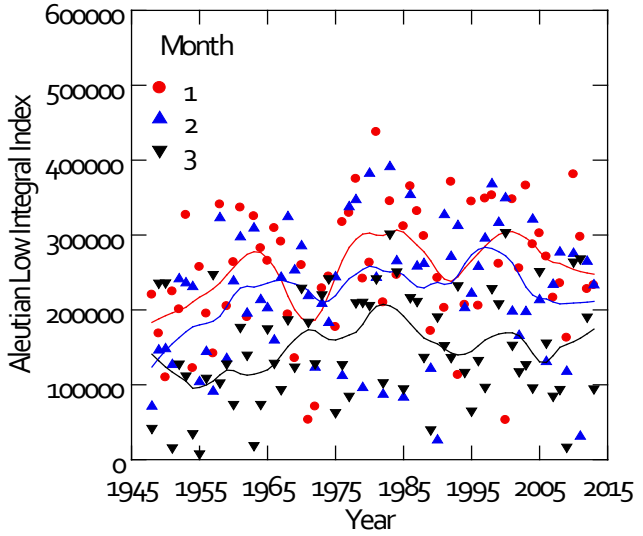


Fig. 5 The Aleutian Low Integral Index is a monthly integral of sea level pressure less than 1008.5 hPa in the North Pacific. Loess smoothers are applied to each month to show the trends. SLP data are taken from the NCEP Reanalysis and are served by NOAA Earth System Research Laboratory, Physical Sciences Division.

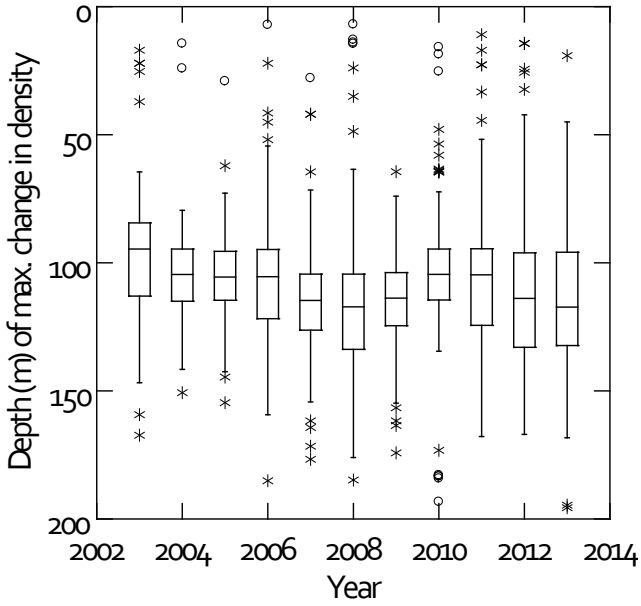


Fig. 6 Box and whisker plot indicating median, quartiles, and outlier depths of the maximum rate of change in vertical density (an index of mixed layer depth) in the months of March and April in the subarctic Gulf of Alaska east of 170°W. The 4051 hydrographic profiles used to create this figure are due to Project Argo.

Vertical profiles of water density in the Gulf of Alaska typically exhibit a sharp increase in density at about 25 m depth in the summer and about 100 m depth in the winter. After applying a smoother to the raw data, the depth of the maximum rate of change in density can be used as an index of mixed layer depth. The average winter mixed layer in the Gulf of Alaska (maximum in March/April) has been about 8 m deeper since 2007 than the four years prior to that, although there is considerable inter-annual variability (Fig. 6). A linear model fit to the individual profiles from 2003 to 2013 has the Gulf of Alaska winter mixed layer deepening over this period at 0.8 m y^{-1} ($P<0.01$). Deeper mixing in the Gulf of Alaska should entrain more nutrients into the surface layer that will foster increased productivity in the spring.

Dr. Skip McKinnell (mckinnell@pices.int) is the Deputy Executive Secretary of PICES. He was 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).

