PICES Press

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

Editorial

Ian Perry (PICES Science Board Chairman) and Roger Harris (GLOBEC Chairman)

Welcome to this joint newsletter from PICES (North Pacific Marine Science Organization) and GLOBEC (Global Ocean Ecosystem Dynamics Project of the International Geosphere-Biosphere Program). This is a special combined issue of PICES Press and the GLOBEC Newsletter, containing articles and items of interest from both the GLOBEC Second Open Science Meeting and the PICES Eleventh Annual Meeting, held sequentially in Qingdao, People's Republic of China, in October 2002. The meetings were closely co-ordinated and included joint sessions and workshops, so that we felt it would be of interest to our readers to report together on their outcomes. In this issue you will find overviews of each of these meetings, as well as descriptions of workshop proceedings and highlights of some of the scientific activities of PICES and of GLOBEC. Introduction of the GLOBEC Project Office and the PICES Secretariat, and a calendar of up-coming events for each program rounds off this special issue. Both PICES and GLOBEC felt that these meetings were very successful and benefited from the combined participation and collaboration. We look forward to continued close connections in the future.

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The state of PICES science – 2002

R. Ian Perry
PICES Science Board Chairman
Fisheries & Oceans Canada
Pacific Biological Station,
Nanaimo, B.C., CANADA. V9T 6N7
E-mail: perryi@pac.dfo-mpo.gc.ca

Dr. Ian Perry is a research scientist with Fisheries and Oceans Canada, at the Pacific Biological Station, Nanaimo, B.C., Canada. He is presently the Chairman of the Science Board, the top scientific committee of PICES. He is also an active member of the IGBP/SCOR/IOC GLOBEC program, having been its Vice-Chairman for the past 6 years, past-Chairman of GLOBEC Focus 1 Working Group on Retrospective and Time Series Analyses*, and present Co-Chairman of GLOBEC Focus 4 Working Group on* Feedbacks from Changes in Marine Ecosystem Structure*. His research specialty is fisheries oceanography, with particular interests in how environmental changes affect fish population dynamics and distributions, and developing ecosystem-based approaches to managing marine living resources (which include the human dimensions).*

PICES continued to be a very busy and productive international marine science organization during 2002. Seventeen workshops and symposia were held in addition to the Annual Meeting, and eight volumes of scientific papers were published, three of which were volumes of primary papers that were first presented at the Tenth Annual Meeting in October 2001. PICES continues to be a leader in the marine sciences in the North Pacific and globally, with active programs to:

- investigate mechanisms by which natural and human-induced changes affect marine ecosystems, from physics and phytoplankton to whales and seabirds;
- develop models of these processes that are useful for understanding and for forecasting; and
- develop efficient systems for long-term monitoring of the North Pacific.

After 10 years of building the organization, PICES is now ready to look forward to new issues and problems facing the North Pacific in the next 5-10 years, and to understand and offer advice on dealing with these problems. The development of the North Pacific Ecosystem Status Report, which began in 2002, is a major initiative to identify such problems.

The Annual Meetings are where many of these discussions start, but they continue in smaller committee and working group sessions. The PICES Eleventh Annual Meeting (PICES XI) provided a good sample of the breadth of these issues and discussions.

Highlights from the Annual Meeting

PICES XI, held October 18-26, 2002, marked the return of PICES to the seaside city of Qingdao, People's Republic of China. PICES last met in Qingdao in 1995 and, just like the spectacular growth and changes that this city has undergone over the past 7 years, PICES is also now a considerably larger and more active organisation. The room that held the Opening Ceremony in 1995 was, in 2002, large enough for just one of the several concurrent sessions. PICES XI was hosted by the Government of China in coordination with the PICES Secretariat, with local arrangements by the Yellow Sea Fisheries Research Institute. There were 14 scientific sessions, 5 workshops, and several Working Group meetings, with a total of 176 oral presentations and 145 posters (including 13 electronic posters). The meeting was closely coordinated with, and linked to, the GLOBEC 2nd Open Science Meeting, such that some PICES presentations were jointly sponsored with the GLOBEC meeting (see report elsewhere in this Newsletter).

The keynote lecture, titled "*The ocean's role in global change: Global oceanography has come*", was presented by Prof. Dun-Xin Hu of the Institute of Oceanology, Academia Sinica. He reviewed the major issues of global change such as climate change, the hydrological cycle, carbon cycle, and living resources. He concluded that the oceans are crucial to all these issues, and that this provides a renewed and wonderful opportunity for oceanography to expand and "go global".

Prof. Dun-Xin Hu giving the Keynote Lecture at the Opening Session.

Attentive audience at the joint PICES/GLOBEC Workshop on Data management of GLOBEC data.

The Keynote Lecture was followed by the theme session for PICES XI, titled "*Technological advances in marine scientific research*". Papers dealt with aspects of new technologies in physical and biological oceanographic observations, new methods for tracking movements of fish and other large organisms, and new approaches to integrate and visualize the large volumes of data that result from these new observing techniques. The current trend is to use smaller and faster devices and to integrate multiple sampling systems, both resulting in ever larger volumes of data. Biological observation systems are taking novel approaches which use the organisms themselves as platforms to sample their environment; however, the ability of biological systems to sample rapidly over a wide range of spatial scales currently lags that of physics. Models which integrate these biological observations are also lacking. The greatest challenge to all of oceanography, however, may be outreach to the scientific community and the behaviour of individual scientists and organizations with respect to data management issues.

In recognition of this data management problem, PICES convened an electronic poster session and a joint PICES-GLOBEC workshop at PICES XI to examine data issues. The E-Poster Session, titled "*Data systems to support technological advances in observation systems*", presented computer-based demonstrations of innovative data acquisition systems, web pages, databases, and tools for analysis and visualization. Many of these presentations are currently on the web at tcode.tinro.ru/tcodes12.html. The PICES-GLOBEC Workshop, titled "*Data management: Exchange, inventory and archival of GLOBEC data*", discussed the inducements and barriers to the exchange and archival of oceanographic data, with a specific focus on GLOBEC data (see report elsewhere in this Newsletter). The PICES Technical Committee on Data Exchange should play a major role in facilitating the exchange of data from the North Pacific, but ultimately each researcher must realize that it is their own responsibility to contribute to the global science legacy.

A session on "*Eutrophication, harmful algal blooms, and nutrients*" (co-sponsored by PICES and Chinese National Harmful Algal Bloom project) examined the global increase in harmful algal blooms (HABs), in particular when and how eutrophication affects the dynamics of these blooms. The session recognized two different impacts of eutrophication on HABs: increases of high-biomass-non-toxic blooms which lead to oxygen depletion *versus* low-biomass-toxic blooms. In addition, the session concluded that future studies should examine the whole planktonic ecosystem, since changes in nutrient delivery patterns can have profound effects on food web structure and on the fate of the bloom through grazing. From the other end of the trophic spectrum, the session on "*Comparison of the productivity of marginal seas with an emphasis on the western Pacific (Japan/East Sea, Yellow Sea and East China Sea) with a focus on small pelagics*" examined some of the most productive areas of the world ocean. The emphasis was on understanding and comparing factors affecting the production of small pelagic fishes and zooplankton among these three regional ecosystems. Presentations demonstrated the importance of these small pelagic species to these ecosystems, and how their variability can be connected directly with changes in system productivity and with climate. The next steps will need to consider age information, and ways to differentiate fishing effects from natural variability.

The session on "*Responses of upper trophic level predators to variation in prey availability: An examination of trophic level linkages*" considered predator responses to prey variability, and the implications of using high trophic level predators as indicators of ecosystem change. Presentations described a wide range of individual-level responses such as body size, stress hormone levels, diet composition,

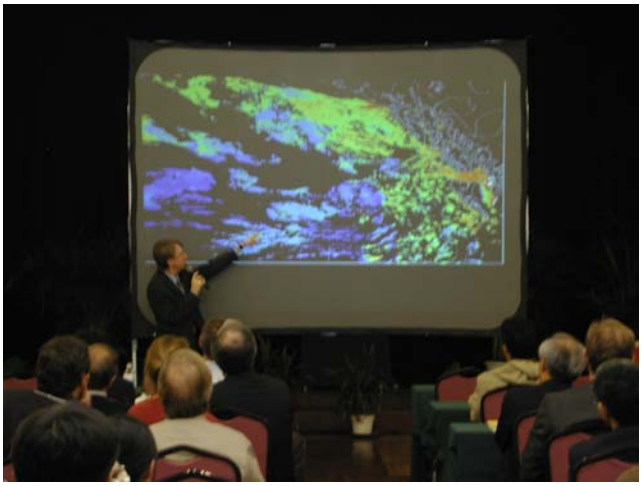
foraging behaviour, habitat use, feeding efficiency and growth; and population level responses such as adult survival, reproductive success, juvenile survival and overall population growth or decline. Some presentations also showed that prey variability and predator responses were linked to climate variability at interannual and inter-decadal time scales, leading authors to suggest that predators can serve as indicators of ecosystem change. The session raised several important questions that could guide future research in this area, including:

- Which life history stages are most sensitive to changes in prey availability?
- How and why do different species in the same system respond differently to changes in prey availability?
- What are the important spatial scales of prey variability?
- Is the mean or the variance in prey abundance most important in driving predator responses?
- What oceanographic processes drive the prey aggregations exploited by predators?

The theme of climate variability and marine ecosystem impacts in the North Pacific has been a very important one for PICES. Three major sessions were held during PICES XI to discuss aspects of this theme. PICES and CLIVAR co-convened a joint workshop titled "*Climate variability in the Pacific and its impact on the marine ecosystem*". The workshop explored the present understanding of climate phenomena in the PICES area and their links to the ecosystems of the region. It was intended to identify ways in which collaboration between CLIVAR and PICES can further understanding and aid the implementation of observational and modeling activities in the wider Pacific. The workshop attracted a large audience and examined the physical, biogeochemical, and ecosystem aspects of climate variability in the Pacific. The workshop concluded there is a need for a more mechanistic approach to establishing the causal links between variation in the Earth's climate and the marine ecosystem. Most studies to date have relied on statistical correlations between climate indices and abundances of species. This, of course, is one of the major challenges of the GLOBEC program, in the North Pacific through the PICES Climate Change and Carrying Capacity Program, and one in which the co-participation of CLIVAR is highly welcome. Further joint workshops are planned.

The MONITOR Task Team held a workshop on the "*Requirements and methods for 'early detection of ocean changes'*". It addressed such questions as "How we can we best design our monitoring programs to reduce the time lag between event and detection?" and "What are the relative costs of false alarms *versus* missed detections?" The workshop concluded that having a broad diversity of measured variables is good, and combining them into a single index is not recommended; biological variables may have higher "signal-to-noise" ratios than physical variables at interannual time scales, possibly due to stronger autocorrelations; having a diversity of analytical methods is also good, in particular those that complement strengths and weakness of each method; and that opportunities for monitoring are increasing with new time series, new technologies, and a greater awareness of ocean changes. Further work on this theme is planned.

A more theoretical approach to this problem was the focus of the session titled "*Detection of regime shifts in physics and biology*". The focus was on retrospective and numerical models which describe the nature of regimes and on conceptual models of the underlying mechanisms connecting physical dynamics to biota. Invited presentations included a coupled atmosphere-ocean model in which the ocean acted to either restore the atmosphere to its present state or, if the ocean exceeded a threshold, to force the atmosphere into a second stable state. The other invited presentation suggested that regime shift signals are stronger in biota such as euphausiids and dissipate at higher trophic levels. The session concluded that, despite the apparently synchronous global patterns, the details at regional scales can be very complex which can make the broad scale patterns unrecognizable. And echoing a conclusion from the PICES-CLIVAR Workshop, there is a need to move from a research focus on correlative pattern recognition to the determination of mechanisms.



Dr. Perry summarizing PICES scientific achievements of 2002 at the Closing Session.

Congratulations are in order for winners of the Best Presentation Award at PICES XI. These awards are given to scientists, nominated by each PICES Scientific Committee and the Science Board, who gave the best presentation in a topic or paper session sponsored by the committee or board. Here are the 2002 winners: the BIO Award to Kohei Mizobata (Japan) for his talk entitled "*Impact of the eddy field on phytoplankton distribution along the shelf edge in the southeastern Bering Sea 1998-2000 using SeaWIFS and TOPEX/ Poseidon time series data sets*" (co-authored by S.-I. Saitoh); the FIS Awards to Alexey Baitalyuk (Russia) for his paper entitled "*Contemporary stock status, distribution, place and role of*

Pacific saury in the Japan Sea/East Sea" and honourable mention to Kyung-Mi Jung (Republic of Korea) for her paper entitled "*Ecological characteristics of walleye pollock eggs in the south-eastern Bering Sea during the 1970s regime shift period*" (co-authored by S. Kim and S. Kang); the MEQ Award to Sheng Liu (People's Republic of China) for presentation of the paper entitled "*Feeding and reproductive responses of marine copepods in South China Sea to toxic and nontoxic phytoplankton*" (co-authored by W.-X. Wang); the POC Award to Shuhei Masuda (Japan) for his paper entitled "*A model of regime transitions in the North Pacific*"; the TCODE Award to Andrew Golik (Russia) for his E-Poster entitled "*Development of Geographic Information System of Northwestern Pacific based on Internet/Intranet*" (co-authored by V. Fischenko); and the Science Board Awards to Sukyung Kang (Korea) for her presentation entitled "*The analysis of trace elements in chum salmon otoliths using laser-ablation technology: habitat characteristics and stock identification*" (co-authored by S. Kim, D. Welch, K. Telmer and Y.-H. Lee) and to Olav Ormseth (U.S.A.) for his poster entitled "*Interannual variability in the distribution of spawning Pacific cod in Alaska: the influence of ocean temperature*" (co-authored by B. Norcross).

Additional highlights from 2002 and features for 2003

In addition to the Eleventh Annual Meeting, PICES also co-sponsored 5 symposia: "*The causes of marine mortality of salmon in the North Pacific and North Atlantic and in the Baltic*" (with NPAFC, NASCO, and IBSFC; March, Vancouver, Canada); "*North Pacific transitional areas*" (with CIBNOR and CICIMAR; April, La Paz, Mexico); "*Recent progress in studies of physical processes and their impact to the Japan/East Sea ecosystem*" (with CREAMS; August, Seoul, Korea); "*Synthesis of JGOFS North Pacific process study*" (with JGOFS; October, Sapporo, Japan), and the GLOBEC 2nd Open Science Meeting. Particularly noteworthy was the joint "Transitional areas" symposium convened in Mexico, which was highly successful and represented the first formal event held by PICES in Mexico; a volume of papers in *Journal of Oceanography* is in progress. The year was also busy with meetings and workshops of specific groups within PICES. These included the various Working Groups and CCCC Task Teams (notably two workshops dealing with lower and upper trophic level models in the North Pacific, and monitoring systems).

PICES has in place two field projects, both of which were very active in 2002. The Continuous Plankton Recorder (CPR) Program conducted surveys from merchant marine vessels along meridional transects in the eastern North Pacific (Alaska to California) and zonal transects from Canada/U.S.A. to Japan. Results from these and earlier surveys are now in press in the scientific literature, and further publications are being prepared. The Iron Fertilization Experiment Panel (IFEP), an Advisory Panel under the CCCC-BASS Task Team, conducted a collaborative (Canada-Japan) iron enrichment experiment in the Northeast Pacific during summer 2002. This experiment was so successful that the resulting phytoplankton bloom was visible from the SeaWiFS satellite, and was observed and puzzled over by remote sensing laboratories in North America.

Two major projects were also begun during 2002. One was the CCCC Integration Workshop, which was held just prior to PICES XI to review the accomplishments of the CCCC Program and to consolidate its next steps. The initial results of this workshop are reported elsewhere in this Newsletter. The other major project is the development of the North Pacific Ecosystem Status Report. This is a major effort to integrate and assess the ecosystems of the North Pacific, identify critical factors causing changes, and to try and forecast the consequences of these changes. A "draft for discussion" Ecosystem Status Report was prepared prior to PICES XI, and received considerable comment. The Ecosystem Status Report activity will be closely linked with a parallel collaborative project between the Census of Marine Life and PICES to report on "*Marine life in the North Pacific: The known, unknown, and unknowable*". These will be major initiatives for PICES during 2003.

