July 2009 ISSN 1195-2512 Vol. 17 No. 2

# PICES Press

Newsletter of the North Pacific Marine Science Organization (Published semi-annually)

## Major Outcomes from the 2009 Inter-sessional Governing Council Meeting: A Note from the Chairman

The 2009 inter-sessional PICES Governing Council meeting (IGC-2009) was held on April 29, in Qingdao, People's Republic of China, following a 2-day workshop (April 26–27) to finalize the development of an Implementation Plan for a new PICES scientific program on "***F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific **E**cosystems*" (FUTURE) and the inter-sessional Science Board meeting (April 28) to review the scientific activities of the Organization since last year's Annual Meeting (PICES-2008) in Dalian, and to discuss the Implementation Plan and steering structure for FUTURE. Many Council members attended the FUTURE workshop and Science Board meeting and provided valuable comments and suggestions. All three events were kindly hosted by the State Oceanic Administration (SOA) of the People's Republic of China.

***Implementation Plan for FUTURE***

The Science Plan for FUTURE was approved in principle at PICES-2007 in Victoria, Canada, and finalized in February 2008. While the CCCC (Climate Change and Carrying Capacity) Program, the first integrative scientific program of PICES, focused mainly on the understanding of responses of North Pacific marine ecosystems to climate change/variability, FUTURE aims to contribute to actual ecosystem-based management in the Contracting Parties. Thus, FUTURE really integrates all scientific disciplines of PICES, including socio-economical aspects of marine ecosystem changes, and has tight linkages with the existing Scientific and Technical Committees and their expert groups. Having Science Board as the Scientific Steering Committee will ensure that all of the scientific capabilities within the Organization are engaged.

The FUTURE Implementation Plan was almost finalized through discussions at the workshop and Science Board meeting, and was approved in principle at the Council meeting. It is expected that the Implementation Plan will be completed and circulated for final approval of Council by the end of June (the Plan was formally approved on June 30 and posted on the PICES website). Inheriting the achievements from the CCCC Program, as well as tackling challenging new questions, will be a key point for the success in implementing FUTURE. Under the CCCC Program, remarkable progress was achieved in linking plankton and fish to climate through the development of ecosystem dynamic models such as NEMURO and NEMURO.FISH, and we should keep our modeling abilities under the framework of FUTURE.

***Cooperation with non-member countries and other international organizations***

Many of the scientific issues addressed by PICES (*e.g*., global warming and harmful algal blooms) are not unique to the North Pacific and concern the entire world. Recruitment of young talents to marine science and building their capacity is also a common issue beyond the Contracting Parties of PICES. Therefore, PICES has been expanding relationships with non-member countries around the Pacific Rim and other international organizations. To facilitate this collaboration, a formal framework to recruit external experts to PICES activities has been discussed by Council since 2006. At this meeting, Council finally approved the amendments of the PICES Rules of Procedures in order to accommodate experts from outside of PICES, as *ex-officio* members, to subsidiary bodies of our Scientific Committees and to Technical Committees.

In Qingdao, Council endorsed the concept of developing a proposal for a joint PICES/ICES Steering Group on *Strategic Planning for Cooperation in Marine Science in the Northern Hemisphere*, and directed Science Board and the Secretariat to initiate discussion with ICES on this issue.

Council also discussed future collaboration with a new Regional Fisheries Management Organization (RFMO) for the North Pacific, currently under consideration following the adoption of the Resolution 61/105 on *Sustainable Fisheries* by the General Assembly of the United Nations. Council agreed that PICES could contribute to sustainable and wise use of the North Pacific marine ecosystems and bio-resources by giving broad scientific advice to the new RFMO, and this would also meet the expectations by the Contracting Parties for scientific products of PICES to be useful for the national policy making. Council confirmed that PICES should pay attention to the future progress of inter-governmental negotiations on the new RFOM.

***Restructuring of the Annual Meetings***

Since the establishment of PICES, its activities have been growing year by year. This is evidence that PICES has become an internationally renowned scientific organization, and we should be pleased with this recognition. However, the appropriate balance must be found in the near future between the increasing activities of PICES and limitations of the human and financial resources in the Contracting Parties and the Organization. An Annual Meeting, the most important event for PICES, is not an exception. At PICES-2008, a Study Group was established to review the present structure of the Annual Meeting and to consider options for its restructuring. At IGC-2009, a preliminary report of the Study Group was presented, including some recommendations on changing the time allocation and order among various events in the Annual Meeting and shortening its duration. After extensive discussion, Council agreed with Science Board that structural changes to be implemented should not compromise the scientific quality and attractiveness of the Annual Meeting, and decided to extend the deadline for the final Study Group report until PICES-2009. Council also approved changing, effective PICES-2009, the format of the Opening Session by abolishing remarks by the Contracting Parties, except for the host country. Instead, the opportunity will be provided to national delegates to make their statements at the beginning of the first session of the Council meeting.

***Schedules of future Annual Meetings***

The plans for future Annual Meetings were confirmed. PICES-2009 will be held October 23–November 1 at the International Convention Center in Jeju, Korea. The overall theme of the meeting, "*Understanding Ecosystem Dynamics and Pursuing Ecosystem Approaches to Management*", is quite appropriate for the initiation of FUTURE. The poster and announcement for the meeting were distributed to the Contracting Parties, and details on the program and logistics can be found on the PICES website. PICES-2010 will be held October 22–31 at the Oregon Convention Center in Portland, Oregon, U.S.A., under the theme of "*North Pacific Ecosystems Today, and Challenges in Understanding and Forecasting Change*". A detailed program will be discussed and decided at the Jeju meeting. Russia kindly agreed to host the Annual Meeting in 2011. The venue and dates will be announced in Jeju.

We had fine weather during these four days, and discussed all issues in a very comfortable atmosphere. In the breaks from the discussion, we much enjoyed the Qingdao scenic beauties and traditional Shangdong dishes. Some of us even tried to swim at the beach in front of the venue, which is becoming a custom of PICES meetings.

Inter-sessional Science Board and Governing Council meetings are not only indispensable for reviewing the activities of the Organization and making decisions in timely manner, but also for providing a good opportunity for communication between the two executive groups. As mentioned above, this year's meetings were very productive, and to a great degree it was due to the support from our Chinese colleagues. On behalf of all participants, I express our deepest thanks to SOA and the staff of the First Institute of Oceanography for their hospitality.

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

# The FUTURE is Here

We recently held a 2-day FUTURE (***F****orecasting and* ***U****nderstanding* ***T****rends,* ***U****ncertainty and* ***R****esponses of North Pacific Marine* ***E****cosystems*) Implementation Plan Workshop (April 26–27) and a 1-day inter-sessional Science Board meeting (April 28) in Qingdao, China. The venue was outstanding, so on behalf of all the participants I want to thank our Chinese hosts, and especially Mr. Gongke Tan, for great hospitality and making sure we had everything needed for an effective and successful set of meetings.

These were very important events in the history of the Organization because the main objective was to conduct a final review of the Implementation Plan for FUTURE, make any necessary changes, have Science Board review and approve the final draft, and then present the results of the review and changes to the Governing Council for their consideration. As with all new ventures, there were times in developing FUTURE when we wondered if we would ever arrive at a completed plan, and there were times throughout the process when we would take one step forward and two steps back, and then have to scratch our heads and wonder – what do we need to do now to get this back on track? But we always did and now we are ready to implement FUTURE as the next-generation PICES integrative science program following on our successful Climate Change and Carrying Capacity Science (CCCC) Program.

So it is with great pleasure to inform you that at the Governing Council meeting on April 29, the Implementation Plan was provisionally approved (the final approval was given on June 30), and we now have both a Science Plan and an Implementation Plan in place. Many of our colleagues in PICES deserve to be thanked for their contributions throughout this multi-year effort to develop these two Plans. But here, I want to express our appreciation to the members of the Implementation Plan Writing Team [Michael Foreman and Jake Rice (Canada), Xianshi Jin, Fangli Qiao and Sun Song (China), Masahide Kaeriyama, Hiroaki Saito, Orio Yamamura and Ichiro Yasuda (Japan), Jung Hwa Choi, Se-Jong Ju, Joon-Yong Yang and Sinjae Yoo (Korea), Oleg Katugin and Vyacheslav Lobanov (Russia), David Fluharty, Anne Hollowed, Nathan Mantua and James Overland (U.S.A.)], and in particular give a special thanks to Drs. Hiroaki Saito and James Overland who very ably served as Co-Chairmen of the Team. Their dedicated efforts resulted in the Implementation Plan that addressed well the objectives of the Science Plan and comments from scientists in the Organization, using as guidance the attributes Governing Council considered necessary in a structure for implementing the science activities. In the process of developing the Implementation Plan, many insightful and useful comments on drafts were provided and, as always, this type of peer review greatly improved the quality of the Plan. In this regard, I think it is appropriate to acknowledge one individual in particular. Dr. Jake Rice's reviews at key stages in the development of the Plan raised centrally important questions and points of consideration, which led to discussions and decisions that improved the focus and sharpened the text of the document to convey clearly the science activities for FUTURE that will achieve the vision we developed.

The main highlight from our review of the Implementation Plan was the final decision that the Scientific Steering Committee for FUTURE will be the PICES Science Board, with the addition of Chairmen of three new Advisory Panels of FUTURE: COVE – *Climate, Ocean Variability and Ecosystems*, AICE – *Anthropogenic Influences on Coastal Ecosystems*, and SOFE – *Status, Outlooks, Forecasts and Engagement*. This means that Science Board will be responsible for initiating the activities of FUTURE by working with our Science and Technical Committees and their expert groups, and will also have the responsibility of evaluating the progress of FUTURE's scientific activities. This is a substantive change from the structure of the CCCC Program, and we are confident that the structure for

*Participants of the FUTURE workshop held on April 26-27, 2009, in Qingdao, People's Republic of China.*

FUTURE will be effective and lead to greater integration of all our Committees into the activities of FUTURE.

I encourage you to visit the PICES website and get a copy of the Plan (www.pices.int/members/scientific_programs/FUTURE/FUTURE_IP_final_2009.pdf), read it and become very familiar with it, because it is now time to stop planning and start executing the Plan. To get started, interim Chairmen to the FUTURE Advisory Panels, Drs. Hiroya Sugisaki for COVE, Glen Jamieson for AICE and Harold Batchelder for SOFE, were appointed at our meeting in Qingdao. Their tasks are to assist with soliciting nominations for each of the Advisory Panels and then develop an agenda for, and chair, the first meetings of the Panels at PICES-2009 in Jeju, Korea. At these meetings permanent Chairmen will be elected.

It has been a long process to get to this important point of having the approval to move forward and implement what I consider, and I hope you do to, a scientifically sound and highly relevant 10-year science program. If conducted well, and with strong and enthusiastic support from all of you, we, as PICES, will contribute significantly to improved understanding of the natural and anthropogenic forces affecting North Pacific ecosystems, and will produce relevant and useful products for our member country governments and societies as they develop policies and actions for the mitigation and adaptation to climate change. We have our strategic vision and our plan to begin to reach that vision, and it is now up to all of us to make it so.

Now I would like to turn to the inter-sessional Science Board meeting. One major agenda item was the review and approval for submission of the FUTURE Implementation Plan to the Governing Council, which has been discussed above. The other key items were: to review the status of the planning for our next Annual Meeting in Jeju, Korea, to evaluate progress on the development of the second edition of the North Pacific Ecosystem Status Report, and to examine a draft report of the Study Group on *Restructuring of the PICES Annual Meeting*. I can report that our Korean hosts and the Local Organizing Committee have arranged for an excellent venue and have made very good progress in developing an outstanding meeting agenda and associated activities. After considering the status of topic sessions and workshops, including invited speakers and co-sponsoring organizations/programs, we are confident that we have the foundation for some very substantive events that will be of broad interest to PICES scientists and to others outside of the community. I hope you are making plans now to be in Jeju, and if you have not, be sure to register for the meeting on the PICES website.

The development of the second edition of the North Pacific Ecosystem Status Report is a high priority for PICES, and I am pleased to inform you that the editors of the report, Drs. Skip McKinnell and Michael Dagg, are doing an excellent job in keeping the Regional Writing Teams on track for completion of initial drafts so that we will be ready for the synthesis workshop in early December, in Honolulu, Hawaii.

It is always good for an organization to periodically review practices and procedures, and in that vein a Study Group on *Restructuring the PICES Annual Meeting* was established. The draft report of this Study Group was reviewed prior to, and discussed at, the inter-sessional meeting. Participation of several Council members in the discussion greatly helped to sharpen our comments. It is premature to talk about the outcomes, but briefly, a number of constructive comments were made that could lead to increased efficiencies in structuring our Annual Meeting while not affecting its effectiveness in fostering scientific exchanges and new international collaborations.

Finally, I would like to let you know that our relationship and interactions with ICES (International Council for the Exploration of the Sea) are still growing, and will continue to do so. Recently, we proposed to work with ICES on strategic issues of mutual interest and to establish a joint Steering Group on *Strategic Planning for Cooperation in Marine Science in the Northern Hemisphere*. Soon after our inter-sessional meeting, we heard that the ICES Science Committee (SCICOM) agreed that this effort would be a unique opportunity to work together, and accepted the proposed Terms of Reference for the Steering Group. As a step towards this opportunity and other interactions we have with ICES, I will be attending the ICES Annual Science Conference in September and will participate in their SCICOM meeting. Subsequently, Mr. Serge Labonté (SCICOM Chairman) and Dr. Adolf Kellermann (Head of ICES Science Programme) will attend PICES-2009 and participate in our Science Board meeting.

I close with a personal note to take some time this summer to be with family and friends and be ready this fall to begin the exciting and important job of implementing our next integrative science program – ***F****orecasting and* ***U****nderstanding* ***T****rends,* ***U****ncertainty and* ***R****esponses of North Pacific Marine* ***E****cosystems*. We have given ourselves an ambitious and challenging task, but one that is critically important as we, as PICES, do our part to improve the scientific foundation for understanding and projecting the effects of climate change on the ecosystem goods and services from the North Pacific that are vital to our well-being as Pacific Rim societies.

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

# PICES Harmful Algal Bloom International Seafood Safety Project

*by Vera L. Trainer and Charles G. Trick*

A PICES Seafood Safety Project was initiated in 2007 in response to the need to develop a system for harmful aquatic organism data collection and exchange in the Pacific Ocean, to assist both in the prevention of impacts on fisheries and to build the capacity of scientists studying this topic in developing countries in the Pacific Rim. Funded by a voluntary contribution from Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF), through the Fisheries Agency of Japan (JFA), the Project is into its second successful year. The Project is conducted by the PICES Section on *Ecology of Harmful Algal Blooms in the North Pacific* (HAB Section), with Dr. Vera Trainer (Northwest Fisheries Science Center, Seattle, WA, U.S.A., Vera.L.Trainer@noaa.gov) as the Principal Investigator, and focuses on preparing and teaching country-specific training courses most needed to ensure seafood safety in Pacific countries outside the PICES region, *i.e.*, in Southeast Asia and in Central and South America.

It was recognized that other attempts to provide a similar assessment and implementation of seafood safety guidelines experienced variable levels of success, and none have proven to be sustainable over the long-term. It was agreed to take a "community research partnership" approach to produce best results with the relatively minor regional contributions that can be made with available resources. An inclusive and sustainable model for the implementation of the PICES Seafood Safety Project was set up to meet the following criteria, regardless of the geographical location:

- Participation in the Project should be initiated and implemented at the community level. Projects aimed at research scientists and government laboratories can succeed in establishing a core of dedicated researchers, but to exist over the long-term, a project must build on community research partnerships;
- Participation in the Project should lead to sustainable involvement at the local and regional levels and ideally be seen as a realistic career path for both community workers and regional scientists;
- Participation in the Project should engage researchers who are in a multidisciplinary research group so that individuals can gain a balanced perspective on both the entire project and the value of their contributions;
- Accepting that partnerships are essential for success, opportunity is required to build partnerships for extended interactions and commitments. Building of partnerships with stakeholder involvement and continuing education or knowledge transfer are essential to maintain a country's research and monitoring capacities.

Investment into creating the proper framework for the implementation of the Project is a major accomplishment that will pay dividends. Without this investment to detailed analysis we risk a non-sustainable effort. There is now a plan in place that will embrace community partnerships leading to sustainable success.

Having criteria for the implementation of the Seafood Safety Project established, opportunities were investigated for partnerships with agencies and individuals active in complementary programs in geographical areas of interest. Through extensive discussions with active scientists and administrators, the potential for integrating the Project into established regional collaborations has been evaluated.

In November 2007, PICES experts observed a HAB Training Workshop, led by Prof. Dr. Yasuwo Fukuyo, at the Tokyo University of Marine Science and Technology, and met with their IOC-WESTPAC (Intergovernmental Oceanographic Commission's Regional Secretariat for Study of the Western Pacific) colleagues to discuss possible directions for the Seafood Safety Project, what might be learned from past IOC-WESTPAC training classes, and potential for collaboration with these organizations to enhance the effectiveness of our training program. A regional presence was achieved by presenting activities of the PICES HAB Section and the rationale and approach for the Project at the second Asian GEOHAB (Global Ecology and Oceanography of Harmful Algal) Conference in Nha Trang, Vietnam (January 2008) and at the WESTPAC Seventh International Scientific Symposium in Sabah, Malaysia (May 2008). At these meetings, PICES experts communicated with GEOHAB and WESTPAC scientists in order to obtain information about research and monitoring needs pertaining to HABs and seafood safety in southeast Asian countries, and to appraise both the willingness of individual scientists to participate in the PICES Project and the existence of the organizational structure and interest within a country's responsible management agencies to sustain a HABs monitoring effort.

The need for a HAB training program in developing countries is also being assessed via a questionnaire sent, with assistance from Dr. Henrik Enevoldsen, through the IOC network to their contact points (representing both regulatory and research entities) in a number of WESTPAC, and IOCARIBE (IOC Sub-Commission on the Caribbean and Adjacent Regions) and ANCA (IOC Sub-Commission in Central and South American) countries. This questionnaire requested a response from countries detailing their research and monitoring needs on HABs and


*Instructors and participants of the PICES HAB International Seafood Safety Project first training class in Manila, Philippines, January 2009.*

seafood safety, and their interest in being involved in the PICES Project. Information received back is being used to determine which countries best meet the criteria in the adopted "community research partnership" approach and have to be targeted for training classes/workshops in following years. As partners with IOC we also have gained access to their training classes, and international education/technology transfer activities.

After conversations with Bureau of Fisheries and Aquatic Resources (BFAR) personnel during a visit to Manila in May 2008, and through subsequent e-mail and telephone contacts, it was concluded that the Philippines appeared to be a perfect match to the criteria used for country selection in the Seafood Safety Project, including (1) the magnitude of the HAB problem, (2) the need for training, and (3) the likelihood of sustainability. A tentative plan was made to hold the first PICES training class/workshop in this country. Equipment and supplies for a Seafood Safety Traveling Field Kit for the detection and monitoring of HAB toxins, harmful algal species, and associated environmental (abiotic) parameters were purchased to be used for this class and other classes in subsequent years.

It was determined that the greatest need in the Philippines was for:

- training in screening tools for toxin detection because of the periodic lack of mice for the mouse bioassays (the standard regulatory method for testing shellfish for paralytic shellfish poisoning (PSP) toxins);
- a review of phytoplankton identification, with specific focus on harmful species in the Philippines;
- an introduction to relational and online databases.

The training class was held from January 15–23, 2009, in Manila, and was highly successful. There were 11 participants from the BFAR Central Laboratory and 3 from the BFAR Regional and Local Governmental Laboratories during the first 2½-day training session on toxin screening methods. Thirty-three participants took part in the 4-day comprehensive training on phytoplankton identification and toxin screening methods. The quality of teaching and the students' comprehension of concepts were assessed from two quizzes and one class questionnaire. A notebook was provided to all participants that included an agenda, a summary of HAB syndromes in humans, a phytoplankton key, individual micrographs of HAB species of concern in the Philippines, and handouts on toxin detection methods, including the Jellett PSP test and Abraxis Enzyme-Linked Immunosorbent Assay (ELISA). BFAR Central Laboratory personnel also received a list of supplies, including purchasing information and description of the


*Top left: Valentino Macasaet (Fisheries Resources Management Division, BFAR), Mark Wells and Vera Trainer (PICES), Malcolm Sarmiento (Director, BFAR), Sandra Arcamo (Head, Fisheries Resources Management Division, BFAR), Juan Relox (Head, Marine Monitoring Section, Fisheries Resources Management Division, BFAR); Top right: Brian Bill (PICES instructor) demonstrating pipetting to (from left to right) Lourdes (Odeth) Legaspi, Jayson Zulueta, Angelica Bautista, Mark Wells (PICES instructor) and Valentino Macasaet; bottom left: Florie Calmorin, Ramie Gengoni and Evonie Dumdumaya identifying harmful algal species by light microscope; bottom right: Lovella Carolino and Ramie Gengoni performing a toxin screening test.*

Association of Official Analytical Chemists (AOAC) International method and Interstate Shellfish Sanitation Conference (ISSC) approval of the Jellett rapid test for PSP toxin screening. Over the next year, the Abraxis ELISA and Jellett test strips will be evaluated by Central Laboratory personnel. Monthly communications between PICES experts and Philippine scientists will assure timely progress. A follow-up visit to the Philippines is anticipated in 2010.

