

# DOCUMENTING SCIENTIFIC SESSIONS AT PICES XI



## Session S1 (Science Board Symposium)

### *Technological advances in marine scientific research*

Co-Convenors: R. Ian Perry (SB), Vladimir I. Radchenko (BIO), Douglas E. Hay (FIS), John E. Stein (MEQ), Kuh Kim (POC), Igor I. Shevchenko (TCODE), Harold P. Batchelder and Makoto Kashiwai (CCCC)

#### Background

This symposium examined the potential for new technologies to advance the scientific activities conducted by PICES researchers. Technological advancements are occurring in a variety of research areas (biology, biomass assessments, physical and biological oceanography, etc.). For example, advances in stock identification methods are occurring in the areas of: microscopic laser ablation techniques; new nuclear DNA techniques; smart tags, including acoustical tags for fish and mammals, etc. For stock assessments there are new developments in the areas of laser technology and associated data analyses that can scan the upper 20-30 m from aircraft and satellite technology. Plankton assessments are advancing through bio-optical recording and analysis systems. There are continuing developments in acoustical assessments, such as towed vehicles with upward- and downward-looking transducers, and long-range sidescan SONAR. Some of the most rapid advancements are occurring in physical oceanography, with the development of smart drifters. This emphasis on technological advancements includes new developments in information technology, numerical modeling, data processing and visualization.

#### Summary of presentations

The session consisted of eleven oral presentations and seven posters. Papers dealt with aspects of new technologies in physical and biological oceanographic observations, in new methods for tracking movements of fish and

other large organisms, and new approaches to integrate and visualize the large volumes of data that result from these new observing techniques. With many “new” techniques, such as observations from satellites, sufficient data have been collected over the past >10 years to begin to permit time series analyses. Modelling techniques that use 4-dimension optimal interpolation methods are also becoming sufficiently developed to integrate and assimilate the large volumes of physical observations. The coming trend is to use smaller and faster devices, and to integrate multiple sampling systems. Current issues to be resolved include data transfer rates (which are presently too slow for the amount of data that could be collected), visualization and analyses of these large data sets, and their dissemination. Biological observation systems are taking novel approaches to use the organisms themselves as platforms to describe their environment, for example, the tagging projects discussed by David Welch and Jeffrey Polovina. However, the ability of biological observations to sample rapidly over a wide range of spatial scales lags the present ability of physics. Models that can integrate these biological observations are also severely lacking. The final oral presentation by Neville Smith underlined the additional problem of managing and archiving these large volumes of data. These latter issues are presently not strong components of most research programs. The greatest challenge may be in the area of outreach to the scientific community and organizational behaviour with respect to data management issues than in the technological problems.

## List of papers

### *Oral presentations:*

**Stephen C. Riser** (invited)

Building a global ocean observing system with profiling floats

**Masafumi Kamachi, Tsurane Kuragano, Xiaobing Zhou and Yosuke Fujii**

JMA operational ocean state estimation and prediction system in the North Pacific: COMPASS-K

**David W. Welch**

POTENT: The Pacific Ocean Tracking & Evaluation NeTwork description & applications in marine science

**Albert J. Hermann, C. Moore and Nancy N. Soreide**

Recent advances in immersive visualization of ocean data: Virtual Reality through the web on your laptop computer

**Joji Ishizaka and Hiroshi Kawamura** (invited)

Near future opportunities in satellite remote sensing of physical and biological properties of the Ocean

**Tommy D. Dickey** (invited)

Toward global ocean interdisciplinary observations using emerging autonomous sampling technologies

**Oscar M. Schofield and Scott Glenn**

Development of coastal ocean observatories for synoptic oceanography

**Gabriel Gorsky** (invited)

Can optical methods quantify, measure and classify zooplankton efficiently?

**Sukyung Kang, Suam Kim, David Welch, Kevin Telmer and Youn-Ho Lee**

The analysis on trace elements in chum salmon otolith using laser-ablation technology: Habitat characteristics and stock identification

**Jeffrey J. Polovina, Don Hawn, Evan Howell and Michael Seki**

A new approach to fisheries oceanography with advances in electronic tags

**Neville R. Smith** (invited)

Ocean Information Technology: Some new opportunities for marine data management

### *Posters:*

**Irina Y. Bragina and Valery N. Chastikov**

The experience of the optical plankton counter TRAP -7A application in the Okhotsk and Japan Seas, 2001-2002

**Irina Y. Bragina and Gennady A. Kantakov**

The results of McLane Autonomous Zooplankton Sampler Application in the Okhotsk Sea, 2000-2001

**Yang Ho Choi and Young Jae Ro**

Web-based realtime monitoring of water quality conditions in the Korean coastal waters

**Joseph C. Huang**

Revisit OTEC System

**Katsumi Matsushita**

An applicable automatic continuous sampling method of small pelagic organisms

**Donghwa Sohn, Sukyung Kang and Suam Kim**

Trace element analysis for the stock identification of Chum salmon (*Oncorhynchus keta*) in Korea

**Vladimir N. Vologdin**

Technique of a combined research of near-surface fish formations behaviour and structure with the help of sonars and echosounders

## Session S2 (BIO/MEQ)

### *Food web dynamics in marginal seas: Natural processes and the influence of human impacts*

Co-Convenors: Paul J. Harrison (Canada) and Hideaki Nakata (Japan)

#### Background

Marginal seas are often one of the most productive regions of the world's oceans. They are sites of abundant natural resources and fisheries. In some cases, nutrients and production are transported offshore, enriching these areas. Human impacts are evident in some areas of these marginal seas and these anthropogenic inputs including excessive nutrients, heavy metals and various organics, have altered various foodwebs. Sometimes changes in the phytoplankton species have resulted in changes in higher trophic levels, including fisheries. Excessive nutrients may lead to over-production of phytoplankton which are not eaten by zooplankton, and the decomposition of the bloom at depth may result in hypoxic or anoxic bottom waters with significant effects on the benthos. We need to understand these changes and their causes, if we are to better manage our marginal seas. For this session, contributed talks and posters on the influence of excessive anthropogenic inputs on food web dynamics were encouraged.