Other major PICES activities in 2003 include several symposia and workshops, such as a MODEL Workshop to *Embed the NEMURO and NEMURO.FISH models into a 3-D circulation model* (March, Yokohama, Japan); the international symposium on the *Role of zooplankton in global ecosystem dynamics: comparative studies from the world oceans* (May, Gijon, Spain); the 3rd PICES Workshop on the *Okhotsk Sea and adjacent areas*, as well as workshops relating to the North Pacific Ecosystem Status Report. Workshops to be held just before PICES XII include "*Harmonization of Harmful Algal Bloom data*", "*Examining and critiquing a North Pacific Ecosystem Status Report*", and "*Distribution and diets of marine birds and mammals*". Among other topics, sessions are planned during PICES XII on the "*Human dimensions of ecosystem variability*", on "*Linkages between open and coastal systems*", on the "*Influence of fishing and/or invasive species on ecosystem structure in the coastal regions*", on "*Latitudinal differences in responses of productivity and recruitment of marine organisms to physical variability*", and on "*Ecosystem-based management*". Readers are invited to visit the PICES web site regularly for more details on these and the other sessions during PICES XII in Seoul, Korea.

Second Annual Wooster Award to Yutaka Nagata

Dr. Yutaka Nagata was honoured with the second annual Wooster Award at the PICES Eleventh Annual Meeting in Qingdao, People's Republic of China. The Wooster Award, named after the principal founder and first Chairman of PICES, Dr. Warren S. Wooster, is given annually to an individual who has made significant scientific contributions to North Pacific marine science, such as understanding and predicting the role of human and climate interactions on marine ecosystem production. Dr. Nagata has demonstrated sustained excellence in science, teaching and administration of marine science in the North Pacific region, and has served a leadership role in oceanography in Japan, and on several international oceanographic committees in addition to those of PICES (see Dr. Nagata's biography in PICES Press Vol. 6(2), 1997). He has over 70 publications in English, with further publications in Japanese, including 10 books. These publications are in a broad inter-disciplinary range, from core physical oceanography to lobster biology. After retiring from being a Professor at two Japanese universities, he established for himself a "second career" as a manager of oceanographic data products, and their quality control (he is the first Director of the Marine Information Research Center in Japan). Dr. Nagata has been a central figure in the successful establishment of PICES, including serving as the first Chairman of the Physical Oceanography and Climate Committee, Co-Chairman of the Climate Change and Carrying Capacity Program, and member of Working Group 1 on Okhotsk Sea, along with an important role in the formation of the Technical Committee on Data Exchange. Science Board is very pleased to name him as the recipient of the PICES Wooster Award for 2002. Dr. Hyung-Tack Huh (Chairman of PICES) presented a commemorative plaque to Dr. Nagata (second photo on left). A permanent plaque identifying Wooster Award winners resides at the PICES Secretariat in Sidney, British Columbia, Canada.

Dr. Nagata giving a speech at the celebratory party held jointly by JODC and MIRC in November 2002. On the wall are photos of the presentation at PICES XI, and his biography published in the PICES Press of July 1997.

Dr. Nagata joined by his many friends and colleagues at the JODC/MIRC celebration in his honour.

Qingdao Open Science Meeting: A major landmark for GLOBEC

Roger Harris
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth PL1 3DH
UNITED KINGDOM
E-mail: r.harris@pml.ac.uk

Dr. Roger Harris is a research scientist at the Plymouth Marine Laboratory in the United Kingdom. He is past Chairman of the IGBP/SCOR/IOC GLOBEC Scientific Steering Committee, having led the GLOBEC programme for the last six years. In addition to a continuing and active interest in GLOBEC, Roger is also particularly involved in the work of the ICES Working Group on Zooplankton Ecology. He is currently helping to organise the 3rd International Zooplankton Production Symposium, co-sponsored by PICES, GLOBEC and ICES, to be held in Gijon, Spain, in May 2003. His current research interests include the control of biological production by physical processes, the role of water-column biology in global oceanic carbon flux, and the laboratory culture and ecology of marine zooplankton.

The First GLOBEC Open Science Meeting was held in Paris, in March 1998. Four years later the GLOBEC science community met again in the coastal city of Qingdao for the Second Open Science Meeting. Qingdao was an excellent venue for the meeting with its pleasant surroundings and strong tradition of marine science. Over 250 scientists attended the GLOBEC meeting from 30 countries. The meeting preceded the PICES Eleventh Annual Meeting, and interaction between the two communities was one of the benefits of the co-location of the two meetings. The Paris meeting had a particular emphasis on seeking community input to the development of the GLOBEC Implementation Plan, published in 1999, as IGBP Report No. 47 and GLOBEC Report No. 13, 207 pp. In Qingdao, the presentations reflected the impressive developments in the programme since the publication of the Implementation Plan and provided examples of an exciting range of implementation activities.

Detailed session reports are given elsewhere in this Newsletter. Overall the 4-day meeting was structured around a series of Plenary Sessions with talks by invited speakers in the mornings, and with parallel sessions of Contributed Papers in the afternoons. The themes for the sessions mirrored the major components of GLOBEC research activity, the four foci and the regional programmes. The meeting began with an introductory session including a speech of welcome by Professor Jilan Su, Chairman of the Intergovernmental Oceanographic Commission (IOC), followed by a keynote presentation on "*Progress of China GLOBEC*" by Professor Qisheng Tang, Chairman of the Local Organising Committee. The subsequent Plenary Sessions addressed:

- *Decadal/centennial variability in marine ecosystems: A comparative approach*
- *Antarctic marine ecosystems and global change*
- *Regional and mesoscale coupled physical-biological models*
- *Comparative studies of North Atlantic ecosystems*
- *Linking zooplankton with fishery dynamics*
- *Modelling of transport processes and early fish life history*
- *Social impacts from changes in marine ecosystem structure*
- *ENSO and decadal scale variability in North Pacific Ecosystems* (joint session with PICES)

The themes for the Contributed Paper sessions were:

- *Novel mechanisms linking climate and fisheries*
- *Variability in Antarctic marine populations - physical and biological causes*
- *Biophysical ocean ecosystem modelling: New models, technologies and observing systems*
- *Zooplankton-climate linkages in different regions of the Northern Hemisphere*
- *Interactions between small, meso- and large scale physical and ecosystem processes*
- *Development and application of indices/ variables for the description/ prediction of ecosystem dynamics*
- *Coupled biophysical processes, fisheries and climate variability in coastal and oceanic systems of the North Pacific* (jointly with the PICES CCCC Program)

The standard of presentations was very high, the research approaches adopted were innovative, and many of the results reported were exciting. The Open Science Meeting showed that the GLOBEC community is active and dynamic. A prominent feature of the meeting was the advances that have been made in GLOBEC modelling over recent years. Many of the talks presented a range of impressive modelling approaches, particularly tackling problems of linking physical transport with population dynamics and life history of target species. Clearly, this is an area where GLOBEC is making significant advances. Similarly the results presented from the wide range of globally distributed ecosystems studied by the Regional and National Programmes and for a variety of target species populations provided many opportunities for comparative studies. Such ecosystem comparisons will be the basis of GLOBEC synthesis and the approaches to this were considered in a discussion session, "*Towards GLOBEC Synthesis: Ecosystem comparisons*", on the final day of the meeting.

The air of enthusiasm and excitement in the discussions, both formal and informal, was a strong feature of the meeting in Qingdao. The venue of the Haitian Hotel was very conducive to interaction, and many GLOBEC initiatives were planned and reviewed in informal satellite meetings. In addition the GLOBEC Scientific Steering Committee held meetings before, during, and after the OSM, and three of the GLOBEC Working Groups, Focus 1 on *Retrospective Analysis and Time Series Studies*, Focus 2 on *Process Studies* and Focus 3 on *Predictive and Modelling Capabilities* met on the weekend before. The collocation of the Working Group meetings in Qingdao meant that joint meetings could be held and a number of promising future initiatives stem from these interactions. Further, the Focus 3 Working Group met with the PICES MODEL Task Team to discuss common modelling issues. On the weekend after the OSM the PICES/GLOBEC Data Management Workshop was held as part of PICES XI convened by Igor Shevchenko (PICES TCODE Chairman) and Hester Willson (GLOBEC Data Manager). 28 people attended the workshop from Canada, Denmark, Japan, Korea, P. R. China, UK, Ukraine, and U.S.A. A report on the Data Management Workshop is given elsewhere in this Newsletter.

The Census of Marine Life (CoML) held their own Steering Committee meeting in Qingdao and there was the opportunity for a joint session with the GLOBEC SSC to explore common interests and the possibility of future joint activities. A joint reception of PICES, GLOBEC and CoML helped further informal interactions.

The Qingdao Open Science Meeting came at a time when IGBP (International Geosphere-Biosphere Program) and SCOR (Scientific Committee for Oceanic Research) are planning a major new OCEANS (**Oc**ean Biogeochemistry and **E**cosystem **An**alysi**s**) initiative as part of Phase II of IGBP. Drs. Julie Hall (Co-Chairman) and Svein Sundby (Member of the OCEANS Transition Team) presented a very well attended Invited Lecture entitled "*OCEANS – linking biogeochemical cycles and ecosystem dynamics under global climate change and variability*". This provoked a lot of interest and provided helpful background to the OCEANS Open Science Meeting in January 2003 in Paris.

The three co-sponsors of GLOBEC, IGBP, SCOR and IOC, were represented at the OSM by Drs. Wendy Broadgate, Ed Urban and Umit Unluata. The support of the co-sponsors contributed to the success of the OSM. The meeting was supported by The Ministry of Science and Technology, People's Republic of China (MOST), Chinese Academy of Engineering (CAE), China Association for Science and Technology (CAST), National Natural Science Foundation of China (NSFC), Qingdao Municipal Government, P.R. China, the Scientific Committee on Oceanic Research, the US National Oceanic and Atmospheric Administration (NOAA) and the US National Science Foundation (NSF). The attendance of seven scientists from developing countries was partially supported by SCOR together with funds from GLOBEC. Some of those supported give their personal impressions of the Open Science Meeting elsewhere in this Newsletter.

The support of the Local Organising Committee was superb, and GLOBEC owes a particular debt of gratitude to Professor Qisheng Tang and Mr. Ling Tong who worked tirelessly to make the OSM the success it was, and to the student support team who helped so effectively in the Symposium Office. The smooth running of the OSM was entirely due to their hard work together with the careful joint planning with the GLOBEC International Project Office.

Selected papers from the Paris Open Science Meeting were published in a GLOBEC special issue of *Fisheries Oceanography* (1999, Vol. 7, pp. 175-390). Similarly, plans are well advanced for a similar special issue of *Fisheries Oceanography* based on papers presented at the Second Open Science Meeting to be published in August 2003. This will provide a lasting legacy, in the open scientific literature, of what was a very successful and memorable meeting.

The complete program for the Open Science Meeting (OSM) can be found at the GLOBEC International website at http://www.globec.org (under "OSM"). Selected highlights of the scientific sessions are given in other articles in this Newsletter.

Session highlights of the Second GLOBEC Open Science Meeting

Session 3: ***Antarctic Marine Ecosystems and Global Change*** (Eileen Hofmann)

The Southern Ocean marine ecosystem experiences variability that takes place on a wide range of time scales. The importance of variability and its consequent effects on the Antarctic marine food web was a theme that ran through the three presentations in this plenary session. The first presentation by A. Clarke from the British Antarctic Survey showed the importance of variability, ranging from tectonic to seasonal time scales, in structuring the Antarctic marine food web. He noted that understanding the factors underlying variability and its effect on biological systems is needed in order to predict how the system will respond to climate change. In particular, he highlighted the need to maintain long-term monitoring programs as part of the effort to understand and detect the effects of variability. Observations from a time series site off Adelaide Island along the west Antarctic Peninsula were used to illustrate this point. The interannual variation in the abundance and distribution of Antarctic krill (*Euphausia superba*) was the subject of the next presentation given by E. Murphy, also from the British Antarctic Survey. This presentation noted the possible influences of atmospheric processes (Antarctic Circumpolar Wave), winter habitat (sea ice extent), and ocean currents (Antarctic Circumpolar Current) in producing observed interannual variations in Antarctic krill populations. Murphy showed results from long-term observations and numerical modeling studies which suggested that the current Antarctic krill biomass is reduced from what it was about fifty years ago. He highlighted the uncertainty in current climate model forecasts for the Southern Ocean, and discussed the range of potential impacts of climate change, including reducing the suitable habitat available to Antarctic krill and its predators, which could drastically alter the Antarctic marine food web. The final presentation, given by E. Pakhomov from the University of Fort Hare, South Africa, focused on the ecological consequences of a southward expansion in the habitat occupied by the pelagic tunicate, *Salpa thompsoni,* that has occurred in the Southern Ocean during the last fifty years. The salp expansion may have been accompanied by a decrease in the biomass and productivity of Antarctic krill. Pakhomov postulated that the shift in the distribution and abundance of these two species could be a result of climate warming which has altered oceanic conditions, and hence habitat. The three presentations clearly indicated that variability resulting from environmental cycles, such as those associated with sea ice, atmospheric forcing, and variations in large-scale and regional circulation patterns, are exerting a strong influence on the Antarctic marine ecosystem. This plenary session highlighted the need for long-term monitoring studies coupled with targeted process studies in key locations to provide the knowledge base needed to predict the effect of climate change on the Antarctic marine food web.

Session 5: ***Variability in Antarctic marine populations – physical and biological causes*** (Steve Nicol)

Southern Ocean GLOBEC has, as its focus, Antarctic krill and the vertebrate predators that feed on krill, and these were the focus in most of Session 5. Novel observation or measurement techniques were highlighted in two of the presentations. That by Andy Brierley reported on the use of an autonomous underwater vehicle to investigate the distribution of krill under the ice. This exciting development indicates that there may be ways in which quantitative measurements of krill distribution and abundance, as well as of other biological and physical parameters, can be made on the meso-scale in this difficult environment. The first circumpolar measurements of krill condition in a single season were reported by Sun Song and his colleagues, from samples collected using an underway sampler. Based on earlier research, they used the relationship between the eyeball size and the body length of krill as a measure of condition and found considerable differences in condition around the continent in a single season. Within a single season, there can be extensive variability in krill distribution and abundance in an area, and the causes of this variability are not generally apparent. Hyoung-Chul Shin and his colleagues demonstrated these differences from meso-scale acoustic surveys in the southwest Atlantic sector which indicated both behavioural and physical changes between the surveys. Antarctic predators also demonstrate temporal and spatial changes on a number of scales. Elephant seals have been showing changes in their population sizes at a number of sites throughout the Southern Ocean, and Daniel Vergani and his colleagues indicated links between some of these changes in the Atlantic sector which could be linked to El Niño – La Niña events. The relationship between the winter distribution of cetaceans, seabirds and krill from the US SO-GLOBEC program was presented in papers by Eric Chapman and Sue Moore, using a mixture of traditional and new techniques including the use of passive acoustics to obtain information on cetaceans. Overall, the session provided valuable new insights into the Antarctic marine ecosystem in understudied regions, and at times of year which have proved difficult to study in the past. These studies had been made possible by advances in technology and by the concerted efforts that could be brought to bear under the auspices of a large-scale international program such as GLOBEC.

Session 7: ***Comparative studies of North Atlantic ecosystems*** (Keith Brander)

The three talks in this session were put forward by the ICES/GLOBEC Working Group on *Cod and Climate Change*, with the aim of presenting a broad overview of recent studies of the consequences of environmental variability and change on cod and their ecosystems.

Dr. Benjamin Planque (France) set the scene by reviewing North Atlantic climate variability, the response of the planktonic ecosystem to this variability, and the implications of our current understanding to the achievement of the goals of GLOBEC. The dominant pan-Atlantic index of atmospheric variability over the past six decades has been the NAO (North Atlantic Oscillation), which is reflected in the variability of a number of atmospheric and oceanic parameters including temperature, wind, precipitation and cloud cover. It has a characteristic geographic imprint, but this can vary over time, as the location of the pressure centres is not fixed. The Continuous Plankton Recorder (CPR), provides a >50-year basin-scale record of near-surface mesozooplankton variability with monthly resolution for comparison with climate indices. Long-term changes in the CPR data often reflect variability in the NAO. For *Calanus finmarchicus*, the dominant calanoid copepod species in the North Atlantic, this is related to its overwintering in the deep ocean and subsequent transport onto the surrounding shelf areas in spring. Northward shifts of several hundred km in the distribution of all calanoid copepod species groupings along the entire northern European shelf edge in recent years were identified. Caution was expressed that because our knowledge of plankton variability is still limited to a relatively short period, forecasts of future variability in the biota resulting from climate change still remain uncertain.