We have begun country-of-focus communications for the next training class in Latin America. Initial discussions took place at the IPHAB (International Panel on Harmful Algal Blooms) conference in Paris in April 2009, where PICES experts met with Dr. Leonardo Guzman, the Chairman of the IPHAB and a member of the IOC HAB Working Group for South America, and Jose Luis Peña Manjarrez, Chairman of the IOC HAB Working Group for Central America and Caribbean Sea. Based on discussions with these individuals representing Central and South America, Guatemala was determined to be one of the countries with the strongest need for HAB training that is not already receiving assistance from other programs. The International Atomic Energy Authority (IAEA) already has planned to give widespread training classes throughout Central and South America in 2009–2010, and because Guatemala is not currently receiving assistance from IAEA, it is considered a logical choice. Our decision is also based on the IOC-supported questionnaire that was submitted by Leonel Carrillo Ovalle, from the Laboratorio de Investigación Aplicada Centro de Estudios del Mar y Acuicultura, Universidad de San Carlos de Guatemala. His response to the questionnaire fulfills our guidelines of need, sustainability and desire of the host country for PICES project training. The first training class/workshop in Latin America is tentatively planned for January–February 2010. This plan will be confirmed during the upcoming site visit of PICES experts to Guatemala in September 2009. We would like to acknowledge MAFF for funding this project, allowing us the opportunity to conduct much needed important work.

# PICES at the 2009 GLOBEC Open Science Meeting

The Climate Change and Carrying Capacity (CCCC) Program was the first major interdisciplinary scientific initiative undertaken by PICES. The basic concept for the CCCC Program was approved at the PICES Second Annual Meeting (October 1993, Seattle, U.S.A.), and the details of its Science Plan were developed during a workshop held prior to the PICES Third Annual Meeting (October 1994, Nemuro, Japan). The CCCC Implementation Plan was developed a few months later at an inter-sessional workshop convened in May 1995 in Honolulu (U.S.A.). At the PICES Fourth Annual Meeting (October 2005, Qingdao, People's Republic of China), the CCCC Program was endorsed as a regional component of the emerging Global Oceans Ecosystem Dynamics (GLOBEC) Program, co-sponsored by the International Geosphere–Biosphere Program (IGBP), Scientific Committee of Oceanic Research (SCOR) and Intergovernmental Oceanographic Commission (IOC) of UNESCO. This endorsement was the first step toward productive PICES-GLOBEC collaboration. We have now a long history of working together, and GLOBEC-PICES interactions and relations over these 15 years have been mutually beneficial. Affiliation with GLOBEC broadened the CCCC Program to include connections with global environmental change research networks and provided integration with the global comparisons being conducted by these networks. At the same time, the CCCC Program worked as a mechanism for integrating national GLOBEC research programs in the North Pacific.

The 3rd and the final (since GLOBEC will formally close in early 2010) GLOBEC Open Science Meeting on "*Marine Ecosystems: from Function to Prediction*" was convened June 22–26, 2009, in Victoria, British Columbia, Canada. It was natural that PICES was invited and agreed to co-sponsor the OSM by providing some monetary support for invited speakers and early career scientists from our member countries, and by assisting in local arrangements for this event held at the location of the PICES Secretariat. PICES also had a booth with our publications and posters summarizing the outcome from the CCCC Program and introducing the new PICES integrative science program, FUTURE (see photos below).

The purpose of the OSM was to contribute to the synthesis and integration of the results of GLOBEC international activities, and it was a very memorable event demonstrating progress of GLOBEC. The meeting included three days of plenary sessions along the following themes: (1) GLOBEC achievements, (2) Ecosystem structure, function and forcing, (3) Ecosystem monitoring and prediction, (4) Ecosystem management and human dimensions, and (5) Marine ecosystem science: Into the future. The first two days were devoted to ten 1- or 2-day topical workshops proposed by the scientific community. PICES scientists were very active in submitting proposals for, convening and attending these workshops. Brief reports from the following seven workshops can be found on pages 9–25 in this newsletter:

- Modeling Ecosystems and Ocean Processes: The GLOBEC Perspective of the Past, Present and Future;
- Krill Biology and Ecology in the World's Oceans;
- Comparisons of Processes and Climate Impacts in Sub-Arctic and Antarctic Marine Ecosystems: Observations and Modeling Approaches;
- Biogeochemistry of the Oceans in a Changing Climate;
- Continuous Plankton Record Surveys of the Global Ocean;
- Plankton Phenology and Life History in a Changing Climate: Observations and Modeling;
- Climate Impact on Ecosystem Dynamics of Marginal Seas.

The Open Science Meeting was a celebration of GLOBEC and its achievements. PICES now looks forward to collaboration with IMBER, the Integrated Marine Biogeochemistry and Ecosystem Research project that will attempt to address GLOBEC's unresolved research questions.


*Left: Julia Yazvenko of the PICES Secretariat putting a PICES booth in order at the 2009 GLOBEC OSM; right: Keen interest being shown in PICES publications by the participants.*

# Modeling Ecosystems and Ocean Processes Workshop

*by Enrique Curchitser, Alejandro Gallego, Michio Kishi and Emanuele Di Lorenzo*

A 2-day workshop on "*Modeling Ecosystems and Ocean Processes: The GLOBEC Perspective of the Past, Present, and Future*", co-convened by the authors of this article, was held at the 2009 GLOBEC Open Science Meeting (June 22–23). It attracted a considerable interest, with approximately 50 attendees over both days. The general goals of the workshop were to summarize the physical and biological modeling activities during the GLOBEC years and discuss future directions. The workshop was divided into four sub-topics: (1) Physical and biological modeling, (2) Biological and advanced ecosystem models, (3) Frontiers in ecosystem modeling, and (4) Climate change in regional marine ecosystems, although there was some unavoidable overlap between these. Workshop activities included five invited (review) talks (by Francisco Werner, Raghu Murtugudde, Jerome Fiechter, Michael Follows and Kenneth Drinkwater), which introduced individual sub-topics, and over 35 submitted talks, in addition to six posters and a final discussion session. Some of the common themes that emerged from the discussions and some of the presentations focused on (1) end-to-end models, (2) agent-based models, (3) complex food-webs, (4) simple *vs.* complex ecosystem models, and (5) evolutionary models.

The traditional ("classical" or more "advanced") physical–biological coupled models, especially NPZD models coupled with three-dimensional physical models, have achieved considerable progress in the study of marine ecosystems. For long-term predictions, like the ecosystem response to climate change, traditional methods using physical–biological coupled models are still useful. Since the 1990's, IBM (Individual Based Models) have been successfully employed to capture much of the physical-biological interaction in marine ecosystems. The IBM approach has also been widely used in modeling zooplankton or larval fish behavior. However, as it was pointed out during the discussions, the more complex models need more data to assess the degree of realism and more parameters need to be specified. There is ample space for discussion on this matter, but we must recognize that, although advances in computing technology allow us to increase the number of biological compartments or refine the grid in our models, ecosystem models are just "models", *i.e.*, representations of nature. Nevertheless, as the impacts of climate change become manifest in all components of the Earth System, the need for high resolution (meter scale) multi-compartment modeling frameworks for policy and decision-making and adaptive management is very clear. The IPCC-class models continue to enhance their spatial resolutions but participatory decision-making on the ground will always require further improvements in the resolution at which Earth System information is provided with its irreducible uncertainties, and will require dynamic and statistical downscaling.

A prototype implementation of a regional Earth System prediction framework was illustrated for Chesapeake Bay by Ragu Murtugudde (Fig. 1). This forecasting system uses the WRF (Weather Research and Forecasting) regional atmosphere model, NOAH land model, ROMS (Regional Ocean Modeling System) ocean model and the SWAT (Soil and Water Assessment Tool) watershed model to generate seasonal predictions and decadal projections for not only meteorological and climatic variables but also for nutrient and sediment loading of streams, pathogens, harmful algal blooms, fisheries, dissolved oxygen, and other ecosystem parameters. An important aspect of this type of regional Earth System prediction approach is to recruit users such as city water supply managers, parks and river keepers, and watermen so that the model forecasts are employed in decision-making. This allows quantitative feedbacks from the users that are important to validate, optimize, provide uncertainties, and improve skills and products of the Earth System prediction. In the case of the Chesapeake Bay system, an interactive decision-making tool has been developed such that users can change land use types, crops, urban sprawl, emissions, population, and other variables of interest to track the impacts on air and water quality, health of the coast–estuarine ecosystems, pathogen levels, and other critical system indicators. While the task of validating the output of these systems with data remains an important issue to address, the philosophy is to demonstrate the feasibility of regional Earth System prediction and its usefulness in determining the observational data needs.

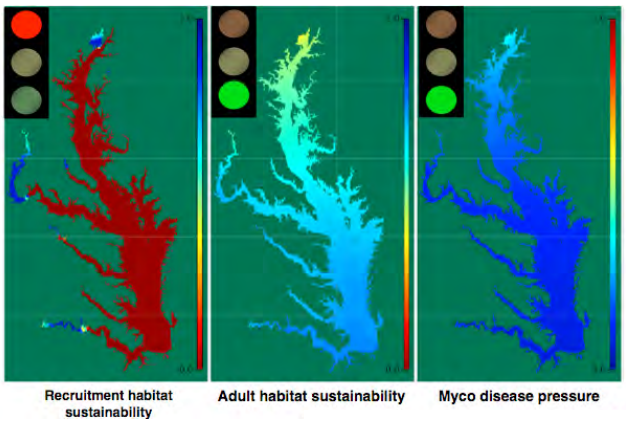



*Fig. 1 Example of the Chesapeake Bay Earth System Prediction framework. Panels show an example of various stress parameters for Striped Bass during a simulation of severe drought in July 1999 (courtesy of R. Murtugudde, University of Maryland, U.S.A.).*

Other topics of discussion about future progress and model applications included the use of modeling tools to describe species migrations (in regional models), including the spread of "invasive" species or, in terms of methodology, allowing for shifting parameters/distributions to describe entropy maximization. An interesting approach based on the self-organizing principle of marine ecosystems was presented by Michael Follows, where the marine ecosystems are organized by the relative fitness of the myriad of potentially viable phenotypes in a given environment. With this guiding principle an ocean model is seeded with many tens or hundreds of plausible phytoplankton physiologies, which are then allowed to "self-organize". Using this approach, a familiar pattern of biogeographical provinces naturally emerge in the model, with a subset of the initialized organisms ultimately dominating the population of each province. The emergent biogeography is broadly plausible, with pleasing correspondence between observed and model–analog ecotypes of the cyanobacterium *Prochlorococcus* (Fig. 2). These types of complex model solutions can be understood using established ecological concepts; in particular, it was found that resource competition theory accurately anticipates the characteristics of the modeled subtropical ecosystems. Based on these results, it was suggested that such "self-assembling" ecosystem approaches are particularly suitable for modeling the broader food web and will provide preliminary illustrations incorporating heterotrophic microbes and predators in a similar manner.

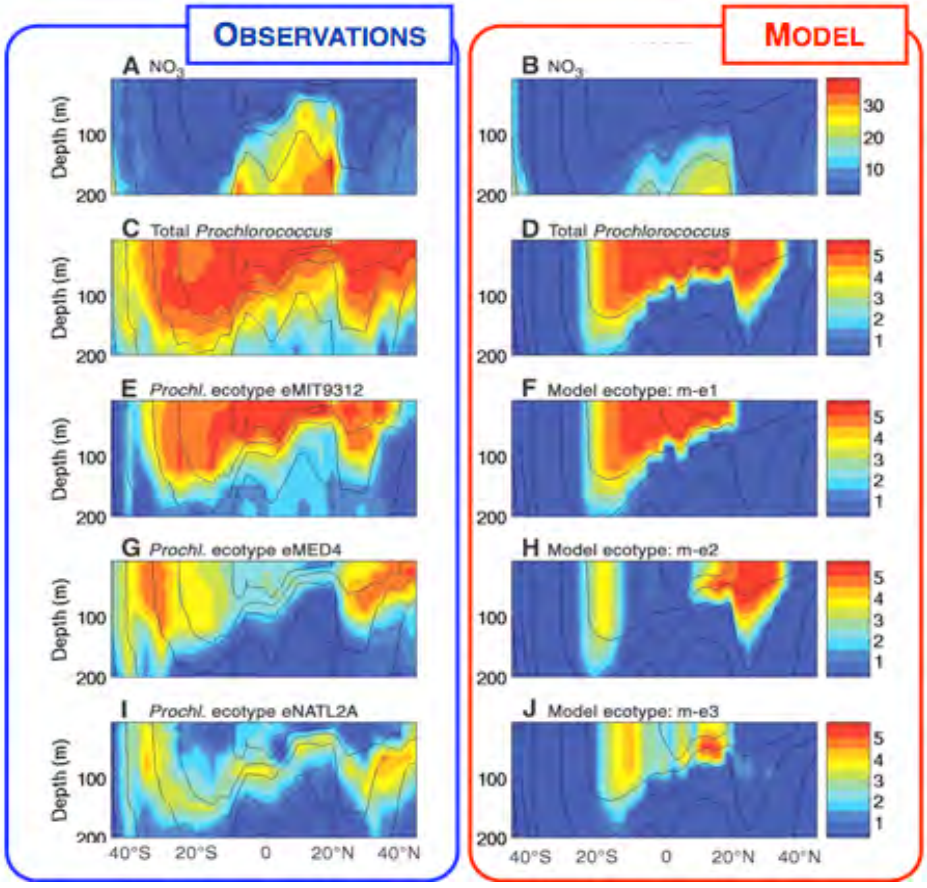



*Fig. 2 Observed and modeled properties along the AMT13 cruise track. Left column shows observations, right column shows results from a single model integration. (A and B) Nitrate (µmol kg$^{-1}$); (C and D) total* Prochlorococcus *abundance [log (cells ml$^{-1}$)]; (E, G, I) distributions of the three most abundant* Prochlorococcus *ecotypes [log (cells ml$^{-1}$)] ranked vertically; (F, H, and J) the three emergent model ecotypes ranked vertically by abundance. Model* Prochlorococcus *biomass was converted to cell density assuming a quota of 1 fg P cell$^{-1}$. Black lines indicate isotherms. Source: Follows* et al., *Science 315, 1843–1846 (2007).*

Another interesting avenue for future ecosystem modeling was discussed by Jerome Fiechter. The approach involves combining existing ecosystem models with Bayesian Hierarchical Models (BHM). BHM is a unified probabilistic modeling methodology that updates uncertain distributional knowledge about process models and parameters in the presence of multi-platform observations. Summary measures of the resulting "posterior" distributions provide realistic quantitative estimates of central tendencies and uncertainties. Process model distributions are based on NPZD-type lower trophic level ecosystem models, including NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) specifically developed and parameterized for the North Pacific Ocean. A significant outcome of BHMs will be a quantitative understanding and comparisons of the relative uncertainties of modeled state variables and

parameters (*e.g.*, from NPZD or NEMURO), region-by-region across different oceanic ecosystems.

As a general observation, the ROMS emerged as the most widely used physical model for coastal and shelf applications, although results using other physical models were also presented. In the case of NPZD models, there was a wide degree of "regional variability". The size of NPZD models averages around ten compartments. In most of these models, each phytoplankton and zooplankton is divided into two to four compartments. The NEMURO model, which was developed by the PICES CCCC (Climate Change and Carrying Capacity) Program's MODEL Task Team, was one of the more popular NPZD models. One of the topics that came out in the discussion period was that the number of compartments in a biological model is not necessarily a measure of its complexity. A four-compartment model may have more parameters to tune, thus making it more complex than a ten-compartment model which has simple feedbacks. The question of what is the appropriate level of complexity was widely discussed and, in the mind of the organizers, will continue to be an important topic in the near future. The workshop was a fitting final presentation of GLOBEC modeling work. We thank the OSM organizers and all workshop attendees and participants and, in particular, we appreciate the interaction with so many GLOBEC friends through these last ten years. The organizers would also like to thank Ivonne Ortiz and Jerome Fiechter for helping with running the workshop.

*Left photo (left to right): Enrique Curchitser, Jerome Fiechter (who helped to run the workshop in the absence of Emanuele Di Lorenzo), Alejandro Gallego and Michio Kishi after completion of the workshop. Right photo: Emanuele Di Lorenzo (left) and Enrique Curchitser (right) in a rare moment of not thinking about low-frequency variability and regional climate impacts.*

*Dr. Enrique Curchitser (enrique@marine.rutgers.edu) is a physical oceanographer based at Rutgers University in New Jersey, U.S.A. In spite of living near the Atlantic, most of his work is on the Pacific Ocean. His main interests are the intersection of climate and biology, regional climate impacts and numerical modeling. His current projects range from downscaling climate scenarios in the northeast Pacific and Bering Sea to trying to understand the low-frequency fluctuations in global sardine populations. He is a member of PICES Working Group on Evaluation of Climate Change Projections.*

*Dr. Alejandro Gallego (a.gallego@marlab.ac.uk) is Leader of the Bio-Physical Processes Group, in the Aquatic Environment Programme of the Marine Laboratory Aberdeen, which is part of Marine Scotland, a Directorate of the Scottish Government. He has carried out experimental work on larval fish ecology, but his main field of research for a number of years has been biological and bio-physical modeling of zooplankton and early-life stages of fish. Alejandro is a member of a number of ICES Working Groups, such as WG on Recruitment Processes (WGRP) and WG on Modelling Physical-Biological Interactions (WGPBI), where he is an enthusiastic participant in its informal "larval fish sub-group", and has been the co-convenor of a number of workshops organized under the auspices of this Group.*

*Dr. Michio J. Kishi (kishi@salmon.fish.hokudai.ac.jp) is Professor at the Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Japan. He is also a Team Leader at the Research Institute of Global Change, Japan Agency for Marine-Earth Science and Technology (JAMSTEC). His research interests include top-down control of regional ecosystems by migrating fish and marine mammals, ecosystem-based management of marine resources, development of NEMURO-family models and their application to fish ecology. For his modeling work Dr. Kishi received the 2005 Uda Prize from the Japanese Society of Fisheries Oceanography and the 2007 JOS Prize from the Oceanographic Society of Japan. In PICES, he was a member and Co-Chairman of the MODEL Task Team and has been serving as Co-Chairman of the Climate Change and Carrying Capacity (CCCC) Program since 2006.*

*Dr. Emanuele (Manu) Di Lorenzo (edl@gatech.edu) is Associate Professor at the School of Earth and Atmospheric Sciences, Georgia Institute of Technology, U.S.A. His research interests and experience span a wide range of topics from physical oceanography to ocean climate and marine ecosystems. More specific focus is on dynamics of coastal ocean circulation, regional ocean predictability and inverse dynamics, Pacific low-frequency variability from coastal to global scales, and impacts of large-scale climate forcing on regional ecosystem dynamics. His work relies on combining advanced numerical, statistical and inverse models of the ocean circulation (and ecosystems) with observations. Manu is also involved in using IPCC class coupled climate models to better understand the links between large-scale dynamics, climate change and ecosystem response. In PICES, he is a member of the Working Group on Evaluations of Climate Change Projections.*

# Krill Biology and Ecology Workshop

*by William Peterson, Jaime Gómez-Gutiérrez, Angus Atkinson and Bettina Meyer*

The final official gathering of the international GLOBEC scientific community was held from June 22–26, 2009, in Victoria, British Columbia, Canada, at the Victoria Conference Centre, a venue well known to most PICES scientists. The five-day meeting included 10 workshops on the first two days followed by three days of invited and contributed talks and posters. This report summarizes activities at the two-day workshop on "*Krill Biology and Ecology in the World's Oceans*" co-convened by the authors of this article.