#### Summary of presentations

The topic of the session was very broad and papers addressed nutrients, heavy metal, organic pollutants and the effects on a wide variety of geographical sites and on a variety of organisms. Therefore, there were no general themes, but here are some generalities.

#### *Nutrients*

Nutrient ratios, concentrations and nutrient fluxes are all important. Eugene Turner clearly showed that nutrient ratios such as Si:N can influence what group of phytoplankton (e.g. diatoms vs. flagellates) will dominate. If diatoms dominate, then copepods are more abundant, and there will be more high quality carbon flux to the benthos in the form of fecal

pellets. If flagellates dominate because the Si:N ratio is  $<1$ , there will be less flux and poorer quality, and therefore the benthos will not benefit as much from the surface productivity. Therefore the final conclusion is that the effect of nutrient ratios propagates all the way up the food chain and down to the benthos. Nianzhi Jiao also showed that parts of the East China Sea might be silicate-limited and affect the abundance of diatoms in this area. Paul Harrison indicated that Hong Kong waters are P-limited in some areas and N-limited in the areas further away from Hong Kong. He suggested that the waters surrounding Hong Kong are not as hypoxic as those of the Mississippi River estuary, because the phosphate concentration is not as high as in the Mississippi River, and therefore the algal biomass production is lower, and hence there is less utilization of oxygen, since there is less algal biomass produced. Iron limitation was discussed in the subarctic gyre and in the South China Sea. Atsushi Tsuda showed that when Fe was added to the western subarctic gyre, only 10% of the primary productivity was eaten by zooplankton, however that amount did decrease the mortality of the naupliar stages of some copepods. Yang demonstrated in some lab experiments that additions of Fe to picoplankton from the South China Sea, did increase their growth rate.

#### *East China Sea*

Carbon flux in the East China Sea was shown to be influenced by downwelling and bottom currents carrying large amounts of sediment, but with low carbon content. Alternatively, there were smaller events with mass sinking that carried organic matter that had high carbon content in it. Jiao showed the distribution of picoplankton in the East China Sea and suggested that temperature, salinity and nutrients were important factors affecting their distribution.

## List of papers

### *Oral presentations:*

**R. Eugene Turner, Nancy N. Rabalais, Quay Dortch and Dubravko Justic** (invited)

Variations in nutrient ratios and aquatic food webs

**Shang Chen and Mingyuan Zhu**

Modeling response of marine pelagic ecosystem to phosphate enrichment

**Nianzhi Jiao, Shujiang Zhao, Zhiliang Shen and Yulin Wu**

Causes and consequences of changes in nutrient structure in a typical coastal waterbody, with special reference to silica-limitation of phytoplankton

**Nelson Sherry**

Predicting the influence of episodic physical events on longer term and/or larger scale estimates of biomass and production at lower trophic levels

**Paul J. Harrison and Kedong Yin**

Eutrophication in Hong Kong waters: Why is it not worse?

**Ruixiang Li and Mingyuan Zhu**

The competition between two HAB species a diatom and a dinoflagellate - mesocosm experiment

**Atsushi Tsuda, H. Saito, J. Nishioka and T. Ono**

Mesozooplankton responses during the Subarctic Ocean enrichment and ecosystem dynamics study (SEEDS 2001)

**Yanhui Yang and Nianzhi Jiao**

Effects of iron enrichment on picoplankton cell abundances in the South China Sea: A result from deck experiment

**Kazuo Iseki** (invited)

Continental margin carbon fluxes in the East China Sea

**Jinhui Wang and Xiuqing Huang**

Harmful algal bloom and nutrient overenrichment of East China Sea

**Nianzhi Jiao, Yanhui Yang, Hiroshi Koshikawa and Masataka Watanabe**

Coupling of hydrographic conditions and picoplankton distribution in the East China Sea, a marginal sea of the Northwest Pacific

**Jintao Li, Dengfeng Yang and Weihong Zhao**

Studies of influence of nutrients on growth of red tide plankton in the East China Sea by field experiment

**Hui Huang, Renlin Zou and Sheng Liu**

Impacts of warm effluent from the Daya Bay nuclear power plant on stony coral community

**Bangqin Huang**

Alkaline phosphatase activity and utilization of dissolved organic phosphorus by algae in subtropical coastal waters

**Olga N. Lukyanova**

Molecular biomarkers in the marine organisms of various trophic level influenced of human impact

### **Session S3 (BIO/POC/FIS)**

#### ***The importance of biophysical coupling in concentrating marine organisms around shallow topographies***

Co-Convenors: Richard D. Brodeur (U.S.A.), John F. Dower (Canada), David L. Musgrave (U.S.A.) and Orio Yamamura (Japan)

#### Background

The primary goal of this session was to bring physical and biological oceanographers together with fisheries scientists, to explore mechanisms underlying the widespread phenomenon of biological aggregations around shallow topographic features. Even though the existence of these dense aggregations and their frequent association with shallow topographies, have long been known, only a few scientific symposia have been devoted to this particular topic. This session featured 10 oral and 6 poster presentations, and included scientists from Canada, Japan, Israel, Mexico, Russia, South Africa and the United States. Of the 16 contributions, 10-12 will be included in an upcoming special issue of the *Journal of Marine Systems* to be edited by Drs. Richard D. Brodeur, John F. Dower and Stewart (Skip) M. McKinnell.