Dr. Geir Ottersen (Norway) used a number of examples, mostly from cod stocks of the North Atlantic, to illustrate various processes of enrichment, concentration and retention of biotic entities such as fish eggs and larvae. The effects of environmental factors on fish can be direct or indirect. Temperature affects physiological and metabolic processes directly and hence growth rates. Variability in the timing of spring blooms caused by environmental factors may indirectly affect the survival and recruitment success of fish populations. Different functional forms may relate environment and fish, because the processes may be linear or non-linear; they may be event-driven and there may be thresholds at which switching from one form to another occurs. He suggested that although there appears to be a direct, non-linear overall response of recruitment of Atlantic cod to temperature, this may in fact be masking an underlying indirect effect, with variability in abundance of *Calanus finmarchicus* as the true, proximate cause.

Dr. Jean-Denis Dutil (Canada) compared the production of the cod stocks across the North Atlantic with emphasis on environmental and food limitation and their impact on surplus production. Growth production per capita was shown to vary by a factor of approximately ten, with the highest values in the warm water stocks such as the Irish and Celtic Seas and Georges Bank, and the lowest values in the cold water stocks such as in the Gulf of St. Lawrence and off Labrador and Newfoundland. Data suggest that increases in temperature within the present range of cod habitat temperatures should result in increased production. Poorly productive stocks are more vulnerable to fishing and environmental deterioration.

Session 10: ***Linking zooplankton with fishery dynamics*** (Serge Poulet)

Three invited speakers, Dr. Hiroaki Saito, from Japan, Dr. David Checkley from U.S.A., and Dr. Michael St. John from Germany, contributed to this short session, which was followed up by a series of exciting questions, obviously triggered by the great interest raised in the audience by their oral presentations. Each presentation was perfectly in phase with one of the three main topics defined in the GLOBEC Implementation Plan, expressed by Objective 2 and specified in one of the Foci, under Task 2.1.3 of Activity 2.1, as specified in the Process Studies.

The first presentation gave a very clear illustration of how both the size structure, species composition and population dynamics of zooplankton, in conjunction with climatic factors, can influence the food availability of post-larval and juvenile sardines *Sardinops melanosticus*, in the Kuroshio current extension and northern waters, one of the major fishery grounds for Japanese sardine. Results showed the drastic changes occurring in the stock size of the Japanese sardine at the interdecadal time scales. Evidence suggested that stock collapse was not the result of over fishing, but was rather related to environmental regime shifts. Past records have shown that sardine recruitment success is mainly dependent on the accumulated survival rate during post-larval stage and age 1. Sea surface temperature change, which was at most 1°C, was not considered as the reason of the stock fluctuation. Fluctuation was correlated to changes in the food-web structure and dynamics. Sardine select larger prey to sustain increasing food requirement for growth. It was clearly established that depending on the abundance and variation in time of small and large size copepods, which dominated the zooplankton assemblages, changes in the prey-size distribution and optimum abundance of each category of prey influenced the availability of food of post-larval sardine, which selectively fed on small size copepods.

The second presentation was focused on the basic mathematical concept, according to which, the variability of a series in time equates to its variability in the frequency domain. When applied to plankton time series, the aim is to understand the behaviour of fish in relation to zooplankton. It was suggested, following a theoretical approach that a valuable insight to linkages between zooplankton and fish may arise from investigations in the frequency domain. Several examples, selected from the CalCOFI time series for zooplankton, anchovy, sardines and euphausiids, indicated that signals of frequency analyses changed drastically with species. Significant peaks in the frequency spectra were identified at various time scales, ranging from 1 to 68 years interval, for zooplankton and fish. The signal was less obvious for euphausiids. Specific types and limitations of analysis in the frequency domain were presented for these three categories of plankton. However, this approach seems very promising in order to better understand the variations in time of both zooplankton and fish in a given ecosystem. Beyond the CalCOFI time series, similar collections of zooplankton exist worldwide, presenting large enough time series, which could be analyzed using a standard technique. One advantage would be to provide data broadly comparable over time and space to investigate long-term changes of both zooplankton and fish, in relation to the environment.

The third presentation gave a different insight into how climate change may modify processes in key trophic level constituents. The copepod *Calanus finmarchicus*, one of the key constituents of fish diets, is linked to the recruitment success of a number of key fisheries stocks in the North Atlantic, Nordic Seas and the North Sea. Among a number of mechanisms, two climatically modulated processes impact on *C. finmarchicus* population dynamics. The first one concerns the degree of overlap between the reproductive population and the spring phytoplankton bloom. Strong overlap between both plankton components contributes to optimal feeding conditions, thereby providing conditions for enhanced copepod population size. The second relates to the importance of phytoplankton production for energetic reserves of over wintering diapause stages. It was shown that knowledge of lipid reserves in copepods, used as biomarkers, allows the determination of the food resources and the mode of feeding of *C. finmarchicus*, leading to enhanced condition of over wintering copepods. This approach also permits better understanding of the value of copepod species, as food to higher trophic levels. This presentation also discussed the importance of climate change for phytoplankton biochemistry and its consequence on the accumulation and transfer of essential biomarkers from copepods to fish.

Taken all together, these presentations have examined a specific range of factors allowing a better understanding of ecosystem dynamics. The focus was at the level of zooplankton population dynamics, variability and frequency of time series and their implications in the match-mismatch processes, and the significance of biomarkers fuelling energy through the marine food web in relation to potential climate change.

Session 11: ***Modelling of transport processes and early life fish history*** (Claude Roy)

A set of presentations emanating from three GLOBEC programs (US-GLOBEC in the North-East Pacific, GLOBEC-Germany in the Baltic Sea and IDYLE-BEP5 in the southeast Atlantic) were selected to illustrate the advances made by the GLOBEC community since the last OSM in Paris, in coupling physical and biological models to simulate and to quantify environmental processes affecting fish early life history.

The presentation by Mullon *et al*. put the emphasis on methodological issues regarding the use of coupled circulation and Individual Based Models (IBM) to study fish recruitment variability. When modelling complex systems, they stressed the importance of setting up an experimental approach that follows a set of simple rules. This results in the design and planning of a series of experiments of increasing complexity, following a logical pathway. The second presentation by Hinrichsen *et al*. illustrated the use of a comprehensive set of interlinked models to investigate the variability in transport, retention, growth and survival of cod larvae in the Baltic Sea. The experiments showed that enhanced larval survival may occur during periods of peak prey abundance or is related to the occurrence of favourable environmental processes such as transport, optimal turbulent conditions, or low ambient temperatures. Finally the presentation by Herman *et al.* provided an overview of recent technical advances in nesting physical and biological models ranging from basin scale (40 km resolution), regional scale (10 km resolution) to local scale (3 km resolution).

Particle-tracking is now widely used for examining the interactions between biological processes and physical transport. Session 11 well illustrated the benefit of using coupled 3D circulation and IBM models to integrate multidisciplinary knowledge within the GLOBEC framework. The widespread use of such modelling tools allows fisheries oceanography to rely more and more on experimental approaches. The challenge for the future is to include detailed physiological and behavioral processes as well as to achieve a better representation of the interactions between the lower and upper trophic levels of marine ecosystems.

Session 12: ***Interactions between small, meso- and large-scale physical and ecosystem processes*** (Roger Harris)

An interesting and varied group of papers addressed the theme of interactions between small, meso- and large scale physical and ecosystem processes. The session began with a talk by Patrick Lehodey describing the application of a spatial environmental population dynamics model (SEPODYM) to skipjack and albacore tuna in the Pacific Ocean. Interestingly the impact of climate signals (ENSO) seems to be opposite according to the species, *e.g.* an El Niño event would have a positive influence on the recruitment of skipjack while the effect would be negative on the albacore.

Moving to smaller scale interactions, Celia Marrase then discussed building a conceptual framework on physical-biological interactions at small scales. She emphasised that a multifactorial approach should be considered when studying the effect of turbulence on plankton dynamics, as the hydrodynamics of the system affect different processes simultaneously. Also considering smaller scales, Oyvind Fiksen presented an analysis of feeding and interactions between prey selection and larval fish using process-based models. Detailed mechanistic models were used to evaluate temporal and spatial (vertical) diel feeding rates of larval cod across Georges Bank. The spatio-temporal fluctuation of turbulence (tidal cycle) and light (sun height) over the bank generates a complex structure in the food intake of larval fish, with different patterns emerging for small and large larvae.

A comparison of copepod egg production in the Mediterranean between winter and summer was presented by Albert Calbet, concluding that a short (phytoplankton-copepods) food web prevailed in winter in contrast to the rest of the year when the planktonic trophic interactions take place through a longer microbial loop. Travis Johnson spoke about chaetognaths, another important component of the mesozooplankton, in his presentation on the effects of a Kuroshio warm core ring on chaetognath ecology. Overall chaetognath community structure was significantly different within the warm core ring as compared to the surrounding Oyashio waters. Dian Gifford discussed the issue of scale in relation to microzooplankton in her talk on spatial distributions: scale and impacts on higher order consumers. Recent studies have shown that under appropriate hydrographic conditions, microzooplankton and microphytoplankton can be distributed in layers ranging in thickness from a few cm to a few metres. Such layers of microplankton are likely to constitute a concentrated source of food for mesozooplankton.

Moving to the mesoscale a talk by Meng Zhou described work on the transport and entrapment of zooplankton in mesoscale currents and eddies off northern Norway. Techniques used included Vessel Mounted ADCP, a towed Scanfish-CTD-Fluorometer-Optical Plankton Counter and a Multiple Opening and Closing Nets and Environmental Sampling System (MOCNESS). From the time series of OPC measurements, the size structures of zooplankton were used to interpret their population processes and productivity within the mesoscale physical features.

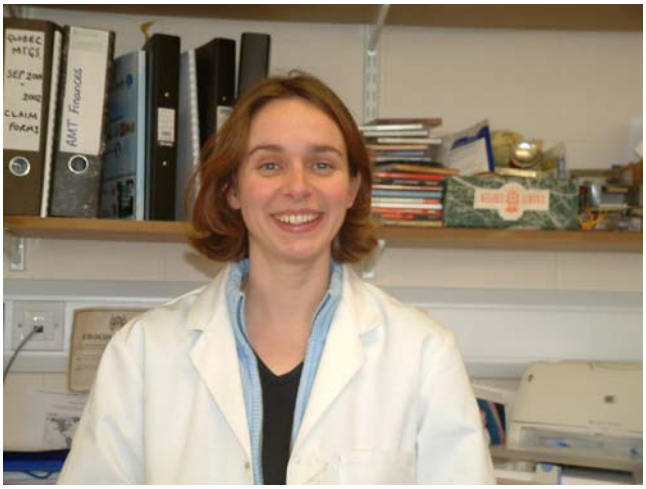
Finally, a presentation by Uli Bathmann brought in a Southern Ocean dimension. The paper addressed the distribution and physiology of krill studied at the beginning of the Antarctic winter on a Polarstern cruise into the eastern Bellingshausen Sea in April 2001. The findings suggest a switch in both feeding and energy conservation strategies, with a trend of reduced and more carnivorous feeding with ontogeny.

Session 14: ***Social impacts from changes in marine ecosystem structure*** (Ian Perry)

This session addressed multidisciplinary approaches to marine resource management, focusing on the collaborative potential of social and natural sciences. The first paper (Rosemary Ommer and Ian Perry) discussed issues on scale and methodology. It concluded that there is a reasonable fit between large-scale models or surveys in both the natural and social sciences. This helps to analyze processes. But it does not get at underlying motivations for human behavior, which work at the level of the individual and group, *i.e* small scale. Case study analysis and building bottom-up solutions to fit with understanding of process seemed most hopeful. The second paper (Kenneth Broad) took the case study of the 1997-98 El Niño in Peru and demonstrated the challenges to efficient and equitable dissemination and use of scientific information. Examples of unanticipated market effects, conflict between industrial and artisanal fleets and the linkage to other sectors (*e.g.*, flooding and transportation disruptions) highlighted the many complexities that must be considered in anticipating the use of probabilistic forecasts to avoid unintended consequences. The third paper (Ussif Rashid Sumaila) dealt with discounting (the economic argument that present value is what motivates economic market behavior) and why it appears to validate fishing to extermination of a stock. An alternative model, which calculates discounting over generations, was offered along with evidence that this would actually permit increased fishing effort over time, because stocks could recover and be sustained at a higher abundance than presently occurs.

PICES/GLOBEC Data Management Workshop

Hester Willson
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth PL1 3DH
UNITED KINGDOM
E-mail: hew@pml.ac.uk



After a BSc in Geography from Sheffield University and an MSc in Marine Science from the University of Plymouth, Hester Willson worked for two years as a research assistant at the Plymouth Marine Laboratory. She then moved to the GLOBEC IPO in December 1999, and worked as the Data Manager for three years. In December 2002, Hester left the GLOBEC IPO to further her research career and is now working on nutrients and trace gases.

The PICES/GLOBEC Data Management Workshop was held on October 19, 2002, as part of PICES XI, and convened by Igor Shevchenko (PICES TCODE Chairman) and Hester Willson (GLOBEC Data Manager). The workshop was attended by 28 people from Canada, Denmark, Japan, Korea, P. R. China, UK, Ukraine, and U.S.A. The workshop discussed the goals and objectives of GLOBEC data management and reviewed status of GLOBEC data inventories in PICES countries, and role of the GLOBEC International Project Office, national GLOBEC Committees and PICES Technical Committee on Data Exchange in this effort.

11 short presentations were given, followed by an afternoon of discussion. Hester Willson opened the workshop with a presentation on GLOBEC Data Management, describing both the achievements and problems of managing GLOBEC data.

Phil Williamson was invited to give a talk on Data Management for UK GLOBEC and the Marine Productivity Thematic Programme, as an example of the best practice in National Data Management. Research leaders for UK GLOBEC projects are encouraged to provide basic information, via DIF entries, to the GLOBEC IPO. The British Oceanographic Data Centre (BODC), hosted by the NERC Proudman Oceanographic Laboratory, interacts with Marine Productivity in the following ways: close involvement in fieldwork planning, formulation of data policy and protocols, and other aspects of programme development, working with the Steering Committee and individual scientists, maintaining a data-tracking system and assembling data into an integrated database, checking on data quality and supporting documentation, providing information services, supervising data access arrangements and publishing data collations, for users within and outside the programme. There has been good progress to date in the transfer of datasets collected on Marine Productivity research cruises in the northern North Atlantic to BODC. For example: 45% completion for Discovery 258 (November-December 2001), and 26% completion for Discovery 262 (April-May 2002).

Todd O'Brien of the Ocean Climate Laboratory (OCL) described the World Plankton Database and suggested how it could be used successfully to archive GLOBEC data. OCL has built an archive of globally distributed historical plankton measurements and associated metadata. As part of the *World Ocean Database*, these plankton data are stored with all available co-located temperature, salinity, nutrient, and chlorophyll data. The *World Ocean Database 2001* contains over 2.1 million globally-distributed Ocean Station Data (OSD) casts, sampled from the early 1800s to the present.

Sergey Piontkovksi focused on the potential of archived data and described the international efforts of scientists from Ukraine, Russia, UK, Kazakhstan, Azerbaijan and the Netherlands, to develop an oceanographic databases for the Indian Ocean, the Atlantic Ocean and its enclosed seas (the Mediterranean Sea, the Caspian Sea and the Aral Sea) using data from the Former Soviet Union. The databases incorporate data on taxonomy, biogeography, and environmental characteristics of pelagic communities and linked to a database management system. This product will be available on CD-ROM from April 2003.