The Bering Sea: Current Status and Recent Trends

by Lisa Eisner

Climate and oceanography

The eastern Bering Sea shelf experienced relatively cold weather from October 2012 through March 2013. This period included an anomalously weak Aleutian Low, as indicated in the sea level pressure (SLP) anomaly pattern (Fig. 1). A weak Aleutian Low generally means suppressed storminess which, in turn, implies a lower than normal incidence of relatively warm air masses of maritime origin *versus* colder air of Arctic or continental origin. This was indeed the case in the present example, during which air temperatures were about 2°C colder than normal on the eastern Bering Sea shelf (not shown). The SLP anomalies also were associated with wind anomalies of 1–2 m/s from the north over the southeastern portion of the shelf.

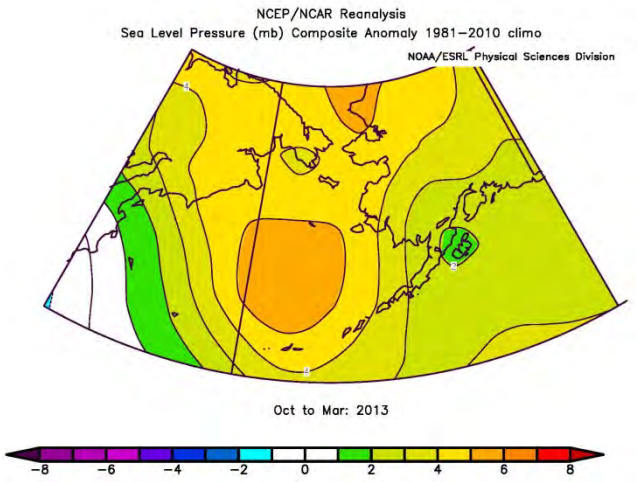


Fig. 1 NOAA sea level pressure (mb) composite anomaly (deviations from 1981–2010 climatology) for October 2012–March 2013. Figure courtesy of N. Bond.

The winter and early spring of 2013 featured more sea ice than usual. It also appears to have included substantial temporal variability in sea ice extent, *i.e.*, a series of marked advances and retreats over the course of winter. This variability is reproduced in the daily air temperatures at St. Paul Island, which show the particularly cold weather that occurred in the early and middle of December 2012, and in the middle and latter periods of February 2013 (Fig. 2). Considering the coverage of sea ice since the first of the year, it can be anticipated that the Bering Sea cold pool during summer 2013 will be larger than normal, but probably not quite as extensive as during some of the extremely cold years in the recent past such as 2010.

Sea surface temperature (SST) variations for the entire Bering Sea were evaluated using Empirical Orthogonal

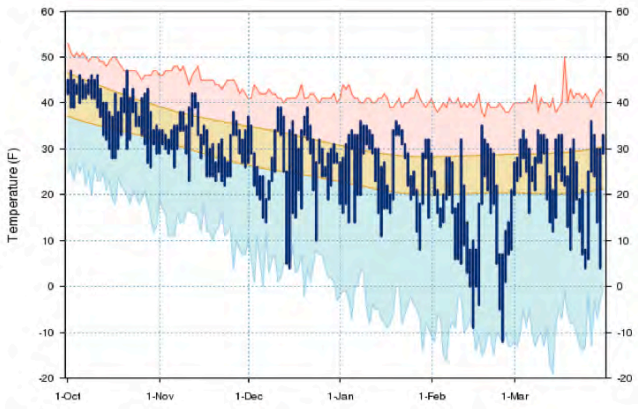


Fig. 2 Daily air temperature (°F) at St. Paul Island for October 2012–March 2013. The reddish and aqua lines at the top and bottom, respectively, refer to the all time high and low temperatures for each date; the tan lines in the center refer to the average daily high and low temperatures for each date. The period of record is 1949 to present. Figure courtesy of N. Bond.