#### Summary of presentations

The session opened with an invited lecture by Amatzia Genin from the Hebrew University of Jerusalem. In his talk, Dr. Genin used a comparative approach to examine the mechanisms underlying aggregations over seamounts, canyons, sills and shelf break fronts. His presentation drew heavily on examples from the North Pacific, and provided an ideal introduction to the session. Several of the key themes to emerge from the invited lecture were also echoed by subsequent speakers. Chief among these was that dense aggregations of zooplankton and fish over shallow topographies are not usually linked to locally enhanced primary production. As pointed out by Dr. Genin (and others), in most cases, dense aggregations of zooplankton over topographic features result from a combination of three mechanisms: bottom-trapping of downward migrating organisms, enhanced horizontal flux

of food in topographically accelerated flows, and counter-upwelling depth retention (in which plankton swimming downward against an upwelling current are accumulated into dense swarms). In turn, the favourable food environment created by these mechanisms acts to attract higher trophic level organisms. These findings served to highlight the importance of interactions between physics and behaviour, and even life history strategies, in producing topographic aggregations. Despite the apparent widespread nature of such aggregations, Dr. Genin ended his talk on a cautionary note, and pointed out that the literature may be biased toward positive results, since studies failing to find topographic aggregations may less likely be published.

Jack Barth discussed some of the mechanisms by which continental shelf banks have been hypothesized to affect the circulation. Included among these are their ability to redirect coastal jets, create regions of weaker flow, enhance vertical mixing, affect the along shore pressure gradient, and lead to re-circulation around the bank. Each of these is likely to have a biological response. Dr. Barth provided examples of these based on multi-disciplinary sampling around the Heceta Bank off Oregon from 1999-2002. Based on shipboard ADCP, CODAR tracking and satellite-tracked drifters, the pattern of circulation was determined to be different from the "classical" upwelling regime, in that there was a shoreward redirection of the coastal jet which created a low-velocity region in the lee of the bank. Within this region was observed very high chlorophyll concentrations during most cruises. Higher trophic level organisms including copepods, euphausiids, seabirds and marine mammals were also found in high densities in this region.

Susan Allen's paper dealt with both the general concept of aggregations around submarine

canyons, as well as the specific case of dense euphausiid swarms around Barkley Canyon off the coast of British Columbia. She began by demonstrating the hydrodynamics of an along-shelf current that encounters a submarine canyon. The result of this interaction is a localized upslope flow along the floor of the canyon, and a re-circulating flow in the near-surface flow above the canyon. This interaction also leads to the formation of dense euphausiid swarms, usually along the downstream edge of the canyon. Dr. Allen explained that this phenomenon likely results from the interactions between the canyon flow, and the diel vertical migratory behaviour of the euphausiids. Thus, euphausiids migrating up out of the canyon at night are carried downstream and become trapped near the edge of the canyon as they attempt to descend near dawn. These aggregations attract fish which feed upon the euphausiids. The process is visible in hydroacoustic data as a series of daily pulses of scatterers that form on the downstream edge of the canyon.

Armando Trasvina discussed the flow dynamics around a shallow seamount in the Gulf of California. There are series of such seamounts in the Gulf, several of which support high abundances of zooplankton and ichthyoplankton, as well as dense aggregations of such top predators as sharks, tunas and billfish. Unlike other seamounts discussed in the session, the seamount in this study is relatively close to shore and its circulation patterns, as well as its productivity, result from both local topographic effects and allochthonous input from the neighbouring Bay of La Paz. Although there is no evidence of a closed re-circulating flow over the seamount, dense aggregations of euphausiids are occasionally found over the seamount. The authors propose that these aggregations are maintained by opposing flow regimes near the surface and at depth, which act to retain the vertically migratory zooplankton.

John Dower suggested that Haida eddies and offshore-directed coastal jets may play a key role in the maintenance of isolated *Sebastes* populations on shallow NE Pacific seamounts. Since 1992, TOPEX Poseidon data have shown

that 11 of the 15 Haida eddies that formed off the west coast of the Queen Charlotte Islands passed over at least one shallow seamount in the region. In one case, a Haida eddy was shown to have become “stuck” over Bowie seamount for at least three months, at a time when the eddy was also found to contain high abundances of coastal zooplankton species. Haida eddies in the general vicinity of these seamounts have also been found to contain coastal ichthyoplankton, including larval sablefish, larval kelp greenling and larval rockfish. The authors propose to test their hypothesis using geochemical tracer techniques to look for evidence of coastal origins in otoliths from seamount rockfish.

The papers by Chris Wilson and George Boehlert and Michael Seki and George Boehlert dealt with the dense layers of micronekton that occur over SE Hancock Seamount in the Subtropical North Pacific near Hawaii. The first paper showed that this micronekton layer displayed strong DVM behaviour, and was composed almost exclusively of the sternothyrid fish *Maurolicus muelleri* and the mysid *Gnathopausia longispina*. In exploring the three-dimensional structure of the aggregations, it was seen that the highest densities were recorded within 100 m of the seamount summit. Since the local flow was quite variable (and therefore not generally conducive to retention), the authors concluded that these species must use active swimming, and directed horizontal movement to maintain their populations over the summit. The second paper examined the community composition in the waters surrounding SE Hancock. Given its position near the North Pacific Subtropical Front, there was considerable seasonal variability in hydrography, productivity (more productive in winter) and thus, community composition. Recurrent group analysis revealed several species groups. The main “seamount group” consisted of the two resident species (*M. muelleri* and *G. longispina*). The three “off-seamount” groups included species whose presence/absence was more seasonal. Also of interest was the observation that neither of the “seamount species” appear to be among primary prey of the large demersal predators on the seamount.

The paper by Kohei Mizobata and Sei-ichi Saitoh presented results from a visual analysis of some 1,500 satellite images covering the period from 1998-2001 (and including TOPEX/ERS SST, TOPEX Poseidon altimetry, SeaWiFS ocean colour and primary production estimates based on SeaWiFS imagery). The data was used to describe the distribution of shelf-edge eddies in the SE Bering Sea, and potential impacts on biological production. The authors found that the number of eddies in the SE Bering Sea ranged from 250-324 per year, with higher numbers found in 2000-2001 than in 1998-1999. Eddy number seemed to be inversely related to eddy longevity (i.e. eddies in 1998-1999 were more stable than in 2000-2001), although most eddies seemed to persist for about one month. Eddy velocity also varied between years: the more energetic eddies from 2000-2001 moved at 1.0 – 1.8 cm/s, whereas the weaker eddies in 1998-1999 moved at speeds of 0.43 – 0.54 cm/s. Chlorophyll and primary production were elevated within the eddies (relative to background conditions) in all four years, although the enhancement was highest (and persisted longest) in 2000-2001. The authors concluded that interannual variability in eddy formation plays an important role in regional production in the SE Bering Sea.