The idea for this workshop originated at a workshop with a similar title that was held at the PICES/ICES/GLOBEC 4th Zooplankton Production Symposium in May 2007, in Hiroshima (Japan). More than 100 krill enthusiasts at this workshop endorsed the need to meet more regularly, thus Drs. So Kawaguchi and Bill Peterson proposed to GLOBEC that another workshop be held at the 3rd and final GLOBEC Open Science Meeting. The proposal was approved and planning began in earnest. The Victoria workshop marked the sixth time that krill biologists had assembled for the specific purpose of discussing krill biology and ecology, with the first two being held in Wilmington (North Carolina, U.S.A.) and Bremerhaven (Germany) in 1982 and 1983. After a long pause, regular gatherings took place with the third and fourth meetings in Santa Cruz (California, U.S.A.) in 1999 and Nagoya (Japan) in 2002. The Hiroshima meeting was the fifth. Discussions are underway to propose a seventh meeting in Pucon (Chile) as part of the forthcoming PICES/ICES 5th Zooplankton Production Symposium to be convened in 2011.

*Krill Biology and Ecology Workshop in session.*

The purpose of the krill workshop was fourfold. Firstly, the conveners recognized the need for those working on different euphausiid species to get together to discuss methods/approaches that have proved effective for one species to see if they could be applied to other euphausiid species. Secondly, we wanted to make sure that there was a degree of harmony (or at least that there was no serious disconnect) in research approaches, recognizing the need to improve technical aspects of specific methods where necessary. Thirdly, we wanted to generate ideas for future collaborations (laboratory/seagoing exchanges of personnel and exchange and pooling of datasets to address broad-scale issues). Finally, we proposed to produce a tangible product, to show where krill research is at the moment, and to identify hurdles to progress and potential solutions. It was agreed that "the krill workshop group" will produce a summary paper for consideration of publication in the *Marine Ecology Progress Series*.

Towards these ends, on the first day (June 22), 16 presentations were made which summarized national programs – nine talks on work in the Antarctic mostly focused on the Antarctic krill *Euphausia superba* by scientists from the UK, Germany, Australia, Korea and the USA and seven talks on work carried out in the Pacific (in Peru/Chile, Mexico, USA, Canada, Japan, China and Korea). At least five common themes emerged from the discussions:

1. The biomass of all krill species has likely been underestimated, and thus there is a need to make better use of acoustics and large plankton nets in order to derive proper estimates of krill biomass;
2. We need to gain a better appreciation of the role of krill as predators and prey in marine food webs, especially with regards to krill as a "wasp-waist" species (*e.g.*, *Euphausia superba*, *E. pacifica* and *Meganyctiphanes norvegica*) – by definition, such species occupy an intermediate trophic level that is strongly dominated by a single species with large fluctuations in biomass such that their prey and predators are measurably impacted by the large swings in biomass;
3. We only have a very rudimentary knowledge of krill behavior and the factors which result in krill forming schools, aggregations and patches at multiple time–space scales and their role in energy cost, physiological adaptation mechanisms to a strong seasonal environment such as the Southern Ocean, species condition and parasite transmission;

4. We need much more pan-oceanic research which will allow us to work out the impact of climate variability and change on krill ecology and production at different latitudinal ecosystems – on this topic, there is abundant evidence that the Antarctic waters are warming and that the ice sheet is melting, two processes that are certain to impact krill but in ways that we can only guess; and
5. Vast improvements have been made using IBM models linked with ROMS (Regional Ocean Modelling System) to gain a better understanding of krill population dynamics and of how eggs of broadcast spawning species and larvae are transported as a result of interaction of currents with ontogenic variations in vertical distributions.

Talks were supplemented by 17 posters that summarized topics such as larval development and growth, maturation, secondary production, parasitism, analysis of exploitation strategies, effect of global warming, grazing rates, variations in digestive enzymes, lipid trophic markers and larval drift modeling in different regions in the Southern Ocean and Pacific Ocean.

The second day (June 23) included talks on four hot topics such as novel uses of bottom-mounted upward-facing echosounders and high-speed video systems to study krill behavior and hydrodynamics of swimming and krill patchiness, estimation of mortality rates of *Euphausia pacifica*, and a comparison of the role of krill as prey in the Antarctic and North Pacific ecosystems. The remainder of this day was devoted to discussions of the structure of a synthesis paper that will be prepared for the *Marine Ecology Progress Series*. This will be one tangible output from the workshop in which we will introduce krill as a "wasp-waist" species in important productive ecosystems around the world. The paper will highlight recent developments and issues in krill biology, improving our understanding of how this group fits into their ecosystems.

Perhaps 50 people from at least 11 nations attended the workshop for the two full days whereas another 50 attended one or more of the talks on the first day. Members of the PICES Working Group on *Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim* were well represented by talks by Bill Peterson, Dave Mackas, Yuji Okazaki, Song Sun, Hyoung Chul Shin, Leah Feinberg and Jarrod Santora.

The workshop was concluded with a power point presentation prepared by Dr. Jaime Gómez-Gutiérrez which honored the life-time achievements of three distinguished krill biologists, Edward Brinton and Margaret Knight (from Scripps Institution of Oceanography) and John Mauchline (from the Scottish Association of Marine Science, Oban, Dunstaffnage Laboratory). Each received a "commemorative diploma", a copy of a krill video and a fetching krill "paper weight" made by Lisa Roberts (see below). Each of these scientists was a pioneer in early work on krill: Ed Brinton for work on zoogeography, taxonomy and ecology of krill throughout the Pacific Ocean; Margaret Knight for work on krill larvae taxonomy, including descriptions of the larvae of 13 euphausiid species, and John Mauchline for his research and periodic landmark reviews in *Advances in*

*Three legends in their young careers studying euphausiids: Left: Edward Brinton at Scripps working on his Ph.D. research; Center: Historic picture of seven distinguished krill biologist in the early 1970s, from left to right A.C. Baker, Brian Boden, Tarsicio Antezana, Elizabeth Kampa, Edward Brinton, K. Gopalakrishnan, and John Mauchline at San Diego California; Right: Margaret Knight working at Scripps Institution Oceanography. Photos provided by Margaret Knight, Tets Matsui, Annie Townsend, Elizabeth Venrick, and SIO Publications.*

*Edward Brinton setting up a MOCNESS net in the Southern Ocean (*circa *1991), Margaret Knight and John Mauchline (recent pictures). Photos provided by SIO Publications, Margaret Knight, and Glen Claxton.*

*Marine Biology* on the biology and ecology of krill worldwide, still considered core texts of euphausiid biology. Tarsicio Antezana (Chile) had the original idea to do this tribute and wrote an informal, sometimes humoristic, poetic text to remember the legacy of Ed and Margaret. Unfortunately our friend Tarsicio was unable to attend the workshop.

The workshop included some outreach materials produced by Lisa Roberts, a Ph.D. student from College of Fine Arts, University of New South Wales, who produced both our "krill logo" and an animation named *Antarctic Energies* which was shown during the workshop breaks and during the poster session. Lisa's delightful and fascinating videos can be viewed at http://www.antarcticanimation.com/content/animation/energies/energies.php. The video *Antarctic Energies* was inspired by Lisa after she traveled to the Southern Ocean on board the R/V *Aurora Australis* and saw schooling krill alive in the Australian Antarctic Division Krill Laboratory in Tasmania and heard the insights of scientists who breed them. *Antarctic Energies* represents physical and biological forces that interact to shape Antarctica: diatoms, krill, sea butterflies (pteropods), seals, albatrosses, humans, sea ice, bottom water circulation, the circumpolar current, ice melting, and sea level rising. Feel free to contact her (lisa@lisaroberts.com.au) or see her webpage at http://www.lisaroberts.com.au/.

*A "krill logo" designed by Lisa Roberts.*

An evening social at the Irish Times pub was attended by about 50 krill biologists and ecologists, where any krill stories were exchanged by all, but most importantly, new, exciting and fruitful collaborations were established. Without a doubt, these two days were truly an unforgettable bonding experience for everyone.

*Dr. William (Bill) Peterson (bill.peterson@noaa.gov) is an oceanographer and zooplankton ecologist at the Hatfield Marine Science Center in Newport, Oregon. He works for NOAA's National Marine Fisheries Service, and his research focuses on climate effects on zooplankton, particularly euphausiids and copepods. Recently his lab has made advances in the business of forecasting the return rates of salmon to their natal streams one year in advance. Within PICES, Bill has served on several expert groups and is currently a member of the Biological Oceanography Committee and Co-Chairman of the Working Group on Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim.*

*Dr. Jaime Gómez-Gutiérrez (jagomezg@ipn.mx) is a biological oceanographer at Centro Interdisciplinario de Ciencias Marinas (Instituto Politécnico Nacional) at La Paz B.C.S., Mexico. His research focuses on the biology and ecology of zooplankton and micronekton in the epipelagic ecosystem, particularly the study, since 1990, of euphausiid diel vertical distribution with hydroacoustic and submarine video cameras, secondary productivity, ecophysiology, and parasitism. He was one of the 15 authors of the PICES Science Report No. 30 entitled: Micronekton of the North Pacific. During 2008–2009 he did a sabbatical research at the Australian Antarctic Division at Kingston, Tasmania, working on a review of euphausiid parasites with Steve Nicol and So Kawaguchi. He did a Ph.D. thesis at Oregon State University working in several GLOBEC research projects studying euphausiid embryonic development rates, hatching mechanisms, reproductive effort, and parasitism of* Euphausia pacifica *and* Thysanoessa spinifera *along the Washington-Oregon–California coasts.*

*Dr. Angus Atkinson (aat@bas.ac.uk) works at the British Antarctic Survey in Cambridge, UK. He is fond of all kinds of invertebrates (even terrestrial ones – see photo), but his real love is Antarctic krill. He started working on krill by accident in 1996 (there were not any amphipods to work on but loads of krill instead) and has worked on them ever since. Topics include feeding, excretion, defecation and growth, and more recently large-scale distribution. All of this involves a healthy amount of laboratory work and experimentation on live animals, and Angus has now participated in 15 Antarctic cruises.*

*Dr. Bettina Meyer (bettina.meyer@awi.de) is a marine biologist at the Alfred-Wegener Institute of Polar and Marine Research (AWI, Germany). She worked on trophic interactions and the seasonal variability in ecophysiological conditions on planktonic crustaceans. Since 1999 her research focuses on the physiology of Antarctic krill, the mechanisms causing synchronization between the seasonal development of krill and the seasonal cycles of environmental features in particular. She has been initiated the LAKRIS project (Lazarev Sea Krill Study), the German contribution to the Southern Ocean GLOBEC program.*

# Polar and Sub-Polar Marine Ecosystems Workshop

*by Margaret M. McBride, George L. Hunt, Jr. and Kenneth Drinkwater*

At the 2009 GLOBEC Open Science Meeting (Victoria, B.C., Canada), the GLOBEC regional programs ICED (Integrating Climate and Ecosystem Dynamics) and ESSAS (Ecosystem Studies of Sub-Arctic Seas) collaborated to convene a two-day (June 22–23) workshop on "*Comparison of Processes and Climate Impacts in Sub-Arctic and Antarctic Marine Ecosystems: Observations and Modeling Approaches*" where anticipated responses to climate change of marine ecosystems in both regions were considered. Eileen Hofmann (U.S.A.) and Eugene Murphy (U.K.) served as convenors from ICED, and George Hunt (U.S.A.), Bernard Megrey (U.S.A.), Sei-ichi Saitoh (Japan) and Hyoung-Chul Shin (Korea) acted as convenors from ESSAS. Approximately 40 scientists participated in this workshop, which included several members of the PICES community who gave presentations on North Pacific regions. In all, 18 talks were presented.

The workshop examined differences between Antarctic and sub-Arctic marine ecosystems, and the processes that create these differences, including ecosystem structure and function, and the effects of physical forcing such as sea ice, winds, and advection on interspecies interactions at lower, mid and upper trophic levels, and species productivity. This forum provided an opportunity for the scientific communities in both regions to compare their approaches. Participants also reviewed progress toward developing functional end-to-end models to study the effects of climate on marine ecosystems. The outcome of the workshop will be a synthesis paper for the OSM special issue, as well as a white paper or blueprint to move forward with further comparative studies of these polar marine ecosystems.

The workshop was introduced by Eileen Hofmann and discussion sessions were led by Ken Drinkwater (Norway), Eileen Hofmann, George Hunt and Eugene Murphy. The workshop was structured into four topic areas, each with a series of presentations followed by a discussion period.

***Topic 1: Setting the stage – Climate studies***

Talks were presented by Charles Greene (U.S.A.) and Eugene Murphy that included material on the role of large-scale climate patterns on regional marine ecosystems. Greene focused on the northwest Atlantic and the importance of remote climate forcing, such as the two modes of high-latitude climate variability: the North Atlantic Oscillation and the Arctic Oscillation for influencing regional ecosystem responses. He also explored the relative importance of climate forcing for bottom-up ecosystem impacts and overfishing in top-down impacts. Implications of these findings were discussed for the management of northwest Atlantic shelf ecosystems and their living resources during the coming decades. Murphy concentrated on the impacts of large-scale climate variability of the Southern Ocean marine ecosystem. There, bottom-up forcing by physical processes appears to dominate ecosystem variability. As in the northwest Atlantic, advective processes are important in the Southern Ocean, both for re-supply of critical nutrients, and as a mechanism for mixing of zooplankton stocks and transport of krill to sub-Antarctic regions such as South Georgia. In the Antarctic, as in the sub-Arctic systems, seasonal sea ice cover plays a critical role in the timing of production and in the use of this production by krill and the availability of the krill to top predators.

***Topic 2: Arctic and Antarctic system comparisons***

Four papers were presented on this topic. Hyoung Chul Shin *et al*. discussed the relationship between the amount of chlorophyll in the water and the amount of krill. He contrasted the layered nature of krill aggregations away from the ice in open water and the more compact aggregations or schools of krill near the ice edge. Hunt compared the effects of current orientation on Arctic and Antarctic marine systems, using as indicators, the seabird faunas of the two polar regions. In the Northern Hemisphere, community similarity is strongest meridionally and relatively weak at comparable latitudes on the two sides of the North Atlantic or North Pacific, a reflection of the north–south orientation of their boundary currents. In contrast, in the Antarctic, patterns of seabird community similarity are strongest in an annular orientation and weaker between latitude bands, a function of the annular orientation of the major current systems of the Southern Ocean. Hunt speculated that the difference in circulation patterns between the Northern and Southern Hemispheres might forestall incursion of temperate species to Antarctic waters, whereas temperate species are already increasing in number and biomass where northward flowing currents are carrying them to the sub-Arctic.

Hofmann *et al*. described the Southern Ocean GLOBEC Program objectives as focused on understanding the physical and biological factors that contribute to Antarctic krill (*Euphausia superba*) growth, reproduction, recruitment, and survivorship throughout the year. The questions posed reflected a broad view of the Antarctic marine ecosystem and included studies of the habitat, prey, predators, and competitors of Antarctic krill, as well as studies specifically centered on Antarctic krill biology and physiology. Overwintering strategies were highlighted as an important but largely unknown component of the Antarctic ecosystem. Murphy *et al*. gave an overview of the modeling efforts that

will occur in ICED as a follow-on to the Southern Ocean GLOBEC program (Fig. 1). They discussed how Southern Ocean ecosystems are changing rapidly, and that these changes constitute a major challenge to develop circumpolar views of the structure, function, and response to change. This is a key to developing ecosystem models that can predict the impacts of climate and harvesting in the Southern Ocean.

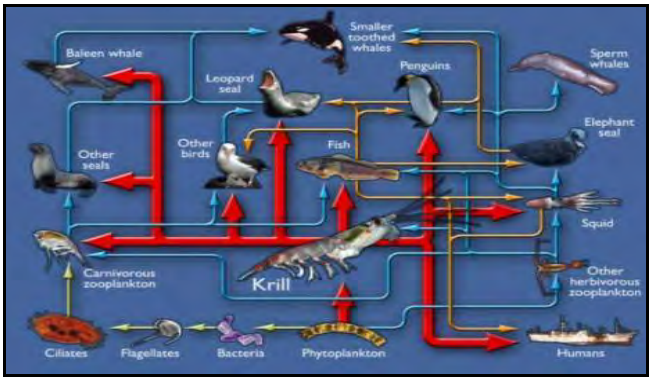



*Fig. 1 Antarctic marine food web (compiled by the British Antarctic Survey) – schematic of the Scotia Sea food web. The primary food web pathways that are dependent on Antarctic krill* (Euphausia superba) *are indicated by red arrows. The importance of alternative pathways (blue, green and yellow arrows) involving other zooplankton species, fish and squid are being increasingly recognized.*

***Topic 3: Lower trophic level comparisons***

Six talks addressed aspects of lower trophic level ecology in the sub-polar and polar seas. Two of the papers discussed variability of chlorophyll distribution in northern and southern seas. Kohei Mizobata (Japan) *et al*. (presented by Sei-ichi Saitoh) described recent drastic sea ice reduction and changes in ocean circulation in the western Arctic Ocean, and how changes in ocean physics impact both climate and marine ecosystems. For instance, recent changes in the spatio–temporal distribution of chlorophyll were linked to long distance basinward transport of high chlorophyll waters, intensified Beaufort clockwise ice–ocean circulation, increased light availability, and increased horizontal advection from the shelf of the Chukchi Sea. For the South Atlantic sector of the Southern Ocean, Jisoo Park (Korea) *et al*. described research results explaining the dominant temporal and spatial patterns of chlorophyll. Variations in levels of chlorophyll there have a periodicity of approximately 7 years, while periodicity in the northern region of the Drake Passage seemed to relate more to the Southern Oscillation.

Three papers focused on the importance of biophysical coupling for the distribution and abundance of zooplankton. Erica Head (Canada) *et al*. compared the ecology of the copepod *Calanus finmarchicus* in the Norwegian and Labrador Seas. Despite its more northerly location, the spring bloom generally starts earlier in the Norwegian Sea. Within each sea, however, there are regional and inter-annual differences in temperature and spring bloom dynamics. The responses of *Calanus finmarchicus* populations to these differences include differences in physical characteristics, physiological rates and seasonal cycles. As temperatures in the Norwegian and Labrador Seas increase up to a certain threshold, the authors suggested that the timing of life history events for *C. finmarchicus* will likely be advanced, and that the time spent in the near-surface layers will probably decrease, although the effect on net productivity may not be large. Sally Thorpe (U.K.) *et al*. described the results of modeling the life cycle and distribution of Antarctic krill in the peninsula region of Antarctica. Krill has a heterogeneous distribution and a large proportion of its circumpolar population located in the southwest Atlantic sector. These populations are believed to be maintained from upstream krill stocks and are closely associated with sea ice which provides a critical habitat during winter. The interaction of the krill with the sea ice can create regions of rapid dispersal or increased retention. Model results showed that variations in currents and the location of the ice edge in the northern peninsula region can affect whether krill there will be advected toward Bransfield Strait or toward South Georgia. On much smaller spatial and temporal scales, Lewis Incze (U.S.A.) *et al*. showed that internal wave fields in the Gulf of Maine are displaced toward the surface during periods of strong tidal flow (internal tides) over shallow banks. The interaction of the waves with the surface layer (convergence, divergence and shearing) results in the formation of ephemeral, but very dense, surface patches of euphausiids, and an ensuing rapid feeding response by herring, marine mammals and birds. The coupled biophysical processes associated with internal waves and topographic forcing can help explain observations of geographic feeding patterns among some predators, and should add to our understanding of temporal variability and possible future changes in these patterns.

The final paper in this topic session was presented by Kenneth Drinkwater who showed how comparative studies within the sub-Arctic seas provided insights into the role of physical forcing on the biological components of marine ecosystems. Two major ESSAS studies were highlighted: (1) NORCAN (Comparison of Marine Ecosystems of Norway and Canada) that compared aspects of the Barents Sea/Norwegian Sea with the Labrador Sea and shelves; and (2) MENU (Marine Ecosystem Comparisons of Norway and the United States) that compared the Bering Sea and Gulf of Alaska in the Pacific with Georges Bank/Gulf of Maine and the Barents/Norwegian Seas in the Atlantic.

***Topic 4: Arctic and Antarctic top predator studies***

Six papers were presented in this section. James Lovvorn (U.S.A.) *et al*. assessed habitat needs of Spectacled Eiders, a threatened species that winters in pack ice of the Bering

Sea. Data on benthic prey, sea ice, and weather were linked using a spatially-explicit simulation model of eider energy balance that integrated field, laboratory, and remote sensing studies. Thresholds of adequate resources were identified; the resilience of these food webs to perturbation may depend strongly on spatial heterogeneity in communities. Explicit consideration of such spatio–temporal effects, and the physical and biological factors that maintain heterogeneity, may be critical to modeling long-term patterns in benthic food webs that lead to top predators. Martin Renner (U.S.A.) *et al*. modeled the distribution and abundance of Northern Fulmars, a seabird, in relation to physical parameters and fishing activity in the Bering Sea. In many parts of their range, the diet of fulmars has been supplemented by offal and discards from fishing vessels. Model results suggest that the pattern of population changes since 1975 have responded more strongly to changes in fishing practices and the availability of offal than to climate variability.

