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PICES Press

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

The state of PICES science – 2003

PICES "Year-in-Review" 2003

PICES continued building a mature marine science organisation in 2003, upon its three pillars for success: scientific excellence, scientific capacity, and scientific advice.

Scientific excellence: Papers presented at PICES scientific sessions were published in dedicated issues or special sections of international journals such as *Canadian Journal of Fisheries and Aquatic Sciences* (from the 2001 FIS Topic Session on "Migration of key ecological species in the North Pacific Ocean"); *Deep-Sea Research II* ("North Pacific biogeochemical processes"); *Journal of Oceanography* (from the 2002 Symposium on "North Pacific transitional areas"); *Progress in Oceanography* (from the 2001 BIO Topic Session on "Plankton size classes, functional groups and ecosystem dynamics" which was dedicated to the memory of the late Prof. Michael Mullin); and *Marine Environmental Research* (studies from the 1999 MEQ Practical Workshop on "Interdisciplinary assessment of marine environmental quality in Vancouver Harbour"). In addition, two reports were published in the PICES Scientific Report Series: from Working Group 13 on *CO_2 in the North Pacific* to summarize the research and technical activities that have been conducted by member nations of PICES, and to synthesize CO_2 data and provide a comprehensive picture of the anthropogenic CO_2 distribution in the North Pacific; and from BASS and MODEL Task Teams of the CCCC Program to summarize efforts on trophic modelling of the Subarctic Pacific Basin ecosystems. An external review of the PICES publication program counted 65 publications (14 peer-reviewed) in six different publication series over the 12-year history of PICES and concluded that this was exceptional, in particular for such a small Secretariat staff.

Scientific capacity: Fifteen workshops and meetings were held by PICES over the past year, in addition to the Twelfth Annual Meeting in Korea. Among the longer and more detailed meetings were a MODEL workshop to *Embed NEMURO and NEMURO.FISH into a 3-D circulation model*, which took place in Japan and was co-sponsored by the Nakajima Foundation; a 5-day inter-comparison workshop on *Underway and drifting/moored pCO_2 measurement systems* also in Japan, which was co-sponsored with other Japanese agencies; a major symposium on *The role of zooplankton in global ecosystem dynamics: comparative studies from the world oceans*, held in Spain with the co-sponsorship of GLOBEC and ICES; the 3rd PICES workshop on the *Okhotsk Sea and adjacent areas*, held in Russia; a *North Pacific Ecosystem Status Report* workshop, a PICES/Census of Marine Life workshop, and a MONITOR workshop to develop a west coast of North America marine observation program, all of which were held in Canada.

PICES continued to build strong relationships with other international marine science organisations by promoting collaborative activities. These organisations included the International Council for the Exploration of the Seas (ICES), the Intergovernmental Oceanographic Commission (IOC), the International Geosphere-Biosphere Program (IGBP), the Scientific Committee on Oceanic Research (SCOR), the North Pacific Anadromous Fish Commission (NPAFC), and the Climate Variability (CLIVAR) program of the World Climate Research Program (WCRP).

Scientific advice: In October 2003, PICES received a formal request from a member nation for scientific advice on the issue of recent regime-like changes in conditions in the North Pacific and their implications for fisheries. This represents an important step in the evolution of PICES, towards providing formal advice on issues of broad concern to North Pacific marine science. This is different than providing short-term advice on particular fisheries management issues such as catch quotas, which has never been part of the PICES mandate. The major effort to produce a status report of the marine ecosystems in the North Pacific represents another method of providing advice. This project progressed very well in 2003, hosting workshops in Russia on the status of the Sea of Okhotsk, and in Korea on the status of the Yellow Sea / East China Sea, as well as the synthesis workshop mentioned earlier. The draft ecosystem status report was the topic of much discussion at the Annual Meeting in Korea. Publication of the final report is hoped for in early 2004.

Highlights from the Annual Meeting

The Twelfth Annual Meeting of PICES, held October 10-18, 2003, in Seoul, Korea, hosted 326 registered participants, 11 scientific sessions, 6 workshops, and several Working Group, Task Team and Advisory Panel meetings. There were 170 oral presentations, 172 posters and 12 electronic posters.

The keynote lecture, titled "Application of otolith chemistry to interpret some issues of oceanic variability and fisheries", was presented by Prof. Suam Kim of Pukyong National University, Busan, Korea. He reviewed the major processes driving global changes in fisheries, and those in Korea in particular, and discussed how examination of the chemical constituents of the ear bones of fish (otoliths) can be used to tracer the migrations and ocean conditions experienced by fish during their lifetimes.

This presentation was followed by the theme session for PICES XII, titled "Human dimensions of ecosystem variability". Papers dealt with the human factor in marine ecosystems, including the impacts of marine ecosystem changes to fisheries management systems and to human societies in general (each of which was presented by a social scientist, new to PICES), and of course the impacts that humans have on marine ecosystems. Most innovative was a presentation by Hidetada Kiyofuji *et al*. from Japan, who examined the potential impacts of high intensity squid jigging lights on fuel use and carbon inputs to the atmosphere. Important points that arose were the bi-directional nature of these interactions (*i.e.* environmental

Dr. Ian Perry summarizing PICES scientific achievements of 2003 at the PICES XII Opening Session.

Prof. Suam Kim giving the Keynote Lecture at the PICES Twelfth Annual Meeting.

Attentive audience at the Science Board Symposium on "Human dimensions of ecosystem variability".

changes and impacts to humans, and how human responses in turn impact the marine environment), and the difficulty in distinguishing natural from anthropogenic effects on marine systems. The session on "Latitudinal differences in the responses of productivity and recruitment of marine organisms to physical variability" identified important themes such as: the role of strong local gradients (fronts, meanders, eddies) in regulating distributions and seasonal and interannual variability of migratory and advective transport pathways; life stage transitions, and the use of different ocean regions during different parts of the life cycles of key species; and physiological rates and constraints and how these affect population response to spatial and temporal gradients. A very successful session on "Management of eel resources" reflected the broad range of research on the genetics, behaviour, physiology, and ecology of eels that is being conducted in East Asian countries and elsewhere, and which is providing valuable new information about eels. Many of these studies also highlighted the need to gain a greater understanding of the mysterious life cycle of eels in terms of their oceanic spawning, larval migration, recruitment, and the choice that eels make to live in either coastal, estuarine or freshwater habitats. Other sessions included: "Physical and biological responses of coastal ocean ecosystems and estuaries to inputs of freshwater"; "Influence of fishing and/or invasive species on ecosystem structure in coastal regions around the Pacific Rim"; "Aquaculture in the ocean ecosystem"; "Comparison of modeling approaches to describe ecological food webs, marine ecosystem processes, and ecosystem response to climate variability"; "Ecosystem-based management science and its application to the North Pacific"; "GIS/Geographic-based applications to marine systems" (Electronic Poster Session); and general paper sessions of the Physical Oceanography and Climate (POC) and Fisheries Science (FIS) Committees. Workshops were convened to examine and critique a North Pacific Ecosystem Status Report (see article elsewhere in this Newsletter); to combine data sets on distributions and diets of marine birds and mammals; to harmonize data relating to harmful algal blooms (see article elsewhere in this Newsletter); to plan a micronekton sampling gear inter-calibration experiment; to examine linkages between open and coastal systems; and to discuss the status of Yellow Sea and East China Sea ecosystems (see article elsewhere in this Newsletter). Sincere thanks are due to all the convenors for their hard work at making each of these scientific sessions and workshops a success.

The Best Paper Award for the Science Board Symposium went to Lawrence Hamilton (U.S.A.) for his presentation entitled "Ecosystem - society interactions in the North Atlantic: Human dimensions of fishery collapses". The Best Poster Award went to Dong-Hwa Sohn (Korea) for her poster titled "Stock identification of chum salmon (*Oncorhynchus keta*) using trace elements in otoltihs" (co-authored by S. Kang and S. Kim). The other 2003 winners are: the BIO Award - Sachihiko Itoh (Japan) for his paper "Effect of eddy transport and blocking on the migration of small pelagic fishes" (co-authored by T. Sugimoto); the FIS Award - Yuki Minegishi (Japan) for her paper "Definitive identification of all species of the genus *Anguilla* using the complete mitochondrial genome" (co-authored by J. Aoyama, J. Inoue, M. Miya, M. Nishida and K. Tsukamoto); the MEQ Award - Sung-Il Lee (Korea) for his paper "Ecosystem-based management of fisheries resources in the Tongyeong marine ranching area in Korea" (co-authored by C.I. Zhang and J.-M. Kim); the POC Award - Sung-Hyun Nam for his paper "The corrections of the high-frequency (2-20 days) fluctuation effects on the TOPEX/POSEIDON altimeter data in the East (Japan) Sea" (co-authored by S.-J. Lyu and K. Kim); the CCCC Award - Rolf Ream (U.S.A.) for his paper "Oceanographic influences on Northern Fur Seal migratory movements" co-authored by J. Sterling and T. Loughlin); and the TCODE Award - Kimberly Bahl (U.S.A.) for her E-poster "North Pacific Ecosystem Theme Page and Metadatabase: A collaborative research tool for fisheries-oceanography and ecosystem investigations" (co-authored by B. Megrey and S. A. Macklin).

Up-coming highlights for 2004

Highlights to look forward to in 2004 include several scientific sessions and workshops: an Iron Fertilisation Experiment Panel workshop on In situ *iron enrichment experiments in the eastern and western subarctic Pacific* (February, Victoria, Canada); a Canadian-SOLAS/PICES Topic Session on *Response of the upper ocean to mesoscale iron enrichment* at the ASLO/TOS 2004 Ocean Research Conference (February, Honolulu, U.S.A.); the international symposium on *Quantitative ecosystem indicators for fisheries management* (April, Paris, France, co-sponsored by SCOR and IOC); a GCP(Global Carbon Project)/PICES/NOAA Workshop on *Understanding North Pacific carbon-cycle change: data synthesis and modelling* (June, Seattle, U.S.A.); and a MODEL Workshop on *The development of a model on coupled responses of lower and higher trophic levels for climate variability in the North Pacific* (funding from Japan Fisheries Research Agency) in June, also in Seattle. The PICES Thirteenth Annual Meeting will be held October 15-23, 2004, in Honolulu, with the theme "Beyond the continental slope – complexity and variability in the open North Pacific Ocean".

We hope that you will watch the PICES web site for announcements of these and other meetings and scientific sessions, and plan to join us in Hawaii.

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2003 Wooster Award

In October 2000, PICES announced a new award that is to be 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; has achieved sustained excellence in research, teaching, administration, or a combination of these in the area of North Pacific; has worked to integrate the various disciplines of the marine sciences; and preferably someone who is, or has been, actively involved in PICES activities.

The award was named in honour of Dr. Warren S. Wooster, the principal founder and first Chairman of PICES, and world-renowned researcher and statesman in the area of climate variability and fisheries production. The award consists of a commemorative plaque and travel support to attend the following PICES Annual Meeting in order to receive the award. A permanent plaque identifying Wooster Award winners resides at the PICES Secretariat in Sidney, British Columbia, Canada. The late Professor Michael M. Mullin (U.S.A.) and Dr. Yutaka Nagata (Japan) were honoured with the Wooster Award in 2001 and 2002, respectively.

At PICES XII in Seoul, Korea, it was announced that Dr. William (Bill) G. Pearcy is the recipient of the 2003 Wooster Award. The following is the citation from Science Board for the 2003 Wooster Award:

Dr. William Pearcy is a world-renowned authority on many aspects of biological oceanography, in particular his extensive work on fishes and squids in the North Pacific. He has made significant contributions to many areas of marine research, including fisheries oceanography, the ecology of deep-sea and open ocean fishes and squids, the trophic dynamics of marine fishes, and pollution and trace metals in the marine environment. He is perhaps best known recently for his contributions to understanding all aspects of Northeast Pacific salmon during their ocean phase. He has over 150 publications in many of the major scientific journals, including *Science* and *Nature*. He has demonstrated sustained excellence in teaching during his years as a professor in the College of Oceanic and Atmospheric Sciences at Oregon State University, where he was major advisor for over 30 graduate students and a committee member for at least 50 more. He has served on numerous international committees, including those of PICES. He was involved with PICES and its committees very early on, and he gave the keynote address at the 1997 PICES Annual Meeting on his work on salmon in the North Pacific. Since his retirement, he has worked tirelessly on a State panel to examine ways to restore natural runs of salmon to Oregon. Science Board is very pleased to name him as the recipient of the PICES Wooster Award for 2003.

At the award presentation ceremony, Dr. Vera Alexander, Chairman of PICES, read a note from Dr. Warren Wooster:

I cannot remember when I first met Bill Pearcy, but twenty years ago we first interacted on the question of environmental variability and its effects on fisheries. In May 1983, we convened a workshop at the University of Washington to review existing knowledge on ocean and fish variability and to develop a strategy for investigation of the interactions. In November that year, Bill Pearcy at Oregon State University held another workshop, on the influence of ocean conditions on the production of salmonids in the North Pacific. These two workshops and the resulting publications focused attention on the importance of environmental influence on marine ecosystems.

Bill Pearcy has been a pioneer in what I like to call "salmon oceanography". Students of these charismatic fish have had a curious fixation on the fresh water phase of their life, after which the fish just disappeared into the black box we call the ocean. As an oceanographer, Bill knew that life in the black box was important to salmon, and was interesting, and complex, as he, with his students and colleagues have successfully demonstrated. This work has exemplified the spirit of PICES where fishery science is intimately linked with the other disciplines necessary for ecosystem studies - meteorology and climatology, oceanography of the several flavors (physical, chemical, biological) and ecology in the broader sense. Of course, as the Science Board citation makes clear, Bill Pearcy's interests are by no way limited to salmon or even to fish. His scientific perspective, both broad and deep, makes him a worthy recipient of the PICES Wooster Award for 2003.

Bill's biography can be found elsewhere in this issue of PICES Press.

Dr. George Boehlert reading Dr. Pearcy's acceptance speech after receiving the Wooster Award on his behalf.

Dr. Alexander presented a commemorative plaque to Dr. George Boehlert, US delegate to PICES, who read a brief acceptance from Dr. William Pearcy:

This is indeed a great honor! And I deeply regret not being here. Grape harvest and a visit from distinct friends have intervened.

This is not just a prestigious honor for me - it is for all my colleagues, students and friends that have inspired, collaborated and helped me throughout my years in science. This includes many PICES scientists, including many here today. It includes colleagues on PICES and SCOR Working Groups, and my Japanese friends from the University of Tokyo and Hokkaido University, and the crews aboard many cruises of the Oshoro Maru.

And I especially thank my loyal friend, Papa Wooster, father of PICES, for this award and for a number of other reasons. Warren prompted me to give the lectures for his series on recruitment fishery oceanography at the University of Washington. This resulted in my little book on Ocean Ecology of North Pacific Salmonids, published in this series by Washington Sea Grant. He also encouraged my participation in workshops and subsequent publications in Interannual Variability of the Environment and Fisheries of the Gulf of Alaska and the Eastern Bering Sea (1983) and El Niño North, Niño Effects in the Eastern Subarctic Pacific Ocean (1985). The 1982-83 El Niño was a nail in the coffin that the ocean had an unlimited carrying capacity for salmonids and as a result stimulated a surge in research on the importance of the ocean lives of anadromous salmonids—research that is prolific today.

I consider Warren to be the venerable, world-renowned fishery oceanographer of the 20th and now the 21st centuries. He has made grand contributions to the world organization and community of oceanographers and marine biologists. He is an inspiration for all of us. Banzai, Warren!

On December 1, 2003, a "COAS Faculty Awards Gathering" was held to acknowledge 5 faculty in the College of Oceanic and Atmospheric Sciences (Oregon State University) for a variety of awards, and Dr. William (Bill) Pearcy, who was one of them, was honoured (again) for his 2003 PICES Wooster Award. The Award plaque was officially presented to him by Dr. George Boehlert.

After the "presentation ceremony", Dr. Bill Pearcy (middle) poses with Drs. Ric Brodeur (former student and friend of Bill, left) and George Boehlert (Director of the Hatfield Marine Science Center at OSU, right), with a commemoration from OSU and the Wooster Award plaque in hand.

Dinner with family and friends to celebrate the Award at the Big River restaurant in Corvallis. Left to right: Susan Boehlert, Amy Schoener (Bill's wife), George Boehlert, Bill, Waldo Wakefield (former student and friend of Bill), Claire Reimers (OSU faculty and CIMRS Director), Ric and Linda Brodeur.

We are now soliciting nominations for the 2004 Wooster Award (Contact the PICES Secretariat *secretariat@pices.int* or see PICES Press Vol. 9 (1) 2001 for selection criteria and award description). **Nominations must be received no later than May 1 2004** and should include the following information: nominee's name institutional affiliation and title address biographical resume and statement of justification for the nomination. The award will be presented during the Opening Session of PICES XIII on October 18 2004 in Honolulu, U.S.A

The state of the eastern North Pacific through summer 2003

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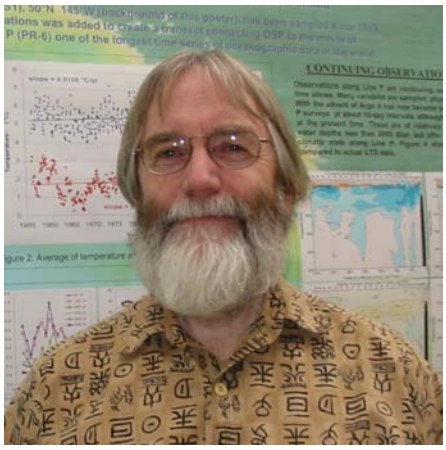

Frank A. Whitney has led the Line P program for the past 12 years, carrying out repeat oceanographic sections for WOCE (1991-97) and hosting the Canadian JGOFS program (1992-97) on these cruises. Through this time, his main research interest has been in understanding processes which control nutrient supply to the upper ocean. He has also surveyed mesoscale eddies several times in an attempt to estimate offshore transport of coastal waters in the Gulf of Alaska. Frank has been working in oceanography on the British Columbia coast since 1969.