David Mackas reported results from a study in Knight Inlet, a deep fjord with a very shallow sill located in British Columbia. Dense aggregations of euphausiids had previously been reported from the sill, but the mechanism underlying this aggregation was unknown. Using an arsenal of nets, acoustics and various optical sensing systems, the authors first confirmed the high abundance (and variance) of euphausiid biomass above the sill. Unexpectedly, they also found abundance minima extending about 10 km on either side of

the sill. Analysis of multi-frequency acoustic data revealed that this pattern results from the very strong tidal flows, which alternately aggregate euphausiids on the upstream and downstream sides of the sill. Small fish in the area seem to aggregate in and feed upon the euphausiid aggregations. As they deplete one aggregation, the fish seem to anticipate the changing tide and move to the other side of the sill where the change in tidal flow will produce the next euphausiid aggregation.

Anne Hollowed's talk presented results from a program designed to examine the effects of fishing on the distribution and abundance of Steller Sea Lion prey (specifically, walleye Pollock and capelin). The study involved a comparison between the Barnabas and Chiniak troughs (one of which was fished, the other was closed to fishing) on the continental shelf east of Kodiak Island. A variety of trawls, drifters, ADCP data and satellite imagery were used to map the local circulation and distribution of the two species in each trough. The two species were distributed differently within the two regions, with capelin being the patchier of the two. Passage of a storm through the system eroded near-surface stratification and resulted in a post-storm surface phytoplankton bloom (likely via mixing of a previously existing sub-surface Chl maximum). The circulation patterns in the two troughs were found to be quite different, and seemed to be linked to the existence of a frontal system in Barnabas trough. In general, it seemed that the capelin distribution followed the distribution of the coldest waters. In contrast, walleye pollock distributions seemed to be related to the feeding environment, and followed the warmer near-shore waters which (due to enhanced cross-shelf advection) were characterized by higher zooplankton advection.

#### List of papers

##### *Oral presentations:*

**Amatzia Genin** (invited)

Trophic focusing: The role of bio-physical coupling in the formation of animal aggregations in the sea

**Jack A. Barth, Stephen D. Pierce and Timothy J. Cowles**

The influence of Heceta Bank, Oregon, on the coastal ecosystem

**Susan E. Allen**

Canyons and euphausiids: Trapping and aggregation mechanisms

**Armando Trasvina, G. Gutierrez de Velasco, A. Valle-Levinson, R. González-Armas, A. Mulhia and M.A. Cosio**

Dynamics of the flow in the vicinity of a shallow seamount top in the Gulf of California

**John F. Dower, Sonia D. Batten and William R. Crawford**

Biophysical coupling and the maintenance of dense rockfish populations on shallow seamounts in the Northeast Pacific

**Chris D. Wilson and George W. Boehlert**

Ocean currents and diel migrators at a seamount in the central North Pacific

**Kohei Mizobata and Sei-ichi Saitoh**

Variability of Bering Sea eddies and primary productivity along the shelf edge during 1998-2000 using satellite multi-sensor remote sensing

**Mark Trevorror, David L. Mackas, , Douglas R. Yelland and Mark Benfield**

Aggregation of macrozooplankton and fish at a fjord sill

**Michael P. Seki and George W. Boehlert**

Species composition and assemblage patterns of oceanic micronekton at a central North Pacific Seamount

**Anne B. Hollowed, Chris Wilson, Phyllis Stabeno and Sigrid Salo**

Effect of ocean conditions on the cross-shelf distribution of walleye pollock (*Theragra chalcogramma*) and Capelin (*Mallotus villosus*) (S3-038)

*Posters:*

**Keith L. Bosley, Richard D. Brodeur, W. Waldo Wakefield, Robert L. Emmett and Kara Rehmke**

Food-web dynamics in Astoria Submarine canyon off the Oregon coast

**Vyacheslav B. Lobanov, V. Zvalinskiy, S. Zakharkov, P. Tishchenko, A. Salyuk, A. Salomatin, S. Ladychenko, Y. Zuenko, V. Nadtochiy and T. Orlova**

Physical causes and biological consequences of cross-shelf water exchange intensification along Primorye coast, Japan Sea in the fall season

**Evgeny Pakhomov**

“Life-support systems” of sub-Antarctic archipelago and seamounts: Physical and biological coupling mechanisms

**Vadim F. Savinykh, Vladimir A. Shelekhov and Vladimir B. Darnitsky**

Biology of the lightfish *Maurolicus imperatoricus* and the importance of physical processes on the dominance of this species over the Emperor Seamounts

**Phyllis J. Stabeno, E.D. Cokelet, N. B. Kachel, C. A. Mordy and S.A. Salo**

Mixing over Portlock Bank, Alaska

## **Session S4 (BIO/FIS/CCCC)**

### ***Responses of upper trophic level predators to variation in prey availability: an examination of trophic level linkages***

Co-Convenors: Hidehiro Kato (Japan), Elizabeth A. Logerwell (U.S.A.) and Gordon A. McFarlane (Canada)

#### Background

There is increasing interest in this topic as evidence accumulates of the impact of physical forcing on prey resources over a wide range of temporal and spatial scales. Predators respond to changes in their prey resources in a variety of ways and over a range of ecological organization, from the individual to the population to the species. Understanding these responses is important for gauging the usefulness of predators as indicators of ecosystem change. In addition, ecosystem management strategies require defined inter-specific relationships and an understanding of the role of predation in the regulation of marine populations. Presentations were invited on the responses of seabirds, mammals and fishes at the individual (behavior, physiology), population (reproductive performance, mortality) or species (evolution) level. Dimensions of prey availability could be quantity, spatial and temporal distribution or quality. Particularly interesting are presentations that discuss predator response as an indicator of ecosystem change, predator-prey relationships in the context of ecosystem management strategies or predation as a regulator of marine populations. This Topic Session complemented the BIO/POC/FIS Topic Session “The importance of biophysical coupling in concentrating marine organisms around shallow topographies”, and focused on the mechanisms resulting in high biomass concentrations that are utilized by many marine predators, and that may represent an important flux that affects the production in many ecosystems.