The coffee break was followed by presentations on the status of GLOBEC Data Management in PICES countries. Robin Brown gave a presentation on the Canadian GLOBEC metadata inventory for the North Pacific. Igor Shevchenko talked about the Metadata inventory of biological data collected by Russian Fisheries Research Institutes. Elena Dulepova described the data collected and the databases at TINRO-Center for the North Pacific. Robert Groman was the last of the scheduled talks with a

presentation on US GLOBEC Data Management. The group was also fortunate to receive talks from Toru Suzuki on archives of plankton datasets in Japan, from Sung-Dae Kim and Xian-Shi Jin on Korea and China GLOBEC Data Management respectively. These excellent presentations set the scene for the lively discussion session that followed in the afternoon.

The discussion session was very productive with several interesting ideas and actions to be undertaken being voiced. The discussion was divided into 3 sections:

- GLOBEC Data Management and Data Management issues/problems;
- Roles and responsibilities of those involved in Data Management: the GLOBEC Data Manager, PICES TCODE, GLOBEC National and Regional Representatives and the GLOBEC Data Management Task Team; and
- Development of an action strategy and a Workplan.

A key issue to come out of the discussions was that Data Management must be USER driven. Scientists must decide what products they would like to see produced by GLOBEC International Project Office and other data managers. The main points that resulted from the discussion were:

- It is critical that the GLOBEC metadata inventory is as comprehensive as possible. Collation of datasets will be important for GLOBEC Synthesis to be successful, and comprehensive metadata is the starting point of identification of datasets.
- Flexibility is a key issue in data submission. The Ocean Climate Laboratory World Ocean Plankton database will take data in any format, including Excel spreadsheets and simple columns of data.
- Data Managers need to offer incentives to encourage scientists to submit data/metadata. For example, good software, good tools to extract data, good tools to view/visualize data and more data for people to work with.
- A liaison system between National Data Centre (NDC) and scientists increases the amount of data submitted. Where this system was stopped due to funding restrictions a negative impact on data submission to NDC has been seen.
- Biologists are generally much more reluctant and slower to submit both data and metadata than physicists and chemists. This is due to the long time necessary for analysis of biological samples. This high level of individual investment in the data increases the proprietorial feeling of the scientist toward the data.
- Scientists are concerned that others will use their data without their consent and before they have had a chance to publish. At present, there is no enforceable system in place to prevent this from happening.
- The value of a dataset is increased the more people use the dataset. Multiple-author papers are becoming more common, especially as funding agencies are increasingly focused on multi-disciplinary science. Steps must be taken to increase the confidence of biologists in sharing their data so that the full benefits of multi-disciplinary studies can be realized.

The group recommended that the following proposals be considered:

- Funding agencies should take a firmer line with those scientists who do not submit data to National Data Centres in accordance with funding requirements.
- Submitting a dataset should carry a similar credit to publishing a paper with funding agencies/employers.
- A system should be developed to give credit to individuals whose data are used in publications. When a paper is published, the metadata entry identifier and database should be cited.
- The longer timescale needed by biologists (in comparison to physicists and chemists) to submit their data should not be used as an excuse for not submitting data within a reasonable timescale.
- Scientists should "claim" their data officially by writing metadata entries. Increased visibility of the dataset would increase awareness of those who were not following dataset-sharing etiquette. By submitting metadata, the scientist would notify the community of the dataset's existence but would be allowed time to work on the dataset and publish before sharing.
- Steps must be taken to increase the confidence of biologists in sharing their data so that the full benefits of multi-disciplinary studies can be utilized.
- Each GLOBEC National programme should be encouraged to produce a CD-ROM of data collected in their projects.

The workshop provided a lot of food for thought for everyone there. The convenors were pleased with the number of people who attended the workshop, an indication that Data Management is being recognized as an essential part of successful science. Every PICES country was represented. The workshop was a great success, and I, for one, came out with lots of new ideas to implement and tasks to achieve!

A full report of the meeting is available at the PICES TCODE (http://tcode.tinro.ru/) and the GLOBEC International (http://www.globec.org, under "*Publications*") websites.

PICES and GLOBEC modelling

Brad deYoung
Department of Physics
Memorial University of Newfoundland
St. John's, Newfoundland, CANADA. A1B 3X7
E-mail: bdeyoung@physics.mun.ca

Dr. Brad deYoung is a physical oceanographer and Professor at the Memorial University in Newfoundland. He studies coastal oceanography and ocean ecology by collecting data, playing with data and working with models. He was Co-Chairman of the GLOBEC Canada program and is presently Co-Chairman of the GLOBEC International Focus 3 Working Group on Modelling and Predictive Capabilities.

The GLOBEC Focus 3 Working Group on *Modelling and Predictive Capabilities* and PICES MODEL Task Team met in Qingdao, China, at the end of the GLOBEC Open Science meeting and before the start of the PICES Eleventh Annual Meeting. This was the first meeting of these two groups and it opened opportunities for further discussions, and possible future joint meetings and activities.

The meeting began with a brief review by each group of their activities to date and their plans for future work. Brad deYoung presented a summary of the activities of the Focus 3 Working Group while Bernard Megrey summarized the work of the PICES MODEL Task Team. The GLOBEC group has tackled a wider range of problems with the result that they have not really produced any new science, while the PICES team has focused on a few, well-defined problems and held workshops to advance these particular projects. The GLOBEC group noted that for the future, they are more interested in limiting their focus to a smaller number of topics that will lead to more concrete results such as those realized by the MODEL Task Team.

One common area of discussion was one that the GLOBEC group has identified as its primary area of interest for the coming year, to write a review paper on the development of basin-scale ecosystem models. There will be two working meetings of small groups of scientists with the primary goal of writing a review of work done to date, and consideration of the basic approaches to, and features of, basin-scale models. There are presently many population models being used in the PICES and GLOBEC communities, many of which have been coupled to physical models, but few have been coupled to basin scale models, as was done by the MODEL Task Team in their development of NEMURO and NEMURO.FISH models. NEMURO is both an acronym (**N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography) and the name of the city in Japan where it was first developed. Bernard Megrey presented an overview of the NEMURO models, the approaches taken in their development and the results from the modelling workshops. The GLOBEC group sees this pragmatic and productive approach to working group meetings as one that it would like to emulate.

The problem of how to verify such models and how to simulate top-down versus bottom-up controls was discussed. The coupling across trophic levels, integrating population models with species life-history fidelity, and linkages with mass-balance models that represent multiple trophic levels was discussed and noted as an area in which there is little understanding. Both groups have worked on the issue of coupling across trophic levels, in particular the coupling to upper trophic levels (e.g. fish), recognizing that this linkage is one of most difficult modelling problems. Many countries, perhaps Asian countries in particular, are only interested in models that include fish, and thus GLOBEC models that stop at zooplankton are not of much interest. It was suggested that the review of modelling activities should include equatorial work in addition to work done in the Pacific, Atlantic and Southern Oceans.

Another area of common interest is the proposal, presented by the GLOBEC group, to hold a workshop on the development of biological models of individuals and populations. This was started as a joint activity between two working groups of GLOBEC International, but the opportunity for broader cooperation on such a workshop was suggested. The planning has begun even though the workshop will not be held until 2004. There was some discussion around the general issues of modeling, including the approach to comparisons with data and the need to design models that are relevant to key questions. Models should be designed to answer questions, but what are the most important questions that we need to answer, and is it possible to construct the appropriate model, i.e. do we know how to parameterize the dynamical processes, and are there adequate data to initialize, run and test the model? Such issues will be addressed at the workshop.

Building capacity for modelling in the community is of common interest to both groups. Each group has had some experience of capacity building activities, with varying degrees of success. It was agreed that truly successful capacity building, where it is both relevant and needed, is difficult. As noted above, not all aspects of modelling are of equal interest everywhere. In developing countries in particular, there is an expectation that the models should be of practical value, yet many of our models are still research tools. It was agreed that opportunities for joint action on training and capacity building should be explored and worked on where possible.

The discussion was lively and there was recognition that communication between the two groups would be beneficial and that opportunities to work together on problems of common interest should be explored. The discussion led to the suggestion of names of scientists from each group who could participate in the basin scale modelling writing group. No immediate plans for further meetings were made although it was agreed that we should act on any such opportunities. It was agreed to share information on plans by e-mail to permit more timely identification of such opportunities.

Some personal impressions of the GLOBEC Open Science Meeting

Funding from the Scientific Committee on Oceanic Research (SCOR) and GLOBEC supported the following scientists to attend the OSM: Sukyung Kang (Korea), Evgeny Pakhomov (South Africa), Tamara Shiganova (Russia), Hyoung-Chul Shin (Korea), Agus Supangat (Indonesia), Daniel Vergani (Argentina), and Eleuterio Yanez (Chile). Some of their impressions of the meeting are given in this short article.

Hyoung-Chul Shin
Polar Sciences Laboratory
Korea Ocean Research & Development Institute
Ansan, P.O. Box 29
Seoul 425-600, Republic of Korea
E-mail: hcshin@kordi.re.kr

The focus of the meeting was the enhanced understanding of the interaction between the changes in the physical environment and ecosystem response. Retrospective analyses to identify such linkages, experimental and observational studies to examine the mechanisms, and modelling efforts to enable prediction were all covered. Regions were well represented, from the Southern Ocean to the North Pacific and North Atlantic. Simply assembling investigators with such diverse research interests in one place ensured the meeting's success. The participants benefited by being introduced to each other, by learning from others' experience and through the establishment of new communication channels. Research efforts are underway, addressing similar problems in a range of locations and for a variety of species, and these efforts are not isolated but are aimed at an ultimate synthesis. From my personal point of view, inclined toward the Southern Ocean and krill, it was good to see that the results of recent focused studies during non-summer seasons are starting to appear. Regional and decadal comparisons on larger scales are being made so that changing roles and representations of krill (and other members of the system) can be examined in relation to more general features, such as circulation and warming trends around the Antarctic. Another highlight was the introduction to OCEANS, a new international research initiative linking global change, ocean biogeochemistry, and ecosystems. Although its success is not guaranteed, it was appealing to see another step in the right direction. Overall, it was a meeting in the right place both for the present and future. I thank GLOBEC for supporting my participation at the meeting.

Tamara Shiganova
P.P. Shirshov Institute of Oceanology
36, Nakhimovsky Avenue
Moscow 117588, Russia
E-mail: shiganov@sio.rssi.ru

The GLOBEC Open Science Meeting (OSM) is an important event for the international scientific community. Attendance at the OSM gave participants an advantage for understanding the comprehensive structure and functioning of the marine ecosystem on the whole, and how they respond to different anthropogenic and climatic changes. The approaches used in the talks included retrospective analyses of time-series data and historical data on biological parameter changes related to hydrophysical data and climate, new studies and modeling biological systems. All talks were presented at a high scientific level with use of modern methods of analysis and instruments for collecting data. Talks connected with analyses of regional ecosystems were also very interesting. All participants could exchange their knowledge and ideas during discussion and breaks.

I must say that the atmosphere of GLOBEC meetings is always warm and friendly. I enjoyed the meeting very much and I left Qingdao with new knowledge and ideas. I greatly appreciate the financial support given to me for participation in the meeting.

Agus Supangat
Study Program of Oceanography
Bandung Institute of Technology
Labtek XI Building, Jl. Ganesha 10
Bandung 40132, Indonesia
E-mail: agussup@DKP.go.id

The paper that we presented to GLOBEC is a preliminary result of the first stage of our 3-year research project "*Modelling of sea surface temperature distributions to predict movement of warm pool (as good fishing grounds for tuna) in the Indonesian waters and their relation to climate variability*." In the first year (2002), we used the COHERENS model developed by Luyten *et al*. (1999), to predict seasonal variations of movement of the warm pool, the salinity front, and the convergence zone in the western and central part of equatorial Pacific. In the second and third years (2003-2004), the model will be applied in the Indonesian waters, which are known to be the most diverse marine region in the world. Fisheries and offshore mining are major industries that provide millions of jobs and significant revenue for Indonesia, and it is our hope that this kind of study can help to recommend a location for fishing ground in the Indonesian waters.

I gratefully acknowledge support from the GLOBEC International Project Office for making funds available to me to attend the 2nd GLOBEC Open Science Meeting to present our paper. The meeting was very important for us, especially as scientists from a developing country, Indonesia. By attending the meeting, we have a chance to establish communication links, research co-operation with other participants and scientists involved in ocean ecosystem dynamics, climate, and fisheries.

Sukyung Kang
Pukyong National University
599-1 Daeyeon 3-dong, Nam-gu
Pusan 608-737, Republic of Korea
E-mail: kangsk@mail1.pknu.ac.kr

I travelled to China on October 14 to attend the 2nd GLOBEC Open Science Meeting (OSM) held in Qingdao. GLOBEC Foci and regional activities were well balanced and organized. There were many good presentations, and the talks by invited speakers satisfied my scientific curiosity. However, due to the parallel session system, I often had a hard time choosing presentations from different sessions. It was a good opportunity to talk with top-level scientists from all over the world even though I had met some of them before. By hearing their presentations, I was greatly inspired. I am sure that this experience will steer my future research direction. The most interesting session for me was "*Decadal/centennial variability in marine ecosystems: A comparative approach*", and the session entitled "*Social impacts from changes in marine ecosystem structure*" was not easy to understand.

During the meeting, I felt great that I was involved in pioneering discussions. The OSM was a highly stimulating and informative meeting, and participation at this meeting was a very useful experience for me. Thanks to GLOBEC for giving me this invaluable opportunity.

Governing Council meeting: front row - Elizabeth Tirpak, Hyung-Tack Huh, Vera Alexander, Laura Richards; back row - Hee-Dong Jeong, Tokio Wada, Ian Perry, Won-Seok Yang , Tokimasa Kobayashi, Denis D'Amours, Lev N. Bocharov, Qian-Fei Liu, Alexander Bychkov, Vladimir Belayev, Alexander Kurmazov, Igor Shevchenko, Skip McKinnell.

The PICES-CKJORC (China-Korea Joint Ocean Research Center) Workshop in session.

Active interaction at the Beer & Dim Sum Poster Session.

Alex and Christina with Best Presentation winners Kyungmi Jung and Sukyung Kang, PICES XIII organizer Sharon Perkins, Secretariat helper Steve Romaine, and ex-PICES Intern Gongke-Tan at the Chairman's Reception.

Serious happy food tasting, toasting and partying at the Extravaganza Dinner.

Three generations of PICES Interns helping at PICES XI - Natalia Bessmertnaya (Russia), Jung-Hwa Choi (Korea), Gongke-Tan (China).

Local organizer for both the GLOBEC and PICES meetings, Mr. Ling Tong, enjoys a rare peaceful moment.

Dr. Roger Harris addressing the GLOBEC Opening Session with Profs. Qi-Sheng Tang and Ji-Lan Su, and Dr. Manuel Barange at the headtable.

GLOBEC Scientific Steering Committee at the PICES/GLOBEC/CoML Reception

GLOBEC Focus 1 Working Group on Retrospective Analysis *in session.*

Three generation of GLOBEC: Brian Rothschild (first Chairman), Roger Harris (outgoing Chairman), Qi-Sheng Tang and Francisco Werner (incoming Chairman) relaxing at the GLOBEC Banquet.

Dr. Suam Kim proudly leads his students to the PICES & GLOBEC meetings. This shot is taken at the GLOBEC Reception.

PICES Climate Change and Carrying Capacity Integration Workshop

Makoto Kashiwai
Hokkaido National Fisheries Research Institute
116 Katsurakoi
Kushiro, Hokkaido 085-0802, JAPAN
E-mail: kashiwai@fra.affrc.go.jp

Dr. Makoto Kashiwai is now a guest researcher at the Hokkaido National Fisheries Res. Inst., after retirement. He has been deeply involved with PICES since its inception. He was the first Co-Chairman of the PICES-GLOBEC Program SSC, then Chairman of the Science Board, Japanese Delegate on the Governing Council, and is currently Co-Chairman of the Implementation Panel of the PICES CCCC Program. But on top of everything, Makoto is best remembered as the legend behind PICES III (Nemuro, Japan, 1994), pulling off the Annual Meeting together after a devastating earthquake damaged the meeting venue a week before the opening day.