Function (EOF) analysis of satellite data for 1982–2013 (Fig. 3). The significant cold that began in November 2011 persisted through January 2013, as shown by negative EOF 1 values (Fig. 3, top left). The loadings for the Bering Sea on EOF 1 are all positive (*i.e.*, the whole sea co-varied positively with this EOF, but to different degrees depending on location, Fig. 3 top right). EOF 1 is correlated with the Pacific Decadal Oscillation (PDO) in winter (r = 0.68 in January). The subdominant mode (EOF 2) shows an east–west see-saw pattern (Fig. 3, bottom right). Positive EOF 2 values (Fig. 3, bottom left) are associated with cold surface temperatures on the Alaskan side and the reverse on the Russian side of the Bering Sea. Positive SLP anomalies (as shown in Figure 1) and north winds over the eastern Bering Sea coincide with a positive sense to EOF 2 for the Bering Sea. So, the combination of negative EOF 1 and positive EOF 2 are associated with a cold eastern Bering Sea during recent years.

BEST-BSIERP Bering Sea Project summary

The collaborative "Bering Sea Project" integrates two research programs, the National Science Foundation (NSF) Bering Ecosystem Study (BEST) and the North Pacific Research Board (NPRB) Bering Sea Integrated Ecosystem Research Program (BSIERP), together with substantial in-kind contributions from the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service. As reported in previous issues of PICES Press, the Bering Sea Project concluded an ambitious series of field seasons in the autumn of 2010. Since then, over 100 peer-reviewed publications have emerged from