The cold layer which has been underlying the surface waters of the Gulf of Alaska in the past couple of years, and caused extreme biological responses in North American coastal waters during the 2002 upwelling (Huyer *et al*., *Geophys. Res. Lett*. 30, 2003), prompted us to assess the uniqueness of this event at Ocean Station Papa (50ºN, 145ºW). Monthly temperature anomalies in the upper several hundred meters show that warm and cool periods can persist for several years (Fig. 1, courtesy of Marie Robert, Institute of Ocean Sciences), especially below the mixed layer (winter Mixed Layer Depth ~100 m). The 1960s were the coolest period in the past ~50 years and the 1990s were warmest.

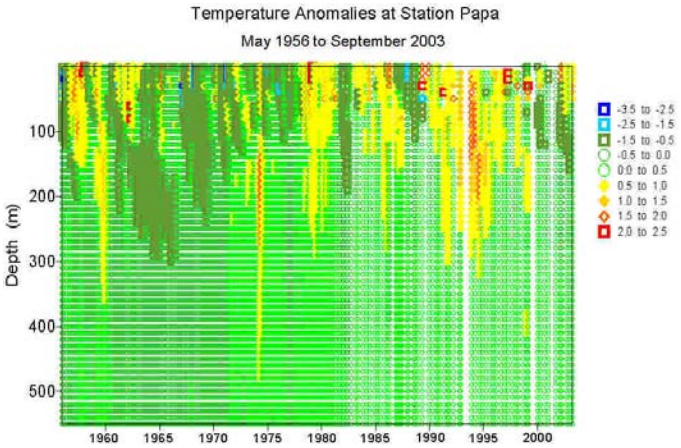

Fig. 1 Temperature anomaly at Ocean Station Papa from 1956 to present. The dark green (strong negative anomaly) to red (strong positive anomaly) shading shows periods of cool and warm waters below the mixed layer.

Huyer and others showed results which defined the coastal upwelling of 2002 along the British Columbia to California coast as the most extreme cool event yet observed. Our results from Stn. Papa are not as dramatic. Cool waters similar to those found in the 1960s, and sporadically in the 1980s, are again observed in the upper 150 m. These waters are slightly less saline than recently seen (Fig. 2, from Marie Robert also), but are well within the range observed at this site. Overall at Stn. Papa, we continue to observe a warming trend in both the surface and subsurface layers, with the rate of warming appearing greater at depth. Salinity shows little change in surface waters and an increasing trend in the 150-250 m layer. An increase in temperature and salinity in subsurface waters suggests that subtropical waters are becoming more dominant. These waters are relatively impoverished in nutrients, thus their presence will reduce nutrient supply to the mixed layer and may decrease the productivity of this area.

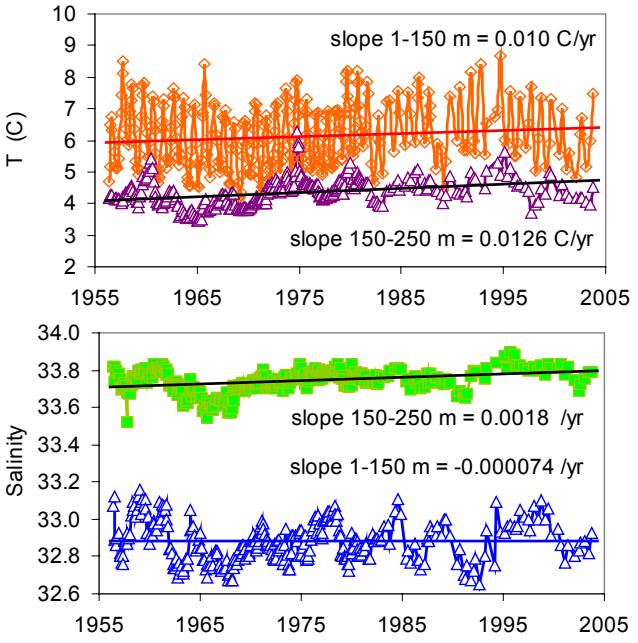

Fig. 2 Average temperature and salinity at Ocean Station Papa in the upper 150 m and 150 to 250 m layers.

The recent development of a cold layer in the Gulf of Alaska, however, did reduce the winter mixed layer depth to ~75 m in 2002. The enhanced stratification of the upper ocean affected nutrient supply and led to extensive silicate limitation of diatom growth in summer 2002 (PICES Press, July 2003). Nutrient supply in February 2003 suggested silicate limitation could be even more severe in the following summer (Fig. 3). Diatoms typically utilize silicate and nitrate at a ratio of 1.2 uM Si:1 uM NO_3. If the supply ratio of nutrients is less than this, then silicate depletion would be expected. However, there is little evidence of silicate limitation in September 2003. Conditions during late summer are quite similar to the long-term average (Whitney and Freeland, *Deep-Sea Res. II* 46, 1999) and show a broadening of the HNLC (high nitrate, low chlorophyll) domain in the Gulf of Alaska.

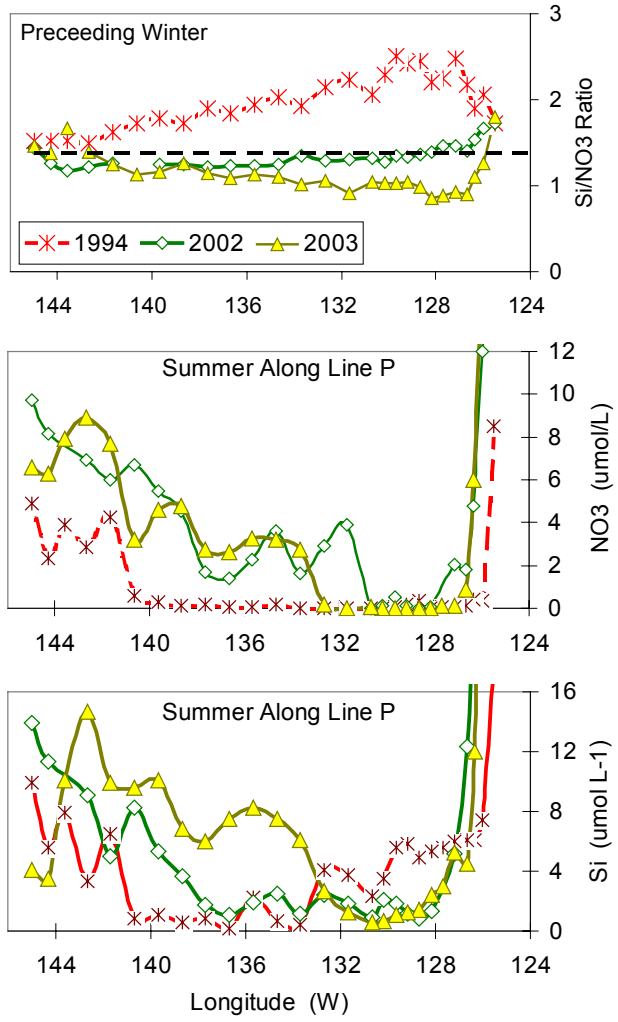

Fig 3 *Silicate/nitrate ratios in surface waters along Line P in winters of 1994 (warm, near normal), 2002 and 2003. Dashed line indicates the ratio needed to support diatom growth. Lower panels show nutrient concentrations in summer for the same 3 years.*

How to make sense of such seasonal inconsistencies? Howard Freeland (Institute of Ocean Sciences) has been using Argo data (http://argo.jcommops.org/) to compute the location of the axis of the subarctic current from the dynamic height field (details can be found at www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Dhgts_e.htm). His analysis shows the subarctic current rapidly shifted 700 km south in spring 2003 at 145ºW, the longitude of Ocean Station Papa (Fig. 4). Because this analysis starts in early 2002 when the axis is to the north, it is not possible to determine from these data which position of this current is "typical". But the sudden southward shift of subarctic waters does explain why silicate depletion was not observed along Line P in summer 2003.

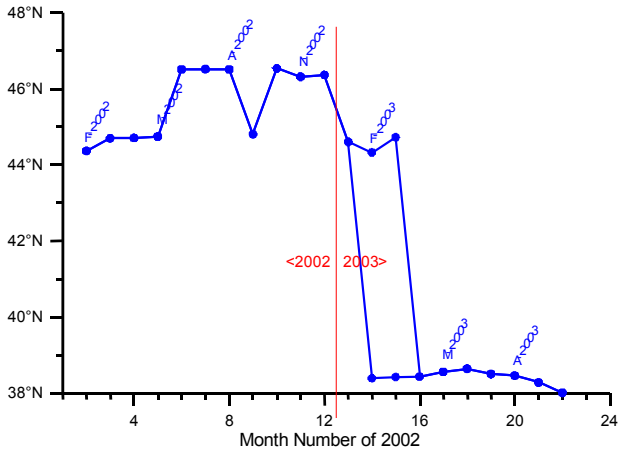

Fig 4 *The position of the maximum in dynamic height at 145ºW is plotted over time starting in January 2002. The plot shows a rapid shift south of the center of the subarctic current in the NE Pacific in spring 2003.*

These Argo results are showing that we cannot assume a similar water mass is being sampled on successive cruises. Many papers have been written making this assumption, and have attempted to estimate seasonal rates of new production based on nutrient drawdown. These estimates are at the core of our understanding of ocean productivity in the subarctic Pacific and are extremely vulnerable to north-south water mass displacements. Whitney and Freeland (*Deep-Sea Res. II* 46, 1999) estimated N-S gradients of nutrients at ~1 uM nitrate and 2 uM silicate per 100 km. A 700 km southward displacement of the subarctic current, as observed in 2003, potentially introduces a nutrient change larger than the annual estimated drawdown of ~7 uM nitrate and 11 uM silicate at Stn. Papa. Several years (decades?) of Argo data will be needed before we can assess the instability in major ocean currents and the frequency of latitudinal shifts. Until this data is available, at least some of the observations of anomalous nutrient utilization along Line P must be considered the result of rapid N-S advection of waters with either subtropical or subarctic characteristics.

The Bering Sea: Current status and recent events

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Pacific Decadal Oscillation index

Previous work (*e.g.*, Mantua *et al*. 1997) has shown that much of the climate variability of the North Pacific can be represented by the Pacific Decadal Oscillation Index (PDO) which is the first mode of the sea surface temperature anomalies in the North Pacific. The recent change in phase of the PDO from negative to positive (Fig. 1) has stimulated predictions of change in the Bering Sea ecosystem. A recent study (Bond *et al*., *GRL*, in press), however, shows that a climate perspective limited to the PDO is incomplete. In particular, the second leading mode of sea surface temperature anomalies accounts for more of the North Pacific climate variability since 1998, and hence should be recognized for its influence on the state of atmospheric forcing (and ecosystem productivity). In other words**,** atmospheric forcing for the Bering Sea/Gulf of Alaska and the southeastern North Pacific (California Current System) appear to have diverged. A north/south dipole in the sea level pressure anomaly (SLPA) has the Bering Sea and Gulf of Alaska experiencing atmospheric forcing characteristic to that after the regime shift of 1976/1977, while the atmospheric forcing for the southeastern North Pacific resembles that before 1976/1977.

Mooring 2 - southeastern Bering Sea shelf

Biophysical mooring data were successfully collected for the ninth consecutive year at Site 2 (56.88°N, 164.03°W) on the southeastern Bering Sea shelf. For the third year in a row, sea ice was not advected over the mooring site during winter (Fig. 2). This is in sharp contrast to the previous six years when ice was present at the site (ice was over the site in February 1996, even though no mooring was present). The lack of sea ice resulted in the water column remaining relatively warm (>3°C) into March. In February and early March of 2003 the water column was stratified, rather than well mixed as expected. While the water column during summer is characteristically two-layered, during winter the strong winds and tidal mixing usually result in the shelf being well mixed to >70 m. The last three years have been significantly warmer than the first six years of observations at this site. Were these observations (no ice and winter stratification) caused by the strong year-to-year variability that dominates the Bering Sea and North Pacific weather patterns, or is it an indication of decadal or longer changes in climate?

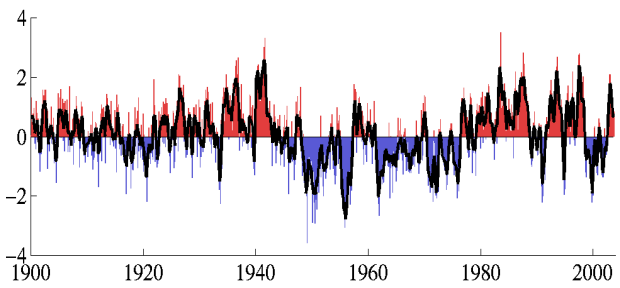

Fig. 1 Pacific Decadal Oscillation Index, 1900 - 2003. Source: http://tao.atmos.washington.edu/pdo/

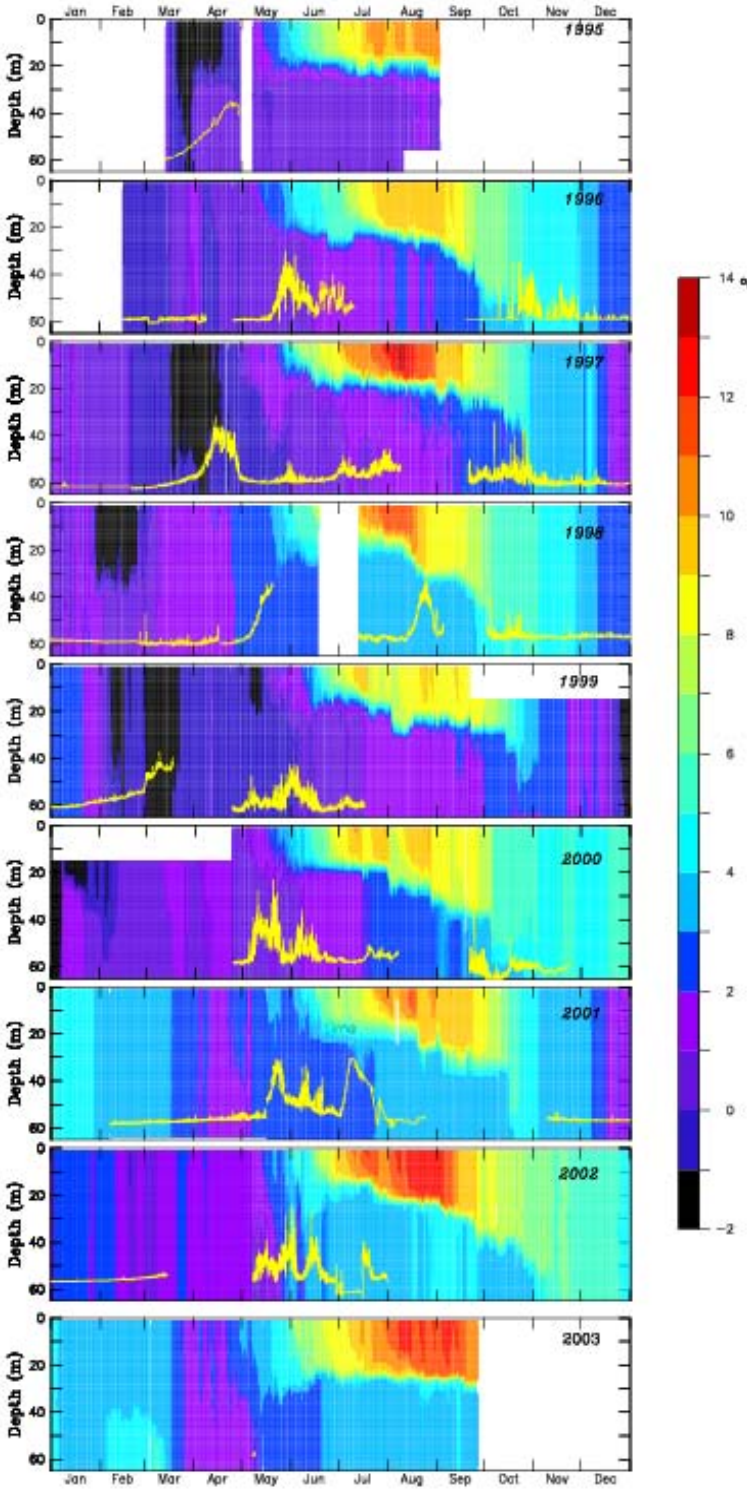

Fig. 2 Time series of biophysical properties measured at Site 2 by NOAA. Color contours show the vertical distribution of temperature (and mixed layer depth). The coldest temperatures (black) occurred when ice was over the mooring. The yellow line is the time series of chlorophyll fluorescence measured at ~11 m. Figure provided by Dr. P. Stabeno.

Shifts in regional climate patterns could have profound impacts on the southeastern Bering Sea ecosystem. The timing of the spring bloom is closely tied to the presence of sea ice. If ice is present after mid-March, there is an ice-associated bloom (Fig. 2). If sea ice is absent, then a bloom occurs in May or June with the stratification of the water column. From 2000-2002, and presumably in 2003, the spring bloom occurred in May or later. It has been hypothesized that blooms after April are utilized within the water column (by zooplankton), while production from blooms in March or April sinks to the bottom and feeds the benthic food web. Therefore, decadal shifts, which determine the prevalent spring bloom pattern, are important determinates of the productivity of the benthic and pelagic food webs of the southeastern Bering Sea shelf ecosystem.

Bering-Aleutian Salmon International Survey

A multi-year, international field research program, Bering-Aleutian Salmon International Survey (BASIS) began sampling in the summer of 2002. This research program includes synoptic surveys of salmon and other marine fish species throughout the Bering Sea with vessels from U.S.A., Japan and Russia (Fig. 3). Research objectives include: (i) understanding stock-specific migration, distribution, and abundance of salmon throughout the Bering Sea, and (ii) identification of linkages between oceanographic conditions, prey abundance and salmon growth and energetics.