*Fig. 2 A female southern elephant seal, with a Sea Mammal Research Unit CTD tag, at Livingston Island, South Shetland Islands, Antarctica. These tagged seals can provide information on not only their preferred foraging locations, but also on the spatial and temporal distribution of water masses as they move from one location to another. Photo provided by D. Costa (University of California, Santa Cruz, U.S.A.).*

Three papers addressed aspects of the ecology of pinnipeds in polar regions. John Bengtson (U.S.A.) provided a nice comparison of the use of the sea-ice environment by seals in the Antarctic and the Arctic and sub-Arctic seas. These animals are important components of the marine ecosystem, both because of their consumption of prey, and because they, in turn, are prey for other top predators. Despite the distance between the poles, he showed that there were striking similarities between the roles of species in the north and the south in terms of their dependence on sea ice and their use of open water. Shifting patterns in the distribution, timing, and other characteristics of seasonal sea ice are critical factors determining breeding success and rates of survival, and for some species, such as the ring seal in the Arctic, the loss of summer sea ice is likely to severely impact their populations. Elephant seals (Fig. 2) figured prominently in two of the papers. Anne-Cecile Dragon (France) *et al*. presented results from a new generation of temperature and salinity satellite-relayed data loggers, collecting temperature and salinity throughout the top 1000 m of the water column covering a vast area of the Southern Ocean extending from the Polar Front to the Antarctic continent. Foraging movements of many individuals allowed precise location of foraging areas, and provided detailed oceanographic information at low cost from areas that are logistically difficult to sample. Daniel Crocker (U.S.A.) *et al*. characterized habitat utilization and foraging behavior of three common seal species in the western Antarctic Peninsula using Satellite Relay Data Loggers. Their results suggest that elephant seals forage in a greater range of habitat types, and that crabeater seals are more dependent on sea ice and would thus be more impacted by climate change.

Konstantin Rogachev **(**Russia) *et al*. explained the mechanism for transport of warm Alaskan Stream water into the Oyashio and Kamchatka region by eddies, rather than by a continuous flow. Results suggest that warming in the Oyashio is likely linked to the penetration of warm Alaskan Stream water westward, and that warming in the Okhotsk Sea is likely linked to the increased transport of warm water westward by the Alaskan Stream and Aleutian eddies. The abundance and vertical migratory behavior of mesopelagic fish species in the region, such as lanternfish (Fig. 3), play a major role in the oceanic food web and these changes in hydrography are likely to affect their ecology.

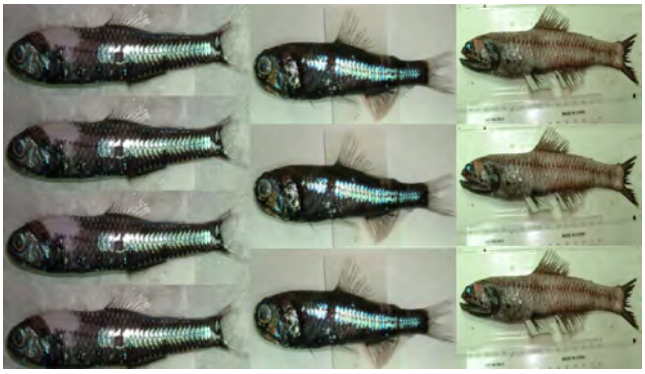


*Fig. 3 Lanternfishes are important mesopleagic fish that produce sound scattering layers. Photo provided by L. Budnikova and K. Rogachev (Pacific Oceanological Institute, Russia).*

Workshop discussions pointed to a number of overarching issues that will lay the foundation for future research to identify differences and similarities between Antarctic and sub-Arctic marine ecosystems, and to facilitate more effective management of natural resources in both regions. As we see ESSAS and ICED change over to IMBER, there is the opportunity to take a broader approach to ecosystem comparisons, including other ecosystems and biogeochemical cycles, as well as the more conventional approaches to ecosystem study.

Information on authors of this article can be seen on page 39.

# Biogeochemistry of the Oceans in a Changing Climate Workshop

*by Francis Chan and Debby Ianson*

The biogeochemical state of today's oceans is the product of feedbacks between climate forcing, ocean circulation and the transformation of energy and nutrients by microbes and metazoans. How ocean biogeochemistry will be altered by a changing climate was the focus of a 1-day workshop held on June 22 at the 2009 GLOBEC Open Science Meeting in Victoria, Canada. This workshop, co-convened by authors of this article, was organized to identify biogeochemical processes of key concern as well as research needs that will be critical for sustaining a continued understanding of the pathways, rates and patterns of biogeochemical changes.

One core theme of the workshop was the unparalleled value of sustained time-series observations in revealing the scope for change in ocean biogeochemistry. For example, Roberta Hamme presented recent findings from the Line-P time-series efforts in the Northeast Pacific where long standing patterns of summertime high nutrient, low chlorophyll conditions were interrupted in 2008 by anomalously elevated levels of primary production and nutrient drawdown. Because such high latitude systems contribute a disproportionately large share to global ocean production, understanding patterns and causes of production variability there is critical. For the well-studied Line-P, a combination of long-term *in-situ* and remote sensing observations were further instrumental in identifying possible causes for the high productivity. Richard Matear similarly presented analyses that show a coupling between increased drought intensity (and aelion iron fluxes) and enhanced productivity over the New Zealand sector of the Southern Ocean.

While the effects of changes in ocean productivity for marine populations have long been central elements of GLOBEC science, workshop participants highlighted the importance of considering biogeochemical changes, such as ocean acidification and hypoxia that can have important, but currently poorly understood impacts on marine food webs. Observations across the Northeast Pacific have revealed declines in the oxygen content of the ocean interior (Fig. 1). Over the continental slope and shelf, this decline has manifested as a shoaling of low-oxygen oxyclines. Along the Oregon coast, strengthening of upwelling wind stress has acted in conjunction with offshore oxygen declines to further promote the formation of anoxia across mid- and inner-shelf waters. Modeling efforts presented by Laura Bianucci were in close agreement with these observations and showed the value of a coupled coastal circulation–ecosystem model in evaluating the effects of climate change on shelf oxygen and carbonate system dynamics. Research from Frank Whitney and colleagues at

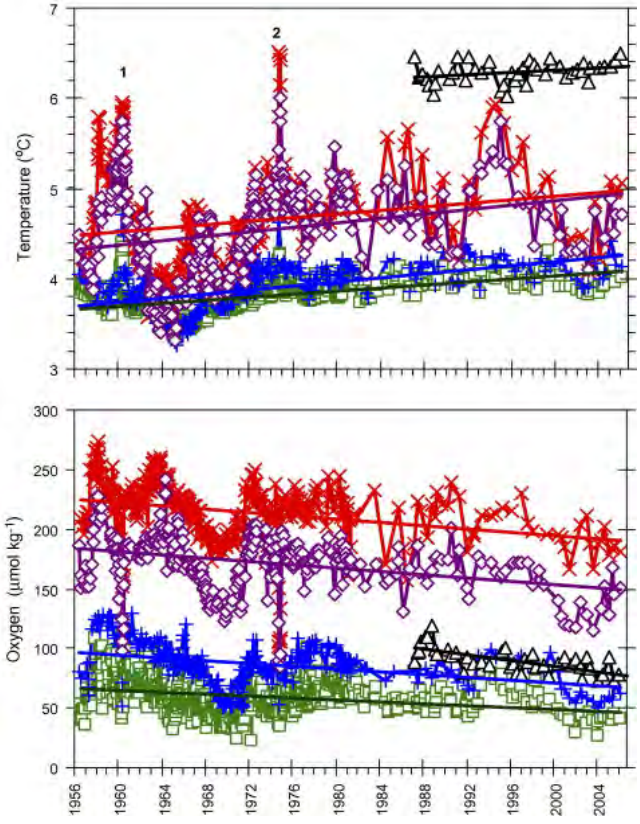



*Fig. 1 Time series of (top) temperature and (bottom) oxygen concentrations in the Alaskan Gyre (Whitney* et al. *2007, Fig. 4) on the 26.5 (red), 26.7 (purple), 26.9 (blue) and 27.0 (green) isopycnal surfaces and near the continental shelf (black) on the 26.7 surface. Two mesoscale eddies are labelled 1 and 2.*

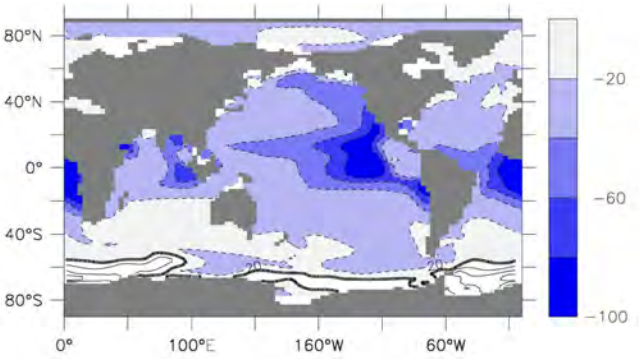



*Fig. 2 Global map of the % decrease in oxygen availability from the present to year 4000 at a depth of 286 m, as predicted by Schmittner* et al. *2008 (Figure 15b) using a business as usual scenario (i.e., the burning of all readily available fossil fuel reserves, corresponding to a total release of 5100 GtC).*

Fisheries and Oceans Canada (DFO) suggests that changes in coastal hypoxia may have already affected groundfish landings along with habitat shifts to more northern waters

for fish populations caught on the leading edge of shoaling oxyclines. If observed rates of oxygen declines were to continue, slope and deep shelf fish populations may see a 60% loss of habitat by 2050 as a consequence of expanding hypoxic zones along western North America. Over longer time scales, Andreas Schmittner's modeling efforts point to marked expansion of hypoxic zones across the global ocean in response to $CO_2$ forcing (Fig. 2). Collectively, these results suggest that changes in oxygen availability and carbonate chemistry resulting from climate change are likely to have a profound influence on ocean biogeochemistry and ecology.

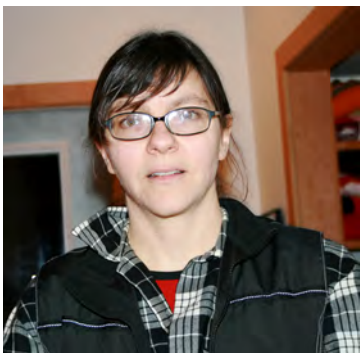
Narrowing the uncertainty inherent in our projections of future biogeochemical changes remains a vital challenge. Stephanie Henson's work provided an example of empirical, biome-specific modeling efforts that exploit observed interannual variability in climate-production functions to derive predictions of within and among biome changes. Scaling from contemporary, within ecosystem observations to future climate scenarios across ecosystems is of course, not without pitfalls. Ricardo Letelier's presentation on coupled biogeochemical and microbial time series highlighted the scope for evolutionary adaptations by microbes as an unresolved source of uncertainty in our understanding of climate–ocean feedbacks. Indeed, workshop participants wrestled with the challenges of incorporating evolutionary processes and the accelerating information on microbial genomic and functional diversity into our conceptual and numerical models of the ocean ecosystem.

The workshop discussion turned to issues of future research directions and needs. It was agreed that a variety of models, over variable time and space scales, statistical and mechanistic, were important to best tackle climate change issues with open communication amongst modellers. There was quick consensus that *in-situ* and remote sensing time-series efforts should be sustained wherever possible, as they will continue to provide an expanding understanding of ocean biogeochemistry and its changes that allow improved model development and validation. Indeed, Jim Christian pointed out that some important time-series efforts are approaching durations (*e.g.*, 30 years) where the ability to resolve secular trends from decadal and interannual variability will be possible. While any list of parameters to be included in time-series efforts will certainly not be definitive, it was recognized that along with temperature and salinity, oxygen, carbonate system parameters, nutrients, primary production, nitrogen fixation, and export production will be among the core suite of measurements that will continue to inform our understanding of ocean biogeochemistry in years to come. In many respects, the call for continued and expanded support for time-series measurements, including their standardization and data archival activities, echo the findings of past efforts that have organized around this topic. This convergence undoubtedly reflects the recognition that sustained ocean observations will be central to meeting an ever pressing need for understanding ocean dynamics in a changing climate.

### *References*

Schmittner, A., A. Oschlies, H.D. Matthews, and E.D. Galbraith, 2008. Future changes in climate, ocean circulation, ecosystems and biogeochemical cycling simulated for a business-as-usual $CO_2$ emission scenario until year 4000 AD. *Global Biogeochemical Cycles*, 22, GB1013, doi:10.1029/2007GB002953.

Whitney, F.A., H.J. Freeland and M. Robert, 2007. Decreasing oxygen levels in the interior waters of the subarctic Pacific. *Progress in Oceanography*, 75, 179–199; doi:10.1016/j.pocean.2007.08.007.



*Dr. Francis Chan (chanft@science.oregonstate.edu) is an ecosystem ecologist at the Department of Zoology in Oregon State University, Corvallis, OR, USA, where he is also a scientist with PISCO – the Partnership for the Interdisciplinary Studies of Coastal Oceans. His research interests are focused on understanding the interactions between biogeochemistry and ecological patterns and processes in coastal oceans. His work includes research on the controls of oxygen dynamics, nutrient cycles and primary production in upwelling systems and their influences on pelagic and benthic ecological communities.*

*Dr. Debby Ianson (debby.ianson@dfo-mpo.gc.ca) is a research scientist at the Institute of Ocean Sciences in British Columbia, Canada. She is interested in interdisciplinary oceanographic problems pertinent to climate variability over a variety of time scales using modeling as a tool with a field component to build and validate the models. Currently her primary focus is on carbon fluxes and pH variability in coastal upwelling regions at temperate latitudes.*

# Continuous Plankton Recorder Surveys of the Global Oceans

*by Sonia D. Batten and Peter H. Burkill*

The Continuous Plankton Recorder (CPR) is an instrument designed to be towed behind ships of opportunity and to collect plankton samples along the ship's path. The samples provide broad scale horizontal coverage of larger hard-shelled phytoplankton and more robust mesozooplankton organisms. There are currently five regional CPR surveys around the globe (Fig 1). The longest running survey, operated by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), has collected samples in the North Sea and North Atlantic in an essentially unchanged fashion since the 1940s. The Gulf of Maine survey has been conducted since 1961 by the U.S. NOAA/National Marine Fisheries Service laboratory in Narragansett, and one in the Southern Ocean has been carried out for 19 years by the Australian Antarctic Division. The North Pacific has a more recent survey; a PICES project managed by SAHFOS is now in its tenth year. The AusCPR survey that began in 2009 will sample the East Australian Current and the ocean between Tasmania and Antarctica.

Each of these surveys has demonstrated their regional value, but the community that runs these surveys now recognises a more holistic requirement. The CPR workshop convened on June 22 at the 2009 GLOBEC Open Science Meeting was intended to address the global issues that now require a global approach. This new scientific focus would bring together these surveys to examine how integration and inter-comparison might enable the global ocean to be better studied. Members from each of the five surveys were present at the workshop and gave presentations covering recent results from these surveys, the lessons learned, as well as a variety of applications and analyses of data.

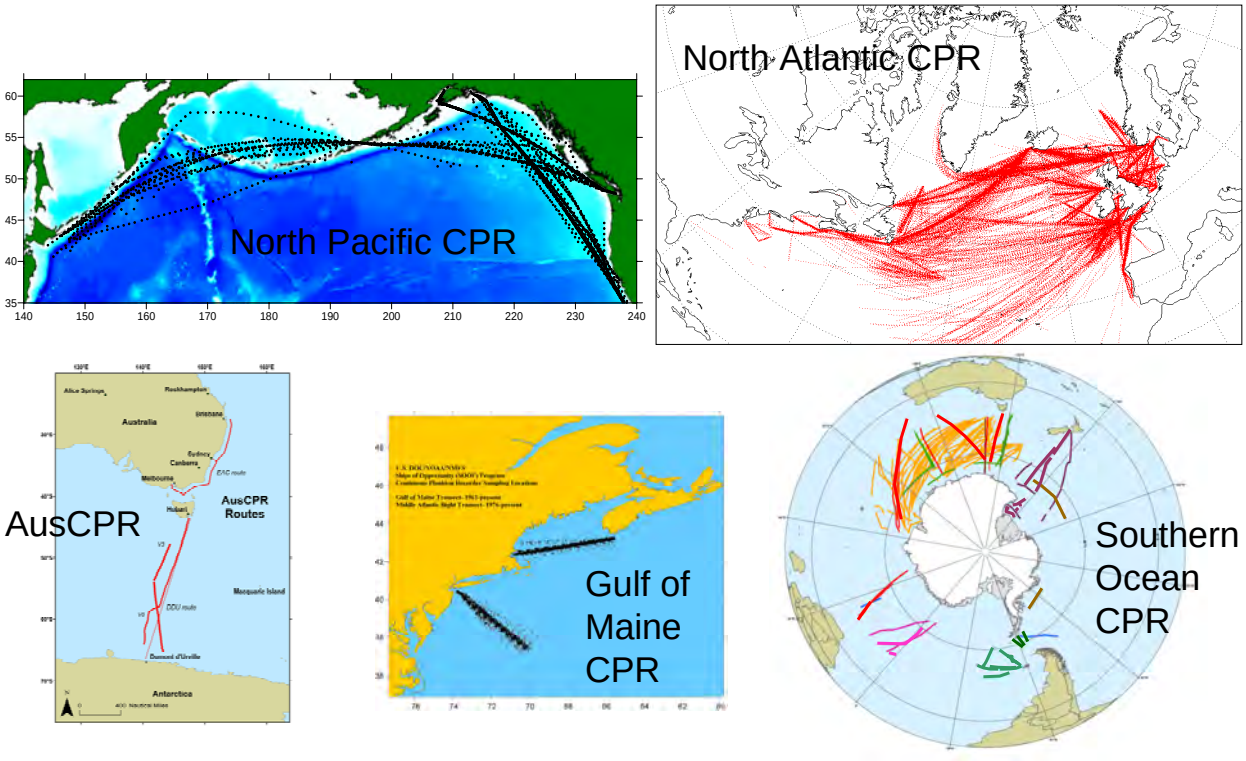



*Fig. 1 Images of the five CPR surveys from the workshop presentations showing the extent of global coverage.*

The workshop addressed a number of questions: Where to go in the future? What do we need to improve? What are the issues concerning standardisation or inter-calibration of methods? Discussion after the presentations was thorough and wide-ranging. There was a consensus that we need to form a 'commonwealth' of surveys, so that mutual benefit is achieved through pooling our wealth of expertise. This commonwealth would tie the surveys more closely together and enhance the sense of belonging to a community. It would also raise the visibility of the CPR approach and this could facilitate new surveys and the development of associated instrumentation in the future. For the latter costs would be lower because there would be a larger potential market visible to the instrument developer. To this end, it was agreed that a Memorandum of Understanding (MOU) would be drawn up. Although an MOU is not a legally

binding document, it would demonstrate mutual recognition and a commitment to work together to develop a global database, identify who to contact for various issues, suggest a framework for data access and a means of addressing common issues. Establishing a CPR commonwealth Project Office at SAHFOS in Plymouth was raised as a possibility and this will be looked into.

The issue of standardisation and inter-calibration received extensive discussion. It was recognised that while a standard set of methods and approaches was desirable, each survey has made particular modifications or has certain requirements, either from historic reasons or local characteristics. It would not be expected that a survey would change protocols at this point. For example, the Baltic Sea (a CPR survey is in the planning stages) has particularly small zooplankton taxa and uses 200 µm mesh to sample. The use of standard CPR mesh size of 270 µm would under-sample the plankton in this region to an unworkable degree. The Southern Ocean CPR survey counts plankton in 5 nautical mile sections by washing the plankton off the filtering mesh, rather than using a special microscope stage that keeps the plankton on the mesh and viewing 10 nautical mile sections as is the norm in the other surveys. However, many indicators of change, such as phenological shifts or changes in species distributions, are independent of the methods used to generate the data and would not prevent data integration. Wherever possible, however, we recommend that inter-calibration exercises be undertaken to allow conversion factors to be generated.