Harold P. Batchelder
Oregon State University
COAS - 104 Ocean Admin Bldg
Corvallis, OR 97331-5503, U.S.A.
E-mail: hbatchelder@coas.oregonstate.edu

Dr. Harold (Hal) Batchelder is an Associate Professor (Senior Research) at Oregon State University, and is Executive Director of the U.S. GLOBEC Northeast Pacific (NEP) Regional Coordinating Office. Previously he served for 6 years as the scientific director of the National U.S. GLOBEC Steering Committee Office, first at the University of California, Davis, and later at Univ. of California, Berkeley. He is Co-Chairman of the Climate Change and Carrying Capacity Program of PICES. His research uses models to examine the interactions of plankton populations and physical flow fields, particularly using Lagrangian-Eulerian approaches that allow coupling of complex biological states and behaviors with lower trophic levels.

The PICES Climate Change and Carrying Capacity (CCCC) Program Integration Workshop was held October 20, 2002, in Qingdao, just after the Second Open Science Meeting of GLOBEC International, and just prior to the PICES Eleventh Annual Meeting. This Workshop was an opportunity for the CCCC Program to begin integration of the original scientific goals established in 1994. The Workshop also provided an opportunity to evaluate where progress has been made and where additional efforts may need to be directed - a mid-life review.

What was the purpose of the CCCC Integration Workshop?

The purpose of the Workshop was to:

- Review and evaluate the progress that has been made in the first decade of the CCCC Program implementation;
- Provide a framework for integration activities of the CCCC Program that have so far been somewhat disconnected; and
- Evaluate whether the current structure of the CCCC Program with four Task Teams (BASS, MODEL, MONITOR and REX) is the best structure to carry CCCC-relevant research forward into the next decade, or whether consolidation of activities (and perhaps Task Teams) is required with re-focusing of principal goals and objectives.

Why an Integration Workshop now?

Over the decade that has passed since the launching of the CCCC Program, substantial progress has been made in linking climate forcing to ocean and ecosystem responses in selected areas of the North Pacific. However, much of this progress has focused on ecosystem or physical changes that are relatively local. It is time now to examine the broader picture of climate forcing and ecosystem responses in the North Pacific, by undertaking cross-disciplinary and international synthesis of the data and observations that have been made during this decade of research.

When the CCCC Program was formed, there was clear recognition that something of great significance had happened in the winter of 1976-77 - something that altered the marine environment of the North Pacific, from the Southern California Bight in the southeast, to the Gulf of Alaska and Bering Sea in the north, to the far-western marginal seas (Yellow Sea, Japan/East Sea). The ocean off Southern California became warmer and apparently less productive after this transition. Conversely, oceanic and coastal regions further to the north appeared to be more productive (both in plankton and fish). Moreover, biota in these regions not only changed in abundance, but also in species composition during these transitions.

Under the auspices of PICES, a one-day symposium was held in Vladivostok, Russia, in October 1999, to document the physical and biological changes and their relations to climate forcing that had occurred during this transition (now called a regime shift). This symposium resulted in a special issue of *Progress in Oceanography* titled *North Pacific Climate Regime Shifts*. In an important paper, Nathan Mantua and his colleagues (Mantua *et al.*, 1997) developed an index (the Pacific Decadal Oscillation, or PDO) to describe (and provide a quantitative measure of) this inter-decadal climate variability of the North Pacific (Fig. 1).

The recognition in the early 1990s that there were several dominant temporal scales of variability, El Niño (few years) and decadal (10's of years) in the North Pacific, with significant impacts on ecosystem structure, composition and productivity, provided a momentum for intensive scientific investigations (many as GLOBEC) in coastal waters of several PICES nations (U.S.A., Canada, Japan and China). Some of these projects have concluded, others are nearing completion, and still, others are ongoing. Fortuitously, these studies of the mid-1990s to early 2000s may have occurred during a period of another regime shift. Species composition and abundances of plankton and salmon from the eastern North Pacific suggests that a regime shift happened in 1998. It is time to evaluate what has been learned "generally" from all of these individual studies. This is the primary impetus for undertaking integration and synthesis activities now. Moreover, the international programs IGBP and GLOBEC have begun synthesis activities, and since the PICES CCCC Program is a regional program of GLOBEC, it is natural that we should also begin synthesis.

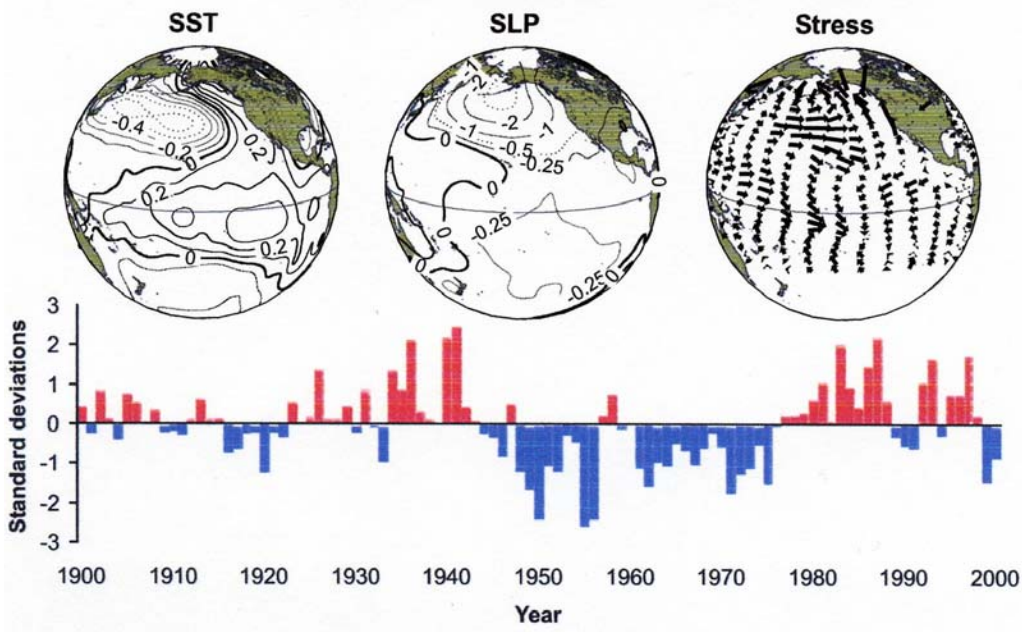


Fig. 1 Spatial patterns of sea surface temperature, pressure, and wind stress over the Pacific during the positive phase of the PDO (above) and the temporal pattern of the PDO (from Mantua and Hare, J. Oceanography*, 2002).*

Why do we need integration/synthesis?

Integration and synthesis are now popular buzzwords among national and international research programs focused on global change. In the North Pacific, and in the PICES CCCC Program specifically, we need better coordination, sharing of data/results, and collaboration of the diverse research programs and individual investigator studies that have been directed at linking climate to physics ecosystems. This is difficult to achieve without a substantial effort because:

- The object of our research (climate and its connection to ocean ecosystems) spans such a large geographical extent that no single institution or country can adequately investigate it.
- The question addressed is the dynamic behavior of a very complex system composed of many interconnected elements.

- The early simplified models failed to answer the whole scope of questions posed by the CCCC Program - either in terms of dynamic scenarios of climate change as a forcer of marine ecosystem change, or in terms of understanding changes in ecosystem structure. Models provide the primary means for synthesis and integration of CCCC process, observational and retrospective studies.
- The CCCC Program established four Task Teams to provide leadership for North Pacific studies of climate and ocean effects. Each Task Team has had substantial successes, whether it be in holding workshops or symposia, or development of specific models or observational platforms (*e.g.*, CPR studies). There has been substantial interaction among the four Task Teams in recent years, but it is time to better integrate and re-focus their activities on the central goals of the CCCC Program.

What is integration/synthesis?

Integration/synthesis as logical activities

Integration and synthesis efforts in a scientific program should be directed at the following:

- To compose a summarized conclusion by combining results from a variety of component research activities;
- To produce a generalized understanding of complex processes/systems by reducing the number of state-variables, dimensions, and/or degrees-of-freedom;
- To incorporate results from different approaches and from different localities/times into a broader scope of understanding;
- To obtain higher-level understanding by reconciling contradictory results or hypotheses.

Integration/synthesis as practical activities

Integration/synthesis cannot be done by a mandate from above. A steering/coordinating body can provide guidance, recommendations and opportunities for integration and synthesis, but ultimately, it is incumbent on the individual investigators and research programs to dedicate energy, time and financial resources to synthesis. Effective steering of an international/interdisciplinary research program focused on integration/synthesis requires sound logical reasoning and starting ideas, hopefully as the result of productive bottom-up (investigator-driven) meetings. Steering/coordination in the CCCC Program includes the following (these are already stated in the Science Plan/ Implementation Plan, but are repeated here because they are necessary and important in the Integration/synthesis Phase of the CCCC Program):

<u>*Communication between different approaches*</u>

The unique features of research on a complex system can be seen in the scientific strategy of the CCCC Program. The Science Plan, which addresses responses of Carrying Capacity of North Pacific marine ecosystems to Climate Changes as main scientific questions, has adopted four research approaches: *Data Analysis, Modeling, Process Studies and Monitoring*.

The major mission of *Data Analysis* is to explore historical data to elucidate the behavior of ocean ecosystems and its components, and to find empirical relationships between forcing factors (climate, ENSO, regime shifts, etc.) and system behavior, in order to identify critical processes of the system and to create possible hypotheses.

Modeling is considered a key activity in coordinating the CCCC Program. Models can integrate information from process studies into ecosystem models, identify critical processes through sensitivity analyses of simulations, provide methods of data analysis, use available data for calibration of the model, be used for hypotheses generation (and perhaps testing), identify critical variables for long-term monitoring, and use monitoring data for evaluation of model adequacy. Models can also provide forecasts of conditions and/or responses to unique situations (*e.g.*, a new regime shift, etc.), although all forecasts must be viewed skeptically until models have been adequately validated. In order to develop robust forecast capabilities, models should include mechanistic detail at relevant spatial and temporal time scales for the questions being addressed.

Process Studies provide detailed mechanistic representation of important ecological processes that are needed for model development and parameter estimation. For example, in the context of ecosystem response to climate changes, the length-at-age or the age-at-maturity of fish cannot be treated as species-specific constant biological characteristics. Instead, these should be viewed dynamically as a response to plasticity of life history, requiring intense experimental investigation under a new paradigm of individual ecological-physiological response to ecosystem changes. Model validations, especially validation of hypotheses used in constructing ecosystem models, require focused process studies in the field or laboratory. An example, under study already by CCCC, involves the role of iron in regulating primary production in the North Pacific. If the results of the Iron Fertilizing Experiment indicate that iron regulates primary production in the North Pacific, we need intense studies on the iron transport process from the Asian continent to the North Pacific. Sensitivity analysis and/or hypothesis testing experiments using ecosystem models will identify key processes that should be investigated by process studies.

Monitoring is the long-term repeated sampling of ocean and ecosystem parameters using standard and calibrated methods. CCCC is taking the lead in developing/designing a monitoring system capable of detecting ecosystem change in the North Pacific. CCCC goals in monitoring are directed toward longer-term climate change, but the system would ideally be suitable also for detecting shorter, and

perhaps more local, changes, due to, for example, pollution or toxic bloom events. Monitoring of the North Pacific will hopefully coordinate with, and contribute to, the design of a PICES-GOOS Monitoring Program.

The *Modeling* and *Monitoring* activities took the form of Task Teams (MODEL and MONITOR, respectively) in the initial implementation of the CCCC Program. *Data Analysis* and *Process Studies* did not take the form of Task Teams *per se*, but rather were considered as focal activities for component national programs, which would be coordinated in comparative studies by Task Team REX (Regional Experiment) and coordinated in basin scale studies by Task Team BASS (Basin Scale Study). Communication among different approaches (Task Teams) is important in the synthesis/integration of CCCC.

Coordination among programs:
Integration/synthesis among programs is (or can be) planned at different levels: Regional Program (*e.g.*, CCCC Program) level, GLOBEC International level, and IGBP level. Each level of integration/synthesis is likely to have its own, perhaps overlapping, objectives.

Regional Program level: The principal mission of integration/synthesis at the CCCC Program level is:

- To answer specific scientific questions related to climate forcing and ocean and ecosystem response in the North Pacific, emphasizing the inter-comparison of results from national or local studies, and
- To contribute to the progress of national programs through exchange of the latest findings and ideas and through the implementation of comparative studies.

GLOBEC International level: For the elucidation of scientific questions specific to the North Pacific, the comparison to other oceans, especially to the North Atlantic (*e.g.*, through the studies being done by the Cod and Climate Change (CCC) program of ICES and GLOBEC), will be useful if efforts are made to use common tools, protocols and models. Thus, GLOBEC International should lead this effort by holding workshops, identifying key issues for comparison, and developing a plan to accomplish this level of integration.

IGBP level: The IGBP Program has many ocean components. Among them, GLOBEC and JGOFS are two near relatives, and both have had large North Pacific components (either as international or national activities). To date there has been no explicit communication between GLOBEC and JGOFS within PICES. The IGBP Program has recently entered its second phase. Within this phase, GLOBEC will continue for some time, and both biogeochemistry (JGOFS) and ecosystems (GLOBEC) studies (probably more the former) will occur within a new OCEANS (**Oc**ean Biogeochemistry and **E**cosystem **An**alysis) Program. This new program may provide a forum for synthesis and integration within IGBP.

Pre-Workshop preparation

The CCCC Task Team (TT) Co-Chairmen developed "White Papers" on the original stated goals of their teams, their activities and progress to date, and the future directions (research and approaches) that they envision for their Task Team. These papers were circulated to the TT members, and posted on the PICES web page (http://www.pices.int/Annual/pices11/annual.asp) prior to the CCCC Integration Workshop. Thus, the bulk of the one-day Workshop was devoted to "forward-looking" program development. In order to develop an Integration Plan, prior to the Workshop, each TT was asked to:

- Select the key scientific questions to be solved by their TT during the integration/synthesis phase;
- Identify important and competing hypotheses for answering those questions;
- Determine appropriate methods, data required, and/or types of models needed to facilitate hypotheses testing;
- Consider whether the 1998/99 Regime Shift should be a common event for hypotheses and/or forecast testing;
- Plan a series of Practical Workshops for hypotheses testing;
- Convene a big international scientific conference (in 2005 or 2006) -
  - Call for contributed papers answering the selected key scientific questions;
  - Report results of Hypotheses Testing Workshops;
  - Publish results as papers in high quality scientific journals; and
  - Publish a book for non-scientists.

Recommendations of the CCCC Integration Workshop

The CCCC Workshop received reports from each Task Team on the results of their meetings, discussed the framework of CCCC Program integration, and made the following recommendations:

- Integrate research activities of the Task Teams toward the selected main topics such as:
  - Comparison of coastal ecosystems around the North Pacific Rim (and North Atlantic), using zooplankton and small fish as focal species;
  - Latitudinal comparison of North Pacific ecosystems, using multiple focal species;
  - Link basin-scale ecosystem models to coastal ecosystem models in the North Pacific, using salmon and associated species as focal species.
- Connect the CCCC Program to past and future ecosystem changes in the North Pacific, MONITOR will focus its Integration activities on two main goals:
  - Improve "timely" detection of changes in ocean ecosystems;
  - Communicate information on changes in the North Pacific ecosystem via "Ecosystem Status Reports" both inside and outside the PICES community.

- Establish an *ad hoc* **N**EMURO **Ex**periment Planning **T**eam (NEXT), which will evaluate and consider possible scientific directions, hypotheses and experiments that may be examined using the NEMURO model developed by the CCCC Program. NEXT will develop an outline (strategy) for a series of model experiments that will examine scientifically important and addressable issues in the North Pacific. The work of NEXT will be conducted through e-mail communication and teleconference calls.
- Hold intensive Practical Workshops that will conduct specific experiments (simulations) using the NEMURO model or its successors to test specific scientific hypotheses.
- Consider the possibility of combining REX and BASS Task Teams, based on the strategy of experiments designed by the *ad hoc* NEMURO Experiment Planning Team.
- Convene in 2005 or 2006, a large international scientific conference, like the *Beyond El Niño Conference* held in March 2000, having one or several key CCCC scientific questions as session topics. This will provide a high-visibility forum for the presentation and discussion of synthesized and integrated results of the first 10 years of research in the North Pacific following the framework suggested by the PICES CCCC Program.
- Establish a CCCC mailing list to provide broad and direct communication with interested PICES scientists.
- Communicate and collaborate with related international organizations and programs for inter-ocean and global comparative studies and for global integration/synthesis.