NOAA's Ocean Carrying Capacity (OCC) program at the Alaska Fisheries Science Center's Auke Bay Laboratory (Juneau) is a member of BASIS, and sampled the southeastern shelf this past September (Fig. 3). Preliminary results indicate that species-specific distribution patterns exist for juvenile salmon along the eastern Bering Sea shelf. Juvenile sockeye salmon were mainly distributed throughout the Middle Shelf Domain. Juvenile chum and pink salmon were distributed along coastal waters north of 57°N, while juvenile chinook and coho salmon were distributed within near-shore locations. Juvenile salmon diet appeared to be related to their distribution (*i.e.* age - 0 pollock for juvenile chum and sockeye salmon; larval and juvenile sandlance for juvenile chinook and coho). Relative abundances of juvenile salmon during 2003 were similar to those observed in 2002; both years had higher relative abundances than those estimated during 2000 and 2001.

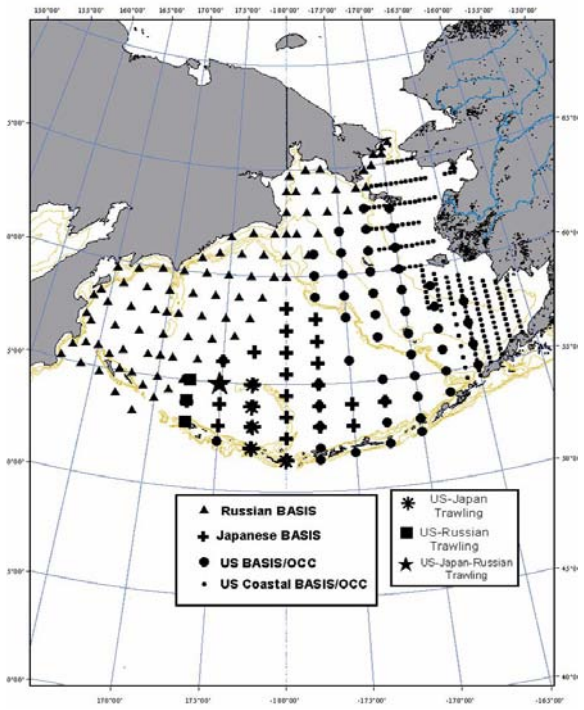

Fig. 3 Station locations for the Bering-Aleutian Salmon International Survey (BASIS) in 2002. Station locations for the 2003 field work were almost identical to that in 2002.

Scientists also collected oceanographic and plankton data at 150 stations during the survey. Fall phytoplankton (likely diatom) blooms were observed at many stations in Bristol Bay. Future analyses will focus on interactions of physical and biological oceanographic variables with the fall juvenile salmon abundances.

Coccolithophore bloom reappears

The eastern Bering Sea coccolithophore bloom, which failed to appear in the summers of 2001 and 2002, re-appeared this past summer. Dr. L. Eisner of NOAA's Auke Bay Laboratory spotted the aquamarine-colored water in September during this summer's BASIS cruise (Fig. 4, top panel). The observation occurred somewhat later than other years; it was not seen during the annual Hokkaido University T/S *Oshoro Maru* cruise (late July). BASIS shipboard observations found it along 166°W from 57.4°N to 57.9°N (~60 km north to south) and along 165°W at 57.3°N. The offshore limit of the bloom could not be determined from shipboard observations. Satellite observations however, show that the bloom covered parts of the Middle and Outer Shelf Domains from the southeast to St. Lawrence Island (Fig. 4, bottom panel).

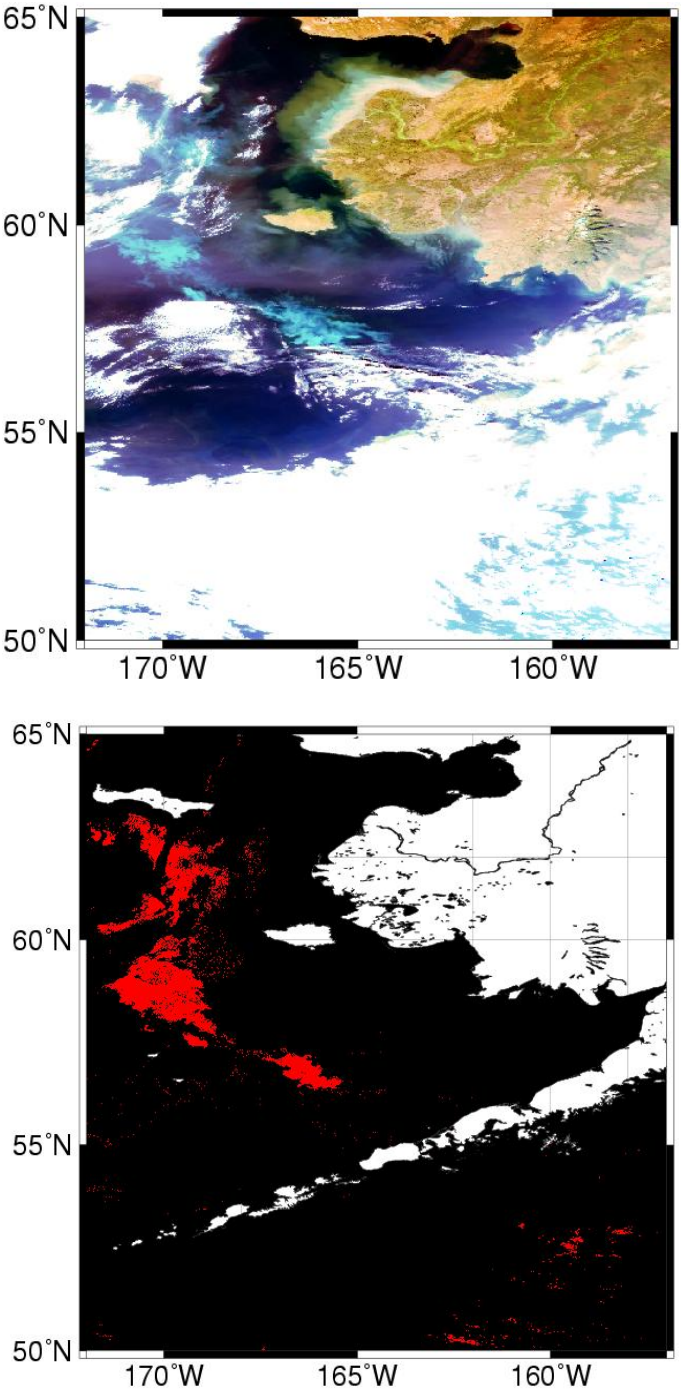

Fig. 4 Top panel: True color SeaWiFS image of the southeastern Being Sea, September 18, 2003. Bottom panel: Same image processed using a special algorithm (coccolithophore mask; Iida et al., 2002) to show extent of waters with reflectance characteristic of coccolithophore blooms. Images generously provided by Dr. S. Saitoh and Mr. T. Iida, Hokkaido University.

Acknowledgement: Many thanks to the following who submitted information and figures used in this report: Drs. Nicholas Bond, Lisa Eisner, Sei-ichi Saitoh and Phyllis Stabeno, and Mr. Takahiro Iida and Edward Farley.

The state of the western North Pacific in the first half of 2003

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Mr. Toshiyuki Sakurai is a scientific officer of the Office of Marine Prediction at the Japan Meteorological Agency (JMA). He is working as a member of a group in charge of oceanic information in the western North Pacific. Using a new "Ocean Comprehensive Analysis System" (in operation since January 2001), this group produces surface and subsurface temperature, salinity and current maps with 0.25×0.25 resolution in waters adjacent to Japan. Monthly averaged fields obtained from the system are included in the "Monthly Ocean Report" published by JMA. Mr. Sakurai is now involved in developing a new daily analysis system for sea surface temperature in the global ocean, using in situ *observations and data from several satellites with infrared and microwave sensors.*

Sea surface temperature

Figure 1 shows monthly mean sea surface temperature (SST) anomalies in the western North Pacific from January to June 2003, computed with respect to JMA's 1971-2000 climatology. Both NOAA/AVHRR satellite data and *in situ* data are used for the area between 20ºN and 50ºN from 120ºE to 160ºE, and only *in situ* observations are used in the other regions.

SSTs were generally below normal in the seas north of 35ºN from the Kuril Islands to east of Japan throughout the period, except for June, and SST anomalies exceeding -1ºC were found between 35ºN and 40ºN from March to May. Figure 2 shows that negative SST anomalies east of Japan lasted from December 2002 to May 2003, with a magnitude of about -1ºC, which is comparable to values observed in 1996 (region 4). In June, SSTs rose considerably in the seas north of 35ºN around Japan (regions 1-4), and SST anomalies exceeding +2ºC were found in the northern part of the Japan Sea.

SST anomalies in the seas south of Japan (region 6 and 9) continued to be positive in the last few years.

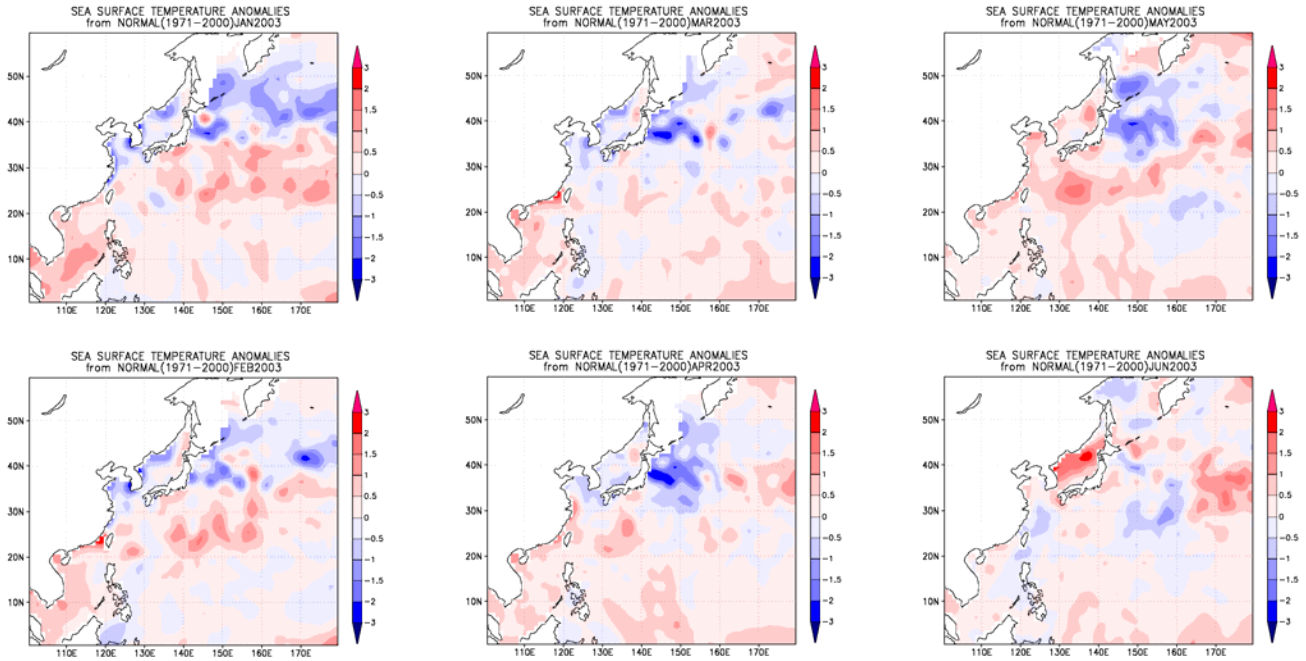

Fig. 1 Monthly mean sea surface temperature anomalies (ºC) in 2002: February, March and May (top row), and June, August and September (bottom row). Anomalies are departures from JMA's 1971-2000 climatology.

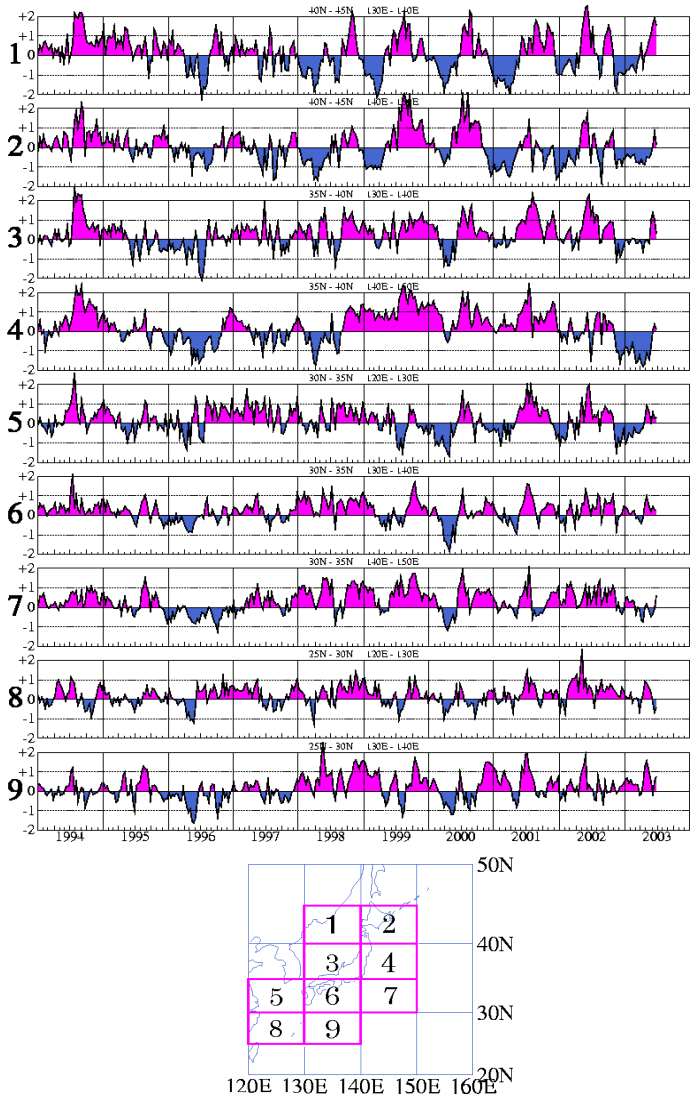

Fig. 2 Time series of the ten-day mean sea surface temperature anomalies (ºC), computed from JMA's 1971-2000 climatology for the areas shown in the bottom panel.

Kuroshio and Oyashio

A meander of the Kuroshio was found around 132ºE from January to March, and the Kuroshio flowed far off the coast between 132ºE and 135ºE from late February to March. The eastward propagation of the meander brought frequent small perturbations in the seas east of 135ºE after March. One of the perturbations developed into a meander around 140ºE in June, and the southernmost position of this meander was 32.5ºN, 140ºE in mid-June (Fig. 3).

Figure 4 shows subsurface temperature distributions at a depth of 100 m east of Japan for March and April 2003. These charts are based on JMA's Ocean Comprehensive Analysis System. The System includes objective analyses and a numerical ocean data assimilation model with 0.25×0.25 resolution adjacent to Japan, using Jason-1 altimeter observations and *in situ* water temperature data from ships and buoys.

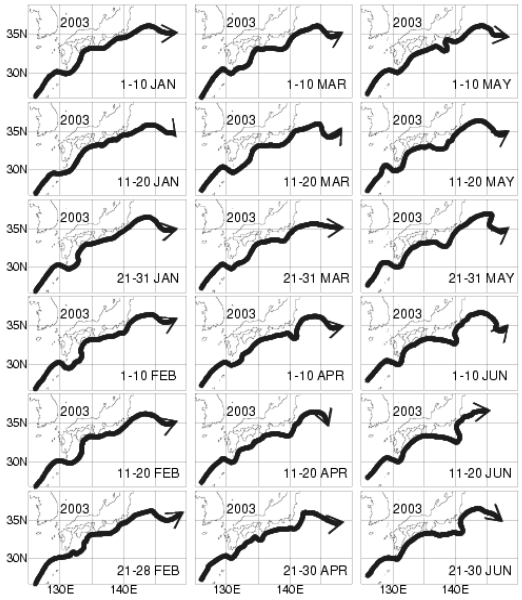

Fig. 3 Location of the Kuroshio axis from January to June 2003.

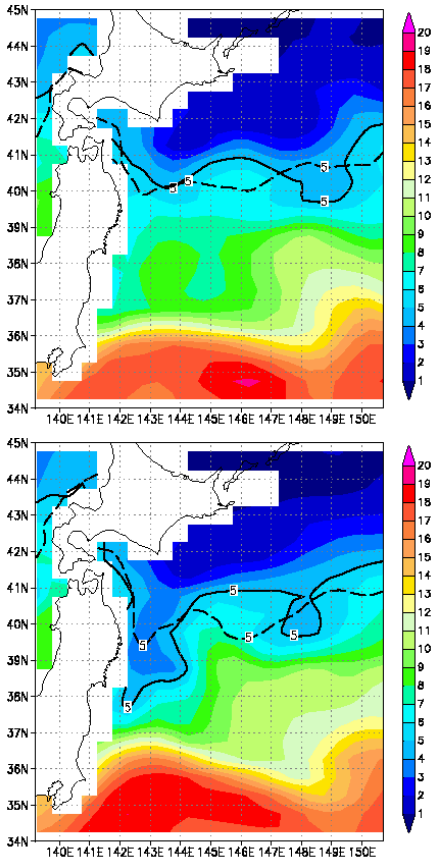

Fig. 4 Subsurface temperature (ºC) at a depth of 100 m east of Japan for March 2003 (top) and April 2003 (bottom). Solid lines denote 5ºC isotherm for 2003, and dashed lines are that of the normal (30-year averaged values from 1971 to 2000).