Molecular techniques are being applied more frequently to CPR material, and the cost is likely to decrease while the abilities of the technique are likely to increase. These would help with taxonomic standardisation and address key issues; *Oithona similis* is considered cosmopolitan in surface waters. How phenotypically and genotypically similar is this species throughout the world? Molecular procedures can be used to facilitate the identification of taxa not easily enumerated by conventional CPR techniques, such as gelatinous plankton and taxa that form harmful algal blooms.

There was recognition that it would be beneficial to have data available more rapidly after sampling. Following normal protocols it takes 12–18 months for full quality controlled data to be available. The Pacific CPR survey processes a portion of the samples within about 3 months, so that some indication of current conditions is possible. Other 'quick and dirty' methods were suggested but each would involve additional processing. Prioritising a proportion of the samples is something that each survey could initiate straight away without adding to the sample processing requirements.

It was agreed that SAHFOS should complete and make available a CPR survey methods handbook, which would include data management. This would greatly help new surveys to get established and provide a valuable resource for existing surveys to maintain consistency in methods.

(*continued on page 36*)

*Dr. Sonia Batten (soba@sahfos.ac.uk) is a biological oceanographer with the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) which operates the Continuous Plankton Recorder survey. Sonia is based in Nanaimo, BC, Canada, coordinating the North Pacific CPR survey. Her research interests include the role of zooplankton in large-sale oceanic ecosystems; the effects of the physical environment on their dynamics and the interactions between zooplankton and higher and lower trophic levels. She contributes to the PICES CPR Advisory Panel and Technical Committee on Monitoring.*

*Dr. Peter Burkill (phb@sahfos.ac.uk) is a biological oceanographer whose interests include long-term observations and global forcing in marine pelagic ecosystems, plankton ecology, marine biogeochemistry, marine food-webs, marine microbial biodiversity and plankton trophodynamics. He works in Plymouth, UK where he is Director of the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) and is Professor of Ocean Science at the University of Plymouth. He chairs the Royal Society's UK Scientific Committee for Oceanic Research (SCOR) Working Group, serves as a Vice-President of SCOR and is the Executive Reporter to SCOR for GLOBEC. He has published over 120 peer-reviewed papers and held more than 50 research grants.*

# Plankton Phenology Workshop

*by David Mackas, Rubao Ji and Martin Edwards*

Ecological consequences of plankton phenologic variability have long been recognized by oceanographers and fisheries scientists (*e.g.*, Cushing's 1969 and 1990 "match-mismatch" hypothesis), but the intensity of research activity and published output has increased greatly during the GLOBEC era. A recent day-long workshop (June 23) at the 2009 GLOBEC Open Science Meeting, co-convened by authors of this article, contained 13 multi-authored talks within the general topic area "*Plankton phenology and life history in a changing climate*". Fortuitously, the numbers of presentations were almost equally balanced between results from "field observation/time series" and "numerical models" (six and seven respectively). Opportunity for close interaction and inter-comparison of the two approaches was one of the highlights of the workshop. There was also a broad geographic distribution of study areas (Fig. 1) and of target taxa (three papers on *Calanus finmarchicus*, seven on multiple zooplankton taxa, two on phytoplankton, and one on the planktonic larvae of scallops).

*Fig. 1 Range of ocean regions examined by papers in the phenology workshop.*

Results from the zooplankton studies indicated that annual phenology outcomes are controlled by a sequence of physiological, developmental and behavioral "choices" made at different developmental stages (Fig. 2). Water temperature during the growing season is an important regulator and cue of these choices, and can often be used to predict year-to-year variations in zooplankton timing. However, temperature dependence of timing varies among taxa, and in some regions shows non-linear thresholds or sign reversals from the "warmer implies earlier" pattern that dominates in mid-latitudes.

The two phytoplankton studies showed the zooplanktologists just how much can be learned from data that have high resolution coverage in both time and space. For example, Thomas and Weatherbee (Fig. 3) partitioned total interannual variability of satellite-sensed chlorophyll among three components: variability of annual mean, variability of seasonal amplitude, and variability of seasonal phase. They found that phase variation (*i.e.*, peak timing) is the largest component for most locations in the California Current System.

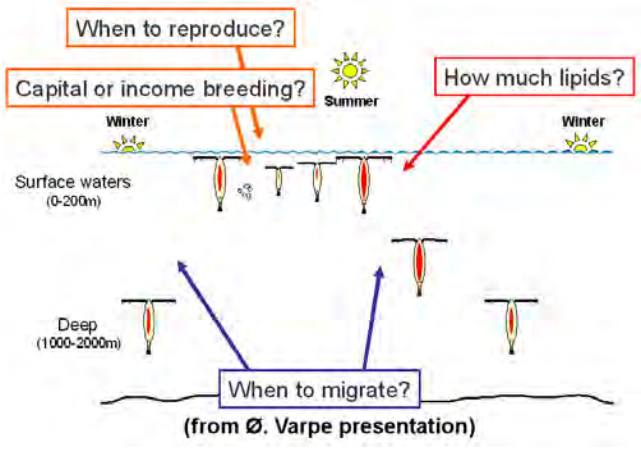



*Fig. 2 For many zooplankton taxa, annual phenology is controlled by choices among life history (red boxes) or behavioral (blue box) strategies made during relatively brief portions of the life cycle. Models can be used to evaluate the adaptive fitness of these choices under differing environmental scenarios. Figure courtesy of Ø. Varpe (The University Centre in Svalbard, Norway).*

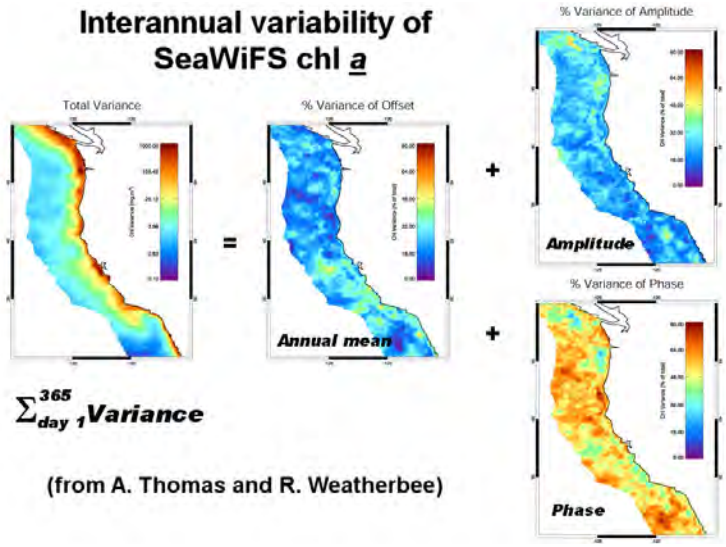



*Fig. 3 Partitioning of total interannual variability of satellite-sensed chlorophyll in the California Current System (left panel) among three contributing components: variability of the annual mean (middle panel), variability of amplitude of harmonic components (top right), and variability of phase (i.e., timing) of the harmonic components (bottom right). Figure courtesy of A. Thomas and R. Weatherbee (University of Main, U.S.A.).*

The workshop included a plenary discussion time-block during which participants identified knowledge gaps within present data and modeling approaches. The following were flagged as important areas for future research:

- Physiological, behavioral, and predator–prey mechanisms that cause phenologic variability;
- Climate drivers of phenologic variability (direct forcing *vs*. triggering cues, proxy *vs*. causal associations);
- Finer resolution of age/stage structure in observational time series;
- Broader attention in models to roles of transport, migration, age-dependent changes in distribution, and exchange with other populations;
- Spatial/temporal scales and potential for spatial/temporal separation of driver and response (closely linked to the previous topic); and
- Broadening the range of modeled life history patterns.

GLOBEC has agreed to fund a small follow-up workshop next autumn at which these and other observations will be fleshed out for publication as a "Horizons" article in the *Journal of Plankton Research*.

*Dr. David Mackas (Dave.Mackas@dfo-mpo.gc.ca) is a biological oceanographer at the Institute of Ocean Sciences (Fisheries and Oceans Canada). His research focuses on zooplankton spatial distributions, and (especially lately) on how low-frequency zooplankton temporal variability is linked to ocean climate. He recently co-chaired (with Hans Verheye) SCOR Working Group 125 on Comparisons of Zooplankton Time Series. Although his personal and scientific homes are firmly in the Pacific, he confesses to a fondness for Mediterranean climate, diet, and lifestyles. Photo (taken near Marseille) courtesy Hal Batchelder.*

*Dr. Rubao Ji (rji@whoi.edu) is a biological oceanographer at Woods Hole Oceanographic Institution. His research is focused on understanding biological–physical interactions in coastal/shelf ecosystems using numerical modeling approaches. He has been involved with GLOBEC since 1999, and is currently a principal investigator on a US GLOBEC Phase 4B project and a Pan-regional GLOBEC project. He is also active in modeling phytoplankton bloom dynamics and copepod population dynamics in the North Atlantic and Arctic Oceans. Ji is currently a member of an ICES Working Group on Modeling Biological-Physical Interactions.*

*Dr. Martin Edwards (maed@sahfos.ac.uk) is based at the Sir Alistair Hardy Foundation for Ocean Science in Plymouth, U.K. His primary research interest is in marine macroecology, recently focusing on large-scale biogeographical shifts, phenology, harmful algal blooms, climate change impacts on marine ecosystems, biodiversity and regime shifts. In addition to numerous peer-reviewed journal articles and book chapters, he was recently a contributing author for the IPCC Fourth Assessment Report on climate change impacts on marine ecosystems and marine fisheries.*

# Workshop on "*Climate Impact on Ecosystem Dynamics of Marginal Seas*"

*by Yasunori Sakurai and Christian Möllman*

Marginal and semi-enclosed seas contribute a substantial share to the world fisheries catch and hence are significantly impacted by human exploitation. Additionally, these areas are increasingly affected by climate variability and change. However, whereas our knowledge on the ecological functioning of ecosystems for particular marginal and semi-enclosed seas has progressed considerably, a synthesis of results derived by GLOBEC regional efforts is still missing. Consequently, a 1-day workshop held on June 23 at the 2009 GLOBEC Open Science Meeting in Victoria, Canada, sought to compare climatic influences on marginal and semi-enclosed seas on a global scale. The geographic scope of this workshop was on traditional GLOBEC study areas such as the Barents Sea, North Sea, Mediterranean, Baltic Sea, Black Sea, East China Sea, Yellow Sea, Okhotsk Sea, Japan Sea, Georges Bank, Bering Sea, Gulf of Alaska, and Scotia Sea (or other Southern Ocean regions). Particularly rewarding periods for cooperative studies are the late 1980s and 1990s, when dramatic changes were observed in the North Pacific as well as in the North Atlantic in association with changes in climatic indices, such as the North Atlantic Oscillation (NAO), Arctic Oscillation (AO) and Pacific Decadal Oscillation (PDO). In total 14 very diverse studies from 11 different areas were presented during the workshop, focused mainly on higher trophic levels, particularly on zooplankton and fish.

Two studies compared climate influences over a range of geographical systems. The response of plankton trophic levels to climate forcing was explored in five European shelf seas: the northwestern Mediterranean, Adriatic, North, Baltic, and Black Seas. The study revealed coherent, synchronized climate-related changes in plankton during the late 1980s (Fig. 1). Similar climate-related changes were reported for several Northern Hemisphere systems, namely the Japan/East Sea, Kuroshio and Oyashio ecosystems, California Current and Iberian Upwelling systems, as well as the North, Baltic and Mediterranean Seas. In spite of the very diverse structure of these different systems, all of them exhibited strong synchronous reactions suggesting large-scale atmospheric teleconnections.

A system-specific synthesis reviewing both the influence of climate and overfishing was presented for the central Baltic pelagic ecosystem. This system, which is characterized by a simple trophic structure and only a few dominant fish species, exhibited both ecosystem regime shifts and trophic cascades. A conceptual model synthesizing the different pathways of change into a holistic understanding of ecosystem functioning has been developed as a basis for reliable ecosystem-based management (Fig. 2).

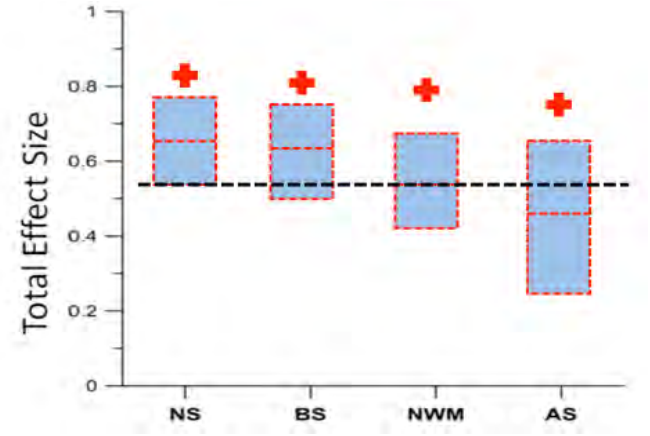



*Fig. 1 Response of plankton to climatic conditions in European shelf seas (1970–2005): North Sea (NS), Baltic Sea (BS), northwestern Mediterranean Sea (NWM) and Adriatic Sea (AS). For each ecosystem at least a 25-year period was tested. Boxes illustrate the variability in the strength of the relationship between plankton and climate, and encompass the first and third quartiles of the distribution. The figure further shows a higher sensitivity in northern ecosystems (NS and BS). However, when considering only threshold climate values, no differences were observed in the plankton response regardless of the geographic locations of the ecosystems investigated. The horizontal line indicates the mean value of the total effect size.*

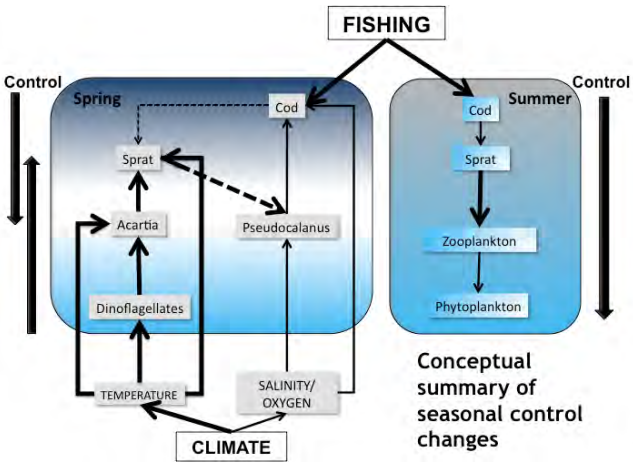



*Fig. 2 Conceptual diagramme of the different seasonally varying effects of climate and fishing on the Central Baltic ecosystem (courtesy of C. Möllmann).*

Research focusing on zooplankton dynamics in the northwestern Pacific marginal seas and in the Balearic Sea (western Mediterranean) indicated an increase in biomass

with climate warming. For the Yellow and East China Seas, a study on *Calanus sinicus*, a key species functionally equivalent to *C. finmarchicus* in the North Atlantic, was presented. Based on data from the last 10 years, the seasonal and regional variations in population distribution, biomass, reproduction and recruitment were studied in relation to the temperature, food supply, cold water mass, fronts and lipid reserves.

Several studies demonstrated climate influences on commercially important fish species. One example was the long-term climate effect on growth and survival of Japanese chum salmon in the Okhotsk Sea. The condition of this stock improved because of less sea ice cover area in winter and higher SST in summer and autumn. The effect of climate on Baltic cod, sprat and herring has been reported. Furthermore, the combined effect of climate and the fishery triggering a shift in the hake population of the northwestern Mediterranean, has been found for the early 1980s.

Finally, a number of presentations dealt with diverse themes, such as the effect of the increased abundance of jellyfish and invasive species on ecosystems in the Mediterranean, climate effects on the Gulf of California, dynamics and functional role of heterotrophic flagellates during the spring diatom bloom in the central part of the Yellow Sea, and the dynamics of chlorophyll-*a* concentration due to climate change and its possible impact on *Sardinella lemuru* at Bali Strait, Indonesia.

In summary, a recurring theme of the workshop was climate-related trends in upper trophic level dynamics of the investigated marginal and semi-enclosed seas. An obvious pattern was regime shifts in ecosystem structure and function which occurred in the late 1980s/early 1990s. Workshop discussions centered around this issue, and large-scale atmospheric teleconnections in the Northern Hemisphere were hypothesized to be responsible for this phenomenon, which has to be discussed with climatologists. In general, workshop participants felt that more synthesis efforts are needed for a comprehensive understanding of the dynamics of these systems, especially considering the interplay between climate and exploitation effects. Further analyses should explicitly include additional expertise from systems not represented at this workshop, *e.g*., the Black and Barents Seas.

To facilitate the intended large-scale comparison of marginal and semi-enclosed ecosystems, GLOBEC has agreed to fund a small follow-up workshop next autumn in which these analyses will be initiated, potentially leading to a synthesis article in a peer-reviewed journal.

*Dr. Yasunori Sakurai (sakurai@fish.hokudai.ac.jp) is Professor at the Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido, Japan. His research focuses on reproductive biology, strategy, and stock fluctuations of gadid fish and cephalopods related to climate change, and the biology of marine mammals (Steller sea lion and seals). Dr. Sakurai has led a number of national research projects and programs on ecosystem-based management for sustainable fisheries in Japan. He has been the Chairman of Japan-GLOBEC, member of the Cephalopod International Advisory Counsel (CIAC), GLOBEC, ESSAS and PICES. He chairs the Japanese Society of Fisheries Oceanography (JSFO) since 2009.*

*Dr. Christian Möllmann (christian.moellmann@uni-hamburg.de) is a fisheries oceanographer at the Institute for Hydrobiology and Fisheries Science at the University of Hamburg, Germany. His research focuses on climate and exploitation effects on marine ecosystems, with a focus on commercially important fish stocks as well as zooplankton populations. Christian's special interest lies in changes in ecosystem structure and function as well as in modelling of future ecosystem dynamics.*

## Erratum

A reference to Figure 2 was missing in the PICES Press article on the PICES/ESSAS Workshop on "*Marine Ecosystem Model Inter-Comparisons*" by Bernard A. Megrey, Masahiko Fujii and Shin-ichi Ito, 2009, Vol. 17, No. 1. Credit should be given to Stow *et al.*, 2009, *J. Marine Systems* 76(1-2), 4–15. The source for the figure can also be found on-line at http://www.pices.int/publications/pices_press/volume17/v17_n1/pp_20_21_2008%20Model%20intercomparisons_f.pdf.

# The State of the Western North Pacific in the Second Half of 2008

*by Shiro Ishizaki*

### *Sea surface temperature*

Figure 1 shows the monthly mean sea surface temperature (SST) anomalies in the western North Pacific from July to December 2008, computed with respect to JMA's (Japan Meteorological Agency) 1971–2000 climatology. Monthly mean SSTs are calculated from JMA's MGDSST (**M**erged satellite and *in-situ* data **G**lobal **D**aily **SST**) which is based on NOAA/AVHRR data, AQUA/AMSR-E data, and *in-situ* observations. Time series of 10-day mean SST anomalies are presented in Figure 2 for 9 regions indicated in the bottom panel.

In August and September, positive SST anomalies exceeding +2ºC prevailed south of the Kamchatka Peninsula. In October and November, SSTs were above normal between 20ºN and 30ºN. Positive SST anomalies dominated in the western equatorial Pacific (west of 150ºE), while negative values prevailed east of 160ºE along the equator. This contrasting distribution of SST anomalies corresponds to the pattern often found during La Niña events.

SSTs were generally above normal around Japan during the period (Fig. 2). Positive SST anomalies exceeding +1ºC in particular were found south of Japan and in the East China Sea. SSTs were below normal southeast of Hokkaido Island, except in September.

### *Kuroshio path*

Figure 3 shows a time series of the location of the Kuroshio path for this period. The Kuroshio took an offshore non-large-meander path far off the coast to the south of Honshu Island (between 135ºE and 140ºE). Its southernmost position in relation to Honshu Island was generally east of the Izu Ridge (about 140ºE) throughout the period.

### *Carbon dioxide*

JMA has been conducting observations for carbon dioxide ($CO_2$) in the surface ocean and atmosphere in the western North Pacific, on board the R/V *Ryofu Maru* and the 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 $\Delta pCO_2$) observed in the western North Pacific for each season of 2007. The sign of $\Delta pCO_2$ 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 $\Delta pCO_2$.