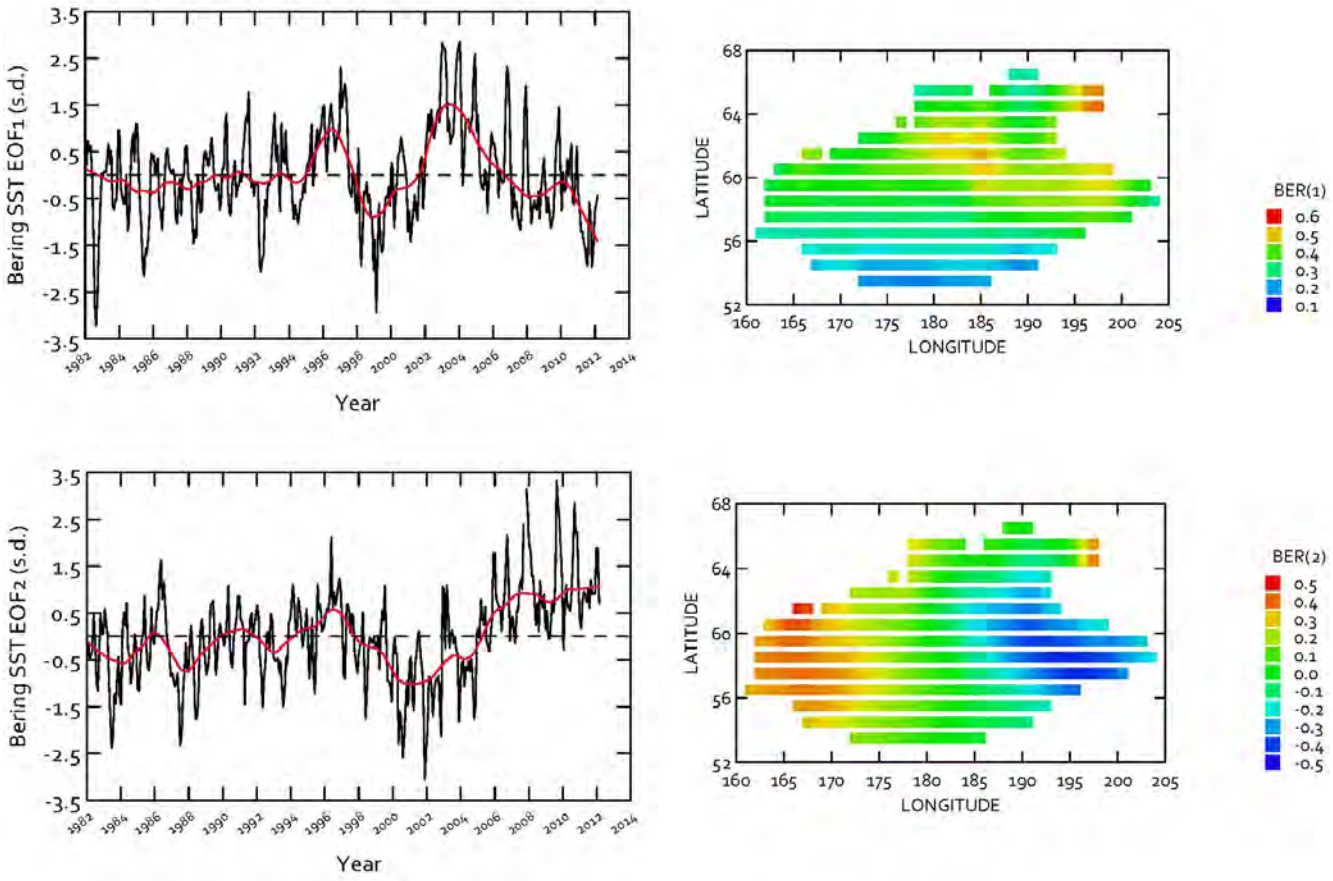


Fig. 3 EOF analysis for the Bering Sea SST for 1982–2013. The upper row is EOF 1 (45%) and the bottom row is EOF 2 (20%). Left and right panels show temporal and spatial variations, respectively. In left-side plots, smoothed data are shown with red trend lines. In right-side plots, the minimum loadings are set to blue and the maximum to red. Data courtesy of S. McKinnell.

the project (http://bsierp.nprb.org/results/publications.html). Around half of those publications are in the first and second Bering Sea Project special issues of *Deep-Sea Research II*; another two dozen manuscripts are currently under review for a third special issue, and a fourth special issue is anticipated with a submission deadline in December 2013.

Highlights from the second Bering Sea Project special issue (in press) include the role of microzooplankton in the Bering Sea ecosystem—Sherr *et al*. found significant rates of microzooplankton herbivory in spring in both non-bloom and bloom conditions; their experiments together with others led by Stoecker *et al*. show that multiple consumers regulate phytoplankton stocks in the Bering Sea, with microzooplankton playing a more significant role than previously understood.

Bering Sea Project results also provide additional understanding of why a key Oscillating Control Hypothesis prediction—that warm years would lead to higher recruitment rates and increased abundance of piscivorous species—has been shown to be incorrect. Siddon *et al*. devised a conceptual model of energy allocation in walleye pollock from larvae to age-1 and propose that the time after the end of larval development and prior to the onset of winter represents a short, critical period for energy storage in age-0 pollock. This links to results from Heintz *et al*., who showed that pollock survival to age-1 can be predicted by the condition of age-0 pollock prior to their first winter, and that survival is improved by cold conditions in the eastern Bering Sea.

Another highlight is a series of five papers centered on the human dimension in the eastern Bering Sea. Fienup-Riordan *et al*., Fall *et al*., and Huntington *et al*. pursued a diverse range of approaches to show interconnectedness between people, culture, change, and the environment. Case studies included Fienup-Riordan *et al*.'s collaborative perspective on the coastal community of Emmonak, Alaska, placing subsistence harvest survey and interview data into an ethnographic and historical context and arguing that a comprehensive approach, including both local and traditional knowledge and cultural history, is essential in understanding contemporary Bering Sea communities. Another collaborative study brought climate and interdisciplinary scientists, harvest and management specialists, and local hunters together to examine environmental influences on walrus hunting success, showing that factors other than ice and wind conditions (*e.g*., fog and fuel prices) collectively dominate the variability in harvest levels.