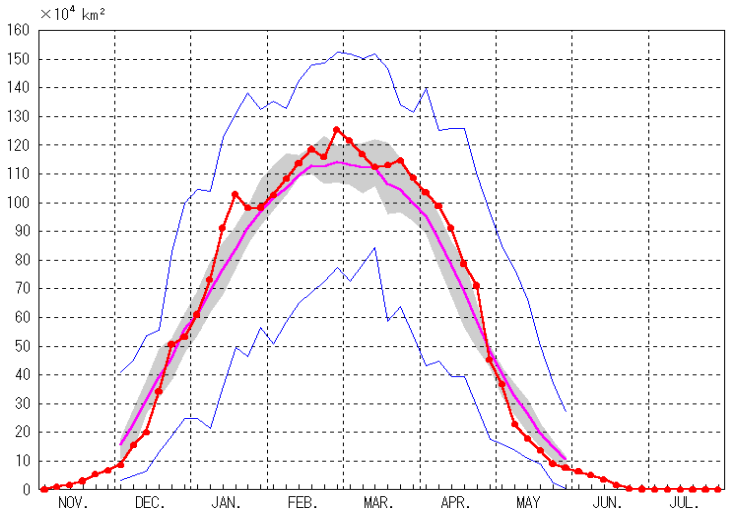

Fig. 5 Time series of sea ice area in the Sea of Okhotsk from November 2002 to July 2003.
time series of sea ice area; normal
near normal; maximum/minimum

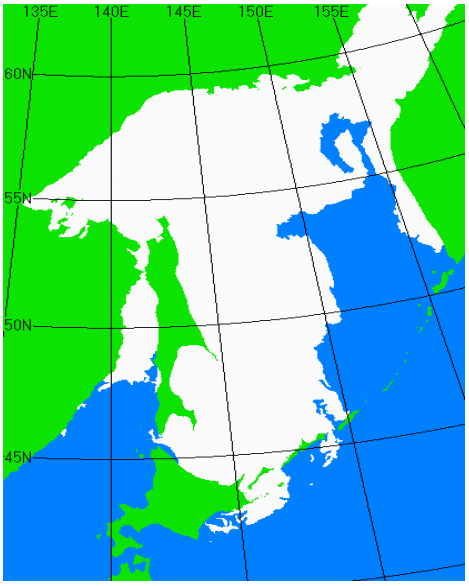

Fig. 6 Sea ice extent (white area) in the Sea of Okhotsk on February 28, 2003.

The southward extent of the Oyashio cold water (area where the temperature is colder than 5ºC in Fig. 4) was almost normal in March. But in April, the coastal branch of the Oyashio cold water extended southward considerably. It reached 37.5ºN, 142ºE in April, which was about 2º in latitude south of the normal position.

Sea ice in the Sea of Okhotsk

Sea ice conditions are analyzed based on visible and infrared satellite images. The extent of sea ice in the Sea of Okhotsk was near normal (30-year averaged values from 1971 to 2000) from November 2002 to July 2003, but was above normal in mid-January (Fig. 5). Sea ice area came to a maximum on February 28, and it was 125.49x10^4 km^2, larger than normal. This means 80% of the Sea of Okhotsk was covered with sea ice (Fig. 6). The area of sea ice was about 110% of normal, and in the southern part of the Sea of Okhotsk (south of 50ºN), was 130% of normal.

A considerable amount of sea ice flowed into the Pacific from early February, and the edge of sea ice extent reached around Cape Erimo in late February. Sea ice flowed into the Japan Sea through the Soya Strait from mid- to late February.

The status of oceanic zooplankton in the eastern North Pacific in 2003

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Dr. Sonia D. Batten is a biological oceanographer working in Nanaimo, British Columbia, Canada, for the Sir Alister Hardy Foundation for Ocean Science (a UK-based organisation). She studies large scale plankton dynamics in the North Pacific using data collected by the Continuous Plankton Recorder (CPR), currently focusing on the effects of environmental change on plankton communities. Sonia co-ordinates the Pacific CPR Program and is a member of the PICES CPR Advisory Panel.

Background

The Continuous Plankton Recorder (CPR) has been deployed on a transect from Prince William Sound, Alaska, to California routinely since 2000 (Fig. 1) to collect near surface plankton samples. The normal time taken to process the plankton samples and produce abundance data is about 1 year, because the Pacific samples are combined with the CPR samples collected in the north Atlantic and processed by the team at SAHFOS (Sir Alister Hardy Foundation for Ocean Science) in order of collection. In 2003, we decided to process a subset of the samples rapidly (within a few months of collection), and to publish summary data on the SAHFOS website at regular intervals to provide timely information on the status of the plankton populations. The impetus for this approach was provided by the recent recognition that 1999 saw a switch in plankton populations from a warm-water community to a cold-water community with consequent changes in various fish abundances (Peterson, W.T. and Schwing, F.B. (2003). A new climate regime in northeast Pacific ecosystems. *Geophys. Res. Lett.*, Vol. 30, 1896; Batten, S.D. and Welch, D.W. (2004, in press). Changes in oceanic zooplankton populations in the northeast Pacific associated with the possible climatic regime shift of 1998/1999. *Deep-Sea Res. II*). It is not known yet whether this change will persist for several more years and come to be called a regime shift with similar magnitude to that of 1976/77, or whether it is a short-term perturbation that will change back again after only a few years. The suggestion of a moderate El Niño in the latter part of 2002 also gave a reason to closely monitor the plankton through 2003 (*e.g.* www.noaanews.noaa.gov/stories/s1080.htm.).

Sampling in 2003

Five transects are usually sampled each year, spaced about 5-6 weeks apart to cover the spring and summer productive season. In 2003, sampling was carried out March 17-21, May 25-31, June 28-July 2, August 2-6, and the final one in early September. At the time of writing, subset data from the first 4 of these transects is available.

The subset consisted of about 20% of the samples that would normally be processed, spread evenly along the transect (10-13 samples each transect). Until all the samples from each transect have been processed, it would not be possible to determine how reliable the conclusions based on data from this sub-sample have been. However, the results show a consistent pattern for each month of 2003, suggesting a good representation of the 2003 plankton populations. The remaining samples are processed routinely by SAHFOS and should be available by mid-2004.

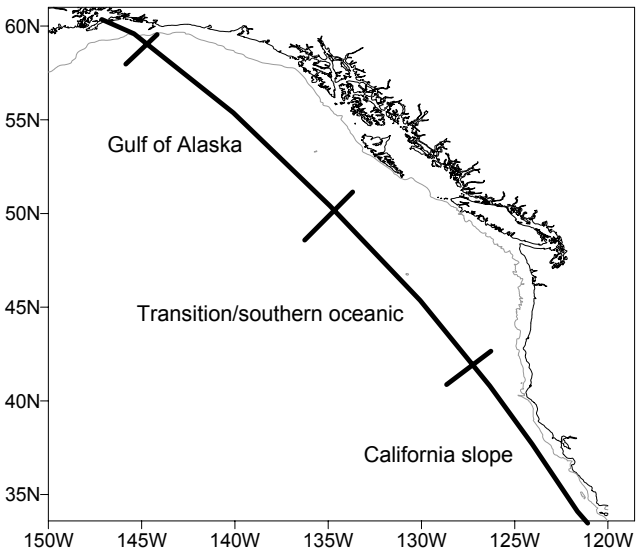

Fig. 1 The normal position of the CPR transect, subdivided into regions based on dominant currents and topography. The 1000 m isobath is also shown.

Data from 2003

The major currents and topography of the northeast Pacific have been used to divide the transect into regions (Fig 1). Data also exist from the Alaska shelf region at the north end of the transect, however, too few of the sub-samples were from this region to provide a meaningful summary. Visitors to the web site (www.sahfos.org and select "Pacific project") can view the plankton taxa recorded in each sample as well as the summaries of mesozooplankton abundance and biomass shown here. Figure 2 shows the time series of seasonal data for each region from 2000 through 2002 (mean and standard error) with the mean data from the sub-sampling in 2003 (usually 3 or 4 samples per region). Estimated biomass is shown in Table 1, where the mean biomass for each 2003 transect is compared to similar time periods from previous years. For all three regions, abundances appear to be generally lower in 2003 than in 2002, however, not outside the values found in 2000-2002.

Gulf of Alaska: Both abundance and biomass are lower than 2002 in the Gulf of Alaska, and similar to 2001. The seasonal cycle is more evident in the biomass values and is similar to previous years, with an increase after the first transect to a peak in early summer and a decline for the last transect.

Table 1 Mean mesozooplankton biomass (mg dry weight per sample) for 2003 transects together with closes (in time) from each previous year for all sampling regions: Gulf of Alaska (I), Transition/southern oceanic (II) and California slope (III).

Date	I	II	III
Mar-03	15.9	25.5	79
Mar-00	22.3	20.6	22.8
Apr-01	30.5	67.5	32.2
Apr-02	48.3	113.7	21.4
May-03	40.0	321.2	15.4
Apr/May-00	24	45	6
May-01	82	125	37
May/Jun-02	141	71	28
Jun/Jul-03	42.0	63.5	99.3
Jun-00	50	58	26
Jun/Jul-01	84	76	81
Jun-02	68	23	24
Aug-03	13.3	10.08	9.8
Jul/Aug-97	43.3	36.8	53.1
Aug-00	22	18	26
Aug-01	81	4	8
Aug-02	19	14	51

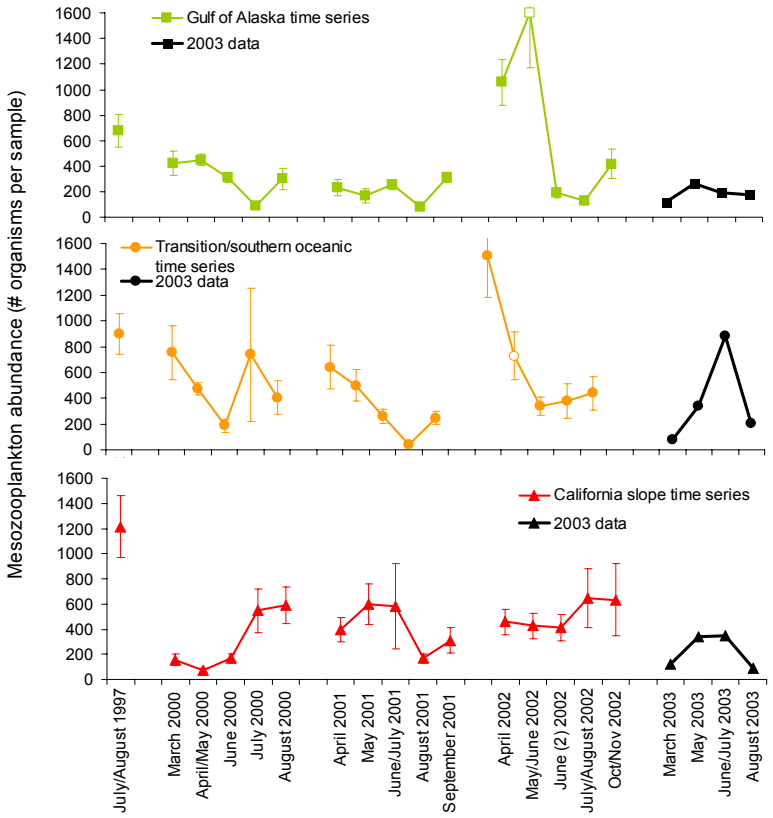

Fig. 2 Mean mesozooplankton abundance (± s.e.) for each CPR transect sampled. Unfilled points in May/June 2002 indicate when the transect was much further east than normal.

Transition/S. oceanic: The transition region has a high abundance peak in June/July 2003, that is the result of a single sample with exceptionally high abundance/biomass (the highest ever recorded in all years). Previous years show this region to be quite variable, even so, the normal seasonal cycle has been a decline from spring through summer with an increase again in late summer. This pattern is not evident so far in 2003.

California slope: The California slope region has shown an increase in abundance in mid-summer in previous years, as small copepods become numerous later in the season. This does not seem to have occurred yet in 2003. However, in 2001 there was a spring increase and a second, small increase quite late (in September). 2003 seems to be following this pattern so far and it may be that the final transect of 2003 will show a similar increase.

A pilot transect was sampled in July/August 1997, before the recent noted change in the ocean ecosystem, and previous studies have shown that the plankton composition of this transect was quite different from the plankton found in 2000 through 2002 at the same point of the season (Batten and Welch, in press). The plankton was dominated by large numbers of small species (as sampled by the CPR, principally small copepods). As shown in the extreme left of Figure 2 and the last block of Table 1, this caused a very high abundance value but biomass estimates were not very different from subsequent years. Although 2003 looks somewhat different from 2002, there is no evidence that the plankton is more similar to the pre-1999 regime and the oceanic communities are still dominated by larger sub-arctic species.

The final transect from 2003 will be posted on the website as soon as the data are available, and this approach will be continued through the 2004 sampling. Comments on the type of data or information that would be useful are welcome (soba@mail.pml.ac.uk).

The precautionary approach to the PDO

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Dr. Skip M^{c}Kinnell is Deputy Executive Secretary of PICES. During one of his former lives, he studied the relationship between various forms of macronekton and the sea. The abundance and diversity of scientific topics crossing his desk still manages to trigger some curiosity about what we think we know about any number of topics and how and why we came to think it. The topic of this article was inspired by some rather stimulating discussions with Jim Overland (PMEL, Seattle), and Steven Bograd (PFEL, Pacific Grove) at the PICES North Pacific Ecosystem Status Working Group meeting in Victoria in August 2003 and the recent paper by Bond et al. (2003).

Our collective approach to the complexity of nature has been to simplify its variability with indices of what we think are the dominant processes. Some typical examples in common use include:

- the difference between surface air pressure at Darwin and Papeete as a measure of the intensity of El Niño events (SOI – Southern Oscillation Index),
- the weighted sea level pressure over the North Pacific Ocean as an indication of average storm activity (North Pacific Index),
- the difference between the air pressure in Iceland and the Azores (NAO index), and
- the temporal pattern of the leading EOF of sea surface temperatures in the North Pacific Ocean, north of 20°N. (PDO index).

The first three of these share a common characteristic; they are continuous, interval-scale variables that represent varying levels of a statistic of some relatively well understood physical process. The fourth does not share this characteristic but it is often used as though it does. A recent and important paper by Bond *et al*. (*Geophys. Res. Lett*, 2003, 30, 2183) gives plenty of reason to be cautious when invoking the PDO index to explain significant fractions of the variability in nature.

During the late 1990s, "we" became fascinated with the idea that ocean/climate variability in the North Pacific was not caused by random perturbations of some steady state. Certainly the ocean appeared autocorrelated, switching at rather infrequent intervals between some apparently limited number of states. The ultimate cause has not yet been discovered, but a paper by Mantua *et al*. (*Bull. Am. Meteor. Soc.*, 1997, 78, 1069) created its own regime shift in scientific activity directed at the idea. They defined the PDO index (PDOI) as the temporal realization (from 1900) of the leading EOF derived from a 5° by 5° latitude/longitude gridded monthly SST anomaly series in the North Pacific, north of 20°N latitude. During its maximum positive phase, the spatial pattern of the PDO is characterized by a zonally oriented region of cold SSTs in the central and western North Pacific accompanied by a warm merdionally oriented region along the North American coast, and the inverse during periods of maximum negative values (Fig. 1). This pattern is now one of the most widely recognized images of earth and ocean sciences.

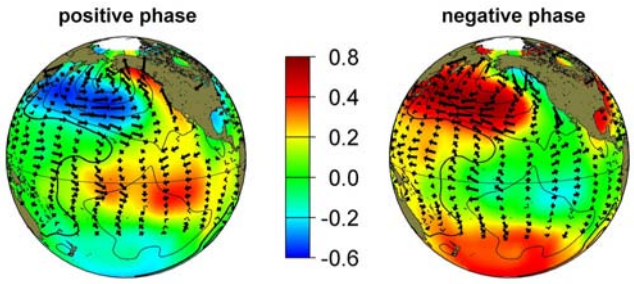


Fig. 1 Extremes of PDO pattern (Mantua et al. 1997)

The PDO pattern receives special attention for a few reasons: (1) it represents the greatest expanse of interannually co-varying surface water in the North Pacific, north of 20°N during the last century; (2) on decadal scales, there is significant autocorrelation as warm/cold phases tend to persist; (3) some aspects of both the atmospheric and biological components of the North Pacific are correlated with these phase changes; and (4) while the patterns are apparent, how it all works is still quite mysterious (to me, at least).

While the PDO may be the dominant pattern over the past century, it represents only ~25% of the SST co-variability. For my own edification, I computed the leading EOFs using a finer grid (1° × 1°) Reynold's Optimally Interpolated SST (Version 2) monthly mean data from 1982 to 2003 (Sept.); each month was analysed independently using the latitudinal range from 20°N to 60°N. Correlations among 4563 timeseries at lat/long grid points were computed and the dominant EOFs extracted using the IMSL routine PRINC. As this is only to illustrate a point, I did not make the extra effort to correct for the correlation bias that will arise at northern latitudes due to converging meridians, but my suspicion is that the bias is not so great.

Restricting the analysis to the most recent 22 year period eliminates the strong "regime-like" changes that occurred earlier in the 20th century but the data have the characteristic of greater consistency in spatial coverage and sampling methodology over this shorter time interval than is possible with the longer reconstructed SST history. The main difference between my result and Mantua *et al*. was that the PDO pattern (Fig. 2b) was the second mode rather than the first. The spatial pattern of the dominant mode from 1982-2003 is characterized in winter (Fig. 2a) by an elliptical region of highest correlation centred in the subtropics near 31°N 175°W and extending southwestward. The region of greatest correlation of opposing sign appears along an well-defined arc stretching from west of the Baja California peninsula through the western Gulf of Alaska just to the west of Station Papa (51°, 155°W) to the western Bering Sea (56°N 168°E).

This result emphasizes the point made by Bond *et al*. that since 1989, the North Pacific has been dominated by variability on their second EOF rather than the PDO. The reorganization of ocean/climate and marine ecosystems in 1989 had been recognized as different from, and clearly not a reversal of the PDO (Hare & Mantua, *Prog. Oceanogr*., 2000, 47, 103; Minobe, *Prog. Oceanogr.*, 2000, 47, 381) but Bond *et al*. (2003) show us why. What was not recognized earlier was that the change in 1989 was a 'mode shift' (change in spatial pattern), rather than a phase shift (change in sign), and this confusion was probably responsible for McFarlane *et al*. (*Prog. Oceanogr.*, 2000, 47, 147) wondering why the change in 1989 was apparent to them in the fish, but not apparent to others looking elsewhere. What is now clear is that there are (at least) two kinds of major pan-Pacific change and we should define them as such in the future.