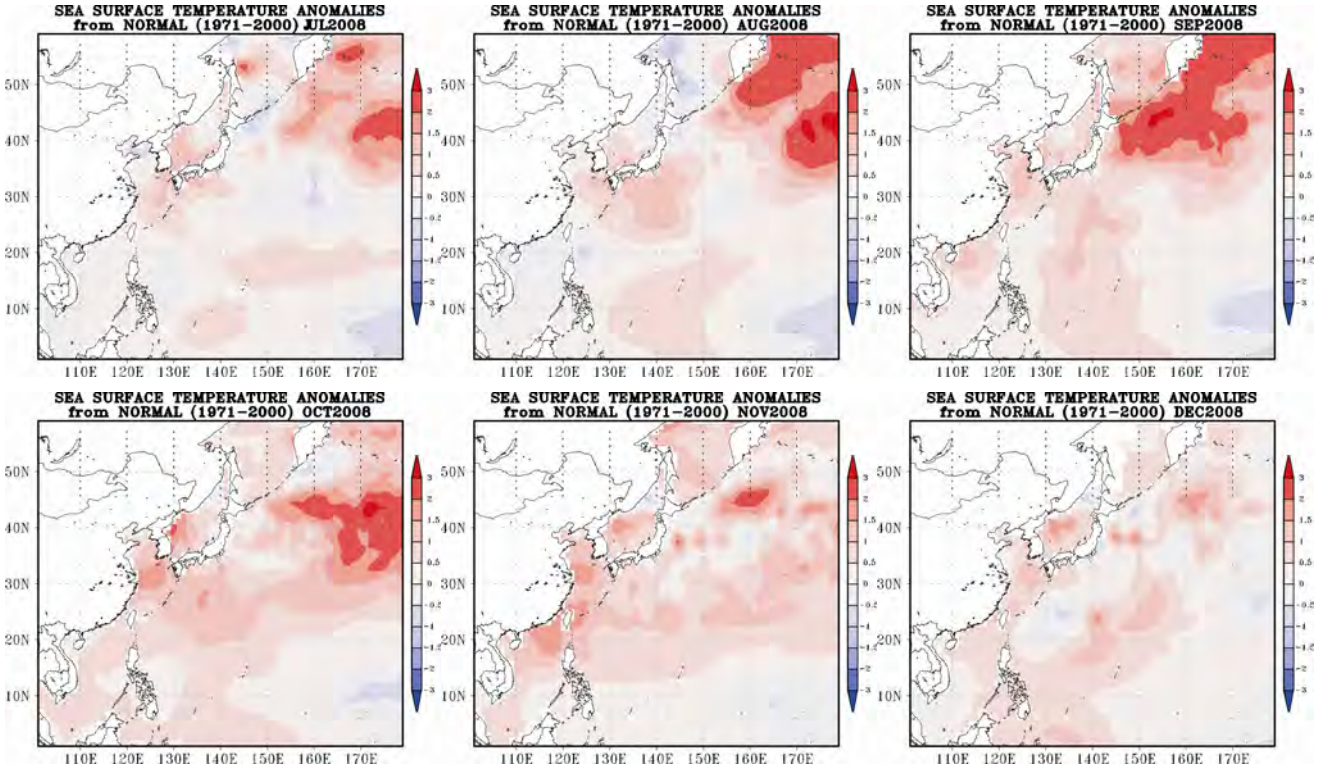
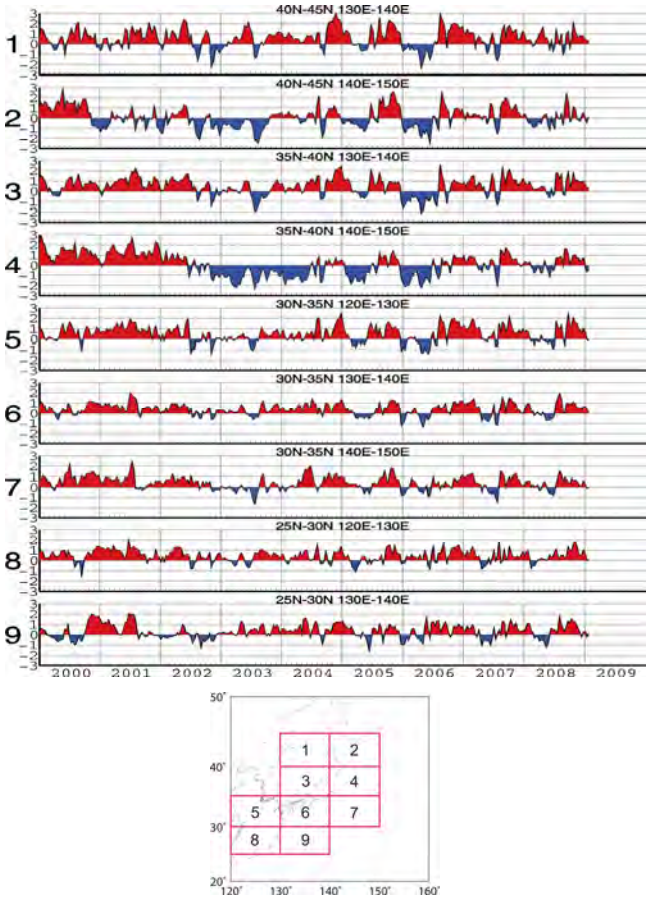
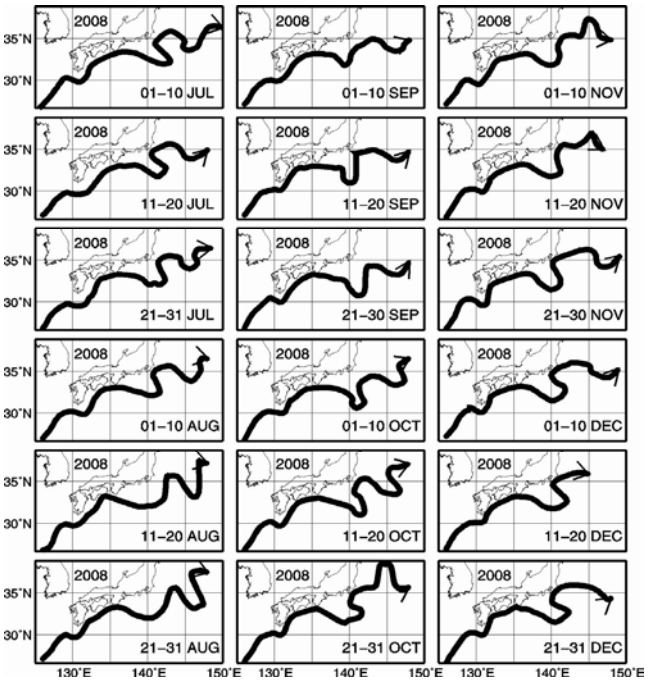



*Fig. 1 Monthly mean SST anomalies (°C) from July to December 2008. Anomalies are deviations from JMA's 1971–2000 climatology.*




Left column:

*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.*

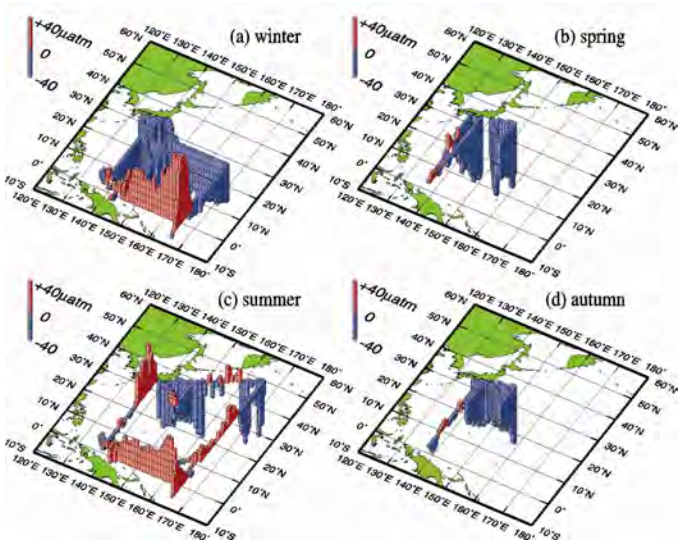
Right column:

*Fig. 3 Location of the Kuroshio path from July to December 2008.*

In the subtropical region, typically between 10–35ºN, the ocean widely acted as a $CO_2$ sink in 2008, except for summer in which $CO_2$ source regions were found.

In the equatorial region, the ocean acted as a $CO_2$ source both in winter and summer of 2008. A La Niña event lasted from spring 2007 to spring 2008, and eastern $CO_2$-rich surface water may have moved westward and covered this region in response to changes in zonal winds. The boundary between the western $CO_2$-poor surface water and the eastern $CO_2$-rich surface water was at 147ºE in winter 2008 during the La Niña event, and was still at 145ºE in summer 2008 after the event.

*Fig. 4 Difference in $CO_2$ partial pressure between the ocean and the atmosphere in the western North Pacific in 2008. Red/blue pillars show that oceanic $pCO_2$ is higher/lower than atmospheric $pCO_2$. Seasons are for the Northern Hemisphere.*




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

# State of the Northeast Pacific into Early 2009

*by William Crawford and James Irvine*

The average temperature of near-surface waters in 2008 along Line P near the Pacific coast of Canada was the coldest in more than 50 years of observations, and the cooling extended through all seasons of 2008. The position of Line P is noted in Figure 1, and temperature anomalies are plotted in Figure 2. This cooling came only three years after the warmest measured temperatures along Line P. This cooling is associated with weather patterns typical of La Niña and of the local cold phase of the Pacific Decadal Oscillation (PDO). By May 2009, when La Niña had abated along the equator, the negative temperature anomalies of the Northeast Pacific Ocean were confined to a relatively narrow strip of coastal waters off western Canada and the lower 48 States.

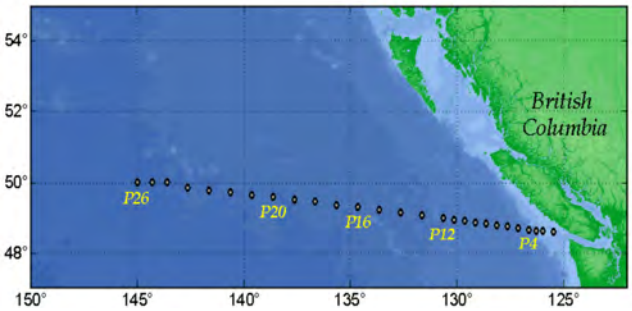



*Fig. 1 Position of Line P sampling stations, where water properties have been sampled regularly for over 50 years by Canadian scientists.*

Surface phytoplankton and zooplankton concentrations were the highest in a decade of observations across the Gulf of Alaska, in August and September 2008 (Fig. 3). The cause is as yet uncertain, but injection of iron by winds or currents is suspected (iron is a limiting nutrient in this region), along with higher levels of nitrate and silicate in spring. Ship-based sampling for phytoplankton in Juan de Fuca Strait revealed high near-surface concentrations in early September. Deep-sea and coastal zooplankton populations continued their recent shift to cold-water species and delayed spring blooms.

In the Gulf of Alaska, the ocean mixed-layer depth was relatively deep in early 2008, and surface oxygen concentrations were relatively high in early 2009. However, oxygen concentrations have generally declined in deep waters along the continental slope over the past several decades. A sudden decline in bottom-water oxygen concentrations in 2008 on the continental shelf of western Canada was likely due to denser water with naturally low oxygen levels moving up onto the shelf in this year, rather than due to anomalous winds and currents. This oxygen drop may have been a factor in the movement of some groundfish species to shallower depths in 2008 in this region.

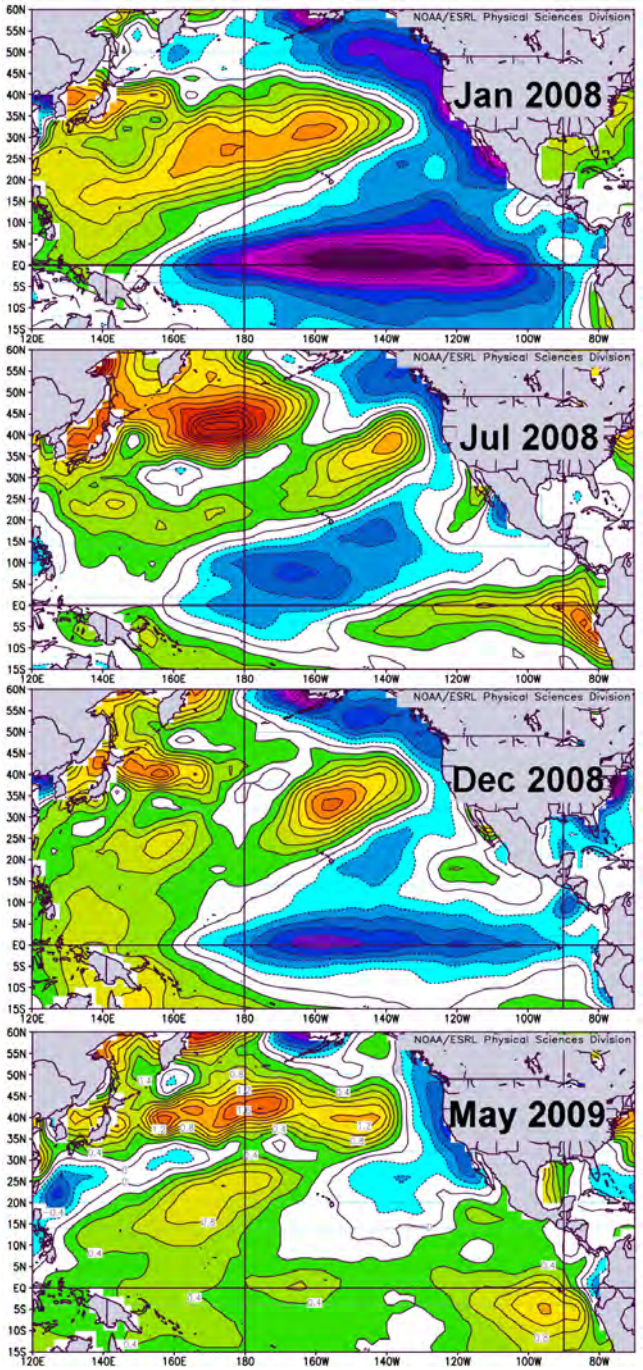



*Fig. 2 Monthly ocean temperature anomalies in °C. White regions denote zero anomalies and contours are at 0.2°C intervals. Reference years are 1968 to 1998. Source: NOAA Environmental Studies Research Laboratory, Physical Sciences Division.*

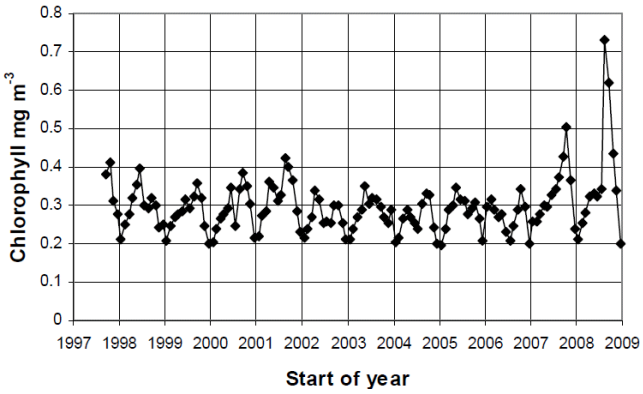



*Fig. 3 Time series of monthly chlorophyll anomalies for the area 44° to 55°N, 134° to 155°W in the Gulf of Alaska for all months since the launch of SeaWiFS. Data for 2008 are from MODIS on Aqua and are available at http://oceancolor.gsfc.nasa.gov/. Figure courtesy of J. Gower (Institute of Ocean Sciences, Fisheries and Oceans Canada).*

Cool marine conditions generally improve marine survival for salmon. However, despite relatively cool ocean conditions in 2007 and 2008, many western Canada populations remain depressed due to low numbers of brood-year spawners, partially attributed to warm oceans in 2003 to 2005. Canadian sockeye returns remain generally low coast-wide, with one notable exception being Okanagan sockeye that returned in record numbers in 2008. High pre-spawn mortality was observed for many Fraser River watershed sockeye populations in 2008, and river entry of returning adults was generally early. Coho populations in southern British Columbia remain extremely depressed, while northern coho populations have improved. For chinook, the situation is somewhat reversed – northern populations continue to decline while the status of southern chinook is highly variable, and large numbers of adults returned to southern Canadian waters in 2009.

Herring biomass has declined recently for all five major British Columbia stocks. In the Georgia Basin of western Canada, where herring biomass was at record high levels earlier this century, the biomass declined almost to the fishery-closure limit in 2008. Three other Canadian herring stocks were at or below the fishing limit. Eulachon populations remain depressed. Although there was no wide-scale hake survey in 2008, their numbers on the British Columbia continental shelf, particularly on the traditional fishing grounds around La Pérouse bank, appear to have been very low, continuing a trend that began developing around 2003–2004. Smooth pink shrimp and English sole along the west coast of Vancouver Island increased in numbers in 2008.

For many of our fish species, including salmon, Pacific Ocean conditions have been improving since the extremely poor year of 2005. Cool water generated bottom-up changes to the food web that have contributed to improving marine survival for many juvenile fish. Linkages between ocean conditions and fish survival are not completely understood and additional exploration of existing data is warranted.

Much of this information is extracted from a recently published 129-page report on conditions of Canadian West Coast waters in 2008 and early 2009, with links to Alaskan ocean summaries: Crawford, W.R. and J.R. Irvine. (2009). State of physical, biological, and selected fishery resources of Pacific Canadian marine ecosystems. DFO Canadian Science Advisory Secretariat Research Document 2009/022. vi + 121 p. (www.dfo-mpo.gc.ca/CSAS/Csas/Publications/ResDocs-DocRech/2009/2009_022_e.htm).

*Dr. William (Bill) Crawford (Bill.Crawford@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada, at the Institute of Ocean Sciences. He and Jim Irvine co-chair the Fisheries and Oceanography Working Group that prepares the annual State of the Ocean Report for Canada's Pacific Region and neighbouring waters. He also serves as president of the Canadian Meteorological and Oceanographic Society.*

*Dr. James Irvine (Jim) (James.Irvine@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada, at the Pacific Biological Station in Nanaimo. In addition to co-chairing the Fisheries and Oceanography Working Group with Bill, Jim is an active member of the North Pacific Anadromous Fish Commission, chairing its Stock Assessment Working Group.*

# Current Status of the Bering Sea Ecosystem

*by Jeffrey Napp*

The current cool to cold period of temperatures in the Bering Sea continued for the fourth straight year. Ice penetration into the southeastern portion was far and early. There was a brief period in March when southwesterly winds temporarily halted the southerly transport of sea ice, but this only lasted for about a week, and then the northerly winds resumed. At the time of this writing (June 2009), the cold pool of bottom water is well developed over the southeastern shelf, and the sea ice edge is at about 61°N between St. Lawrence and St. Matthews Islands. The front is composed of 4 to 6 tenths ice up to 30 cm thick. Eight to 10 tenths sea ice coverage was present between St. Lawrence Island and the Bering Strait.

The U.S. Coast Guard Cutter (Ice Breaker) *Healy* had two cruises to the eastern Bering Sea this spring. Both were part of the collaborative research by the U.S. National Science Foundation's Bering Sea Ecosystem Study (BEST) and the North Pacific Research Board's Bering Sea Integrated Research Program (BSIERP). The first cruise was from March 10–31 and focused on the northeastern portion of the Bering Sea with an emphasis on the patch dynamics of walrus in relation to their benthic food supply (www.eol.ucar.edu/projects/best/cruise_summary_info.html). Most of the stations were located to the south of St. Lawrence Island in the Middle and Coastal Domains. The second cruise was April 3–May 12 and consisted of four major east–west transects and stations along the 70-m isobath (www.eol.ucar.edu/projects/best/cruise_summary_info.html).

During the second cruise, rate process measurements for parts of the food web were made every other day. Once the ship was within the ice, short and long ice stations were occupied to sample the ice and its associated chemistry and biota. Observations for seabirds and marine mammals occurred during daylight for the duration of the cruise: 4173 kilometres of track line visual observations were obtained for seabirds and mammals. There was also a science education team aboard to help communicate the purpose of the mission and its importance. During the cruise there was a significant northerly retreat in the position of the ice edge. At most stations, the biological activity (*e.g.*, primary production, grazing) in the water column was low, except in a large patch of water to the southwest of St. Matthews Island along the 100 m isobath where a phytoplankton bloom was occurring. Surface nitrate appeared to have been reduced from winter levels along the middle and coastal domains, but not along the outer shelf and shelf break. Complete depletion of dissolved nitrate was observed in some inner shelf areas. The initial report states that large numbers of scyphozoa continue to persist over the southeastern middle shelf.