#### Summary of presentations

This session included nine oral presentations (three of which were invited) and eight poster presentations. Participants were from U.S.A., Canada, Republic of Korea, Russia and Japan.

Several presentations described field studies that show how predators respond to variability in prey. The kinds of responses documented included individual-level responses such as body size, stress hormone levels, diet composition, foraging behavior, habitat use, feeding efficiency and growth; and population level responses such as adult survival, reproductive success, juvenile survival and overall population growth or decline. Most of these presentations provided direct measures of the changes in prey availability thought to cause the observed responses. Some also showed that prey variability, and thus predator responses, were linked to climate variability at inter-annual and inter-decadal time scales, leading authors to suggest that predators can serve as indicators of ecosystem change. Prey availability can vary via changes in prey quality or quantity. Most presentations described variability in prey quantity. One presentation showed that changes in prey quality (caloric density) resulted in decreased growth in captive marine mammals.

Two posters and one oral presentation reported on predator diet composition. Although these studies do not deal directly with predator response to prey variability, these types of data are necessary to design field studies and to build trophic models.

Two presentations on trophic modeling were included in this session. One described a new way of modeling the functional response of predator consumption rate to changes in prey quantity. Anomalies in this functional response were observed in a time series of diet composition data from the Eastern Bering Sea, and were shown to propagate up the food web. Another presentation showed a different model of the functional response which was then incorporated into “NEMURO.FISH” to model changes in herring and saury growth as a function of environmental change.

The presentations described so far showed how predators *respond* to variability in prey, a handful of presentations showed how predators *drive* variability in prey. One of the invited presentations suggested that predation determines mortality of salmon early in the first marine year, but that growth (and thus energy stores) determines marine mortality during the first winter. Another talk presented the results of a field study to directly measure the growth of both predated and non-predated Japanese anchovy larvae. The authors found that mean growth rates of predated larvae were significantly lower, and that the effect was independent of length. A poster showed how information of predator-prey relationships was incorporated into stock assessment.

Several interesting issues were raised during the session. These questions may provide guidance for future research in this area:

- What is the temporal scale of food stress (acute versus chronic, recent to distant past)?
- What is the functional response of predator

consumption rate to variability in prey abundance?

- What is the shape of the predator response with varying prey availability (linear or non-linear)?
- Which life history stages are most sensitive to changes in prey availability?
- How and why do different species in the same system respond differently to changes in prey availability?
- What are the important spatial scales of prey variability?
- Is the mean or the variance in prey abundance most important in driving predator responses?
- What oceanographic processes drive the prey aggregations exploited by predators?
- How does diet composition vary among individuals of the same species (by sex and/or size)?
- Is predation mortality or growth mortality most important in determining survival during early life history of fish?
- Does growth directly control predation mortality (independent of size or stage duration)? If so, what is the mechanism?

### List of papers

#### *Oral presentations:*

**Alexander S. Kitaysky** (invited)

Are top-predators breeding in the Bering Sea food-limited?

**Tsutomu Tamura** (invited)

Diet variability of common minke whales in relation to changes in food availability

**Kerim Y. Aydin**

Where do predator/prey anomalies come from in the eastern Bering Sea

**William J. Sydeman, K.L. Mills, C.A. Abraham, J.A. Thayer and P. Warzybok**

Marine birds of the southern California Current ecosystem: Demographic and foraging consequences of variation in prey availability and quality

**Douglas F. Bertram, B. Smith, A. Harfenist and A. Hedd**

Contrasting adult survival of Cassin's Auklet on colonies in different oceanographic domains within British Columbia: 1994-2000

**George L. Hunt, Jr., Lucy Vlietstra, Jaime Jahncke and Kenneth O. Coyle**

Feathered oceanographers: The foraging ecology of marine birds

**Andrew W. Trites and David A.S. Rosen**

Responses of marine mammals to variability in prey availability

**Richard J. Beamish and Gordon A. McFarlane** (invited)

Predation and other beliefs and speculations

**Akinori Takasuka, Ichiro Aoki and Isamu Mitani**

Is a slower growing larval Japanese anchovy actually removed by predation at a given moment in the sea?

*Posters:*

**Jae-Bong Lee, Yeong Chull Park, Dong Woo Lee, Doo Hae Ahn, Hyung Kee Cha, Seok Gwan Choi and Chang Ik Zhang**

Predation by yellow goosfish, *Lophius litulon*, on yellow croaker, *Pseudosciaena polyactis*, in the East China Sea of Korea

**Bernard A. Megrey, Robert A. Klumb, Francisco E. Werner, Kenneth Rose, Douglas Hay, Shin-ichi Ito, and Michio J. Kishi**

Application of a nutrient-phytoplankton-zooplankton-fish bioenergetics trophodynamic simulation model (NEMURO.FISH) to Stocks of Pacific Herring and Pacific Saury in the North Pacific

**Sue E. Moore, Janice M. Waite**

Distribution of mysticete whales along the Alaskan coast: Southeast Alaska to Bristol Bay

**Ilyas N. Moukhametov**

Feeding habits of Pacific halibut *Hippoglossus stenolepis* from the southern Kuril Islands

**Svetlana V. Naydenko**

The role of Pacific saury in trophic structure in the epipelagial in the south Kuril Islands

**Alexei M. Orlov**

Summer diets, feeding habits and trophic relations of the most abundant elasmobranchs in the western Bering Sea

**Yasuhiro Ueno and Mitsuyuki Namiki**

Function of the gill-raker of the major pelagic fishes and the density effect

**Yutaka Watanuki, Tomohiro Deguchi and Akifumi Nakata**

Effects of Tsushima current on annual variation of diet and chick production in surface and sub-surface foraging seabirds breeding at Teuri Island, northern Hokkaido

**Session S5 (FIS)**

*Comparison of the productivity of marginal sea with emphasis on the western Pacific (Japan/East Sea, Yellow Sea and East China Sea) with a focus on small pelagics*

Co-Convenors: Vladimir Belyaev (Russia), Suam Kim (Korea), Hideaki Nakata (Japan) and Qi-Sheng Tang (China)

Background

The northwestern Pacific marine ecosystem, including three regional sub-areas (i.e., Japan/East Sea, Yellow Sea and East China Sea), is one of the most productive ocean areas in the world. The emphasis of this session was on understanding and comparing factors affecting the production of small pelagic fishes and zooplankton among the three regional ecosystems. Also, the submission of papers for new and innovative approaches, especially those that focus on decadal-scale changes in

productivity and shifts in species dominance, was encouraged.