The practical consequences of distinguishing a mode shift from a phase shift are important. The PDOI has often been correlated with other temporally indexed variables of interest, in the hope of demonstrating some correspondence between the two. Yet these practitioners have not realized that this potentially makes no sense. There is not an interval scale mapping of the range values of the PDOI onto known geographical SST patterns. The PDO spatial pattern does not exist at PDOI=0, a not infrequent occurrence during the last century, especially the first half. In fact, over the entire record, the winter PDOI distribution is normal with a mean not significantly different from 0, hence the central tendency of SSTs in the North Pacific on a centennial scale is not the PDO. This may explain why reconstructions of the PDOI from correlations with various proxies are not that consistent.

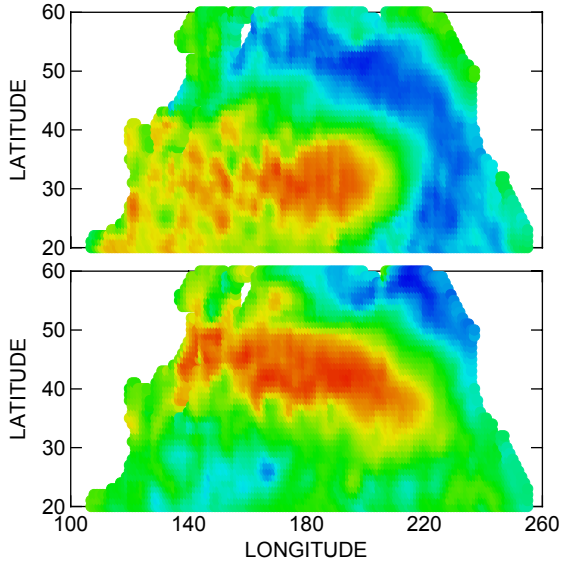


Fig. 2 Victoria spatial pattern (EOF 1 - above) and PDO pattern (EOF 2 - below) calculated from January SSTs from 1982-2003.

Closing thoughts:

- *Regime shift* has been a catch-all phrase for all manner of rapid shifts in the state of nature.
- It is now clear that *mode shifts* (changes in pattern) must be distinguished from *phase shifts* (sign reversals of a particular pattern) as they are different species of the genus *regime shift*.
- 1989 was a mode shift, not a phase shift (of the PDO).
- As these ideas germinated at a PICES meeting last August in Victoria, B.C., I propose that the EOF 2 pattern (my EOF 1) be known as the *Victoria Pattern* and the temporal realization as the *Victoria Oscillation Index*, or perhaps just the *Victoria Index* until we see if it reverses.
- 1999 was a phase shift between the negative and positive phases of the Victoria Index.
- Dramatic changes have occurred in the California Current system since ~1989, including the demise of many Pacific salmon populations during the 1990s. Their equally dramatic reappearance since the 1999 phase shift suggests that their abundance in this region corresponds more closely to the phases of the Victoria pattern than to that of the PDO.
- Future work might consider ecosystem response in each of the 4 dominant states (PDO +/- and Victoria +/-); AND December 2003 resembles neither pattern!

Governing Council representatives at PICES XII: H.C. Lim, L.N. Bocharov, L. Richards, T. Kobayashi, R. Marasco, J. Fujita, E. Tirpak, G. Boehlert, T. Wada, V. Alexander, K.O. Kim, P. Vorobev, H.T. Huh, A. Bychkov, R. Brown.

Dr. Vera Alexander, Chairman of PICES, opening the Twelfth Annual Meeting. At the head table are national representatives L. Richards, T. Kobayashi, L.N. Bocharov, R. Marasco, C.S. Kim, and Chairman of Science Board, I. Perry.

Mr. Young-Nam Kim, Acting Vice Minister of MOMAF, welcomes all participants to PICES XII on behalf of Korea.

Mr. Gong-Gu Back (Local Organizing Committee), Mr. Gong-Ke Tan (first PICES Intern), Ms. Christina Chiu (Secretariat) and Mr. Chuanlin Huo (current PICES Intern) mingle at the Welcome Reception.

Dsr. David Griffith (left) and Tokio Wada (right) ponder the next step after being served the landscape-themed dessert at the Extravaganza Dinner.

Dr. Chris Frid is awed by certain exciting information Dr. Dan Minchin is sharing with him at the "Punch and Rice Cake Poster Session".

Korean scientists discussing an electronic poster.

An attentive audience during one of many scientific sessions at PICES XII.

Enjoying a relaxing moment at the Chairman's Reception: Drs. Laura Richards and Vera Alexander, Dr. and Mrs. Hyung-Tack Huh, and Ms. Christina Chiu.

Dr. Ian Perry summarizing achievements of PICES XII and looking ahead to PICES XIII at the Closing Session.

Hosts and officials at the Farewell Reception: Dr. Hyung-Tack Huh, Mr. Choon-Su Kim, Dr. Sang-Kyung Byun, Drs. Vera Alexander, Tokimasa Kobayashi, Alexander Bychkov and Mr. Hyun-Churl Lim.

The PICES Secretariat, members of the Local Organizing Committee, volunteer helpers and scientist friends in a memorable shot after the Farewell Reception.

William G. Pearcy: Renaissance oceanographer

In this age of ever-increasing specialization, where researchers spend a lifetime studying the minutia of one particular organism or process, it is rare to find a scientist who has studied the full spectrum of oceanography from physics all the way up to whales. The recipient of the 2003 Wooster Award, Dr. William G. Pearcy, is such a unique individual. His accomplishments and substantial contributions to the field of fisheries oceanography go well beyond what most scientists can only hope to attain.

Bill Pearcy had an unlikely origin for someone destined to become a major contributor to the field of marine science. He was born and raised in a suburb of Chicago, thousands of kilometers away from the nearest ocean. He had a love for nature at an early age, fishing for bass and trout as a boy, and gained much experience working with animals as a zookeeper at the Brookfield Zoo in Chicago. He received his B.S. and M.S. degrees at Iowa State University. His Master's thesis was on the limnology (*i.e.*, freshwater oceanography) of Clear Lake, Iowa. His initiation into the marine environment came as he continued his graduate studies for one year at the University of Hawaii. With the onset of the Korean War, Bill enlisted in the Naval Air Force, became an Air Intelligence Officer and was stationed at Virginia Beach on the Atlantic Ocean. Two cruises on aircraft carriers in the Mediterranean piqued his curiosity about the ocean and the life contained within it.

Following his military service and cruising the Bahamas in a sailboat, Bill applied to Yale University for his doctoral studies and worked on the estuarine ecology of winter flounder under the supervision of Drs. Sarah Richards and Gordon Riley. His first publication was in the prestigious journal *Science* and described seasonal changes in the osmotic pressure of flounder sera. Upon graduation from Yale in 1960, Bill was contacted by Dr. Wayne Burt, the Chairman of a fledgling Oceanography Department at Oregon State University (OSU), about joining their faculty. Bill was the fifth faculty member hired and only the second biological oceanographer. At the time, the ocean off Oregon was almost completely unknown with only a few studies available dating back to the original *Albatross* expedition in the late 19th century. Bill made his mark getting involved with a group of collaborating scientists studying the distribution and potential impacts of radionuclides on animals from the near-shore to oceanic waters off Oregon and the Columbia River. This led to several significant studies and several publications in the journal *Nature* on the distribution of radionuclides measured in marine animals.

In the late 1960s and 1970s, Bill's research, along with his graduate students, branched out substantially, but his main interests focused on the distribution and ecology of mesopelagic fishes, squids and crustaceans that were seldom sampled and poorly known at the time. This work, funded mainly by the U.S. Navy and National Science Foundation, led to many papers on the distribution, abundance, and acoustic properties, and some of our earliest notions about the ecology of oceanic mid-water species. As an expert on net sampling of these organisms, Bill was named as the Chairman of a SCOR Micronekton

Bill at age 17 (on right) fishing for walleye pike with his brother Don on Leech Lake, Minnesota.

In the Navy (Virginia Beach) around 1952.

At the helm of a 37-foot ketch cruising around the Bahamas in 1956.

Sampling Working Group that led to net sampling and acoustical assessment of euphausiids during the winter in Norwegian fjords and a major volume on micronekton sampling. It is interesting to note that PICES is following in these footsteps, with its current Working Group on micronekton sampling.

Aboard the Norwegian Research Vessel Johan Ruud *during a sabbatical in Tromso, Norway, in 1980 doing net and acoustical assessment of euphausiids as part of a SCOR Micronekton Sampling Working Group.*

At the same time, Bill was involved in Sea Grant-funded studies on larval and juvenile fish recruitment. Along with Sally Richardson, he organized some of the first surveys of larval fish north of the CalCOFI region. In addition, he led research on juvenile flatfishes in both estuarine and near-shore waters off Oregon and collaborated in studies of deep-sea fishes and cephalopods.

A sabbatical at the Ocean Research Institute (ORI) in Tokyo during 1978 led to a Japan-U.S. exchange of scientists and culminated in a major symposium in Honolulu on the Subarctic Pacific, which Bill co-organized with the late Dr. Takahisa Nemoto, a colleague and director of ORI. In the early 1980s, Bill collaborated with scientists from Hokkaido University and went on several cruises on their famed research vessel, *Oshoro Maru,* where he conducted extensive studies of the feeding habits of salmonids and the distribution of oceanic nekton in collaboration with his students. These cruises helped stimulate the next phase of his research career, studying the ocean life of salmon from the time they enter the estuary to the time they come back to spawn.

As an avid fisherman and student of salmonids in their freshwater environments, Bill had been aware of the paucity of studies examining the "black box" of salmon's life history in the ocean, and decided that it was time to start opening that box. Using his knowledge of the physics and biology of the North Pacific and putting together several sources of funding, he was able to conduct systematic surveys of juvenile salmon to examine their ecology during this critical early period in their marine life. Those of us who participated in those early cruises were treated to the energy Bill brought to his work and stimulated to follow his example. He convened the first scientific meeting on salmon ocean ecology in November of 1983 in Newport, Oregon. His research and knowledge was extremely broad in scope and culminated in the writing of his classic book "Ocean Ecology of North Pacific Salmonids" in 1992. This book was assembled from a series of invited (by Warren Wooster) lectures presented at the University of Washington. Another meeting convened in 1996, also in Newport, updated these works and stimulated an annual salmon ocean ecology meeting of west coast scientists that is entering its sixth year. Bill continued to produce major works on salmon and other species until his retirement in 1998.

Bill on the back deck of the Canadian Research Vessel Ricker *monitoring the retrieval of an Isaacs-Kidd mid-water trawl in September 1999, on one of his last cruises.*

Bill in his office at Oregon State University in September 2003.

Giving the keynote lecture at PICES VII in 1997.

Over the course of his career, Bill has contributed substantially to our understanding of the marine environment, extending from the estuaries to the open ocean and the surface to the abyssal depths. His interest in the total ecosystem was documented within his more than 150 scientific papers on both commercially important species (whiting, rockfish, tuna, and salmon) as well as ecologically important taxa not widely known or understood (meso-pelagic and deep-sea nekton), and especially in analyzing food web linkages. He has even described some species of squid and has had other taxa named after him. He was involved with some of the first research submersible dives ever made off the Pacific Northwest coast. Bill's impact on science is demonstrated in how other scientists cite his papers. A paper published in *Ecology* (1962) has been cited 84 times, with 20 citations since 1996. Another published in *Biological Oceanography* (1982) has been cited 77 times, 30 since 1996. This clearly shows that the value of even his early publications has endured.

Bill's contributions extend well beyond his research. He has taught many courses over the years, most notably a very comprehensive course on marine nekton unlike that taught anywhere in the world. He has served as a major advisor for over 30 graduate students during his career-long tenure at OSU, and has served on committees and mentored countless more. Bill had a way of stimulating scientific curiosity among his students, and convincing many of them to work just a little harder on their projects -- many of these students have gone on to achieve international recognition on their own. He has served on numerous university, national and international committees and panels, contributing a substantial amount of his own time advocating worthy causes. He was named the first Director of the Cooperative Institute for Marine Resources Studies in 1983, and moved temporarily to OSU's marine laboratory in Newport to take the position. He was involved early on in PICES, serving on committees and working groups. He also delivered the keynote lecture on *Carrying capacity of the North Pacific Ocean* at the PICES Seventh Annual Meeting in Fairbanks, in 1997. Among the previous peer recognitions he has received are the American Fisheries Society Outstanding Marine Fishery Biologist Award (1996) and the American Institute of Fishery Research Biologists Outstanding Achievement Award (1998).

Left: Bill with his catch of a Deschutes River summer steelhead trout in Eastern Oregon from the 1986 FOCOFF (Florida-Oregon-California Order of Fly Fishermen) rendezvous (photo by Jeffrey Dambacher).

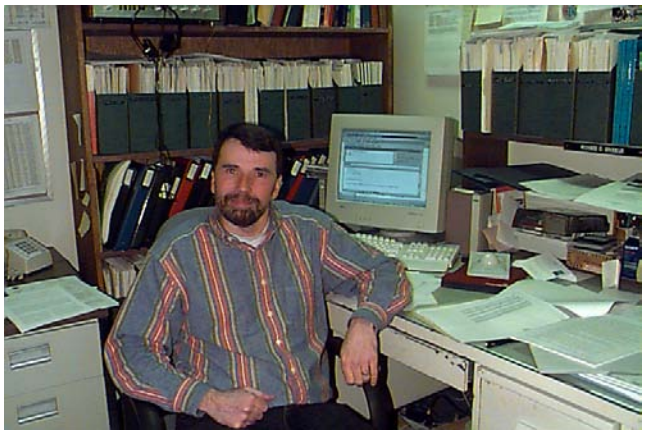
Right: Bill enjoying his retirement at home on the farm pruning the fruit trees with Harry the cat.

Fishing with his wife Amy near Steens Mountain and the Malheur Wildlife Refuge in Eastern Oregon in 1995, and showing the size of the one that got away!

Bill maintains his commitment to his profession and his colleagues. Since his retirement, he has served on many national committees and panels and is presently Co-Chairman of the Independent Multidisciplinary Science Team for the Oregon Plan for Salmon and Watersheds to help restore natural salmon runs in Oregon. He maintains emeritus status at Oregon State University, and is often sighted in his office on campus working on reports or reviewing papers.

Despite his many accomplishments, Bill is as modest an individual as you will find anywhere and is willing to give his time and advice to the youngest student. He avoids the limelight whenever possible. He has always dedicated time to his family (helped raise three now grown children) and outside pursuits. Bill is truly a proponent of the "Work hard, play hard" philosophy. He has maintained a long-standing (>40 years) relationship with a group of hunting and fishing buddies and has always dedicated some of his vacation time to birding or canoeing trips in eastern Oregon. He is an active member of the local Audubon Society and is involved with many other community groups and his local watershed council. Bill loves to travel with his wife Amy to exotic places around the world where he pursues his fascination for nature. Among the things he treasures most are his family and friends, and sharing a passion for gardening, beekeeping, wine making, and sheep husbandry with Amy at his picturesque 60 acre farm in Western Oregon – in fact he missed receiving the Wooster Award at PICES XII in Seoul because of a conflict with critical timing for the grape harvest. It is uncertain at the time of this writing when or if Bill will ever slow down – it just doesn't seem to be in his nature. As a model and inspiration for all of us who follow, Bill Pearcy is truly a renaissance oceanographer.

This article is published in appreciation and recognition of Dr. William G. Pearcy's outstanding service to the marine ecosystem science and Pacific Rim scientific community over many years. The essay was written by Dr. Richard D. Brodeur, who was Dr. Pearcy's M.S. student and has considerable collaborative experience with Bill. Author would like to acknowledge George Boehlert for his valuable comments to this article and Amy Schoener and Jeff Dambacher for providing photos.



Dr. Richard Brodeur is a research fisheries oceanographer working in the Fish Ecology Division of the Northwest Fisheries Science Center, NOAA Fisheries, and is based in Newport (Oregon). Ric received his B.S. in Fishery Science from the University of Massachusetts, his M.S. in Oceanography from Oregon State University, and his Ph.D. in Fisheries from the University of Washington. Following a year-long postdoctoral position at the Pacific Biological Station in Nanaimo (British Columbia, Canada), he began his career working on early life history and recruitment dynamics of walleye pollock in the Gulf of Alaska and Bering Sea for the Alaska Fisheries Science Center based in Seattle. He returned to Oregon to work again on habitat preferences and trophic ecology of juvenile salmon. Over the years, Ric has been heavily involved with PICES, serving on several committees and working groups and organizing a number of special sessions. His scientific interests include zoogeography, ecology and behavior of fish and invertebrates, but much of his research has focused on juvenile salmon.

KORDI/PICES/CoML Workshop on "Variability and status of the Yellow Sea and East China Sea ecosystems"

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Dr. Sinjae Yoo is the Director of Marine Living Resources Research Division in KORDI (Korea Ocean Research & Development Institute) and is based in Ansan, Korea. Sinjae received his B.S. and M.S. in Oceanography from the Seoul National University, and his Ph.D. in Ecology and Evolution from the State University of New York at Stony Brook. He has been involved in various research projects including the Yellow Sea Large Marine Ecosystem. He was a panel member of IOCCG and Coastal-GOOS. Over the years, Sinjae has been involved with PICES, serving on the Biological Oceanography Committee and the MODEL Task Team. His research interests include long-term change in primary production and phytoplankton dynamics in various marine environments.