Fig. 4 The participants of the Friday Harbor workshop on "Sea ice and large crustacean zooplankton in the eastern Bering Sea". Photo by T. van Pelt.

Peer-reviewed publications will shape the core accomplishment of the Bering Sea Project, but participants also are communicating their work in a variety of other ways. The 2013 Alaska Marine Science Symposium in Anchorage was again a popular venue for presenting Bering Sea Project results, with a dozen talks and 20 posters. And 30 PIs and collaborators came together for an NSF-sponsored 'synthesis' workshop in late February 2013 at the Friday Harbor Labs on San Juan Island, Washington, focusing on the impact of sea ice on bottom-up and top-down controls of crustacean zooplankton (Fig. 4); for more information see http://www.jisao.washington.edu/data/BEST-BSIERP.

Looking forward, the Project Steering Committee submitted a proposal for a special session at the upcoming AGU/ASLO/TOS Ocean Sciences Meeting to be held in Honolulu, Hawaii, in February 2014. The Science Advisory Board and program managers are also planning a one-day 'Open Science Meeting' in conjunction with the 2014 Ocean Sciences Meeting. This is intended as one of the final activities before 'closing' the Project and also to welcome participation by people in other programs or regions. Program managers are currently soliciting expressions of interest for this meeting to help plan the logistics and scientific program and also to better anticipate participation in these times of strained travel budgets—visit http://bsierp.nprb.org/meetings/index.html for more information and an online survey.

2013 surveys planned

Fisheries oceanography surveys are planned for summer and fall 2013. Hokkaido University's T/S *Oshoro Maru* will conduct a survey in the Bering Sea and Chukchi Sea from June 16–July 31. NOAA's Alaska Fisheries Science Center will conduct a forage fish acoustic, surface and mid-water trawl survey in the northern Bering Sea and eastern Chukchi Sea (Arctic EIS, 2nd year), on the F/V *Bristol Explorer*, from August 1–September 2; an eastern Bering Sea bottom trawl survey on board the F/V *Aldebaran* and F/V *Alaska Knight*, from June 3–August 9, and a Chukchi Sea survey (ArcWEST program), from August 19–September 12. The Russian Pacific Federal Fisheries Research Institute (TINRO) will conduct two complex surveys in the western Bering Sea on the R/V *Professor Kizivetter*, from June 2–July 17 (salmon survey) and R/V *TINRO*, from August 8–October 10 (emphasis on pollock and salmon).

Upcoming science meetings

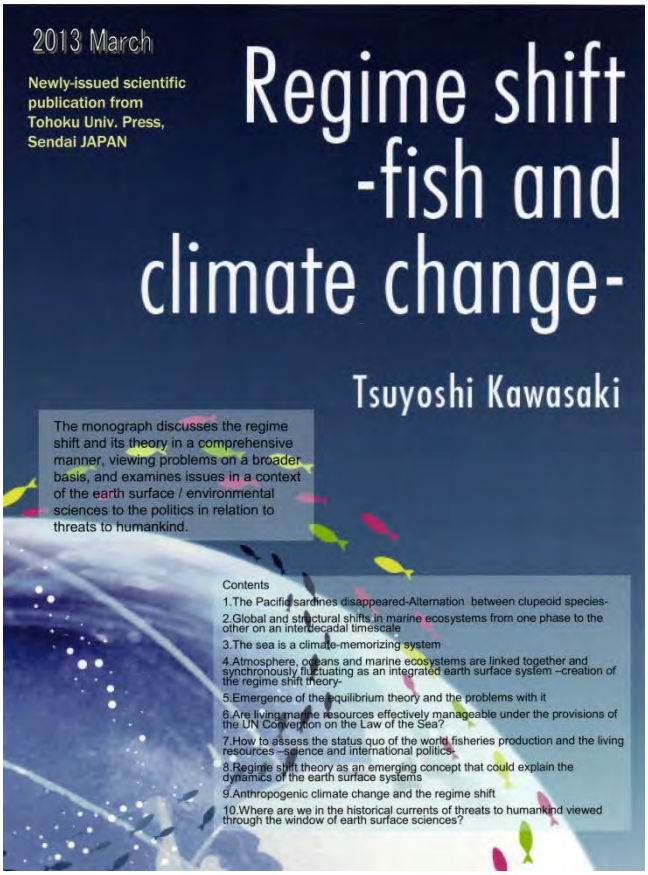
Meetings in the second half of 2013 and first half of 2014 of interest to scientists working in the Bering Sea include:

- PICES Annual Meeting, October 11–20, 2013, Nanaimo, Canada;
- Alaska Marine Science Symposium, January 21–25, 2014, Anchorage, U.S.A.;
- AGU/ASLO/TOS Ocean Sciences Meeting, February 23–28, 2014, Honolulu, U.S.A.

Acknowledgements: Many thanks to the following scientists who helped create this report: Drs. Nicholas Bond, Robert Lauth, Skip McKinnell, Olga Temnykh and Thomas van Pelt.

Dr. Lisa Eisner (lisa.eisner@noaa.gov) is a Biological/Fisheries Oceanographer at the Alaska Fisheries Science Center of NOAA-Fisheries in Juneau, Alaska. *Her research has focused on oceanographic processes that influence phyto-plankton and zooplankton dynamics and fisheries in the eastern Bering Sea. Lisa has been the lead oceanographer for the U.S. component of the BASIS program (Bering Aleutian Salmon International Surveys). She is a scientific steering committee member of NOAA's Fisheries and the Environment program (FATE) and a co-PI on current (and past) Bering Sea and Chukchi Sea research programs.*

For your Bookshelf



Atmospheric and oceanic components of marine ecosystems vary together at inter-decadal time scales and global spatial scales. This type of coherent variability is referred to as "regime shift". The regime shift theory originated from Professor Tsuyoshi Kawasaki's recognition of synchronous changes in biomasses of a small pelagic fish, the sardine, in various marine ecosystems bordering the Pacific Ocean. Over the last four decades, this theory has developed into a leading study area, not only in fisheries science, but also in marine biology, meteorology, climatology, and physical and biological oceanography. Professor Kawasaki was acknowledged internationally as the "father-of-regime-shift", a title offered by Professor Warren S. Wooster, a principal founder and the first Chairman of PICES.

A new book by Professor Kawasaki, titled "*Regime Shift – Fish and Climate Change*" (Tohoku University Press, March 2013, 162 pp., ISBN 978-4-86163-205-1 C3044) discusses the beginning of the regime shift theory, its application to sustainable use of living marine resources, and potential mechanisms responsible for regime shifts. In the mid 1970s, Kawasaki recognized synchronous changes in the sardine populations of the Kuroshio/Oyashio, California and Humboldt Current systems and noted their correlation with changes in global temperature. He first described these findings at the FAO Conference in San José, Costa Rica, in April 1983 (Kawasaki, T., 1983, Why do some pelagic fishes have wide fluctuations in their numbers?, FAO Fish. Rep. 291, 1066–1080). Prior to Kawasaki's revelation, the prevailing hypothesis regarding populations of small pelagic fishes focused on the balance between commercial fisheries catch and the carrying capacity of the ecosystem. Kawasaki's new theory was not well received initially, however, a subsequent paper on population dynamics of sardines and their relation to global variability in temperature (Kawasaki, T. and M. Omori, 1988, Fluctuations in the three major sardine stocks in the Pacific and the global trend in temperature. Long Term Changes in Marine Fish Populations, pp. 37–53.) attracted the interest of many scientists and motivated workshops to further investigate "regime problems". Principal aspects of the regime shift theory, which are highlighted in the book, include the dynamic nature of the earth system and utilization of living marine resources after consideration of their natural variability. With regard to potential mechanisms of regime shifts, Kawasaki recently proposed the trophodynamics hypothesis as a concept of variable energy flow in the food chain among phytoplankton, zooplankton, and small and large pelagic fishes in response to climate changes.