Summary of presentations

Comparison of catches of the small pelagic fishes in the different ecosystems (Zhang) showed the very large role of these species in the fish communities and economy of these regions. Long-term variability of the ecosystem in the northwestern Pacific connects directly with climate and productivity changes (Kang, Tang). These small pelagic fish species (anchovy, jack mackerel, saury, etc.) are very important

elements of the ecosystem of the northwestern Pacific (Takahashi, Kim and Lee).

An overview of the temporal variation in the hydrological and biological conditions in relation to the stock changes in several small pelagic fishes (including sardine, anchovy, saury, mackerels) was made for the Japan/East Sea ecosystem (Davydova, Belyaev and Baitalyuk), showing dynamic features of the stock changes in response to the thermal regime. An interesting hypothesis on the success/failure of the hatching of common squid eggs in the shelf/slope region was proposed (Yamamoto), providing support to the explanation that squid catch responds to the cold/warm regime. On the other hand, a peculiar pattern of distribution of zooplankton in the near bottom layer (Guo), and temporal and spatial changes of the fish community structure (Xu) in the Yellow Sea, were well demonstrated.

After the oral presentations, participants discussed the issues, directions and problems in research, and all agreed that the session was very successful, but recognized some gaps in

research. The most valuable point was the comparison of ecosystems. Several case studies were reported in this session, and some presentations showed similar phenomena. However, different findings due to the difference in dynamic systems or different hydrographic characteristics were also found. It was concluded that in the future, elaboration of ecological phenomena can be made through collaboration among research groups, and that "integration" of ecosystems as the direction of the next steps should be considered.

There is a lack of information to understand the entire ecosystem. Oceanic and fisheries information from some areas, e.g., North Korean waters, are not available at this moment. Age information should be included in fishery biology, and some ways to differentiate fishing effects and natural variability should be investigated. Also, it was realized that this session did not include some upper-trophic level organisms such as marine birds and mammals. One suggestion was made to include various economic properties for the proper management of fish resources.

#### List of papers

##### *Oral presentations:*

**Chang-Ik Zhang, Jae Bong Lee, Young Il Seo, Sung Il Lee, Man Woo Lee, Sun Kil Lee, Sang Chul Yoon, Kyum Joon Park and Yeong Gong** (invited)

Productivity of small pelagics in Korean waters

**Young Shil Kang and Ginger A. Rebstock**

A comparison of three marine ecosystems surrounding the Korean peninsula: Responses to climate change

**Qi-Sheng Tang and Xianshi Jin**

Long-term variability in the ecosystem productivity of the Bohai Sea and control mechanisms

**Motomitsu Takahashi and Yoshiro Watanabe**

Growth of larvae and early juvenile Japanese anchovy, *Engraulis japonicus*, and environmental condition in the Kuroshio-Oyashio transition region

**Hee-Yong Kim, Shingo Kimura and Takashige Sugimoto**

Transport of jack mackerel eggs and larvae inferred from the numerical experiment in the East China Sea

**Jae-Bong Lee, Yeong Gong and Chang Ik Zhang**

Relationship between the abundance of Pacific saury and biological productivity in the East Sea

**Svetlana V. Davydova** (invited)

Factors affecting the production of small pelagic fishes in the Japan/East Sea

**Vladimir A. Belyaev, V.B. Darnitzkiy and S.Yu. Shershenkov**

Dynamic processes in the fish community of the Japan Sea epipelagial

**Alexey A. Baitalyuk**

Contemporary stock status, distribution, place and role of Pacific saury in the Japan Sea/East Sea

**Jun Yamamoto, Yasunori Sakurai and Tsuneo Goto**

Does pycnocline depth affect the hatching success of Japanese common squid paralarvae from pelagic egg masses?

**Xuewu Guo and Zhinan Zhang**

Zooplankton in the near bottom layer of the Yellow Sea in summer

**Xian-Shi Jin, Binduo Xu and Zhenlin Liang**

Changes in the fish community structure in the Yellow Sea

*Posters:*

**Ichiro Aoki and Tetsu-ichiro Funamoto**

Comparison of reproductive patterns of inshore and offshore spawning populations of Japanese anchovy *Engraulis japonicus* around Japan

**Vladimir A. Belyaev, V.B. Darnitskiy and S.Yu. Shershenkov**

Abundance dynamic of Japanese mackerel in the Japan Sea

**Seok-Gwan Choi, Jin-Yeong Kim, Soon Song Kim, Young Min Choi and Kwang Ho Choi**

Biomass estimation of anchovy (*Engraulis japonicus*) by acoustic and trawl surveys during spring season in the Southern Korean Waters

**Nianzhi Jiao, Yanhui Yang, Koshigawa Horoshi and Masataka Watanabe**

Distribution patterns of autotrophic picoplankton and heterotrophic bacteria and their affecting factors in the East China Sea

**Nianzhi Jiao, Yanhui Yang**

Ecological studies on *Prochlorococcus* in China Seas

**Olga Moukhametova**

Some peculiarities of fish eggs and larvae distribution in northern Japan Sea

**Yanhui Yang and Nianzhi (George) Jiao**

Distribution of virioplankton in the Kuroshio current and the adjacent area in the East China Sea as determined by flow cytometry measurements