Background

The Yellow Sea and East China Seas (YS-ECS) are epi-continental seas (Fig. 1) bounded by the Korean Peninsula, mainland China, Taiwan, and some Japanese islands (Ryukyu and Kyushu). Presumably, the YS-ECS ecosystems, with dense population living along the coasts, are amongst the ecosystems in the Pacific that are under the strongest influence of various human activities, such as fishing, mariculture, waste discharge, dumping and habitat destruction. There has also been strong evidence showing a gradual increase in the water temperature in the past decades. Given the variety of forcing factors, complicated changes in the ecosystem are anticipated. Indeed, rapid change and large fluctuations in the species composition and abundance in the major fisheries have occurred. In this respect, it was timely that the YS-ECS ecosystem status was evaluated as a part of the PICES and Census of Marine Life (CoML) efforts of status assessment of the North Pacific Ecosystems. A workshop for this purpose was scheduled in April 2003, to gather scientists who have been working in this region and to discuss and summarize what they learned about the YS-ECS ecosystems during the past. Many scientists expressed interests in participating in the workshop, however, the workshop was postponed twice due to the outbreak of SARS in the spring of 2003. The workshop was finally held October 9, 2003, immediately prior to the PICES Twelfth Annual Meeting in Seoul, and convened by Drs. Sinjae Yoo and Hyung-Tack Huh (KORDI), and Skip McKinnell and Ian Perry (PICES). A draft chapter on the status of YS-ECS ecosystems for the PICES North Pacific Ecosystem Status Report (NPESR) was written before the workshop based on the contributions by Drs. Hiroshi Ichikawa, Xian-Shi Jin, Young-Shil Kang, Suam Kim, Jai-Ho Oh, Sinjae Yoo, and Chang-Ik Zhang, instead of after the workshop as was originally planned. This way, the workshop was more focused on the discussion of the draft.

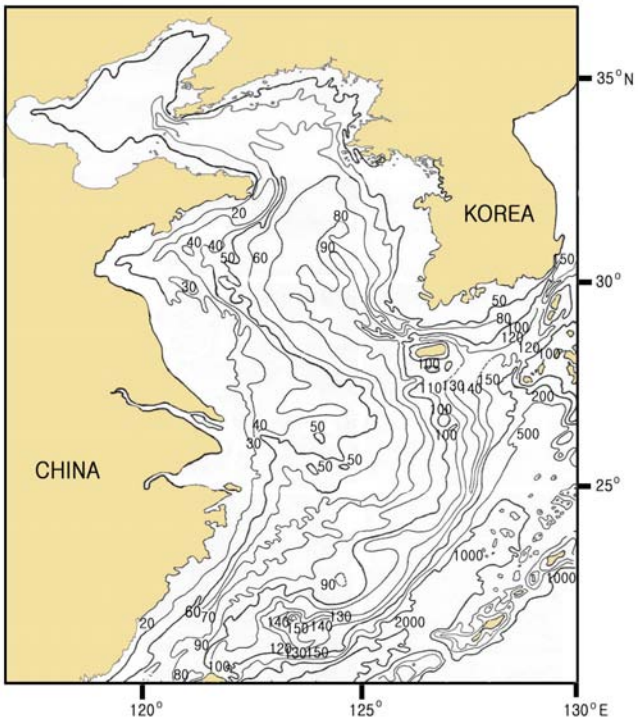

Fig. 1 Geography and bathymetry of the Yellow Sea and the East China Sea.

Overview of presentations

About twenty scientists from all PICES member countries participated in the workshop. Since the workshop was more focused on revising the draft chapter, presentations and discussion were done in a very informal fashion. Dr. Ian Perry (Chairman of PICES Science Board) gave a general introduction to the NPESR project. The objectives, structure and target audience of the report were briefly explained.

Dr. Sinjae Yoo (Republic of Korea) presented the outline of the draft for the YS-ECS chapter. First, geography, topography, circulation, flora and fauna of the region were described as background information. Next, potential critical factors causing change in the YS-ECS ecosystems were identified: environmental contamination, eutrophication, habitat destruction, overexploitation, and changes in the circulation. In addition to climate-related change in the circulation, the building of the Three-Gorges Dam in the upper reaches of the Changjiang River could bring changes to the ecosystem. Possible adverse effects were pointed out such as a decrease in the primary productivity in the vicinity and reduced flushing in the YS. Then, details were described for physics, climate and chemistry of the region. There has been an increase of 1.8ºC in the water temperature in February in the seas around Korea during the past one hundred years. The rate of change became greater during the past decade. The nutrient loads into the sea have more than doubled during the last two decades. Data of heavy metals, PCBs, PAHs, and other persistent organic pollutants were shown. Phytoplankton species composition and primary productivity of the region were discussed next. There seem to be still uncertainties in the primary production estimates for both the YS and ECS. It seems interesting that both phytoplankton and zooplankton biomass increased in the YS since the late 1980's (Fig. 2).

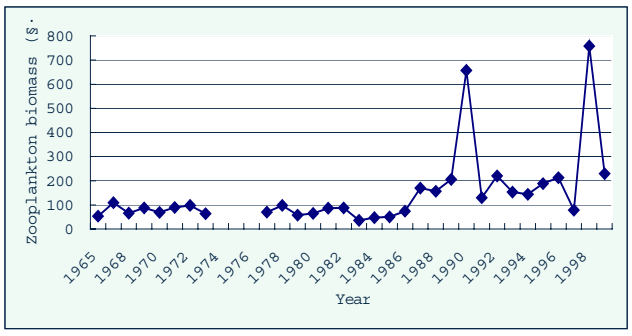

Fig. 2 Time series of average annual zooplankton biomass (mg/m^3) in the eastern Yellow Sea (from bi-monthly surveys during 1965-1999, data by Y. S. Kang).

Another sign of ecosystem change is the abrupt increase in the HAB incidences in Chinese and Korean waters causing huge economic damages. Concurrently with the changes in the physics, chemistry and lower trophic level, there have been dramatic changes in the higher trophic level in the YS and ECS as evidenced by fisheries data in the past three decades. Such changes can be summarized as follows. First, declines in biomass and catch of demersal species have occurred, and as a result, pelagic species have increased in catch proportions, while demersals have decreased. Second, the catch of pelagics species showed large fluctuations. Third, the average trophic level of fishery catches has gradually decreased, more rapidly in the YS than in the ECS (Fig. 3). Following fisheries data, a brief description was made on the endangered species in the YS.

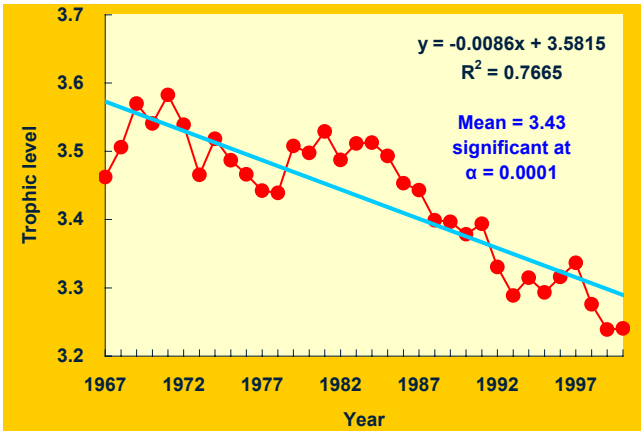

Fig. 3 Time series of average trophic level from the catch of resource organisms in the Yellow Sea (data by C.I. Zhang)

After the presentation of the draft outline, talks were given for each area ranging from climate and physics to fisheries. Dr. Jai-Ho Oh (Republic of Korea) reported on long-term changes in the air temperature in Korean cities. He showed that there has been an increase of 0.11~0.23°C/decade since the 1910's at eight cities. The number of summer days increased by 22, while the number of winter days decreased by 27 days, showing a clear trend of warming. He also presented projections of future acceleration in the temperature rise using the regional climate MM5 model.

The next two presentations were on physical oceanography of the region by Drs. Heung-Jae Lie (Republic of Korea) and Hiroshi Ichikawa (Japan). Dr. Lie discussed the origins of the Jeju Warm Current and Tsushima Warm Current, and seasonality of the coastal currents. Using drifter data, he showed that the Tsushima Current branches from Kuroshio along the shelf edge of the ECS. In the YS, strong cyclonic circulation develops along the coasts in summer, while in winter, southward currents develop along both Chinese and Korean coasts. Dr. Ichikawa summarized the general characteristics and forcing of the regional currents. His talk focused on the inter-annual variation in the Changjiang (Yangtze) River discharge and its influence

on the oceanographic properties in the vicinity. Classification analysis of water masses in the ECS using T, S, nutrients and chlorophyll-*a* was also presented.

After presentations on the physics and climate in the morning session, talks on chemistry and biology followed in the afternoon. Dr. Jae-Ryoung Oh (Republic of Korea) showed results of the pollution surveys in the YS in 2000. Heavy metals, and organochlorine compounds including pesticides, PCBs and PAHs were analyzed from samples of sediments, tissues and liver of fish. Except for a few hotspots, in most of the samples the level of these pollutants was below the known safe values. However, there are no criteria for safety for some chemical species and continued monitoring is necessary.

Dr. Xian-Shi Jin (People's Republic of China) presented Chinese records of dominant species of phytoplankton, zooplankton, and major fisheries species in the YS, ECS and Bohai Sea. The trend of major fisheries species composition paralleled that which was observed in the Korean waters, *e.g.*, pelagics increased while demersal decreased. As an example of large fluctuations in the pelagics, he described the case of Japanese anchovy (*Engraulis japonicus*) which collapsed in the early 2000's. In contrast to the Korean records that showed a doubling trend in the zooplankton biomass in the YS since the late 1980's, the zooplankton biomass in the Chinese side decreased during the same period.

Dr. Ming-Yuan Zhu (People's Republic of China) presented the recent trend in HAB outbreaks in the ECS. The most frequent time of the outbreaks was from May to June. There was a dramatic increase in the reported HAB outbreaks since 2001, partly due to intensified monitoring activities. He also reported on the oceanographic conditions of the outbreaks in 2002. In 2002, 79 events were reported, 55 of which occurred in the ECS and 4 occurred in the YS. It was suggested that changes in the N/P ratio might be important in the HAB outbreaks.

Investigation, using satellite data, on whether there have been real changes in the YS ecosystem over the past two decades was the topic of the next presentation by Seung-Hyun Son (Republic of Korea). He compared data of two ocean color sensors CZCS (Coastal Zone Color Scanner: 1978~1986) and SeaWiFS (Sea-viewing Wide Field-of-view Sensor: 1997~present). On average, higher chlorophyll values were seen in SeaWiFS data. Likewise, water-leaving radiance decreased at 443 nm and increased at 555 nm (Fig. 4). The *in-situ* data showed less evidence of decadal trends, but there were slight increases in temperature and zooplankton biomass, and slight decreases in salinity and Secchi depth.

Dr. Bernard Megrey (U.S.A.) gave a brief introduction to the North Pacific Ecosystem Metadatabase promoted by NOAA. He demonstrated the metadatabase webpage and asked the audience for future participation.

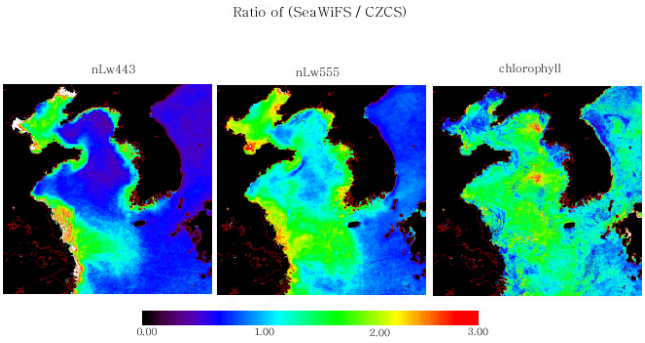

Fig. 4 Comparison of composite bio-optical values from CZCS (1979-1984) and SeaWiFS (1998-2002) (data by S.H. Son).

Discussion

The discussions that followed focused on how to improve the draft of the YS-ECS chapter. The main question was "What is missing and whether such information is available?" A number of items were listed including alien species, parasites, disease and bacterioplankton. Data might be available for these items but too scanty to be representative values. There are some items such as benthos with good data coverage, and certainly should be incorporated in the draft. Also the distribution and productivity of commercial invertebrates, and the impact of aquaculture on natural communities would be valuable information for assessing the ecosystem status. Fish catch data in China as well as in Korea in the draft need to be updated as some pelagic fishes show high frequency fluctuation.

In addition to the missing data, discrepancies were found between datasets. For example, the zooplankton biomass in Korean waters in the YS increased since the late 1980's, while that in Chinese waters decreased in the same period. Sampling details should be compared to interpret such discrepancy. This illustrates the need for comparable sampling methods and gears in the future.

There were different views about the impact of the Three-Gorges Dam on the YS-ECS ecosystems: some think the impact would be substantial, while others believe not. But most participants agreed on the need to monitor the future change. Then there was a suggestion that a PICES Working Group might be needed for this interesting semi-natural macrocosm experiment.

The YS and ECS are ecosystems where you can find complicated action of multiple forcing factors. Will we ever be able to understand what factors contribute, and how much, to the ecosystem change we observe?

PICES/IOC Workshop on "Harmful algal blooms - Harmonization of data"

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Dr. Vera Trainer is the Program Manager of the Marine Biotoxin group at the Northwest Fisheries Science Center. Current research activities include refinement of analytical methods for both marine toxin and toxigenic species detection, assessment of environmental conditions that influence toxic bloom development, and understanding how shellfish cope with toxins in their environment. She is the co-principal investigator on a regional Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) research project that will study Pseudo-nitzschia blooms off the WA coast over the next 5 years. Vera is also the lead investigator of the Olympic Region Harmful Algal Bloom (ORHAB) project, a regional monitoring effort involving federal, state and local agencies, coastal tribes, and academic institutions. She received her B.S. in Biology from Indiana University of Pennsylvania, and both her M.S. in Biological Oceanography, and Ph.D. in Biochemistry and Molecular Biology at the University of Miami, with postgraduate studies in the pharmacology department at the University of Washington. Vera was a member of the PICES WG 15 on Ecology of harmful algal blooms (HABs) *and now co-chairs the new PICES Section on HABs.*

The understanding of the environmental factors contributing to harmful algal bloom (HAB) events is limited by our access to comparative data from similar coastlines worldwide. A free flow of information to all interested investigators is vital in planning experiments, analyzing relevant data and modeling HABs, and the eventual development of a predictive capability to forecast HAB events in Pacific coastal regions. Such future forecasting to protect coastal fisheries in all PICES member countries will not be possible without the knowledge of, and access to, the relevant biological, chemical and physical factors which have influence on bloom development. However, the historical data sets available for analysis of coastal HAB events are widely dispersed among the various agencies responsible for monitoring biotoxin events. These data exist in various degrees of processing, quality assurance, and public availability, and much of the available data (*e.g.* phytoplankton assemblage characteristics) are in forms that are difficult to use effectively. In order to address these problems facing PICES member nations, two PICES groups, the Working Group 15 on *Ecology of harmful algal blooms in the North Pacific* and Technical Committee on Data Exchange, together with the Intergovernmental Oceanographic Commission (IOC) of UNESCO, co-sponsored a 1.5-day workshop on HAB data harmonization in conjunction with the PICES Twelfth Annual Meeting in Seoul. The workshop was held October 10-11, 2003, and convened by Drs. Vera Trainer (NWFSC, U.S.A.) and Hee-Dong Jeong (NFRDI, Korea). A major goal of the workshop was to determine how national- and community-level data on harmful algal blooms and red tides could be shared among PICES member countries. The workshop was attended by more than 20 scientists from 7 countries.

At the workshop, Henrik Enevoldsen presented the IOC/ICES database for the North Atlantic, termed the Harmful Algae Events Database or HAE-DAT. The main purpose of creating HAE-DAT is to develop an international structure for data storage that allows easy integration of data, efficient search tools, and the possibility of conducting data analysis. This database does not share raw (primary) data and only includes harmful events that cause economic or agricultural loss and human illness. Problems that must be overcome in a harmful algae database comprise:

- Some events are very difficult to compile in a common database;
- Some data are not accessible to the public;
- Data types are sometimes not comparable; and
- Compilation of the database is very resource intensive.

HAE-DAT currently runs under the MS Access 97 programming routine (scheduled for replacement in the near future) and includes the general (location and date, microalgae type, environment and harmful effects) and complementary information about harmful algal blooms. HAE-DAT maps of HAB occurrences (see Fig. 1 as example) are not yet linked automatically to the database, although this is anticipated to occur over the next year. Decadal maps are prepared by IFREMER in France. The information plotted includes the presence of toxins or observations of mortalities (regardless of levels of toxicity). Blooms of potentially toxic species have been omitted. In the future, ICES delegates will divide their countries into HAE regions to overcome data sensitivity issues.

Our ambition is that HAE-DAT will eventually become a global database and will incorporate information on North America and Europe (including the Mediterranean Sea region), IOS ANCA (Caribbean), IOC FANCSA (South America), the North Africa network, and PICES, thereby establishing worldwide system for sharing biological data.