Two other spring cruises were conducted on the NOAA Ship *Oscar Dyson* (April 23–May 4, and May 7–20) as part of the combined BEST/BSIERP program and NOAA's North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) Program. The first cruise recovered and redeployed the NOAA biophysical moorings on the eastern Bering Sea shelf. Subsequent to deployment, the mooring to the east of St. Paul Island (M4) was temporarily lost as the ice shoved it about 6 nautical miles to the south. The mooring was found at its new position in June by the R/V *Knorr*. The second cruise conducted a plankton survey in the area around the Pribilof Islands and along the northern side of the Alaska Peninsula. Water temperatures were cold everywhere (<1°C), and larval fish were conspicuously absent. Walleye pollock eggs were abundant around the Pribilof Islands in the neuston, but concentrations of fish larvae of any species were low along the Peninsula. Transiting from the Pribilof Islands to the Peninsula, the ship had to navigate through a large field of sea ice over the Middle Shelf Domain (this was the ice that displaced mooring M4).

The Alaska Fisheries Science Center National Marine Mammal Laboratory conducted a dedicated marine mammal research cruise from May 13–June 11 aboard the NOAA Ship *MacArthur II* that focused on ice-associated seals in the eastern Bering Sea (http://www.afsc.noaa.gov/nmml/polar/cruise/index.php). Scientists are working to develop accurate population assessments of the four species of seals as well as comprehensive descriptions of their distribution and habitat use. Sixty-eight spotted and ribbon seals were sampled and measured, and 52 of them were tagged with satellite-tracking and data-logging instruments, the largest-ever tagging effort for these species in their sea ice habitat. More than 3500 positions had been received from the seals by mid-June, documenting their behavior during the seasonal period of rapid ice retreat. An unmanned aircraft system (UAS) was flown on 10 occasions for a total of 49 hours, collecting 27,000 digital photographs along more than 1000 nautical miles of track line. A small subset of the photos, examined for presence of seals, clearly demonstrated the capability to collect useful data from a small UAS platform.

The Alaska Fisheries Science Center also began its annual bottom trawl survey in late May of 2009. The Groundfish Assessment Program had accomplished approximately 100 stations by mid-June. Bottom temperatures were lower than average, and the cold pool extended into parts of Bristol Bay. Qualitatively the bottom water temperatures seemed a bit warmer than last year. There were very few 1 year old pollock in Bristol Bay and no large catches of adult pollock. Catches of 1–3 year old Pacific cod were above average catches in Bristol Bay. Plankton tows were

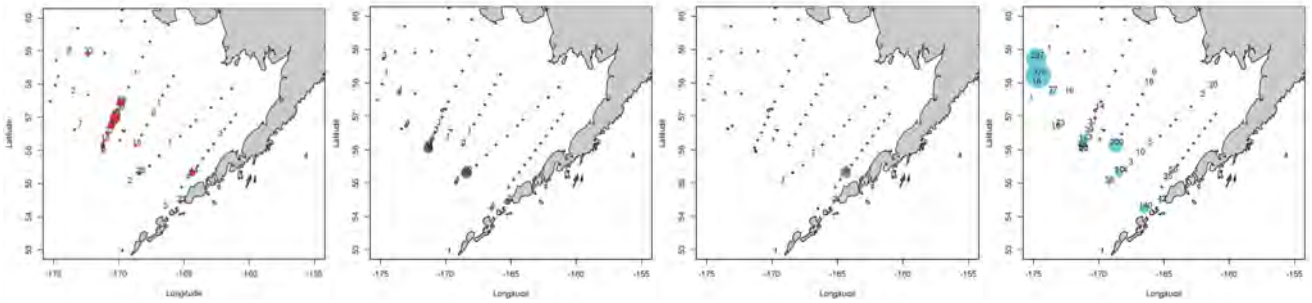


*Fig. 1 Rough counts (accomplished at sea) of four taxa of larval fish removed from the drogue net of a MOCNESS sample. Panels from left to right: walleye pollock* (Theragra chalcogramma); *arrowtooth and Kamchatka flounder* (Atheresthes stomias *and* A. evermanni); *Pacific cod* (Gadus macrocephalus), *and rockfish* (Sebastes spp.). *The data represent all tows taken before July 1, 2009. Figures courtesy of E. Siddon and Dr. T. Smart.*

having difficulty with high concentrations of *Phaeocystis pouchetti* and with what was estimated to be higher than usual catches of the scyphomedusa, *Chrysaora melanaster*. The survey will conclude in late July, and a map of bottom temperatures will be available late this summer.

The NOAA Ship *Oscar Dyson* began conducting an echo-integration mid-water trawl survey of the eastern Bering Sea in June (June 9–August 7). Alaska Fisheries Science Center scientists from the Marine Assessment and Conservation Engineering program will use multiple frequencies to help identify acoustic targets. In addition to assessment of walleye pollock, scientists hope to provide estimates of the distribution and abundance of forage species such as capelin and euphausiids.

The BEST/BSIERP summer cruise on the R/V *Knorr* left Dutch Harbor on June 14 and will be at sea until July 13. The goal is to conduct a follow-up cruise to the spring USCGC *Healy* cruises. For example, scientists are sampling around drifters released during the spring cruise in a patch of pollock eggs at the Pribilof Islands. Summer catches of walleye pollock along the peninsula and at the Pribilof Islands suggest that some spawning occurred in those locations after the spring cruise on *Oscar Dyson* (Fig. 1). Updates and the eventual cruise report can be viewed at www.eol.ucar.edu/projects/best/cruise_summary_info.html. Scientists are already reporting high concentrations of *Phaeocystis* and *Chrysaora* at the time of this writing.

The T/S *Oshoro maru* from Hokkaido University (recipient of the first PICES Ocean Monitoring and Service Award, POMA) will spend most of the summer in the Bering Sea and Northern Pacific Ocean: north and south of the Aleutian Island chain (June 13–19), in the deep Bering Sea basin and along the eastern continental shelf break (June 22–July 5), on the eastern Bering Sea shelf from Unimak Pass in the south to the Bering Strait in the north (July 8–17), and in the central Aleutian Island area (July 20–23).

Later this summer there will be additional cruises to observe the eastern Bering Sea ecosystem. The U.S. NOAA NPCREP program will recover and redeploy moorings aboard the NOAA Ship *Miller Freeman* (from September 19 to October 12) as part of BEST/BSIERP partnership, and will collect physical, chemical, and biological oceanographic samples across and along the shelf (70-m isobath) from the Alaskan Peninsula to St. Lawrence Island. Examination of inorganic carbon and pH will be part of that exercise. In addition, the U.S. component of the Bering–Aleutian Salmon International Survey (BASIS) from the Alaska Fisheries Science Center will conduct a broad-scale fisheries oceanography survey for pelagic fish, plankton, and biophysical oceanographic data using the NOAA Ship *Oscar Dyson* (September 2–30) and a charter vessel (from August 18 to September 7) also in support of the NPRB and NSF partnership. The *Dyson* will work primarily in the southeastern portion of the shelf and the charter vessel will work from Nunivak Island to the Bering Strait.

Seasonal coverage of the eastern Bering Sea is extensive this spring and summer thanks in a large part to the partnership between the U.S. National Science Foundation and the North Pacific Research Board. We are in the second of three field years for the BEST/BSIERP projects, and the multiple observations of the ecosystem should yield some great new insights into its structure and function.

Acknowledgements: Many thanks to the following PICESans who helped create this report: Drs. Peter Boveng, Janet Duffy-Anderson, Ed Farley, Lisa Eisner, Robert Lauth, Tracey Smart, Jim Overland, Phyllis Stabeno, and Troy Buckley and Elizabeth Siddon.

*Dr. Jeffrey (Jeff) Napp (jeff.napp@noaa.gov) is a biological/fisheries oceanographer at the Alaska Fisheries Science Center of NOAA-Fisheries. He is Head of the Recruitment Processes Program at the Center and co-leader (with Dr. Phyllis Stabeno) of NOAA's Ecosystems and Fisheries Oceanography Coordinated Investigations (EcoFOCI). His research is focused on physical and biological processes at lower trophic levels that affect recruitment variability in fish populations. He is a Principle Investigator on an NPRB-sponsored Bering Sea Integrated Ecosystem Research Plan (BSIERP) project. Jeff is also a member of the PICES Technical Committee on Monitoring.*

# 2009 Salmon Forecasting Forum

*by Skip McKinnell, Robert Emmett and Joseph Orsi*

The 11th *ad hoc* Salmon Ocean Ecology Meeting (SOEM) was held April 7–8, 2009, in Juneau, Alaska, under the chairmanship of Joseph Orsi of the NOAA Alaska Fisheries Science Center's Auke Bay Laboratories. Dr. Douglas DeMaster (Director of the Alaska Fisheries Science Center) welcomed more than 100 participants to Juneau, and Dr. Phillip Mundy (Director of Auke Bay Laboratories) and Dr. James Irvine (Co-Chairman of the DFO Fisheries Oceanography Working Group) set the stage for the discussions with overviews of the state of the ocean and fisheries in 2008. The remainder of the meeting included 40 presentations over two days on variability of the Northeast Pacific and its potential effects on salmon marine survival and abundance. The meeting concluded with a session on outlooks (informal) and forecasts (formal) for salmon survival and returns in the upcoming year and beyond. Some of the findings will make their way into the next PICES report on the status and trends of marine ecosystems in the North Pacific.

The major oceanographic feature of the west coast of northern North America is a boundary that separates the fresher, colder subarctic Pacific Ocean in the north from the warmer, saltier subtropical Pacific Ocean in the south. Along the coast, however, a tongue of cooler water penetrates southward providing a subarctic-like environment whose character is enhanced or diminished by variability in the intensity of upwelling winds along the west coast and the amount of colder subarctic water that enters the California Current. Orsi *et al*. (2007) found that the major change in fish community composition occurred off the coast of British Columbia. If the position of the North Pacific Current and its British Columbia bifurcation were static, life would be simplified but its annual excursions north and south offer a challenge for geographically oriented forecasts.

The first salmon forecasting forum occurred at the SOEM in 2007, with the primary objective of providing a small, focused forum for scientists to apply their knowledge of the potential consequences of ocean/climate variability by regularly presenting and reviewing the success of their forecasts of salmon abundance and survival. In the fullness of time, a discussion of the reasons for successes and failures with a larger interdisciplinary community will provide directions for new research that will lead to improved understanding and, potentially, to improved forecasts of adult salmon runs.

This approach was copied from the ENSO forecast forum where scientists at universities and government agencies around the world are using different models and approaches to provide forecasts of sea surface temperature in the NINO3.4 region in the tropical Pacific, an El Niño indicator. Model forecasts are updated monthly, sent to a single website (Columbia University) and made available for the world to see. Application of this approach to forecasting Pacific salmon abundance and survival is much more difficult because no single stock is the focus of everyone's efforts. Nevertheless, the process of making, evaluating, and updating forecasts annually for multiple stocks has significant merit because of its capacity for learning.

As a consequence of investments made by various agencies in Canada and the United States in observations of the ocean, conducted by oceanographers (of all persuasions) and biologists (of many persuasions) along the west coast of North America during an era of high year-to-year variability, the basic research results are becoming clear. While it has been known for some time that salmon tend to survive poorly in a warmer ocean and better in a cooler ocean, the reason or reasons why this occurs are only now

*Table 1 List of stocks forecast for 2009.*

Pink
- Fraser River
- Southeast Alaska

Chum
- Nitinat River (WCVI)*
- Southeast Alaska

Coho
- West coast (OR/WA)**
- Carnation Creek (WCVI)
- Robertson Creek (WCVI)

Sockeye
- Fraser River/major groups: Early Stuart, Early Summer, Summer, Late, Miscellaneous
- Fraser River/Chilko Lake only
- Barkley Sound
- WC Vancouver Island
- Long Lake (central BC)***
- Kvichak (Bristol Bay)
- Southeast Alaska

Chinook
- Sacramento River fall
- Klamath River fall
- Columbia River Springs
- Columbia River Summers
- Snake River
- Columbia River Falls

* West coast of Vancouver Island; ** Oregon/Washington; *** British Columbia

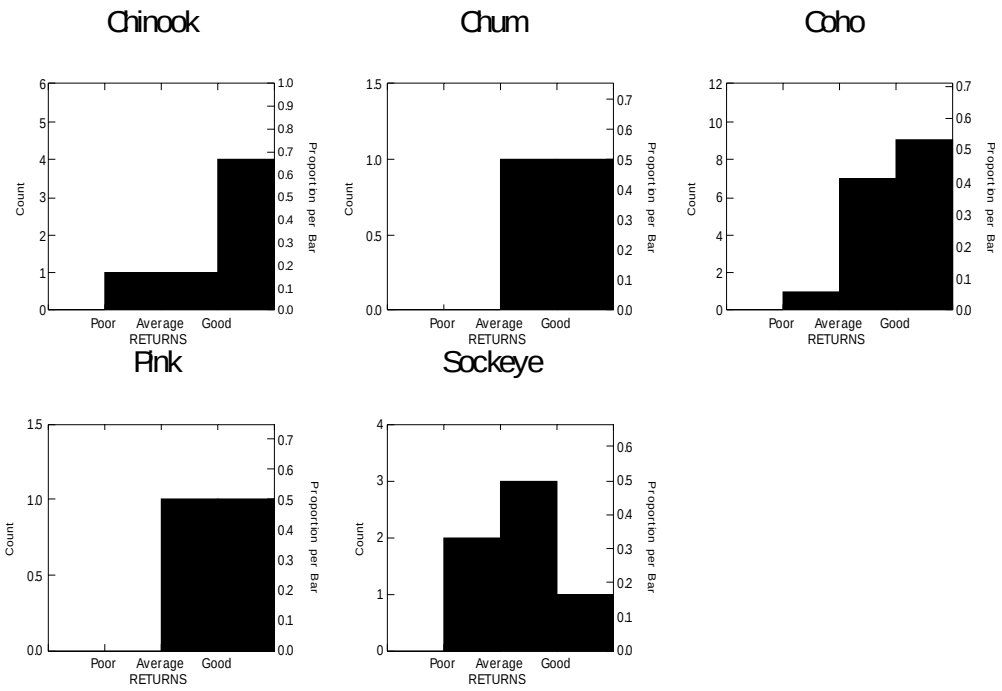



*Fig. 1 Frequencies of anticipated returns in 2009 by species for all stocks in this year's forecasting forum. The heights of each of 3 bars indicate the numbers of stocks in each of 3 categories ranging from poor to good.*

beginning to reveal themselves. While warm ocean temperatures provide a clue to the fate of salmon, it may not affect salmon survival directly, nor is it likely to act as a sole agent of mortality. Observations of coastal ocean ecosystems reveal that ocean warmth is reflecting a number of complex changes in the coastal marine ecosystem that the salmon experience when they first enter the sea.

Frequencies of anticipated returns in 2009 by species for all stocks in this year's forecasting forum are shown in Figure 1. In summary, except for sockeye salmon, adult salmon returns for the stocks considered in the forecasting forum (Table 1) are expected to be average or good for all species. For coho and pink salmon the lack of "poor" expectations reflects significant "improvements" in the state of the coastal ocean during their ocean entry year of 2008. Comparisons across various indices indicate that the coastal ocean was far more subarctic than subtropical in 2008, with plankton and fish community composition and abundances that appear to be suited to improved juvenile salmon marine survival.

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

*Dr. Robert Emmett (Robert.Emmett@noaa.gov) has been working for NOAA Fisheries forever – 30 years. His primary research activities are presently focused on salmon marine survival and population fluctuations in coastal pelagic fishes (sardine, anchovy, herring and smelt).*

*Joseph (Joe) Orsi (Joe.Orsi@noaa.gov), who works as a Fishery Research Biologist at the Auke Bay Laboratories, Alaska Fisheries Science Center, has been studying the early marine ecology of Pacific salmon off the coast of Alaska for the past 28 years. Most recently, Joe's research has focused on monitoring juvenile salmon and their associated biophysical parameters in key ocean migration corridors in southeastern Alaska for the past 12 years. Joe was the chairperson of the Salmon Ocean Ecology Meeting in held in Juneau, Alaska, this year, and also helped as a steering committee member when the meeting was held in Canada in 2008.*

# The Third Argo Science Workshop: *"The Future of Argo"*

*by Howard Freeland*

The first Argo Science Workshop took place in Tokyo in November 2003, with the second being in Venice in March 2006. It was then with great pleasure that the Argo Steering Team accepted the generous offer from China-Argo to host the Third Argo Science Workshop (ASW-3) on March 25–27, 2009, at the Zhejiang Hotel in the beautiful city of Hangzhou. The Argo Steering Team thanks all of our Chinese hosts for the smooth and efficient organization of this meeting, and especially for arranging the deployment of a very large Chinese Argo float in the West Lake during the meeting. That must have been very hard to arrange.

*A view across the West Lake showing an Argo float about to make its first dive with the deploying vessel shown to the left.*

The focus of ASW-3 was the OceanObs'09 Conference to be held in the autumn of 2009 in Venice. To prepare for OceanObs'09 we needed to consult with our user community, find out what worked in the design of Argo and what needed improvement, and so develop a community sense of what changes one might consider making to the general design of Argo. Scientists were invited to present talks on any aspect of ocean science provided that substantial use was made of Argo data. Speakers and poster presenters were also asked at some point to address the sufficiency of Argo from the point of view of their own research. Specifically, we wanted to know if Argo was perfect for the project reported or if some changes in design might have made Argo work better in some way. We anticipated that there might be a call for more rapid sampling in some areas of the ocean, or perhaps a perceived need for more floats, or a sub-sample of floats sampling abyssal waters, *etc*. Suffice it to say, our instructions to the authors were addressed, and we did receive the input we requested. We have now material that will be used in the Community White Paper on Argo to be presented to, and discussed at, OceanObs'09.

The workshop was co-sponsored by several Chinese organizations: the Ministry of Science and Technology, the State Oceanic Administration (SOA), the Second Institute of Oceanography and the State Key Laboratory of Satellite Ocean Dynamics. The North Pacific Marine Science Organization (PICES) served as the international sponsor and provided assistance by assembling the abstracts and program volume and giving considerable advice on how to run a meeting like this. The workshop was also supported with contributions towards an evening banquet event from the following industrial exhibitors: Aanderaa Data Instruments (Norway), JFE Alec Co. Ltd. (Japan), Laurel Scientific, NKE Instrumentation (France), Rockland Scientific International (Canada), Sea Corp. (Japan), Teledyne Webb Research (U.S.A.), Optimare (Germany) and Yichang Institute of Testing Technology (China). We would like to thank them all for their generosity and support.


*Madam Yue Chen, Deputy Director-General of the Department of International Cooperation of SOA, welcomes delegates to ASW-3.*

Following the opening ceremony and speeches from our sponsors, we began the science program with reviews of the current state of Argo (Dean Roemmich) and the current state of the data system (Sylvie Pouliquen). These were necessary to ensure that everyone attending understood the current status of the program. The remaining talks were roughly divided into five general themes:

1. Heat and salt budgets on global to regional scales;
2. Estimation of circulation fields on global to regional scales;
3. The role of Argo in constraining ocean data assimilation models;
4. Seasonal to interannual variability as seen by Argo;
5. New technology.

Talks were fitted only loosely into these themes as we wanted to hear from as many speakers and poster exhibitors as we could and so decided against strict adherence to categories.

*Participants of the Third Argo Science Workshop (March 25–27, 2009, Hangzhou, People's Republic of China). There are 108 people shown in this photo, which includes most of the attendees.*

Eleven Argo nations were represented in oral and poster presentations (among them were five PICES nations) and several more were represented in the audience; this was a good cross–section of the international Argo community.

An innovation was a decision to conscript two wise people, Stan Wilson and Kimio Hanawa, to lead a guided discussion at the end of each day. The concept here was that these are two people who are knowledgeable about Argo but have not (at least not for many years) been central elements of the Argo Steering Team. They were, therefore, qualified to offer opinions as informed outsiders. The task set to them was to highlight important items that they had heard each day and to comment on conclusions achieved. The intention was to create a medium for discussion and debate at the end of each day.

I was pleased with the level of discussion and debate that took place, and this was a relief to everyone who knew that they had contributions to a Community White Paper to write. Also, as one of the organizers of this event, I was surprised firstly by the level of interest in the meeting. I was frequently in touch with the ASW-3 local organizers, Jianping Xu and Renqing Liu, and there was a palpable sense of panic developing in the weeks immediately prior to the workshop that just perhaps the meeting might be too popular and we might have more people interested in attending than we could easily accommodate in the meeting hall. It is easier to deal with that problem than the opposite problem. I always knew that there would be some people who agreed to present talks and then would be unable to attend. But in fact, after the program was assembled, there were only two people who dropped out. For a meeting of this size, it is a surprisingly small number. We were very grateful to Denis Gilbert and Mathieu Belbéoch who graciously agree to step in at the last moment with well-prepared talks.