**Session S6 (FIS)**

***Physical forcing of walleye pollock life history and population structure: new approaches to identifying critical spatial and temporal scales***

Co-Convenors: Martin W. Dorn (U.S.A.), Akira Nishimura (Japan) and Mikhail A. Stepanenko (Russia)

Background

Walleye pollock (*Theragra chalcogramma*) occupy diverse habitats in the North Pacific Ocean, ranging from semi-enclosed fjords to large oceanic basins. For some pollock populations, an annual migration between spawning and foraging habitats can be identified; in other populations, a gradual ontogenetic shift in distribution seems most prevalent. Although evidence of fine-scale

population structure in walleye pollock is equivocal, pollock spawning aggregations are highly consistent in timing and location. This session explored new approaches to studying the life history and population structure of walleye pollock, a key species ecologically, and the target of major fisheries in the North Pacific. Papers and posters with a meta-analytical orientation were encouraged, in which population characteristics, such as life history traits, per unit carrying capacity, migratory

patterns, responses to physical forcing or commercial fishing, and decadal trends in abundance, are contrasted.

#### Summary of presentations

The session consisted of eight oral presentations and eleven posters concerning pollock throughout the geographic distribution of this wide-ranging species. While Bering Sea populations received the most attention, population structure and life history of pollock from the Pacific coast of Japan, the Japan Sea, and the Sea of Okhotsk were also discussed. Several papers dealt with the complex process of aggregation for spawning. Spawning

aggregations can be highly dynamic - both the location and timing of spawning vary in response to decadal-scale environmental forcing and density-dependent effects. Other papers dealt with the early life history of pollock, contrasting years with favorable and unfavorable conditions for larval drift, and settlement. Finally, several papers described novel techniques for characterizing ontogenetic patterns of habitat use by juvenile and adult pollock, and the seasonal migration between feeding areas and spawning sites. In the eastern Bering Sea, different age groups of pollock show a highly consistent pattern of distribution, which is displaced on or off the Bering Sea shelf by environment forcing.

#### List of papers

##### *Oral presentations:*

**James N. Ianelli** (invited)

Patterns in the abundance of pollock in the Bering Sea: an integrated view of stock structure issues

**Yasunori Sakurai, A. Suzaki, J. Yamamoto, T. Hamatsu, T. Hattori and Y. Mihara**

Effect of variations in the flow of the coastal Oyashio Current on the year-class strength of walleye pollock in northern Japan

**Kyung-Mi Jung, Suam Kim and Sukyung Kang**

Ecological characteristics of walleye pollock eggs in the southeastern Bering Sea during the 1970s regime shift period

**Anatoly V. Smirnov**

Spatial and temporal spawning patterns and interannual variability of walleye pollock in the Sea of Okhotsk

**Akira Nishimura, Takashi Yanagimoto and Kei-ichi Mito**

Rise and fall of pelagic walleye pollock resources in the Aleutian Basin

**Alexander I. Glubokov and Boris N. Kotenev**

Spatial – temporal distribution of Alaska pollock *Theragra chalcogramma* in the Northern Bering Sea

**Hiroya Miyake**

Population structure of the North Japan Sea walleye pollock stock

**Mikhail Stepanenko**

Structure of eastern Bering Sea pollock (*Theragra chalcogramma*) spawning aggregations and its functional composition

##### *Posters:*

**Gennady V. Avdeev**

Parasitism by indicator species as evidence of walleye pollock redistribution in the Okhotsk Sea

**Alexandr Buslov**

The use of vertebrae for walleye pollock age estimation

**Alexandr Buslov**

Growth of walleye pollock during the first year of life

**Elena N. Kuznetsova**

Geographic variability of the growth rate of walleye pollock from different regions of the northwest Pacific

**Alexander V. Nikolaev, M.Y. Kuznetsov, M.A. Stepanenko and L.A. Boretz**

Abundance and distribution monitoring of walleye pollock (*Theragra chalcogramma*) in the northwestern Bering Sea by echo integration surveys (1997-2001)

**Michael C. Palmer and Brenda L. Norcross**

Environmental forcing of walleye pollock, *Theragra chalcogramma*, growth in the southeastern Bering Sea

**Alexandr I. Varkentin and N.P. Sergeeva**

Walleye pollock size-age composition in the eastern Sea of Okhotsk

**Alexandr I. Varkentin and N.P. Sergeeva**

Walleye pollock survival in the eastern Sea of Okhotsk

**Anatoly F. Volkov and Konstantin M. Gorbatenko**

Diet of walleye pollock in the Okhotsk Sea during the spawning period

**Takashi Yanagimoto and Akira Nishimura**

Genetic variation in the walleye pollock, *Theragra chalcogramma* by PCR-RFLP and sequencing analysis of mitochondrial DNA

**Oleg G. Zolotov and Pavel A. Balykin**

Walleye pollock eggs and larvae drift in waters off Kamchatka Peninsula

**Session S7 (MEQ, co-sponsored by Chinese National Harmful Algal Bloom project, CEOHAB)**

***Eutrophication, harmful algal blooms, and nutrients***

Co-Convenors: Edward Black (Canada), Ming-Jiang Zhou (China) and Maurice Levasseur (Canada)

Background

There is growing evidence that the incidence of harmful algal blooms (HABs) has increased on a global scale in recent years. The role of macro- and micro-nutrients in the initiation, propagation and toxicity of HABs is an area of active research. There is also increasing evidence that eutrophication is associated with the initiation and propagation of HABs, although the mechanisms are not fully understood. Determining when and how eutrophication affects bloom dynamics is central to developing effective mitigation strategies that reduce the effect of anthropogenic nutrients on these blooms. Moreover, better knowledge of the natural role of nutrients in HAB events is essential if we are to understand the effects of climate and oceanography.

Summary of presentations

This session attracted 14 papers, including 10 oral presentations and 4 posters. The presentations are divided into several categories:

- Nutrient status assessment and natural biogeochemistry process;
- Relationship between nutrient status and development of harmful algal blooms;
- The role of species-specific physiological characteristics in the development of harmful algal blooms.