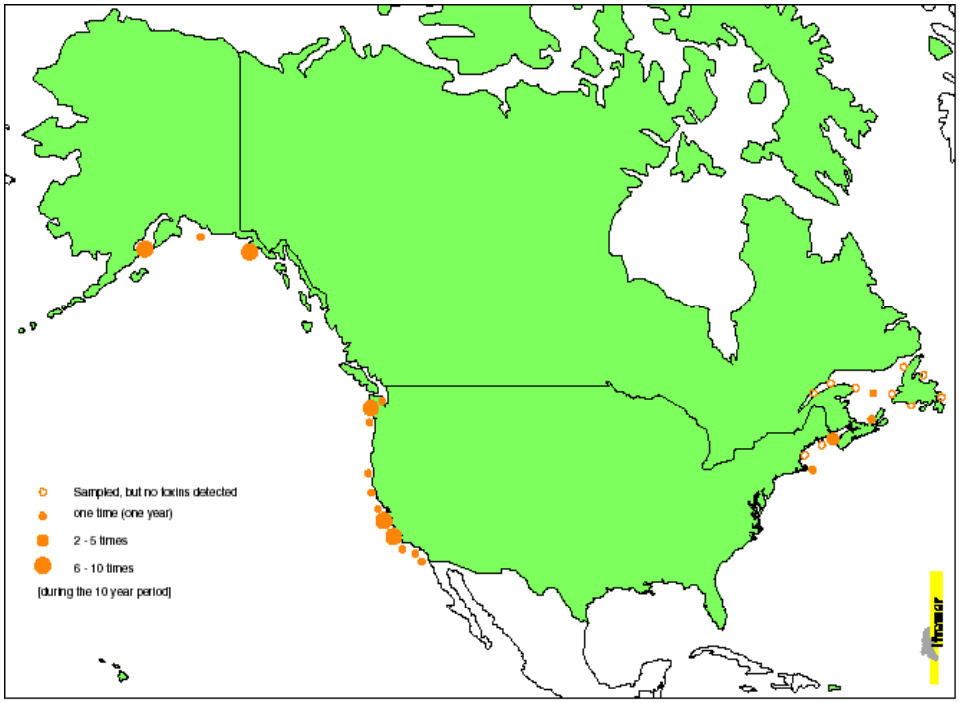

Fig. 1 An example of a HAE-DAT map showing ASP toxin occurrence in North America, in 1990-1999. This picture is available from the HAE-DAT website (http://ioc.unesco.org/hab/data33.htm). A goal of the HAB Section is to strive towards creating such maps and their corresponding relational data for all PICES member countries.

Information on HAB data collection and data management was presented by each PICES member country. The following problems with data sharing were identified during these presentations and following discussion:

- Data are collected by managers and are not always accessible to researchers;
- Different countries have different definitions of what constitutes a harmful algal bloom (*e.g.*, in China and Japan "red tides" are defined as those algal blooms that attain sufficient densities to discolor water, but do not necessarily produce a toxin, while in Canada and the United States these algal blooms are not normally considered harmful);
- Different toxins are monitored in different countries (*e.g.*, whereas both DSP and PSP toxins are routinely monitored in Japan, in Canada or the western United States shellfish are only monitored for PSP and ASP toxins);
- Data are not always GIS referenced, rather shellfish closures are recorded for a region, not for a specific site;
- Shellfish monitoring is intense in some areas of coastline and in some countries, but not in others (*e.g.*, in Russia, although HAB species are identified, there is currently no routine monitoring of toxins);
- Data are site specific (*e.g.*, most shellfish monitoring in western Canada occurs in the southern regions where commercial shellfish and fish farms are concentrated); and
- Data available from offshore research cruises indicating high toxin concentrations or elevated cell abundance estimates may not result in any significant coastal impact. Should such data be included in an "events" database?

At the workshop, all PICES member countries unanimously decided to adopt the IOC/ICES database for a one-year trial period. This database will now be called the HAE-DAT joint database to reflect the fact that PICES is actively using it. It was agreed that:

- Each country will enter one year's HAB data in the database using the year of their choice;
- Each country will decide which data to enter, or in other words, will decide what constitutes a "problem" HAB in their country;
- Each country will define "regions" for their data entry that could include exact locations or more general areas (*e.g.* prefectures in Japan). This will allow issues of data sensitivity to be overcome;
- Each country will decide on a point person to oversee data entry into HAE-DAT during the next year; and
- For the next PICES Annual Meeting (October 2004, Honolulu, U.S.A.), each country will complete a "report card" describing what worked within the database, types of data that were difficult to deliver (data access issues, etc.), and the overall usefulness of the database.

The workshop participants unanimously recommended to convene a 1-day follow-up workshop on "Developing a North Pacific HAB data resource", co-sponsored by IOC and PICES, at PICES XIII in Honolulu. The primary goal of this workshop will be to provide an interim "report card" on the use of the HAE-DAT database. The central tasks include: (i) to ascertain how well the database process worked; (ii) to identify any difficulties in data delivery from member nations; (iii) to assess the effectiveness of the interactive web-based window to the developing resource; and (iv) to determine if further modifications are needed to encompass unique aspects of Pacific Rim marine resources.

The proposal was approved by the PICES Governing Council, and the workshop will be organized by a new PICES Section on *Harmful Algal Blooms*. This section was established under the MEQ (Marine Environmental Quality) Committee with the following Terms of Reference:

1) To develop and implement annual bloom reporting procedures that can be consistent with ICES procedures and therefore incorporated into HAE-DAT. This will be important in assessing impacts of HAB events and as a research tool to look at patterns that will lead to prediction capability.
2) To exchange national reports of HAB incidents and development in order to inform Section members of new toxins, new developments, and new approaches. Both toxin producing and non-toxic (but harmful) algal species should be included.
3) To focus on specific needs for scientific advice among PICES member countries by identifying topics of interest, and providing syntheses of the available scientific information on those selected topics. Example topics for discussion and syntheses might include:
   a. Mitigation practices to reduce the impact of HABs;
   b. Numerical model development of HAB initiation and transport for predictions and forecasts;
   c. Relationship between oceanographic processes and HAB formation (*e.g.*, How the physics of nutrients, trace metals tie into bloom formation);
   d. Organism identification using molecular biological techniques;
   e. Discussion of possible changes to certain monitoring techniques (*e.g.*, cell numbers vs. toxin levels);
   f. Species introductions including issues of anthropogenic sources (*e.g.* ballast water) or natural systems (*e.g.*, species range extension).
4) To develop, together with TCODE, a metadatabase that describes HAB monitoring and research efforts in each PICES member country.
5) To support the harmonization of methods for identifying HAB species. This could include inter-calibration workshops co-sponsored by PICES and ICES and future capacity building efforts.
6) To develop early warning systems for the detection of HABs. This could include discussion of ocean observing systems and techniques.
7) To educate the community (managers, students) about HAB organisms. For example, an in-depth study of selected HAB species (top ten) could include information about physiology, taxonomy, etc.

The HAB Section will be co-chaired by Drs. Vera L. Trainer (U.S.A.) and Hak-Gyoon Kim (Korea) and will carry on future work on PICES HAB data sharing.

From physics to predators: Monitoring North Pacific ecosystem dynamics

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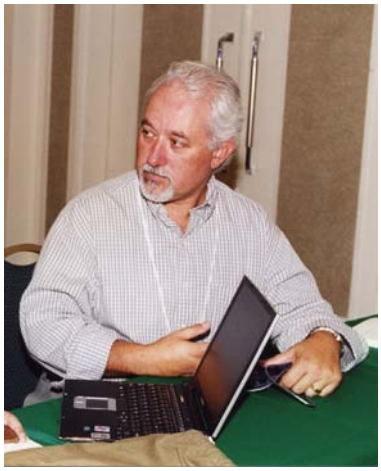

Dr. William Sydeman is the Director of the Marine Ecology Division at PRBO Conservation Science (previously Point Reyes Bird Observatory). His research interests include the biological oceanography and evolutionary ecology of top marine predators (marine birds, pinnipeds and cetaceans) in variable marine systems, particularly the California Current System. Dr. Sydeman has been involved in long-term studies of climate/ecosystem fluctuations in the North Pacific for the past 23 years. He serves as Co-Chairman for the PICES Marine Birds and Mammals Advisory Panel, and is also a member of the PICES MONITOR Task Team.

Over the past 50 years, there has been growing appreciation of climate/ecosystem fluctuations in the world's oceans. Nowhere is this more important than in the highly dynamic, ever-changing large marine ecosystems of the North Pacific. Why are these fluctuations of fundamental significance? The simple answer is that because North Pacific marine communities are not constant in space and time, management decisions based on ecosystem homeostatis could be flawed; the distribution and abundance of marine species vary according to current or shifting environmental conditions. Consequently, we are faced with a serious scientific challenge: to recognize, document, and interpret, in real-time, the temporal and spatial variations in climate, patterns of ocean productivity, and food web structure that influence marine populations of interest. An understanding of the ecological consequences of climate variability could be integrated within an adaptive management framework for North Pacific living marine resources. Conceptually, what is needed is a continuing information loop, with new information regularly supplanting old, in support of annual decision-making processes. Ecosystem considerations, based on real time monitoring, could then become a primary first-step management tool for setting harvest quotas for fisheries in relation to the environmental variability that is known to shape plankton, fish, and top predator life histories and populations in the region.

But, how can we accurately assess climate-ecosystem fluctuations in such a timely fashion? Many scientists in the PICES community have been actively engaged in considering this question. It has three basic components:

- How should we monitor North Pacific marine ecosystems?
- What are the appropriate temporal and spatial scales of observation? and
- What indicators might best describe system 'state'?

Attempting to answer these questions is by no means a simple task. In a series of workshops held during the past 5 years, the PICES community has been gaining insight into approaches for ocean monitoring, and an appreciation of the variables that can be measured simply and inexpensively over long periods of time, to allow for more informed management decisions about marine populations (PICES Scientific Report Nos. 17, 18, 20, 21 and 26). The latest in this series was a workshop, convened by David Mackas, Sei-ichi Saitoh, Phillip Mundy, Vyacheslav Lobanov and myself, at the PICES Twelfth Annual Meeting in Seoul, Republic of Korea, on October 10-11, 2003. This article summarizes, reviews, and evaluates some of the notable results from this workshop, which included presentations from marine scientists from the Atlantic and Southern Oceans, as well as many contributors from the North Pacific.

Indeed, this workshop follows from the successful efforts of many scientists who contributed to previous workshops and special symposia. In 2003, this work culminated in the first draft "North Pacific Ecosystem Status Report (NPESR)", a multi-investigator effort led by Drs. Ian Perry (Chairman, PICES Science Board) and Skip M^{c}Kinnell (PICES Secretariat). The draft NPESR formed a basis for discussion and was highlighted in the title of the Seoul workshop – *Examine and critique a North Pacific Ecosystem Status Report*.

The workshop began as the conveners discussed the goals and potential products of the workshop. They sought novel recommendations from participants on how to weave and synthesize disparate, ongoing marine monitoring programs into one for the entire North Pacific, to discuss issues of multi-system and multi-investigator database management, and finally, to define the role of the PICES MONITOR Task Team relative to ecosystem status reporting in the future. Three plenary presentations filled the morning session, including Keith Brander, of ICES (International

Council for the Exploration of the Sea), who spoke on *Choosing, presenting and maintaining indicators for marine ecosystem monitoring – experience from the NE Atlanti;* Keith Reid, of the British Antarctic Survey, who spoke on *The CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) ecosystem monitoring program: Application to the management of krill fisherie;* and Ian Perry, PICES Science Board Chairman, who presented a talk on *The Draft PICES North Pacific Ecosystem Status Report: Synthesis.* Lively discussion ensued on the value of matching indicators from the North Atlantic, North Pacific and Southern Ocean, the role of upper trophic-level predators in ocean ecosystem monitoring, and a critique of the draft NPESR.

It was noted that maintaining methodological consistency within time series is usually more important, and more feasible, than altering ongoing programs to obtain standardization among time series, but that key variables should be obtained and reported for all systems. In the Pacific, key basin-scale environmental indices currently include the Pacific Decadal Oscillation, Aleutian Low Pressure Index, and the Arctic Oscillation; the latter two reflect sea level pressures, and aid in understanding winds, upwelling/downwelling, frontal formation, and current structures. The role of monitoring marine birds and mammals to help to assess the abundance and demographics of lower trophic level taxa *(i.e.*, prey) was clearly illustrated by studies of diet and reproductive success of penguins and fur seals at Bird Island, South Georgia. But, at only one study site was the functional relationship between penguin productivity and euphausiid abundance (based on hydroacoustic surveys and net tows) established. The group noted that additional calibration of these relationships is required to fully utilize the predator information in real time monitoring of key food web components, such as krill and forage fish. The synthesis chapter of the NPESR was critiqued, and most noted the exceptional job done by Dr. Perry and colleagues in producing the first-ever draft ecosystems report for the North Pacific. Questions arose concerning which of the large-scale environmental indices were most valuable, and how to interpret the reported FAO total fishery catches (rather than CPUE) in relation to climate variability when human effort needs to be considered as well. The afternoon session consisted of invited and contributed reports describing regional monitoring and ecosystem status assessment efforts in different parts of the North Pacific. Presentations were made by Kiyotaka Hidaka, Gennady Kantakov, George Shevchenko, Gong-Ke Tan, Ming-Yuan Zhu, Franz Mueter, Patricia Livingston, Gordon McFarlane, and Steven Bograd. Several of these presentations provided a more detailed look at the material contained in the draft NPESR. There were many examples of ecosystem changes driven by basin-scale and regional-scale climate forcing, as well as anthropogenic changes in nutrient loading and freshwater discharge patterns.

The second day included discussions of some new monitoring approaches and hypotheses of interest from a global (or near global) perspective. Initially, we heard a presentation summarizing evidence for global synchrony of zooplankton variability (Ian Perry). This talk was based on a synthesis of ideas and data from the joint ICES/PICES/GLOBEC Zooplankton Production Symposium, held in May 2003, in Gijón, Spain. This was followed by an analysis of ecosystem structure, from copepods to sea birds, based on multi-ecosystem, multi-trophic level monitoring made from ships-of-opportunity in the North Pacific (Sonia Batten), and a description of broad-scale ecosystem-level information made available based on dietary analyses of North Pacific marine birds and mammals (Julie Thayer and Hidehiro Kato, respectively). These contributions clearly demonstrated the remarkable potential for understanding simultaneous or lagged fluctuations in biological populations on a global-scale, and how various biological indicators, from plankton to predators, can be used to inform us on the amplitude and timing of ecological responses to climate variability and change. Moreover, the presentations also provided numerous examples of how complex studies of mid trophic-level organisms (*e.g.*, macro-zooplankton, forage fishes and squids) can be augmented and complemented by information on their predators. Reports of operational oceanography initiatives in western North Pacific marginal seas were also presented, including *Circulation Research in the East Asian Marginal Seas* (CREAMS) (Kuh Kim), and *North-East Asia Regional GOOS* (NEAR-GOOS) (Vyacheslav Lobanov). Both of these ongoing programs are entering a second phase of design and implementation, and both are becoming multi-disciplinary in focus. For both programs, there was much noted success with real-time data collation, transfer and analysis. Data management for other North Pacific ecosystem monitoring programs is now in development under the auspices of the Integrated Ocean Observing System (IOOS) and may be modeled after these successful initiatives.

Extensive plenary discussion of how to produce future editions of the PICES NPESR continued in the afternoon. Topics included NPESR content (what is in the report now, what should be added next time), update interval and format ('as available' on the web, ~3-5 year interval as a printed document), quality/completeness checks and peer-review mechanisms (combination of internal and external), tools for outreach to 'users' and feedback from 'users', and broadening the base of PICES contributors. The role of MONITOR in NPESR preparation and review was discussed. Task Team members agreed that this is an important work for MONITOR. Potential actions and activities by MONITOR include:

- contribute expertise to "scientific peer-review"
- initiate future NPESR editions (however, this role assumes a 'permanent' mandate for MONITOR, probably extending beyond the duration of the CCCC Program)

- help future chapter authors find relevant 'data' and 'specialist expertise'
- contribute to 'outreach' communication

Although much was accomplished, there is still much work to be done. In particular, workshop participants recommended that a formal analysis on information needs and gaps should be conducted. While participants agreed that ongoing time series and monitoring programs should not be redirected to obtain 'standardization', there is a need to coordinate basic data collection and analysis at the regional level to facilitate cross-system analyses and interpretations. Augmenting ongoing programs with new variables would seem to be a reasonable approach to enhancing these efforts. Other questions pertaining to the coupling of interannual to interdecadal climate variability and effects on marine systems, *e.g*, El Niño in a cold regime such as that witnessed in 2003, remain to be addressed; what do we need to measure to disentangle these effects? Additional thoughts on operational oceanography is also required: for example, how and when should scientists advise managers of ecosystem changes and what indicators of change may be most appropriate for management needs. Finally, there are continuing questions about database management: how can the PICES community work together to access, coordinate, and synthesize vast and disparate data sets? Who will fund this?

In conclusion, the latest workshop convened by the MONITOR Task Team was a great success. Recommendations and scientific criticisms made by dozens of participants will enable the PICES community to reach new heights in applied ecosystem monitoring and operational oceanography. Participants from across the globe brought insights from various ecosystems that greatly strengthened discussions and made for dynamic interactions. To all, we offer sincere appreciation.

Toward a coastwide network of Northeast Pacific coastal-ocean monitoring programs – a brief workshop report

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Dr. David Mackas is a biological oceanographer specializing in zooplankton time series and spatial patterns. Within PICES, he is a member of the Biological Oceanography Committee and Continuous Plankton Recorder Advisory Panel, and a member and outgoing Co-Chairman of the MONITOR Task Team. Despite (or perhaps because of) time spent in committees, he remains an advocate for dirty hands and wet boots. He is shown here aboard the CSS VECTOR downloading several bites of euphausiid data from a recently-deceased Squalus acanthias *BAUV (Bionic Autonomous Underwater Vehicle).*

After many years of planning and preparation, the Global Ocean Observing System (GOOS) is now rapidly coming on-line. It is already clear that GOOS will bring large changes in the rate and regularity with which the ocean is sampled. GOOS will also bring important new opportunities (and obligations) for individual data collectors and data users.

Many think that PICES will be an important and welcome player in these changing activities. In their presentations to PICES' Governing Council on behalf of the Intergovernmental Oceanographic Commission and GOOS Steering Committee (PICES 2002 Annual Report, pp. 37-39), Drs. Ji-Lan Su and Neville Smith noted the strong track record of PICES in compiling and analyzing "physics-to-ecosystems" cross-disciplinary time series, and successes in promoting alliances among member nations to study various parts of the North Pacific. Dr. Smith also pointed out the value of successful pilot projects for raising the profile of GOOS and ocean monitoring, and attracting new investment in ocean observation and data systems. The PICES Eleventh Annual Meeting (Qingdao, China, October 2002) also produced a recommendation by the MONITOR Task Team, that PICES should sponsor and endorse two North Pacific "GOOS pilot projects" focussed on the marginal seas and continental margin boundaries of the Northwest and Northeast Pacific (PICES 2002 Annual Report, p. 145). The Northwest Pacific pilot program was envisioned to be built around the expanding NEAR-GOOS program. The Northeast Pacific pilot program was envisioned as a coast-wide linkage of new and existing regional and national ocean monitoring programs in the California Current and Alaska Current systems.