Next steps in the development of a CCCC Integration Plan

The CCCC Integration Workshop was the first step in developing an Integration Plan for CCCC. In order to complete this Integration Plan, the following tasks are needed:

- To raise the level of completion for Task Team "White Papers", so as to be feasible for publication;
- To develop an e-mail Mailing List for interested participants;
- To list hypotheses to be tested in model experiments (can be done through Task Team White Papers or through a virtual workshop by Mailing List);
- To design hypotheses testing model experiments and necessary models (can be done by NEXT);
- To decide the best structure for implementation of the Integration Plan, based on the recommendations of NEXT.

Towards a future CCCC Program

A proposal for a science program to follow the CCCC Program is one of the important items in integration process. Logically, synthesis and integration should identify scientific questions that have been adequately answered. Equally important, it should identify questions/problems that remain unknown or unresolved; establish priorities for these; and, provide guidance for how to tackle them. These are all relevant in developing a follow-up to the CCCC Program. Since the integration/synthesis phase of the CCCC Program is still in its infancy, it seemed premature to explore a next-generation program at the CCCC Integration Workshop. Moreover, many participants thought that the next-generation program should consider the broader needs of all of PICES scientists and member governments (*e.g.*, perhaps be of a wider scope). Thus, it was recommended that Science Board should design a process for the development of a successor to the CCCC Program. Clearly, the results of the CCCC Integration and Synthesis phase will be an important contributor to this process.

PICES/CLIVAR Workshop
on *Climate variability in the Pacific and its impact on the marine ecosystem*

Kimio Hanawa
Department of Geophysics
Graduate School of Science
Tohoku University
Aoba-ku, Sendai 980-8578, JAPAN
E-mail: hanawa@pol.geophys.tohoku.ac.jp

Dr. Kimio Hanawa is a professor of Physical Oceanography Laboratory, Graduate School of Science, Tohoku University, Japan. His research is mainly focused on the large-scale air-sea interaction, surface water mass formation, circulation and their variabilities. This year Prof. Hanawa becomes the Editor-in-Chief of the Journal of Oceanography.

Kelvin Richards
International Pacific Research Center/SOEST
University of Hawaii, POST Bldg. 409
1680 East West Road,
Honolulu, Hawaii 96822, U.S.A.
E-mail: rkelvin@hawaii.edu

Dr. Kelvin Richards has recently moved from the University of Southampton, UK, to take up a faculty position at the International Pacific Research Center (IPRC), University of Hawaii. His research interests include equatorial dynamics, low frequency variations of the ocean system, mixing and stirring of reactive tracers and the impact of physical processes on biological production. He also chairs the international CLIVAR Pacific Panel.

Background

The Pacific sector is influential in a wide range of climate phenomena on interannual to decadal timescales. Climatic variations in both the atmosphere and ocean affect primary productivity and higher trophic levels of the marine ecosystem, and the cycling of important biogeochemical constituents, such as carbon. Improved understanding of the physics of these climatic phenomena and their predictability is the remit of the WCRP's (World Climate Research Program) CLIVAR project. PICES is concerned with the marine ecosystem from physical forcing to primary production, biochemical cycles and fisheries in the North Pacific Ocean. The purpose of this joint PICES/CLIVAR workshop was to bring together these two scientific communities. The intent was to explore our present understanding of the climate phenomena in the PICES area and their links to the ecosystems of the region. The hoped-for outcome was the identification of ways in which collaboration between CLIVAR and PICES can further our understanding and aid the implementation of observational and modelling activities in the PICES area and over the wider Pacific.

Overview of presentations

The Workshop was held on October 20, 2002, as a part of the PICES Eleventh Annual Meeting, and convened by Drs. Kimio Hanawa (PICES) and Kelvin Richards (CLIVAR). Funding for the workshop came from WCRP, NSF, NOAA, NASA and PICES. We are grateful to these organizations for their support.

The subject matter attracted a large audience. A number of keynote speakers were invited to give overviews on particular topics related to climate variability and changes to the biological and chemical marine system. In order to give speakers enough time to elaborate on their theme, each speaker was allotted 30 minutes. A series of shorter presentations were also given to further extend the topics under discussion. Without diminishing the contribution by other speakers this report will focus on the keynote talks.

A list of all speakers can be found in the 2002 PICES Annual Report.

The morning was spent primarily on the physical aspects of climate variability. An excellent overview of what we know about seasonal to decadal variability of the physical environment was given by Dr. Stephen Riser. Over the last few decades our knowledge of how the ocean is changing on decadal timescales has increased remarkably. However, there is still much to be learnt about what causes the observed changes.

Providing a good estimate of the state of the ocean was the topic of the talks by Drs. Neville Smith and Tony Lee. Dr. Smith gave an update on the progress of GODAE, a programme designed to provide an ocean prediction system for the global ocean. Progress towards this goal has been better than expected, and the programme will move shortly to its operational demonstration phase. Dr. Lee talked about constraining ocean models with data and the ECCO (Estimation of the Circulation and Climate of the Ocean) programme designed to provide a near operational tool to understand climate variability of the ocean. Again results to date are encouraging but point to the need for ways of estimating the impact of model deficiencies in model solutions.

The progress achieved in climate research is in no small part due to the massive increase in computer power over the last few decades. Dr. Akimasa Sumi reported on Japan's latest effort to increase the computing power available for climate research still further. The *Earth Simulator* is the result. Plans are to run a high resolution coupled atmosphere/ocean model for O (1000 yrs) and have the capacity to run the model several times allowing numerical experimentation.

The afternoon talks were devoted to biogeochemical cycles and the marine ecosystem. The problem of distinguishing anthropogenic CO_2 from that occurring naturally makes it difficult to not only provide estimates of the ocean's uptake of CO_2 since the industrial revolution, but also to study naturally occurring changes to that uptake caused by changes to variations in the atmosphere/ocean system. Dr. Christopher Sabine discussed the methodologies of estimating anthropogenic CO_2 in the ocean and the most recent estimates. We now have a global estimate of anthropogenic CO_2 distributions based on high-quality WOCE, JGOFS and OACES data. He also described the Global Carbon Project, which is designed to coordinate and synthesize global carbon observations.

The most direct impact on the marine ecosystem of a variable climate is through primary production. Dr. Daniela Turk described a multi-sensor approach to monitor the inter-annual variations of production applied to the equatorial Pacific. Ways of extending this approach to higher latitudes were discussed.

Dr. Arthur Miller concentrated on the organized basin-scale patterns of variability observed in the Pacific and how these may relate to the response of the ecosystem.

Zooplankton are often quoted as being key indicators of climate change because of their reliance on food supply and transport by ocean currents. This was clearly shown by Dr. David Mackas for zooplankton communities along the NE Pacific continental margin. Records going back to the 1970s show regime shifts in population abundance and community structure.

Dr. Richard Beamish highlighted that only relatively recently did scientists accept the fact that climate variability also impacts upon higher predators and fisheries. Variations in pink salmon stocks, for instance, can quickly shift to a new regime following changes in the physical environment. He concluded by remarking that climate variability needs to be taken into account in the management of fisheries.

Discussion

The talks during the day sparked off a lot of discussion. However, because of the structure of the programme, there was little time left for a formal discussion period. Most people were also exhausted after such a long and stimulating day. However, one of the overriding impressions to come out of the workshop was the need for a more mechanistic approach to establishing the casual links between variations in the Earth's climate and the marine ecosystem. Most studies to date, with a few notable exceptions, rely on statistical correlations between climate indices and abundances of species. CLIVAR is committed to establishing the mechanisms of climate variability and change. It is timely to apply a similar approach to the impact of climate variability on marine biology and chemistry.

The convenors hope this workshop is the first step to establish a strategic consortium between the PICES and CLIVAR communities. To this end, at the PICES POC Committee meeting following the workshop, it was agreed to hold a further workshop on a joint CLIVAR/PICES theme at PICES XIII in Honolulu, focusing on the mechanisms of climate-induced decadal variability of the marine ecosystem. Such a session needs careful planning and it would be useful to hold discussion at PICES XII in preparation for the session.

One final comment, a workshop held within one day can be a tiring affair. The organizing committee might consider splitting a session, and particularly a workshop, by starting in the afternoon of one day and finishing mid-day the next. In that way people have the opportunity to discuss the science in the evening and formulate their ideas for general discussion before starting afresh in the morning.

IGBP/SCOR Open Science Meeting on
Ocean Biogeochemistry and Ecosystems Analysis

With the completion of the Joint Global Ocean Flux Study (JGOFS) in 2003, there will be a gap in major international marine research relating to ocean biogeochemistry and lower trophic levels and their roles in mediating or exacerbating global change. This has been recognized by the International Geosphere-Biosphere Program (IGBP) and the Scientific Committee on Oceanic Research (SCOR), who have jointly supported planning over the past two years for a major program to fill this gap. This planning has culminated in a draft framework for future research on biological and chemical aspects of global change in the ocean (http://www.igbp.kva.se/obe/) and an Open Science Meeting to build the scientific foundations for a new international OCEANS (**Oc**ean Biogeochemistry and **E**cosystem **An**alysi**s**) program, which was held January 7-10, 2003, at the UNESCO Headquarters in Paris, France.

The meeting was very successful, and brought together almost 400 participants from around the world for 1.5 days of presentations, over 200 posters, and 2.5 days of discussions in plenary and in 10 working groups. Three broad research issues were identified by the project Transition Team (co-chaired by Julie Hall, New Zealand, and Patrick Monfray, France) in the meeting background documents:

1. *What controls the time-varying biogeochemical state of the ocean system and how will it respond to global change?* This question focuses on research involving the physical forcing of biogeochemical cycles at time scales longer than the interannual, the transfer and transport of materials between surface waters and the mesopelagic layer beneath, coupling between water column and sediment nutrient cycling, processes at the sediment-water interface and interactions with benthic biota and the dynamics of "hot spots" (*e.g*., upwelling and deep mixing zones) and their sensitivity to global change.

2. *How will marine food webs respond to, and force, global change?* Key challenges include integrated analysis of marine food webs, from viruses to fish, and the sensitivity of individual components to change; comparison of open-ocean and continental margin food webs and an analysis of their sensitivities to changes in forcing; the relationship between diversity, stability and structure of food webs, and biogeochemical function; and the drivers of non-linear processes that generate "regime shifts" in food webs and foodweb structure and function.

3. *How does carbon accumulation in the ocean, as well as the release of carbon dioxide and methane, respond to global change?* Several gaps exist in understanding the carbon cycle and feedback mechanisms. These include cycling in the ocean interior and in high-flux regions, and the sensitivity of this cycling to changes in external forcing; the transformation and transport of terrigenous carbon in the marine environment; and carbon cycling in the continental margins. Other important research issues relate to attempts to sequester atmospheric carbon dioxide in the ocean and processes related to the deposition and release of methane clathrates in continental margin sediments.

The ten Working Group topics were identified as:

- Trace elements in ecological and biogeochemical processes
- Physical forcing of biogeochemical cycling and marine food webs
- Climatic modulation of organic matter fluxes
- Direct effects of anthropogenic CO_2 on biogeochemical cycles and ecosystems
- Integrating food web dynamics from end to end
- Continental margins
- The mesopelagic layer
- Biogeochemical hotspots, choke points, triggers, switches and non-linear responses
- Feedbacks to the Earth System
- Coupled models of biogeochemical cycles and ecosystems

After the Open Science Meeting, the Transition Team met to begin drafting a Science Plan for this new program. The developing draft is expected to be presented at the 3rd IGBP Congress (Banff, Canada), in June 2003, and put onto the IGBP and SCOR web sites for comments shortly thereafter. Since this new program is likely to involve considerable interaction with GLOBEC and PICES, we would like to give here a brief discussion of the Paris meeting and a sense of the major findings of the various Working Groups.

Each Working Group was asked to identify (a limited number of) key themes, key scientific questions, strategies and approaches, and impediments for their topic. The following represents a summary of the key themes as presented at the meeting (the proceedings are expected to be available later in 2003):

1. *Trace elements in ecological and biogeochemical processes* (Keith Hunter, Chairman; Peter Statham, Rapporteur)

a) Interactions between trace elements and biota, for example:
   - What elements are needed by biota, and how are they assimilated, and recycled?
   - How do trace elements influence species composition and community structure?

b) The role of trace elements in major global biogeochemical cycles, for example:
   - Are trace elements drivers or "passengers" in biogeochemical cycles?
   - How do these processes change with climate?

c) Sources, sinks, and transformations of trace elements, for example:
   - What will be the impact of global change on the relative importance and variability of sources and sinks of trace elements in the ocean?
   - What is the importance of colloids in trace elements cycles?

d) Proxies, for example:
   - Can existing trace elements be used to improve understanding of global biogeochemical cycles, and can new proxies using these elements be developed?

2. *Physical forcing of biogeochemical cycling and food webs* (Michael Follows, Chairman; Evgeny Pakhomov, Rapporteur)

a) What are the mechanisms underlying the observed ecological and biogeochemical responses to climatic changes? For example:
   - What are the underlying interactions between climate, ecology, and biogeochemistry?
   - What are the paleo-proxies for ecological change?

b) How does the physical variability associated with large scale or global climate regimes modulate the chemical composition of the oceans and air-sea gas fluxes? For example:
   - How are biogeochemical cycles controlled by food webs?
   - What is the role of mid- and high-latitude oceans on interannual variability in the air-sea flux of CO_2?

c) Ocean margin – open ocean interface, for example:
   - What is the role of mean flow and mesoscale features in the exchange of nutrients and organisms between shelf and open oceans?
   - What is the role of atmospheric dust and sedimentary sources of nutrients to marginal seas?
   - How significant are ecosystem disturbances by gelatinous zooplankton?

d) What is the role of mesoscale and submesoscale (frontal) features in controlling large-scale ecological and biogeochemical distributions and fluxes? For example:
   - What is the local impact of mesoscale and submesoscale motions on ecology (*e.g*. nutrient supply and community composition)?
   - How do eddy transfers modulate the mean overturning circulation and vertical exchanges in the southern ocean?
   - How might these influences change with climate change?

e) Scale interactions of the climate and biogeochemical systems: what do we need to get right? For example:
   - How do elements of climate variability project onto the variability of elements of marine ecosystems?
   - Which elements of physical and biological variability impact most on ecosystems and biogeochemistry?

3. *Climatic modulation of organic matter fluxes.* (Andreas Oschlies, Chairman; Osvaldo Ulloa, Rapporteur)

a) What are the mechanisms and controls of organic matter fluxes? For example:
   - What controls the partitioning between inorganic and organic pools in space and time?
   - What are the relative contributions from sinking of particulate organic material, passive transport of dissolved and particulate organic material, and active transport by vertically migrating zooplankton?
   - What factors control organic matter burial and release from the sediments?

b) Which climate variations are important, how, and where? For example:
   - What are the regional patterns and modes of variability in organic matter fluxes and their relationship to atmospheric and oceanic variability?
   - What ecosystem properties are most sensitive to climate change (*i.e*. which might be early warning indicators)?

c) How does climate variability affect food-web dynamics and its interaction with organic matter fluxes? For example:
   - What is the relation between functional groups/key species and organic matter fluxes?
   - What is the impact of internal food web variability on organic matter fluxes?

4. *Direct effects of anthropogenic CO_2 on biogeochemical cycles and ecosystems* (Jim Orr, Chairman; Carol Robinson, Rapporteur)

a) Direct effects of anthropogenic CO_2 on ecosystems, for example:
   - Which are the pH sensitive organisms and metabolisms in the ocean?
   - Can organisms adapt to changes in pH and CO_2 and what can be learned from the past about their survival?

b) Biogeochemical consequences, for example:
   - How will changes in community structure and growth rates affect export, re-mineralization, particle fluxes and sediment processes?
   - How will changes in community structure modify the potential for CO_2 uptake?

c) Assessment (past, present, future), for example:
   - What are the distributions of uptake, transport and storage of anthropogenic CO_2 and how will these change?