*Science in action (top) and science inaction (bottom) at ASW-3.*

During the workshop we received suggestions for extending the Argo array poleward from its original design criteria of 60°S to 60°N. In fact, there are now floats reporting from ice-infested regions in both the northern and southern hemispheres. There was considerable discussion following several suggestions that Argo should switch from 10-day sampling to 5-day sampling in the equatorial Indian Ocean. The issue here is that more frequent realizations of the state of the tropical Indian Ocean are needed to support coupled assimilation modelling and especially monsoon forecasting in the Indian basin. An alternative view was that changing the sampling frequency of individual floats from 10 days to 5 days is not cost effective, as their expected lifetime will

drop from 5 years to 2½ years, so requiring earlier replacement. Thus, it was suggested that it might be more cost effective (factoring in ship costs) to double the number of floats reporting in the critical areas.

There were also repeated requests that Argo floats sample ocean conditions all the way to the ocean surface. This is a message we have received, and Argo is almost ready now to supply temperature all the way to the surface. However, salinity is a larger problem. The issue here is that the CTD on board an Argo float is a pumped system. At the moment we turn off the pump, and so stop measuring salinity at a depth of 4 metres. This is done to protect the salinity measurements from contamination by surface bio-chemical films. Experience dictates that we should not pump surface contaminants through the CTD system. In fact, an alternative system has been proposed that would allow the measurement of surface salinity, but the cost is high and requires careful evaluation.

Argo has existed now for 10 years and is engaged in a process that will affirm the direction that it has taken or lead to changes in the design of Argo. As the title of the workshop suggested, ASW-3 was designed to be an important step along the way to the next 10 years, the *Future of Argo*, and the Argo Steering Team had high expectations from the workshop. ASW-3 met and surpassed those expectations.

Following the completion of ASW-3, contributions to the Community White Paper were received and assembled into a coherent document titled "*Argo-A Decade of Progress*" by Freeland *et al*. This is now available on the OceanObs'09 website (http://www.oceanobs09.net/), and a mechanism now exists that allows community input to the document. Comments are solicited until some time in July 2009 when the papers will be revised, taking the comments into account, but they are still not final. Following round-table discussions at OceanObs'09, the papers will be subjected to further modification. From this process we expect to receive guidance from the entire oceanographic community that will help us plan the next 10 years of Argo.

In conclusion, I cannot possibly list everyone who was important to making this meeting a success. I assume you all know who you are. Thank you to all.

*Dr. Howard Freeland (Howard.Freeland@dfo-mpo.gc.ca) is a physical oceanographer conducting research on the circulation and dynamics of the N.E. Pacific and works for Fisheries and Oceans Canada at the Institute of Ocean Sciences. He was launching profiling floats before the Argo concept emerged. Since then Howard has been involved in every meeting of the International Argo Steering Team and Executive Committee and presently he co-chairs the International Argo Steering Team. Howard received his B.A. at the University of Essex (England) and his Ph.D. at Dalhousie University, in Halifax, Nova Scotia.*

(*continued from page 21*)

The existing CPR surveys have extensive spatial coverage, but there is still a vast amount of the global ocean not sampled. For instance, there is no sampling in the tropics, in the south Pacific, in the Mediterranean, or in upwelling regions. Emphasising the value of CPR data to resource and policy decision-making processes may help find a local champion who can work with the CPR commonwealth to set up a new survey in some of these key areas. Expansion into these regions would additionally help compile data for the next report of the Intergovernmental Panel on Climate Change (IPCC). The workshop felt that momentum was gaining on the role of CPR data in contributing to the biological observations needed by ocean observing systems. A white paper that is being prepared for the upcoming OceanObs'09 conference (September 21–25, 2009, Venice, Italy) will incorporate the discussion from the workshop, in addition to contributions by the wider community, to maintain this momentum.

The *Journal of Plankton Research* had expressed an interest in publishing papers from the workshop, and about 5–6 articles are likely to form a themed section in the journal (deadline for submission was agreed as the end of 2009).

We concluded that with the very positive views expressed in working more closely together, scientists from the CPR surveys need to meet more often and communicate more frequently and that we should utilise many different fora to make this happen. We intend to take advantage of future international symposia to convene workshops (including annual taxonomic workshops that are to be hosted by SAHFOS), produce a newsletter and initiate an internet-based CPR list-serve where updates and ideas can be posted. The benefits of meeting in person were felt by everyone and it has not happened frequently enough in the past. The workshop agreed that a more holistic global approach is now warranted.

# 2009 ESSAS Annual Science Meeting

*by Kenneth Drinkwater, Margaret M. McBride and George L. Hunt, Jr.*

The 2009 Annual Science Meeting (ASM) of the Ecosystem Studies of Sub-Arctic Seas (ESSAS) program was held on June 18–19 at the University of Washington in Seattle (U.S.A.) and attended by approximately 70–80 scientists.

The morning of June 18 was taken up with a plenary workshop on "*Gadoid-Crustacean Interactions*" co-convened by Drs. Earl Dawe (Canada) and Franz Mueter (U.S.A.), Co-Chairmen of the ESSAS Working Group (WG) on *Climate Effects at Upper Trophic Levels*. This WG is undertaking comparative studies between different subarctic seas to elucidate the processes that lead to shifts between demersal fish, especially gadoids such as cod and pollock, and crustaceans, such as shrimp and crabs. The workshop began with two keynote papers; the first one was given by Dr. David Armstrong (U.S.A.) on crab dynamics with special emphasis on the Bering Sea stocks. The second keynote was by Dr. Svein Sundby (Norway) on cod dynamics in the North Atlantic. These were followed by regional reviews of gadoid–crustacean dynamics, environmental conditions, and the effects of targeted fisheries for several ESSAS areas, including the Oyashio, Bering Sea, Newfoundland and Labrador, West Greenland, Iceland and the Barents Sea.

The WG met in closed session during the afternoon of the second day to discuss the results of the plenary workshop and to plan future activities. In contrast to previous work that suggested particular top-down control of shrimp populations by cod, the overviews revealed that this is not a general pattern across the 6 regions, and that there may be relatively little control by cod on shrimp or crab populations. The reviews also revealed a great deal of variability across ecosystems, with some systems exhibiting fluctuations of shrimp and cod that were in phase while others showed out of phase relationships. There was general agreement that more attention must be paid to spatial processes within each region, in particular, the spatial overlap between gadid and crustacean stocks. The WG agreed that more research is needed to establish the spatial overlap among the gadoid and crustacean stocks to quantify the extent of the match or mismatch between populations. Other areas of research that are needed included the influence of alternative prey and hence the temporal variability in predation of shrimp and crab by gadids, and how the diets of the gadids change as a function of size and season. The WG will follow up on some of these issues before reporting at next year's meeting. They are also contemplating writing a paper comparing the gadoid–crustacean interactions in the different regions.

In the afternoon of June 18, the WG on *Bio-physical Coupling* convened a workshop on "*The Role of Advective Processes in Sub-Arctic Ecosystems*" led by Dr. Ken Drinkwater (Norway), Co-Chairman of ESSAS. This was a follow-up workshop to one on advection held at the 2008 ESSAS ASM in Halifax, Canada. This year's workshop was conducted jointly with scientists from the Arctic/Sub-Arctic Ocean Fluxes (ASOF) program and was used to explore the possibility of greater collaboration between ESSAS and ASOF in the future. ASOF has been involved in the measurements of volume, heat, and salt exchanges between Arctic and sub-Arctic regions over the last 5 plus years and recently published a book entitled "Arctic-Subarctic Ocean Fluxes: Defining the Role of the Northern Seas in Climate" (Eds. R.R. Dickson, J. Meincke and P. Rhines, Peter, 2008, X, 738 p.) on the results of their findings. ASOF is moving into Phase II of their research program during which they wish, through collaboration with ESSAS, to determine the effects of these exchanges on the flora and fauna.

A total of nine presentations were made on various aspects of transport and their effects, three by ESSAS and six by ASOF. These included presentations on the physical oceanographic dynamics of the circulation patterns and flows, for example in the Bering Sea, the Bering Strait, the Barents Sea and the North Atlantic Sub-Polar Gyre. The circulation patterns in the Sea of Okhotsk were shown to carry significant quantities of iron into the Northwest Pacific, which increases primary production in the region. At West Greenland, the offshore transport of low salinity water into the northeastern Labrador Sea is responsible for the early spring bloom in the region through the establishment of sufficient vertical stratification for the phytoplankton to grow. Initial results from the Atlantic Bloom Experiment southeast of Iceland were presented using state–of–the–art sampling platforms, including gliders, to follow the initiation and development of a spring bloom. An example of the role of advection on zooplankton distribution in the Oyashio region off Japan was also given, as was a talk on the effects of changes in the Sub-Polar Gyre circulation on blue whiting in the region in the Northeast Atlantic. Following the presentations, a discussion of potential future collaborations between ESSAS and ASOF was held. Possibilities included: the addition of biological sensors on ASOF moorings, the use of ASOF transportation estimates for biological fluxes, the development of joint proposals for new field research aimed at determining the processes through which advection influences the biota, and cooperative modeling studies. These possibilities will be explored further during the coming year.

On June 19, Dr. James Overland (U.S.A.), Chairman of the ESSAS WG on *Regional Climate Prediction*, presented the

final report of this WG, which was charged with exploring which of the IPCC Global Circulation Models (GCMs) would be most useful to downscale to regional models of the sub-Arctic seas. Based on how well the GCMs performed in hindcasting recent climate, a list of GCMs was published for several Sub-Arctic seas with the selected GCMs differing between regional seas (Overland and Wang, 2008). It was also suggested that several GCMs should be used when downscaling to regional models. A "best practices" manual for downscaling is also being written. Following the report, Dr. Michael Wallace of the University of Washington gave an open lecture entitled "Global Modes of Climate Variability on Regional Ecosystems". The global modes he discussed included the Northern and Southern Annular Modes that are centered over the Arctic and Antarctic, respectively, as well as the El Niño–Southern Oscillation (ENSO) and the Pacific–North America (PNA) Mode. These modes were shown to be strongest in winter and to impact regional coastal systems such as the subarctic at annual time scales and longer through their effects on winds, precipitation and temperature patterns.

This was followed by a report from Dr. George Hunt (U.S.A.) who provided an update on work initiated at the 2007 ESSAS ASM in Hakodate, Japan, on biological hotspots in sub-Arctic seas, *i.e.*, areas of high biomass concentrations. Dr. Hunt is leading a paper on the locations of biological hotspots and the physical/ biological processes that determine them. He reported that the paper is well underway and should be completed by next year's meeting. Dr. Mike Sigler (U.S.A.) then presented a paper on forge fish hotspots in the southeastern Bering Sea and their influence on Steller sea lions. He showed that geographical persistence of the prey may be just as important as density of prey aggregations to predators; particularly for predators that do not have the ability to search large areas efficiently.

The final workshop of the ESSAS ASM was organized by the Working Group on *Modeling Ecosystem Response* and was convened by two of its Co-Chairmen, Drs. Shin-ichi Ito (Japan) and Kenny Rose (U.S.A.). The main purpose of the workshop was to discuss the development of different end-to-end models and how to compare and contrast them. Presentations were given on three different types of end-to-end models. The first was on a model for the Bering Sea called FEAST (Forage and Euphausiid Abundance in Space and Time) that is an upper trophic level model, including zooplankton and fish, and connects to a lower trophic model. It also will provide input to a fisheries and economic model. The second model is being developed by the ESSAS Modeling Working Group in collaboration with others. They are designing and constructing a fully integrated, biophysical ecosystem model that will be coupled to a hydrodynamic model using the Regional Ocean Modeling System (ROMS), include biogeochemical cycles that support biological production (nutrient dynamics) and primary/secondary production using multiple functional groups (NPZ) and a spatially explicit, individual-based model to represent upper tropic level (UTL) functional groups, which initially will be fish but could be extended to include birds and marine mammals. The third model is ATLANTIS, an end-to-end model developed in Australia by Dr. Beth Fulton. This model includes physics to fish as well as fisheries and economics. It has been applied throughout Australia and in several locations around the world. ESSAS was informed about the application of ATLANTIS in the California Current and its use to explore different fisheries management scenarios. A second presentation was made on the development of an ATLANTIS model for the Barents Sea, what it will be used for and the challenges in implementing it. Finally, a presentation was given on minimal ecosystem models to remind us that sometimes simple models may be the best way to go to answer some fishery questions. The presentations were followed by a lively debate on various aspects of ecosystem modeling and how to carry out comparative modeling studies.

*Drs. Jim Overland (top) and Shin-ichi Ito (bottom) presenting the results from the Working Group on* Regional Climate Prediction *and on* Modeling Ecosystem Response *during the ESSAS SSC Meeting.*

In addition to the Annual Science Meeting, ESSAS held a Scientific Steering Committee (SSC) meeting the day before the ASM and for half a day after. The most important issue dealt with was the future of ESSAS after the completion of GLOBEC at the end of 2009. GLOBEC was one of two IGBP (International Global Biosphere

Program) programs dealing with the oceans. The other is Integrated Marine Biogeochemistry and Ecosystems Research (IMBER), which developed after GLOBEC and will continue after GLOBEC finishes. The question was whether ESSAS would join IMBER. Dr. Julie Hall, the Chairman of IMBER, made a presentation to the ESSAS SSC on IMBER, its goals, what it could do for ESSAS and what it would request from ESSAS. After discussion, the SSC unanimously voted to join IMBER. The aims and goals of ESSAS will not change but there will be an effort to include more biogeochemistry within ESSAS. ESSAS looks forward to working within IMBER and with the other regional programs of IMBER.

Another important issue discussed by the SSC was the planning of the ESSAS Open Science Symposium in 2011. This will be at approximately the expected mid-life of ESSAS, and it was felt it would be an opportunity to present some of the results of ESSAS to date, and to explore new avenues of research for the coming years. It was decided to hold the meeting in Seattle, pending exploration of the costs and availability of suitable facilities. PICES has agreed to have the Secretariat help with the registration and the logistics of the Symposium, and ICES will be approached to support it as well. Several different theme sessions were discussed and a decision will be made as to which ones will be chosen in the coming months.

Reports on the ESSAS national and multinational activities were provided to the SSC by representatives from Japan, Korea, the United States, Canada, Denmark (representing West Greenland), Iceland and Norway. Decisions were also made on the future of the ESSAS Working Groups. The WG on *Regional Climate Prediction* has completed its terms of reference and has been terminated. Discussions were held on forming a new Working Group to investigate the effects of future climate change on the sub-Arctic seas. It was decided to wait until after the PICES/ICES/FAO Symposium on "Climate Change Effects on Fish and Fisheries" to be held in the spring of 2010, in Sendai, Japan, before deciding what the terms of reference should be for such an ESSAS Working Group. The WG on *Bio-physical Coupling* will be terminated with its completion of the paper on hotspots. The work on the role of advection in sub-Arctic ecosystems will continue and may form the basis of a new Working Group. The WG on *Modeling Ecosystem Response* will continue its development of an end-to-end model as well as comparative modeling studies between regions and between different types of models. The WG on *Climate Effects at Upper Trophic Levels*, having gathered together data sets of environmental and relevant fish and invertebrate data for many of the sub-Arctic seas, will undertake extensive comparative studies to understand the processes linking climate variability and gadoid–crustacean dynamics. Each of the existing Working Groups and potential new Working Groups will be discussed at next year's ESSAS meeting. Iceland offered to host the 2010 ESSAS ASM in Reykjavik during the first week in September.

In addition to the scientific presentations and discussions, the ESSAS meeting provided the opportunity for catching up on the news of old friends to meet new ones. To facilitate this a meeting dinner was held at Ivar's Salmon House in Seattle. George Hunt hosted a smaller gathering for the SSC and international visitors at his apartment at the end of the Science Meeting, complete with beef steaks, wine and cheese.

*Dr. Kenneth Drinkwater (ken.drinkwater@imr.no) is a fisheries oceanographer conducting research on climate variability and its effects on the marine ecosystem, with a special interest in fish populations. Having worked many years at the Bedford Institute of Oceanography in Canada, he is now working at the Institute of Marine Research (IMR) in Bergen, Norway. Ken is Co-Chairman of the ESSAS Scientific Steering Committee.*

*Ms. Margaret Mary McBride (margaret.mary.mcbride@imr.no) is a research fisheries biologist with over 30 years of experience. She is now a coordinator of the ESSAS International Project Office at IMR. In addition to this duty, Margaret is working on issues related to ecosystem-based research and management through an Intergovernmental Personnel Action (IPA) between IMR and NOAA Fisheries.*

*Dr. George Hunt (geohunt2@u.washington.edu) joined the School of Aquatic and Fishery Sciences at the University of Washington as a Research Professor after retiring from the University of California, Irvine. For many years, George studied the reproductive and foraging ecology of seabirds in various regions. More recently, he has participated in ecosystem-level studies of the southeastern Bering Sea and the Aleutian Archipelago. He co-chairs the ESSAS Scientific Steering Committee and serves as a member of the PICES CFAME (Climate Forcing and Marine Ecosystems) Task Team.*

# A Visit Fit for an Emperor and Empress of Japan

Sunday, July 12 of 2009, marked the day that the Emperor and Empress of Japan graced the halls of Fisheries and Oceans Canada's Institute of Ocean Sciences (IOS), site of the PICES Secretariat, in Sidney, British Columbia. Although Emperor Akihito had last visited Canada as a Crown Prince in 1953, this was his first visit to Canada as reigning Japanese Emperor. Apart from the more traditional meetings and events that marked his official 11-day visit to Canada, the visit to IOS was for personal interests, as the Emperor is a noted and passionate marine biologist, with 30 published papers.

The Emperor and Empress rarely make public appearances even in their home country, so it was considered quite a coup for IOS to have them visit the facilities. Befitting such an extraordinary honour, preparations for the visit went into high gear at the Institute many weeks before Their Majesties' arrival. Except for the Imperial visitors, Japanese and Canadian delegations of senior officials and invited scientists, the Institute visit was a closed event. After formal greetings by, among others, Dr. Timothy Parsons, 2001 Japan Prize recipient, the visitors were treated to a short film (in Japanese) about the Institute and its activities. The film included the role PICES, as an inter-governmental science organization, plays in encouraging scientific collaboration among its member countries in the study of the North Pacific Ocean.

During a scientific tour that followed, senior IOS scientists (several of them have been also playing an important role in PICES activities) gave presentations at stations along the display path. Dr. Kenneth Denman (2007 PICES Wooster Award recipient) reviewed research on the effects of climate change on North Pacific marine ecosystems. Dr. Eddy Carmack described the International Polar Year and the Canadian Three Oceans Program focused on the Arctic and climate change. Dr. Richard Thomson introduced the international Canadian-led NEPTUNE Cabled Ocean Observatory project. Dr. David Mackas greeted Their Majesties at the plankton lab and presented research linking plankton and climate change. Overall, the biggest problem encountered was to keep the event on schedule. What originally was supposed to be a 45-minute tour of the facilities turned into one almost two hours long! Their Majesties were both very engaged and interested. Their knowledge of ocean science was impressive, and they were "up close and personal" with the presenters, asking many astute questions. Discussions with scientists continued during a light lunch tastefully arranged at the IOS cafeteria overlooking the grounds and the waters of Saanich Inlet.

The event was a resounding success, and this success was the product of a lot of hard work by many people, spread across all of the organizational units at IOS and coordinated by Mr. Robin Brown, Manager of Ocean Sciences Division. This visit not only gave scientists the opportunity to interact with Their Majesties, but it also provided His Majesty the opportunity to put his own scientific interests into a wider context of climate change and issues involving ocean processes. We are grateful to DFO/IOS for giving PICES the exposure and opportunity to be introduced to Their Majesties, and the accompanying media, during the visit.

*Emperor Akihito and Empress Michiko pass a polar bear image during a tour of IOS (Photo by Todd Korol, Reuters).*

*PICES Executive Secretary, Dr. Alexander Bychkov, and Dr. Sus Tabata (IOS Senior Scientist, retired) are introduced by Dr. Wendy Watson-Wright (Assistant Deputy Minister of Science, DFO) to the Emperor and Empress during their visit to IOS (Photo by Adrian Lam, Times Colonist).*

**PICES PRESS**

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