As a step toward building such a Northeast Pacific monitoring network, PICES organized a 2-day (November 20-21, 2003) workshop on "Development of pilot coastal monitoring program(s) in the NE Pacific" in Victoria, Canada. Partial funding was provided by the Pacific Coastal Observing System (PaCOS) and the Gulf Ecosystem Monitoring Program (EVOS-GEM). The meeting was chaired by David Mackas (DFO Canada, and 2001-2003 Co-Chairman of the PICES MONITOR Task Team) and Skip McKinnell (PICES Deputy Executive Secretary), with coaching and cheerleading from John Hunter (US NMFS) and Phillip Mundy (EVOS, NPRB, US GOOS Steering Committee, and incoming Co-Chairman of PICES MONITOR). All participants are listed in Table 1. A full workshop report is planned as a 2004 PICES Scientific Report, but this article is intended as a quick-look summary of the discussions and recommendations.

We began with a discussion (really more an affirmation) of the need for ongoing time series, and the need for a coast-wide monitoring network. For many parts of the NE Pacific continental margin, we already have very good and detailed "snapshots" of local conditions. But one-time baseline sampling is clearly not enough. We now know that the ocean responds dramatically, at inter-annual and decadal time scales, to natural and anthropogenic forcing. "Now" is different from "then", and "tomorrow" will be different from "today". Sustained and systematic time series observations are needed to track these changes. Local repeated observations are the basic ingredient of time series. But we learn much more if we can also look at the larger spatial pattern of the changing ocean. A shared network of local and regional observations will give us this perspective.

Table 1. Participants of the PICES MONITOR Workshop on "Development of pilot coastal monitoring program(s) in the NE Pacific".

US Alaska	**Canada DFO**
Molly McCammon, AOOS	Robin Brown, IOS
Elizabeth Logerwell, NMFS	Kenneth Cooke, PBS
Bernard Megrey, NMFS	Howard Freeland, IOS
Jeffrey Napp, NMFS	Gordon McFarlane, PBS
Brenda Norcross, UAF	David Mackas, IOS
Phyllis Stabeno, PMEL	
	NEPTUNE/VENUS
US California Current	Christopher Barnes, UVic
David Martin (NANOOS)	Richard Dewey, UVic
Elizabeth Clarke (PaCOS)	Verena Tunnicliffe, UVic
Harold Batchelder (US GLOBEC)	
William Peterson, NMFS	**Mexico IMECOCAL**
Edmundo Casillas, NMFS	Lydia Ladah, CICESE
Republic of Korea	**PICES**
Suam Kim (PNU)	Ian Perry, Science Board
Sinjae Yoo (KORDI)	Alexander Bychkov, Secretariat
	Skip McKinnell, Secretariat

What and where: Extent and ingredients of a west coast monitoring network

The region of interest (Fig. 1) is large, and both politically and ecologically diverse. It extends across three national jurisdictions, from the tropics (southern tip of Baja California) nearly to the Arctic Circle (Bering Sea), and from the coast to slightly beyond the continental slope. But all parts are also strongly interconnected by shared atmospheric forcing, by the two major NE Pacific boundary currents (California and Alaska), and by the extensive alongshore migration and drift of many important species.

Starting from the south, Mexican programs (summarized by Lydia Ladah) include the IMECOCAL ship-based surveys of the southern part of the California Current, and a near-shore array of moored instruments (Baja COMNet). Both are new programs (~5-years duration), but have been productive and are hopeful for ongoing funding.

Within the United States, there is now strong and high-level commitment to a coastal ocean observing system. With this commitment comes strong agency and Congressional expectations for a robust governance system and clear deliverables. Some of this is already in place but much still needs to be developed. David Martin, Elizabeth Clarke and Molly McCammon described the planned structure: a "sustained ocean observing and prediction federation (Ocean.US)" made up of spatially-nested global, national "backbone", and intensive regional elements. For the US west-coast, four regions have been identified (southern California, central California, northern California-Oregon-Washington, and Alaska). In-region implementation plans are now being developed. Their full implementation is probably a decade or more away, but a substantial increase in funded activity is expected within the next 2-3 years. In the interim, key existing time series such as the US GLOBEC LTOPs and CalCOFI are seeking bridging funding from their parent agencies, and PaCOS and AOOS (Alaska Ocean Observing System) are working toward maintaining and expanding larger scale California Current, south and central Alaska, and Bering Sea "backbone".

Fig 1. The region of interest (bounded by the red dotted line).

Monitoring of the Canadian continental margin (located strategically between Alaska and the US "lower 48") is at present done mostly by the Department of Fisheries and Oceans. The DFO program consists of a combination of ship-based oceanographic and fishery assessment surveys (seasonal to biennial interval), instrumented moorings, and offshore Argo drifters. With the exception of the new Argo program, most have now been underway for about 20 years. Soon to join this mix is a major Canadian and US investment (approximately US$250M) in an extensive network of cabled seabed observatories covering Canadian inshore waters (VENUS), and extending seaward and southward across the Juan de Fuca tectonic plate (NEPTUNE). Installation of the NEPTUNE array is scheduled for 2007-2008. Once installed, the operational phase of NEPTUNE will continue for at least 30 years.

What can we look forward to during the next decade?

- Great improvements in the amount and diversity of up-to-date time series data;
- Changes in the dominant kinds of sensors and measurement platforms (certainly more buoys, drifters, … but perhaps a shortage of ships and ship time); and
- Expectations that data will be freely shared (which leads to the next topic).

Data and data management issues: Collection, archival, access, use and user expectations

Who will gather, store and use the pending flood of GOOS data? Part of the answer is "we will", with "we" being the familiar community of PICES marine scientists. But both the data originator and data user communities will be considerably broader than PICES. GOOS has developed with a strong and consistent emphasis on delivery to end-users outside the scientific community. The US GOOS Steering Committee and its governmental counterpart, the Ocean.US office, have recently completed a Data Management and Communications Plan, emphasizing these as top priorities for the US program. Continued careful planning and considerable program investment will be required to insure that raw data get transformed into information products that satisfy user needs.

For me, one of the high points of the workshop was the discussion stimulated by Harold Batchelder's presentation on "user expectations". Briefly, members of the scientific community are trained to want (and to collect) high quality raw data, to evaluate that data based on technical criteria, and to use the data to produce (or criticize) scientific interpretations of "how the world works". In contrast, many (perhaps most) non-scientist end-users will not particularly want (and lack the time and training for technical evaluation of) large volumes of raw data. They will however want and expect reliable, accessible and up-to-date interpreted summaries (attractively packaged). The goal and model for meeting this expectation is the oceanic equivalent of a TV weather channel or on-line website. This goal is not entirely unfamiliar – it is what PICES is attempting to meet with the North Pacific Ecosystem Status Report. And, fortunately for us, many things in the ocean vary a bit more slowly than the weather. But we will certainly have to automate and "contract out" a lot of the basic data collection, processing/archival and quality evaluation, if we want time to continue with interpretation and development of new knowledge.

Workshop recommendations

The final hours of the workshop were spent developing a list of needs and recommendations for action:

What is needed

- Integrated coast-wide monitoring and analysis are critical for a variety of societal needs. The appropriate spatial scale for a Northeast Pacific (NEP) Coastal Monitoring Network extends along the continental margin of North America from the Bering Sea through the Baja California Peninsula.
- Several long-term observation programs that currently contribute to understanding these linked coastal ocean regions are ending soon (*e.g*. NEP GLOBEC), but the need for them is not ending. We must design and implement their successors.

Role of PICES

- PICES provides a pool of expert, willing field scientists, data analysts and data managers, and a forum for coast-wide information exchange and ecosystem reporting (*e.g*. the North Pacific Ecosystem Status Report).
- PICES should encourage participation in the network by other groups (*e.g*. near-shore ecology and oceanography, instrument designers, information technology engineers).
- PICES MONITOR Task Team should establish an Advisory Panel that provides coordination and synthesis of NEP coast-wide monitoring.

Scope and governance

- The NEP coastal monitoring network should coordinate measurement and availability of a set of core variables in all regions, and also apply large-scale information to locally measured variables and issues.
- An international governance structure should be established to coordinate regional activities, data exchange, and synthesis.
- The governance structure should be implemented by MOUs between PICES and the appropriate national committees (*e.g*. GOOS and IOOS).
- To implement the above, a funded "PICESOOS" office should also be established.

PICES Special Issues

1999-2003

Ecosystem dynamics in the eastern and western gyres of the Subarctic Pacific (Guest editors: Richard J. Beamish, Suam Kim, Makoto Terazaki and Warren S. Wooster) – *Prog. Oceanogr.* 1999. Vol. 43, Nos. 2-4, pp. 157-488.

North Pacific climate regime shifts (Guest editors: Steven R. Hare, Shoshiro Minobe and Warren S. Wooster) – *Prog. Oceanogr.* 2000. Vol. 47, Nos. 2-4, pp. 99-408.

Pacific climate variability and marine ecosystem impacts (Guest editors: Stewart M. McKinnell, Richard D. Brodeur, Kimio Hanawa, Anne B. Hollowed, Jeffrey J. Polovina and Chang-Ik Zhang) – *Prog. Oceanogr.* 2001. Vol. 49, Nos. 1-4, pp. 1-639.

Physics and biology of eddies, meanders and rings in the PICES region (Guest editors: William B. Crawford, Alexander S. Bychkov, Stewart M. McKinnell and Takashige Sugimoto) – *J. Oceanogr.* 2002. Vol. 58, No. 5, pp. 627-745.

Variability in the Bering Sea ecosystem (Guest editors: S. Allen Macklin, Sei-ichi Saitoh, Vladimir I. Radchenko, Jeffrey M. Napp, Phyllis J. Stabeno and Stewart M. McKinnell) – *Prog. Oceanogr.* 2002. Vol. 55, Nos. 1-2, pp. 1-262.

Migration of key ecological species in the North Pacific Ocean (Guest editor: James Irvine) – *Can. J. Fish. Aquat. Sci.* 2002. Vol. 59, No. 12, pp. 1845-1998.

North Pacific transitional areas (Guest editors: Stewart M. McKinnell, Michio J. Kishi, Daniel Lluch-Belda, Arthur J. Miller and Yoshiro Watanabe) – *J. Oceanogr.* 2003. Vol. 59, No. 4, pp. 387-536.

Plankton size classes, functional groups and ecosystem dynamics (Guest editors: M. Angelica Peña and Alexander S. Bychkov) – *Prog. Oceanogr.* 2003. Vol. 57, Nos. 3-4, pp. 239-480.

PICES interdisciplinary assessment of marine environmental quality (Guest editor: Richard F. Addison) – *Mar. Envir. Res.* 2004. Vol. 57, Nos. 1-2, pp. 1-153.

Upcoming in 2004

JGOFS North Pacific synthesis (Guest editors: Toshiro Saino, Alexander S. Bychkov, Chen-Tung A. Chen, Paul J. Harrison and Ichiro Yasuda) – *J. Oceanogr.* – collection of invited papers.

Recent progress in studies of the Japan/East Sea ecosystem (Guest editors: Stewart M. McKinnell, Alexander S. Bychkov, Kyung-Ryul Kim and Makoto Terazaki) – *Prog. Oceanogr.* – selected papers from the 2002 PICES/CREAMS workshop.

Role of zooplankton in global ecosystem dynamics: Comparative studies from the world oceans (Guest Editors: Roger Harris, Tsutomu Ikeda, Luis Valdes, William T. Peterson and Stewart M. McKinnell) – *ICES J. Mar. Res.* – selected papers from the 2003 PICES/GLOBEC/ICES Zooplankton Production Symposium.

Importance of biophysical coupling in concentrating marine organisms around shallow topographic (Guest editors: Richard D. Brodeur and John F. Dower) – *J. Mar. Systems* – selected papers from the 2002 Topic Session at PICES XI.

Publications in the PICES Scientific Report Series

2002-2003

Report of the 2001 BASS/MODEL, MONITOR and REX Workshops, and the 2002 MODEL/REX Workshop. 2002, No. 20, 176 p.

Report of the PICES 2002 Volunteer Observing Ship Workshop. 2002, No. 21, 38 p.

PICES Science: The first ten years and a look to the future. 2002, No. 22, 102 p.

Harmful algal blooms in the PICES region of the North Pacific. 2002, No. 23, 152 p.

CO_2 in the North Pacific (final report of PICES WG 13). 2003, No. 24, 49 p.

Report of BASS and MODEL Task Teams on "Trophic models of the subarctic Pacific basin ecosystems". 2003, No. 25, 93 p.

Report of the 2003 MODEL Workshop to "Develop a marine ecosystem model of the North Pacific Ocean including pelagic fishes". 2003, No. 26.

Report of the 2002 MONITOR Workshops on "Requirements and methods for 'early' detection of ocean changes" and "Monitoring from moored and drifting buoys". 2003, No. 27.

Upcoming in 2004

Marine life in the North Pacific Ocean: The known, unknown and unknowable.

Guide of best practices for oceanic CO_2 measurements and data reporting.

Effective sampling of micronekton (Final report of WG 14)

Proceedings of the Third PICES Workshop on "Okhotsk Sea and adjacent areas".

Report of the 2003 PICES Iron Fertilization Panel Workshop on "*In situ* iron enrichment experiments in the eastern and western Subarctic Pacific".

Report of the 2003 MONITOR Workshop to "Examine and critique a North Pacific Ecosystem Status Report".

PICES Thirteenth Annual Meeting

October 15-23, 2004
Honolulu, Hawaii, U.S.A.

Beyond the continental slope - complexity and variability in the open North Pacific Ocean ($^3/_4$-day Science Board Symposium/S1)

Mechanisms that regulate North Pacific ecosystems: Bottom up, top down, or something else? (1-day BIO Topic Session/S2)

Role of gelatinous zooplankton in coastal and oceanic ecosystems ($^1/_2$-day BIO Topic Session/S3)

Hot spots and their use by migratory species and top predators in the North Pacific (1-day FIS/BIO Topic Session/S4)

Natural and anthropogenic introductions of marine species (1-day MEQ Topic Session/S5; co-sponsored by ICES)

Marine Protected Areas ($^1/_2$-day MEQ Topic Session/S6)

Application of Global Observing Systems to physics, fisheries and ecosystems (1-day POC/MONITOR Topic Session/S7; co-sponsored by Argo)

The impacts of climate change on the carbon cycle in the North Pacific (1-day POC Topic Session/S8; co-sponsored by IOCCP)

CCCC, GLOBEC, and GLOBEC-like results: First steps toward a synthesis of the impacts of large-scale climate change on North Pacific marine ecosystems ($1^1/_2$-day CCCC Topic Session/S9)

Modeling approaches that integrate multiple spatial scales and trophic levels between shelf and open oceans ($^1/_2$-day CCCC/MODEL Topic Session/S10)

Data visualization of open ocean processes in the North Pacific (TCODE Electronic Poster Session/S11)

BIO Paper Session ($^1/_2$-day)

FIS Paper Session ($^1/_2$-day)

Micronekton sampling gear intercalibration experiment (1-day MIE-AP Workshop/W1)

The seasonal cycle of plankton production in continental shelf waters around the Pacific Rim (1-day CCCC/REX Workshop/W2)

Linking open ocean and coastal ecosystems II (2-day CCCC Workshop/W3)

Scale interactions of climate and marine ecosystems (1-day PICES/CLIVAR Workshop/W4)

Developing a North Pacific HAB Data Resource – Phase II (1-day MEQ Workshop/W5; co-sponsored by IOC)

Combining data sets on diets of marine birds and mammals – Phase II ($^1/_2$-day MBM-AP Workshop/W6)

Effects of climate on the structure and function of marine food webs and implications for marine fish production in the North Pacific Ocean and marginal seas (4-day MODEL Workshop; pending APN funding)

PICES Calendar

- IOCCP/PICES workshop on "*Ocean surface $p(CO_2)$ database and data integration*", January 14-17, 2004, Tsukuba, Japan
- PICES-IFEP workshop on "In-situ *iron enrichment experiments in the eastern and western subarctic Pacific*", February 11-13, 2004, Victoria, Canada
- Canadian-SOLAS/PICES-IFEP session on "*Response of the upper ocean to mesoscale iron enrichment*", February 17-18, 2004, Honolulu, U.S.A., at the TOS/ASLO 2004 Ocean Research Conference (http://aslo.org/honolulu2004/)
- Symposium on "*Quantitative ecosystem indicators for fisheries management*", March 31-April 3, 2004, Paris, France (http://www.ecosystemindicators.org)
- Interim PICES Science Board meeting, May 6-8, 2004, Jeju Island, Republic of Korea
- PICES/NOAA Workshop on "*Potential implications of recent regime shifts in the North Pacific for fisheries*", June 2004, venue on the US west coast to be decided
- NOAA/GCP/PICES workshop on *Understanding North Pacific carbon cycle change: Data synthesis and modeling*, June 2004, Seattle, U.S.A.
- PICES-MODEL Workshop on "*Development of a model on coupled responses of lower and higher trophic levels for climate variability in the North Pacific*", August 2004, Seattle, U.S.A.
- PICES Thirteenth Annual Meeting, October 14-24, 2004, Honolulu, U.S.A. (http://www.pices.int)
- CREAMS/PICES workshop on "Japan/East Sea circulation: What we know and how well can we forecast?", summer 2005, near Vladivistok, Russia
- NPAFC/PICES Symposium on "*State of Pacific salmon and their role as indicators of the health of North Pacific ecosystems*", November 2005, Seoul, Korea
- PICES Fourteenth Annual Meeting, September 30-October 8, 2005, Vladivostok, Russia
- Symposium on "*CCCC Program synthesis: Connections between climate variability and ecosystem structure and functioning in the North Pacific*", April 2006, Honolulu, U.S.A.

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