- What are the possible consequences of purposeful injection of CO_2 in the ocean?

d) Mechanistic understanding, for example:
   - What processes control calcification and carbonate dissolution?
   - Which oceanic areas are most vulnerable (or suitable) to deliberate CO_2 sequestration?

5. *Integrating food web dynamics from end to end* (Mike St. John, Chairman; Angelica Pena, Rapporteur)

a) Quantify the ocean's role, as mediated by the biota, in determining elemental fluxes between global compartments, for example:
   - What are the key species/functions/processes, and how are they controlled in space and time?
   - What is the importance of the continental shelf to global and regional biogeochemical cycles?

b) Determine the nature of changes in ecosystem state and develop techniques to monitor and predict them, for example:
   - How do climate cycles and elemental cycles select for life cycles?
   - What is the role of biodiversity for function and adaptability of the systems?
   - How do large and small perturbations of an ecosystem by human activities affect food webs, their emergent properties, and the time-scale of return to the previous or a new ecosystem state?

c) What is the role of adaptation for global change and what are the effects on ecosystem dynamics? For example:
   - How do communities respond to environmental changes, in terms of genetic "options", phenotypic variability, species replacements?
   - How important are biodiversity and the persistence of rare species for future surprises in an ecosystem?

d) How does the nature of empirical and modeling aggregation influence our ability to understand and predict the dynamics of an ecosystem and elemental fluxes? For example:
   - What is the impact of "arbitrary" definitions of taxonomic level and functional groupings?
   - How much complexity in foodweb models is required?

6. *Continental margins* (Kon-Kee Liu, Chairman; Laura David, Rapporteur)

a) How do continental margins interact with land, ocean interior, and atmosphere? For example:
   - What are the key processes that lead to important functions, and how might these be modified by global changes?

b) What is the distribution and magnitude of sources and sinks of carbon and nutrients in continental margins? For example:
   - Where are the hot spots for sources and sinks?

c) What are the unique characteristics of continental margin ecosystems and how do they respond to global changes? For example:
   - How do continental margins control the food webs?
   - How is the pelagic realm coupled to the benthic realm?

d) How do we model continental margins by including critical forcings and characterizing their relative importance in the past, present, and future?

7. *The mesopelagic layer* (George Jackson, Chairman; Temel Oguz, Rapporteur)

a) Characterization and development of a predictive capability for the fluxes and material transformations in the mesopelagic. For example:
   - What are the fluxes through the mesopelagic in space and time?
   - What are the main processes involved in transformations?
   - How will these respond to global changes?

b) Characterization and development of predictive capability for the mesopelagic ecosystem structure, dynamics, and function. For example:
   - What are the structures and variability of these ecosystems, and how are they controlled?
   - How do ecosystems control the fluxes of materials through the mesopelagic?

c) Characterization and development of predictive capability for the interactions and feedbacks between mesopelagic and boundary systems. For example:
   - How does the mesopleagic respond to material fluxes from above, from below, and from the sides (*e.g.* continental margins)?

8. *Biogeochemical hotspots, choke points, triggers, switches, nonlinear responses* (Christopher Sabine, Chairman; Catharine Goyet, Rapporteur)

a) Understand hot spots and choke points, for example:
   - What regions and biogeochemical processes are most sensitive to climate change, and therefore need special study?
   - Do these locations need to be protected (conserved) or treated differently because of the potential consequences of their responses to global changes?

b) Understand the controls, triggers and switches on biogeochemical cycling and ecosystem structure, for example:
   - What controls oceanic productivity, and species composition of blooms?
   - What allows the decoupling of growth and grazing?
   - How do regime shifts in climate trigger shifts in ecosystem structure?

c) Identify natural and human-induced reversible and irreversible changes on time scales relevant to climate change, for example:

- What are the non-linear controls on the trophic levels and can changes in trophic structure be reversed?
- What affects the timing and duration of seasonal cycles of productivity and biogeochemical cycles?

d) Identify thresholds, for example:
- What biogeochemical and physical shifts might result from methane release?
- What are the true threshold processes versus non-linear effects, and how do we study them?

9. *Feedbacks to the earth system* (Graham Shimmield, Chairman; Tony Michaels, Rapporteur)

a) The carbon cycle and climate, for example:
- What are the mechanisms that control the portioning of CO_2 between the ocean and the atmosphere?

b) Other "radiatively-important" gases, for example:
- What are the sign, magnitude, and controls on the feedbacks of these gasses to the atmosphere and climate system, *e.g.* DMS fluxes, methane clathrates in sediments, methane and N_2O in anoxic waters and sediments, etc.

c) Biology and physical structure, for example:
- To what extent does heating of the surface ocean changes as a result of the profile and dynamics of phytoplankton, and how does this affect the local climate?

d) Human activities, for example:
- Do feedbacks involving human activities affect the ocean and how do they impact society's options for sustainability?

10. *Coupled models of biogeochemical cycles and ecosystems* (Shubha Sathyendranath, Chairman; Richard Lampitt, Rapporteur)

a) What triggers sporadic biological events in the ocean that are relevant to biogeochemical cycles?

b) What controls the distribution of species today, and how will it be modified by global changes?

c) What sustains the present ecosystem, and how does it respond to perturbations?

At the conclusion of the meeting, Dr. Patrick Holligan summed up what he felt were the main themes arising from the conference, such as

- Ecosystem dynamics and biogeochemical cycles
- Physical and chemical feedbacks on the earth system
- Boundary conditions, between ocean provinces, ocean margins, and the interior
- Time series data

He suggested what he felt was the "big question" for the new program: *How do ocean ecosystems respond to, and force, global change in terms of their biophysical and biogeochemical properties and their capacity to sequester biogenic material?*

The challenge is now to the program Transition Team and the sponsors, in consultation with the scientific community, to refine these discussions to develop the new 10 year program on ocean biogeochemistry.

Ian Perry and *Roger Harris*

Subarctic Ecosystem Response to Iron Enrichment Study (SERIES): Eastern Subarctic Pacific, July 2002

C.S. Wong
Climate Chemistry Laboratory
Institute of Ocean Sciences
9860 West Saanich Road, Sidney, B.C.,
CANADA. V8L 4B3
E-mail: WongCS@pac.dfo-mpo.gc.ca

Dr. C.S. Wong is a senior research scientist in the Ocean Science and Productivity Division at the Institute of Ocean Sciences (Fisheries and Oceans Canada), and team leader of the Climate Chemistry Laboratory. His research interests include the oceanic carbon cycle, halocarbon and isotopic tracers, iron fertilization and mitigation CO_2 in the oceans. He is a member of the PICES Physical Oceanography and Climate Committee and WG 17 on Biogeochemical data integration and synthesis*, and Co-Chairman of the Iron Fertilization Experimental Panel.*

W. Keith Johnson
Climate Chemistry Laboratory
Institute of Ocean Sciences
9860 West Saanich Road, Sidney, B.C.,
CANADA. V8L 4B3
E-mail: JohnsonK@pac.dfo-mpo.gc.ca

W. Keith Johnson has worked in oceanography on the British Columbia coast since 1971. He is presently lab manager for the Biogeochemistry group. He has been studying iron as a micronutrient in the NE Pacific for the past 5 years in an effort to understand its role in relation to climate. His other research interests include carbonate chemistry and green house gases in the NE Pacific. He has also recently participated in a number of cruises in conjunction with the International Collaboration Project on CO_2 Ocean Sequestration.

In recent years, low iron values have been shown to be a major cause for limiting phytoplankton growth in large, macronutrients-rich areas of the world's oceans. Iron enrichment experiments conducted in the Equatorial Pacific (IRONEX I and II) and the Southern Ocean (SOIREE), regions of high nitrate, low chlorophyll (HNLC), have demonstrated increased productivity as a response to the added iron. However, the sub-arctic Pacific waters had not been investigated. In 2001, the first such experiment (**S**ubarctic Pacific Iron **E**xperiment for **E**cosystem **D**ynamics **S**tudy - SEEDS) was conducted in the Northwest Pacific with similar results. This was part of a collaborative project between Canada and Japan, to study iron limitation in the subarctic Pacific, which has strong zonal gradients in atmospheric iron deposition and plankton communities. The co-operative plan was conceived at the first meeting of the PICES Iron Fertilization Experiment Advisory Panel (IFEP), held in Tsukuba, Japan, in 1999, in conjunction with PICES IX. Here we describe the second subarctic experiment: SERIES (**S**ubarctic **E**cosystem *R*esponse to **I**ron **E**nrichment **S**tudy), near station P (50ºN, 145ºW) in the Northeast Pacific. SERIES was the first field experiment of Canadian SOLAS (Surface Ocean Lower Atmosphere Study) funded jointly by NSERC (Natural Science and Engineering Research Council), CFCAS (Canadian Foundation for Climate and Atmospheric Sciences) and DFO (Fisheries and Oceans Canada).

SERIES involved scientists from universities and government institutions across Canada as well as international collaborators. Three ships, the CSS *John P. Tully*, the M/V *El Puma* (leased from Mexico) and the M/V *Kaiyo Maru* from Japan, along with 45 researchers from over 20 institutions participated in the experiment. The objectives included:

- measuring the response of bacteria, phytoplankton and zooplankton to the addition of iron
- measuring CO_2 draw-down and carbon flux to depth
- quantifying climate gas production and controlling factors, including biological production of DMS (dimethylsulfide) and its influence on atmospheric sulphur budget, sulphate aerosols and cloud microphysics

Fig. 1 SERIES participants on the CSS J.P. Tully *with SF_6 tanks in background.*

SERIES would enable comparison of varying plankton responses along the longitudinal dust gradient in the North Pacific, which causes distinct differences in phytoplankton communities between the western and eastern subarctic gyres. This was also to be the first detailed atmospheric study associated with an iron enrichment experiment in the ocean, and one of the most detailed studies on DMS, foodweb and iron interactions. By using three ships and staggering their schedules, we extended the continuous occupation of a created iron patch to probably the longest observational period to date. With this extended time frame we hoped to observe the post-bloom particle export, not seen in other iron enrichment experiments with shorter periods.

Preliminary field-testing of the SF_6-iron injection system was conducted in February 2002, on the CSS *John P Tully*. A small 25 km^2 patch was created by injecting SF_6-saturated seawater using the "creeping line forward method", and was monitored over 4 days to track the patch drift, buoy drift, and test mapping capabilities and instrumentation.

The SERIES experiment began on June 29, 2002, when the CSS *John P Tully* departed from IOS with 21 scientists on board (Fig. 1). Enroute to the test area, the regular line P and station P time-series work was conducted to ensure the experimental site was within HNLC waters. A CTD survey was carried out to determine density gradients in the surface water. In order to minimize the possibility of an iron patch subduction, an area with uniform physical characteristics was chosen to the northeast of station P.

Prior to arrival in the test area, two steel tanks containing 2,700 to 2,800 litres of seawater were saturated with SF_6 over a 36-hour period and sealed for later injection. Another two tanks were each filled with just under 10,000 litres of seawater acidified to a pH of 1.6-1.7 by HCl. 1,068 kilograms of iron sulphate heptahydrate were then added to each tank. This amount of iron was expected to give a 4 nM iron increase to ambient levels for a 65 km^2 patch of 30 meters depth.

The injection was initiated at 00:50 local time of July 9, on site (50º 08.6'N, 144º 45.4'W) using an "expanding square method" made possible by the ship's Search and Rescue EcPIN package. The release track covered an area of 4.75 x 4.74 nautical miles and was completed in 18 hours travelling at a speed of ~ 4 knots. The SF_6 and iron solutions were mixed and pumped over the stern into the prop mixed waters at rates of 5 and 20 litres per minute, respectively, at a depth of ~7 meters.

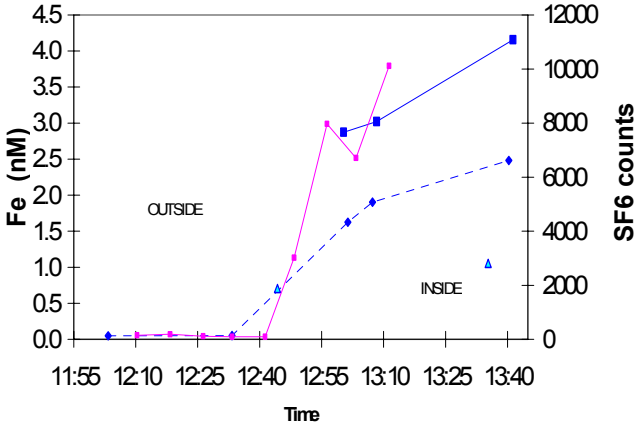


Fig. 2 Day 1 surface survey/transect into the patch for soluble (Δ), dissolved (♦) and labile (■) iron and SF_6 (□).

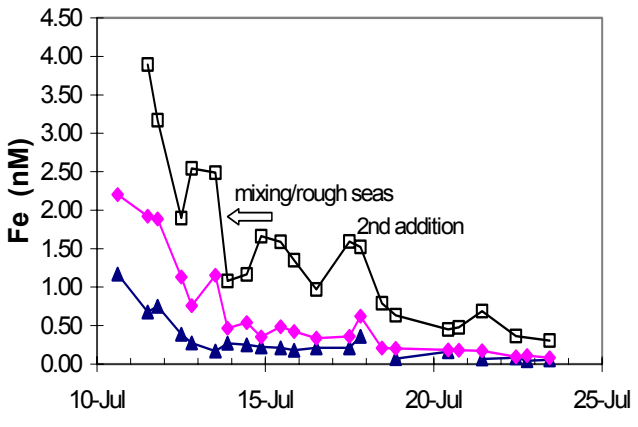


Fig. 3 Time series of soluble (▲), dissolved (♦) and labile (□) iron at 10-meter depth.

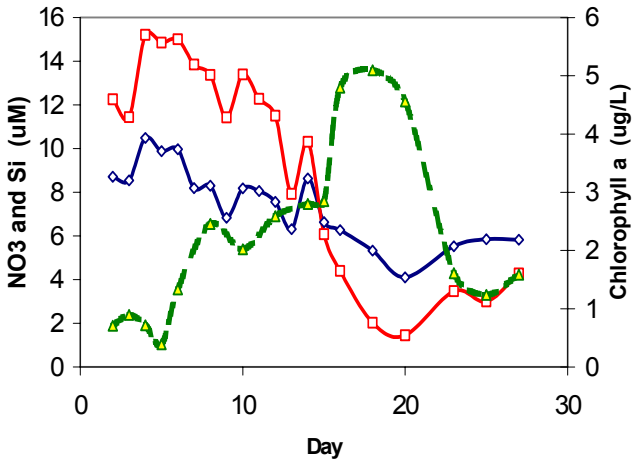


Fig. 4 Mixed layer NO_3 (◊), Si (□) and chlorophyll-a (Δ) levels throughout the SERIES experiment in July and August 2002. Data provided by F. Whitney, J. Barwell-Clarke, Y. Nojiri and H. Saito.

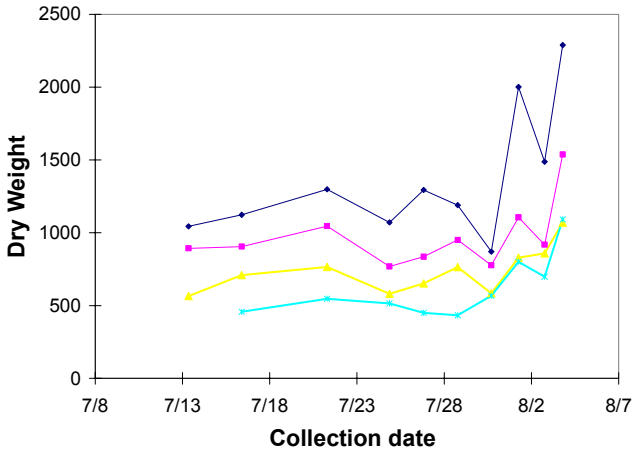


Fig. 5 Preliminary dry weight (mg/m^2/day) data at 50 m (♦), 75 m (■), 100 m (▲) and 125 m (*) depths from Knauer Free Drifting Sediment Traps, courtesy of Y. Nojiri.