Nearly four decades have passed since the initial development of regime shift theory. For his contribution to the community's understanding of marine resources and their dynamics, Professor Kawasaki was awarded the Shinkishi Hatai Medal from the Pacific Science Association at the Twenty-First Pacific Science Congress in Naha, Okinawa, in July 2007 [This medal was established in 1966 to honor contributions of Dr. Shinkishi Hatai, the first professor in biology at Tohoku University (Sendai, Japan), to Pacific marine biology. The medal has been awarded since at every Pacific Science Congress to distinguished leaders in this research field (www.pacificscience.org/hataimedal.html).].

Professor Kawasaki has worked diligently to share his theory with the scientific community worldwide and has published some monographs in Japanese. One of them for the general public was translated into Korean with the English title "*Climate Change and Fish*", and published in 2012. A long-awaited English version includes more thorough discussions for scientists, managers and politicians and also a concise description of his life's work on the science of the earth system.

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Howard Freeland takes home Canadian awards

by Robin Brown

Howard Freeland (Institute of Ocean Sciences (IOS), Fisheries and Oceans Canada) has received some major awards in Canada. The Canadian Meteorological and Oceanographic Society (CMOS) awarded him the John P. Tully Medal in Oceanography, which is given to a person "whose scientific contributions have had a significant impact on Canadian oceanography". Howard was recognized for his extensive research on fiord oceanography, coastal circulation, seamounts, open ocean oceanography and Project Argo. Howard joins the list of previous recipients.

John P. Tully Medal in Oceanography

2012	H.J. Freeland	1997	L. Mysak
2011	D. Welch	1996	J. Lazier
2010	J.W. Loder	1995	S. Calvert
2009	E. Carmack	1994	–
2008	C. Garrett	1993	C.R. Mann
2007	S. Tabata	1992	F.W. Dobson
2006	S.J. Prinsenberg	1991	N.J. Campbell
2005	J.-C. Therriault	1990	P.H. LeBlond
2004	B. Petrie	1989	T.R. Parsons
2003	R.E. Thomson	1988	R.W. Stewart
2002	S. Pond	1987	M.J. Dunbar
2001	R.A. Clarke	1986	G.L. Pickard
2000	–	1985	W.M. Cameron
1999	–	1984	W.L. Ford
1998	N. Oakey	1983	J.P. Tully

More information can be found on this award and on John Tully.

Howard was also presented the Public Service Award of Excellence 2013 in the category of Scientific Contribution. It is the highest honour for public service in Canada and was given for his sustained and enthusiastic contributions to Project Argo within Canada and internationally. This is a prestigious award and will be presented by His Excellency the Right Honourable David Johnson, the Governor General of Canada, in a formal ceremony at Rideau Hall, Ottawa, in the fall.

Howard attended many PICES Annual Meetings as a scientist. He served as a Canadian member of the Physical Oceanography and Climate Committee for 6 years (1996–2001) and as a co-convenor of international the symposium "*Time series of the Northeast Pacific: A symposium to mark the 50th anniversary of Line-P*", co-organized by Fisheries and Oceans Canada and PICES (2006). Starting in 2001, he has often represented Argo at various PICES events (Annual Meetings, symposia, 2013 summer school).

Howard will be retiring from Fisheries and Oceans Canada at the end of July, but he will continue as an emeritus scientist at IOS and part-time (and unpaid!) Director of the International Argo Program.

Fig. 1 Howard Freeland receiving the 2012 Canadian Meteorological and Oceanographic Society's John P. Tully Medal in Oceanography at the 47th CMOS Congress in Saskatoon, Canada, in May 2013.

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