The ship then remained outside the patch for a few hours to allow for vertical mixing. By that time, the M/V *El Puma* had also arrived in the test area so both ships were ready to start sampling on day 1. Typically the CSS *John P. Tully* located the patch center by using underway SF_6 measurements, sampled for a few hours, then moved out to allow the M/V *El Puma* in to sample. Meanwhile the CSS *John P. Tully* worked at a reference station outside the patch, and moved back in the afternoon to continue sampling inside the patch after the M/V *El Puma* had finished for the day. During the evening and night the CSS *John P. Tully* mapped the patch, so that by morning, a map with a projected center was available for that day's sampling of other chemical and biological properties. As the experiment progressed and the biological response was evident, underway surface pCO_2 and fluorescence augmented the SF_6 mapping.

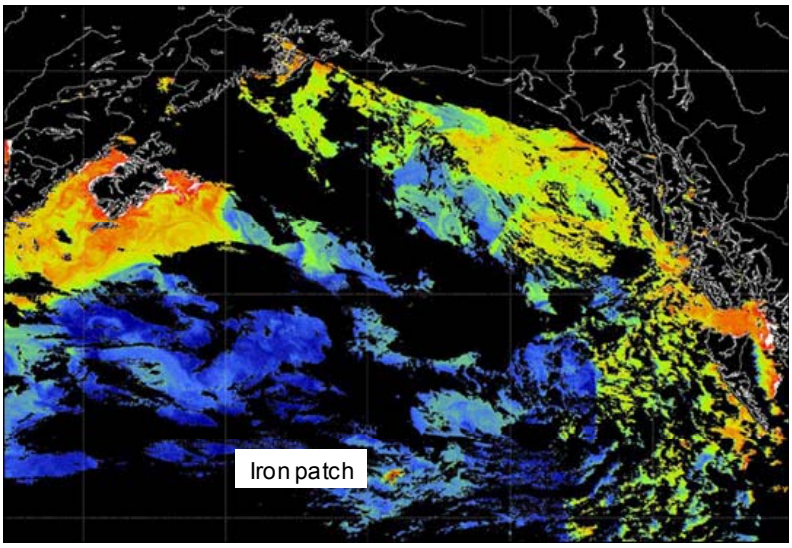


Fig. 6 Satellite image of chlorophyll in the North Pacific 20 days after iron injection, courtesy of Jim Gower (black is cloud coverage).

The following day a transect using a V-fin Fish was conducted to collect clean seawater as the ship travelled from outside the patch towards the expected center. Samples for analysis were collected and processed on board for labile (unfiltered seawater buffered to pH 3.2), dissolved (filtered through 0.22 micron cartridge filter) and soluble (filtered through 0.03 micron filter) iron. Figure 2 showed that both the SF_6 and iron were good indicators of the patch. The iron values were near the target of 4 nM, even though the 30-meter mixed layer was complicated by a weak 10-meter thermal layer caused by unusually calm weather.

Although the iron started to decrease immediately (Fig. 3), the biological response was much slower. After some stormy weather chlorophyll-*a* increased but only by 2-fold from initial values, and therefore a second smaller (25% of original iron) injection was carried out on July 16. By this time the chlorophyll-*a* levels were almost an order of magnitude higher, and these changes could be seen with the naked eye. But it was not until the CSS *John P. Tully* left and the M/V *Kaiyo Maru* arrived that the chlorophyll-*a* values peaked (July 24 to 26) at close to 5 ug/L (Fig 4). At the same time there was a large drawdown of silica and pCO_2.

After the CSS *John P. Tully* left, the M/V *Kaiyo Maru* continued to monitor the patch until August 4, giving 26 days of coverage which is the longest continuous monitoring of an iron-enriched patch to date. Sediment trap

deployments showed no increase during the observational period of the CSS *John P. Tully*. However, the M/V *Kaiyo Maru* was able to see a doubling of material settling at all depths (50 m, 75 m, 100 m and 125 m) indicating a flux of particulate matter out of the surface layer (Fig. 5).

A good SeaWiFS satellite image (Fig. 6) was obtained showing the drastic difference between the iron-enriched waters of the patch and the natural surrounding waters.

To facilitate discussions and publications on the experiment two workshops have been planned. The first is a Canadian SOLAS Workshop on *SERIES preliminary results and data*, to be held March 9-12, 2003, at the Institute of Ocean Sciences, Sidney, British Columbia, Canada. The objectives of this workshop are:

- to foster exchange of preliminary SERIES data and ideas;
- to establish inventory of data holdings and archiving at the Canadian SOLAS office; and
- to co-ordinate co-authorship of manuscripts for a second workshop.

The second workshop, under the auspices of the PICES IFEP, on *"*In-situ*" iron enrichment experiments in the eastern and western subarctic Pacific*, will be convened December 4-6, 2003, also at the Institute of Ocean Sciences. The objectives of this workshop are:

- to synthesize results from the two *in-situ* iron enrichment experiments performed in the eastern and western subarctic Pacific (SEEDS-2001 and SERIES-2002);
- to discuss responses in lower and higher trophic levels, carbon cycles, trace-gas production and ocean-atmosphere flux and models;
- to determine similarity and differences in biogeochemical and ecosystem responses to iron addition between eastern and western subarctic Pacific;
- to identify specific scientific questions for the long-term experiment in the western subarctic Pacific (SEEDS-2004).

GLOBEC International Project Office

Dr. Manuel Barange (center)

I am the Director of the GLOBEC International Project Office. GLOBEC is a core project of the International Geosphere-Biosphere Programme (IGBP), and is co-sponsored by the Scientific Committee on Oceanic Research (SCOR), and the Intergovernmental Oceanographic Commission of UNESCO (IOC). My principal role is to co-ordinate the overall implementation of GLOBEC at national, regional and international levels in consultation with the GLOBEC Scientific Steering Committee, as well as fund raising and management of international programme funds. I also facilitate, oversee and contribute to the scientific agenda of GLOBEC's four Foci working groups.

Lotty Ireland (left)

As Office Manager my principal role is to manage the affairs of the GLOBEC IPO on a day-to-day basis and to give administrative and financial support to the office. My responsibilities include the management of the GLOBEC finances, liaising with suppliers and ensuring the efficient and smooth running of the office, offering support to other members of the IPO in addition to committee members worldwide. Other responsibilities include assisting in the production of the bi-annual GLOBEC Newsletter, reimbursement of expenses following GLOBEC meetings and the maintenance of the GLOBEC mailing lists.

Dawn Ashby (right)

I have recently been appointed to the post of GLOBEC and AMT International Project Officer replacing Hester Willson. I have worked at the Plymouth Marine Laboratory since 1993, following an Environmental Science degree at Plymouth. My first appointment was as an assistant to the manager of the Biogeochemical Ocean Flux Study (BOFS) programme and then as an Information Scientist at the National Marine Biological Library. My role at the GLOBEC International Project Office includes maintenance of GLOBEC's website, management of the GLOBEC meta-databases, helping to produce GLOBEC publications such as the GLOBEC International Newsletter and assisting the GLOBEC Executive Officer in managing the programme.

GLOBEC 2003 Calendar

- *Open Science Meeting for the Developing Ocean Biogeochemistry and Ecosystems Project,* January 7-10, 2003, Paris, France
- *GLOBEC-NEP/CGOA Symposium on Marine Sciences in the Northeast Pacific: Science for Resource Dependent Communities,* January 13-17, 2003, Anchorage, U.S.A.
- *BENEFIT-GLOBEC Forum 2003,* March 31–April 4, 2003, Swakopmund, Namibia
- *LOV/IOC Workshop on Regime Shift,* April 13-16, 2003, Villefrance-sur-mer, France
- *GLOBEC-ICES CCC Synthesis Workshop,* May 5-7, 2003, Massachusetts, U.S.A.
- *3rd JGOFS Open Science Meeting - A Sea of Change: JGOFS accomplishments and the Future of Ocean Biogeochemistry,* May 5-8, 2003, Washington D.C., U.S.A.
- *GLOBEC-PICES-ICES Zooplankton Production Symposium,* May 21-23, 2003, Gijón, Spain
- *GLOBEC Focus 2 WG Meeting,* May 24, 2003, *Gijón, Spain.* Check the PICES Home Page (www.pices.int) for the latest information on the program, spousal participation & the Extravaganza Dinner!!!
- *ICES/GLOBEC CCC Working Group Meeting,* May 2003, Woods Hole, U.S.A.
- *GLOBEC SSC Meeting,* June 18, 19 and 24, 2003, Banff, Canada
- *IGBP Congress,* June 19-24, 2003, Banff, Canada
- *GAIM and WGCM (WCRP) – International Conference on Earth System Modelling,* September 15-19, 2003, Hamburg, Germany
- *IHDP Open Science Meeting,* October 16 –18, 2003, Montreal, Canada
- *GLOBEC-CLIOTOP Planning Meeting,* November 3-7, 2003, Sete, France

PICES Secretariat

Alexander Bychkov (first from left)
PICES is an inter-governmental organization established to promote and coordinate marine scientific research in the temperate and subarctic region of the North Pacific. As the Executive Secretary of PICES, I am responsible for the administration of its activities, especially the implementation of all scientific and administrative decisions made by the Organization and management of funds. Overseeing and coordinating efforts of the Secretariat is not difficult considering the qualification and dedication of my staff. In my pre-PICES life, I graduated from the Moscow State University, received my Ph.D. (Analytical Chemistry) from the USSR Academy of Sciences, and then spent more than 20 years working as a Research Scientist and Head of Laboratory at the Pacific Oceanological Institute in Vladivostok. My scientific interests are focused on the carbon cycle in the North Pacific and its marginal seas. I was involved in regional (national and international) cooperation related to the Joint Global Ocean Flux Study (JGOFS), and I still serve as the Chairman of the JGOFS North Pacific Synthesis Group.

Stewart (Skip) M. McKinnell (right)
Since 1999, I have been Deputy Executive Secretary of PICES. I earned a B.Sc. (Biology) from the University of Victoria and a Ph.D. (Fish Biology) from the Department of Aquaculture, Sveriges Lantbruksuniversitet (Swedish University of Agricultural Sciences). In former lives I was Head of Scientific Computing at the Pacific Biological Station and Head of the Fisheries Oceanography section via the Institute of Ocean Sciences. Day to day life at the PICES Secretariat is filled with correspondence about the planning, organizing, and implementing of PICES' expanding scientific activities, and getting the output of these efforts into the primary literature. I contribute to the PICES North Pacific Ecosystem Status Report and attempt to publish as time allows. In keeping with the PICES mandate, my current research interests include atmospheric-oceanic interactions and their effects on marine ecosystems; my daughter accuses my of being too interested in the weather.

Christina Chiu (second from right)
The last time I had to write something like this was almost 10 years ago, for the inaugural issue of PICES Press, in June 1993. I flipped through it and it felt like reading history! 10 years is a not a short period of time, and obviously I started working for the PICES Secretariat at a very tender age ... My background remains unchanged, and completely non-scientific, though I believe in hands-on experiments and research, my preferred subjects being wools, cottons, silks, tea and, to a lesser extent, food. My degrees are in Arts, specifically Japanese Literature (B.A.) and Japanese Theatre (M.A., both from the University of Toronto). Design is my favourite task and finances are a dread. Though my position title was recently re-named (to Deputy of Administration), my role is basically the same, which is to make things happen in general - from ordering toner cartridges, planning trips, paying everyone and for everything, to producing reports and brochures, and organizing meetings and receptions for 50-500 people. Don't be misled, I am not the PICES know-it-all, but I think I at least know where to ask, or offer vague and grandiose approximations.

Julia Iazvenko (middle)
I grew up in Azerbaijan and received my first degree in Russia (B.A. in History, Moscow State University). After I moved to Canada, I continued my education (M.A. in History, University of Waterloo). I worked in the Pylos Regional Archaeological Project in Greece as a member of an international team of scientists and archaeologists, and later as technician and translator/editor and junior programmer at various private sector companies. My major responsibility as Administrative Assistant is maintenance of the PICES Database and Home Page, which is no small task when 400-500 scientists submit abstracts to and pre-register for our meetings. Other duties are general office support and assistance in the production of PICES publications, and support to the Annual Meetings. My hobbies are hiking, rock-climbing, canoeing, and swing dancing. My favourite music is jazz.

Natalia Bessmertnaya (second from left)
Being a Pacific Research Fisheries Center (TINRO-Center, Vladivostok, Russia) staff, I jointed the PICES Secretariat in April 2002 as the third intern under the PICES Intern Program. I graduated from the Far Eastern Fishery University (Vladivostok, 1989) and from the Far Eastern State University (1996). My degrees are in Fish Biology and English Philology. At PICES Secretariat, I am involved in formatting various PICES publications, and in providing secretarial support to PICES bodies, scientific meetings and other day-to-day Secretariat activities.

PICES Twelfth Annual Meeting

October 10-18, 2003
Seoul, Republic of Korea

Human dimensions of ecosystem variability (Science Board Symposium)
Natural and anthropogenic influences on pelagic-benthic coupling in coastal systems (BIO/MEQ Topic Session)
Latitudinal differences in response of productivity and recruitment of marine organisms to physical variability, from Subarctic to subtropical waters, along the eastern and western sides of the Pacific (BIO/POC/CCCC Topic Session)
Influence of fishing and/or invasive species on ecosystem structure in coastal regions around the Pacific Rim (CCCC Topic Session)
Comparison of modeling approaches to describe ecological food webs, marine ecosystem processes, and ecosystem response to climate variability (CCCC Topic Session)
The role of sharks in marine ecosystems of the North Pacific Ocean (FIS Topic Session/S5)
Management of eel resources (FIS Topic Session/S9; jointly with EASEC)
Aquaculture within an ocean ecosystem (MEQ/BIO Topic Session)
Ecosystem-based management science in the context of the North Pacific (MEQ/BIO/FIS Topic Session)
Physical process impacts on biological and fish populations with variability in freshwater inputs to the ocean (POC/BIO Topic Session)
GIS/Geographic-based applications to marine sciences (TCODE Electronic Poster Session)
Linkages between open and coastal systems (BASS Workshop)
Examine and critique a North Pacific Ecosystem Status Report (MONITOR Workshop)
Combining data sets on distributions and diets of marine birds and mammals (MBM-AP Workshop)
Harmful algal blooms - harmonization of data (WG 15/ TCODE Workshop)
Planning a micronekton sampling gear intercalibration experiment (MIE-AP Workshop)

PICES Calendar

- Fifth Annual Workshop on *Salmon ecology in coastal ecosystem*, February 11-12, 2003, Newport, Oregon, U.S.A.
- MODEL Workshop to *Embed NEMURO and NEMURO.FISH into a 3-D circulation model,* March 3-6, 2003, Yokohama, Japan
- SCOR/IOC/PICES inter-comparison of *Underway and drifting/mooring p(CO_2) measurement systems*, March 10-14, 2003, Tsukuba, Japan
- Interim PICES Science Board and Governing Council meeting, April 7-9, 2003, Sidney, Canada
- KORDI/PICES/CoML Workshop on *Variability and status of the East China Sea and Yellow Sea ecosystems,* April 28-29, 2003, Seoul, Republic of Korea
- PICES/CoML *Regional marine life expert* Workshop-I, May 2003, venue TBD
- ICES/PICES/GLOBEC International Symposium on *Role of zooplankton in global ecosystem dynamics: Comparative studies from the world oceans*, May 19-23, 2003, Gijón, Spain. Check our Home Page for the latest information on the program, spousal participation & the Extravaganza Dinner!!
- Third PICES Workshop on *Okhotsk Sea and adjacent areas*, June 2003, Vladivostok, Russia
- *North Pacific Ecosystem Status Report* Workshop, August 2003, Sidney, Canada
- GCP/PICES Workshop on *Ocean surface pCO_2 database and integration*, October 6-8, 2003, Tsukuba, Japan
- PICES Twelfth Annual Meeting, October 10-18, 2003, Seoul, Republic of Korea
- PICES/CoML *Regional marine life expert* Workshop-II, November 2003, Sidney, Canada
- PICES IFEP Workshop on *"*In-situ*" iron enrichment experiments in the eastern and western subarctic Pacific*, December 4-6, 2003, Sidney, Canada
- SCOR/IOC (co-sponsored by PICES) international Symposium on *Quantitative ecosystem indicators for fisheries management*, March 31-April 3, 2004, Paris, France

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