Isao Kudo (invited) introduced the spring diatom bloom dynamics and nutrient cycles in the subarctic coastal region, taking Funka Bay as an example. The spring diatom bloom consumes large amounts of nutrient accumulated during winter time. Nitrate depletion terminated the spring diatom bloom in the Bay. However, remineralization of organic material produced during the bloom at depth contributes to the

surface production in summer. This has a direct effect on the development of *Alexandrium tamarense* blooms, a HAB species causing paralytic shellfish poisoning.

Patricia Glibert (invited) discussed the relationship between nutrient supply and development of harmful algal blooms. She indicated that some factors, like nutrients ratio, have been successfully applied in predicting shifts from diatoms to dinoflagellates blooms. But many factors, like species-specific nutritional preferences, environmental conditions, and the presence or absence of alternative nutrition uptake mechanisms, make the relationship more complex. Therefore, the ultimate success of a given species depends on its ability to exploit the available nutrients pool, both quantitatively and qualitatively, the timing and intensity of the nutrient supply, other environmental factors such as temperature, presence or absence of competitors for the resource, and finally the grazing pressure.

Three papers were presented on nutrient status assessment and natural biogeochemistry process. Two were reporting studies conducted in the East China Sea, where large-scale red tides occurred in the past three years. The first presentation (X. Wang) introduced the results obtained during the first cruise of the Chinese national key project on harmful algal blooms. It was found that the concentration of the major nutrients in the coastal area was higher than that in the open sea area. Negative correlations between salinity and nutrients concentrations were detected, indicating that Yangtze River was the major source of nutrients. The second presentation (Liu) showed the role of sediments as a nutrient source. The results showed that the regeneration of nutrients from the sediments is responsible for the significant flux of nutrients to the waters column. One more presentation (B. Wang) emphasized the importance of the very high dissolved inorganic nitrogen pool and N/P ratio of the waters of the Yangtze River.

There were two presentations on the relationship between nutrient status and development of harmful algal blooms. One presentation (Foreman) introduced the status of toxigenic

phytoplankton *Pseudo-nitzschia* (PN) in Washington and British Columbia coastal waters. Results from the ORHAB project were presented and field, laboratory, and modeling works to be conducted in the recently funded ECOHAB project were outlined. The second presentation (Zuenko) was on seasonal changes in the abundance of phytoplankton. The conditions and driving mechanisms of the succession of spring, summer and autumn blooms in Japan Sea were discussed.

Three papers were presented on the role of species-specific physiological characteristics in the development of harmful algal blooms. One presentation (Fan) introduced the physiological characteristics of *P. minimum* in relation to bloom development in Chesapeake Bay, U.S.A. It was found that an initial pulse of nitrogen from river flow was essential to initiate the bloom. Physiological preference for reduced nitrogen uptake by *P. minimum* also plays an important role in bloom maintenance. A model based on the physiological characteristics of *P. minimum* was tentatively developed. A second presentation (Yu) showed the influence of different nitrogen sources on the growth and toxin production in *Alexandrium minutum*. The results showed that nitrate, ammonia and yeast extract can promote the growth and toxin production of the algae, but urea can be used neither for growth nor for toxin production. The last paper (Huang) demonstrated the role of alkaline phosphatase activity (APA) as an indicator of the dissolved organic phosphorus algal utilization in subtropical coastal waters.

Four posters were presented, including the *in situ* daily growth rate of *Prochlorococcus* at the chlorophyll maximum layer at 6.3°N, 110°E in the South China Sea based on cell cycle analysis (Yang), the distribution of viroplankton in the Kuroshio current and the East China Sea determined by flow cytometry (Yang), the effects of nutrient status on growth and toxin production in two toxic *Alexandrium* species (D. Wang), and the variations of Alkaline Phosphatase Activity of algae in a mesocosm experiment during a phosphate-induced algal bloom (Ou).

In discussion, participants addressed different issues related to the session theme. From these, several points were made. First, the importance of distinguishing between low-biomass-toxic blooms from high-biomass-non-toxic blooms was made. For example, a change in nutrient delivery pattern in the coastal zone may either result in a large increase in biomass leading to oxygen depletion, or to a change in cell toxicity. This represents two widely different impacts of eutrophication on HABs.

All participants agreed that it is important to consider the influence of eutrophication not only on a single HAB species but also on the whole food chain. Changes in nutrient delivery patterns may have profound effects on the structure of the food chain, and indirectly on HABs. It has been recommended that future studies should look at the whole planktonic ecosystem. Along the same line, the importance of better assessing the mechanisms responsible for the fate of the bloom was mentioned. For example, eutrophication may alter zooplankton grazing pattern which in turn may affect HAB development.

In order to understand and develop a capacity to predict HABs, it is crucial to include a strong

physical component in future field studies. The lack of physical oceanographers in the HAB research field was mentioned, and it was recommended to try to encourage the participation of physicists in future studies.

Aquaculture facilities often represent an important point source of nutrients. Some participants would like to see more studies on the impact of aquaculture on HABs. This could be done in the context of long-term study of the impact of eutrophication on HABs.

Finally, not all HABs are triggered by eutrophication, and it was proposed that the comparison between eutrophic and pristine systems sustaining HABs may help to discriminate between the role of natural (freshwater input, wind, precipitations, etc.) and anthropogenic forcing contributing to these blooms. This is particularly important in the present context of climate change.

Participants proposed to hold, during the PICES Twelfth Annual Meeting, a special session on the long-term interaction among eutrophication, ecosystems and HABs in coastal regions.

#### List of papers

##### *Oral presentations:*

##### **Isao Kudo**

Spring diatom bloom dynamics and nutrient cycles in subarctic coastal region

##### **Patricia M. Glibert** (invited)

Nutrients and harmful algal blooms: The importance of nutrient quality as well as quantity

##### **Xiaoyong Shi, Xiulin Wang and Xiurong Han**

Nutrient distribution in a high frequency area of red tides in the East China Sea

##### **Michael G. Foreman, Barbara Hickey, Vera Trainer and Amy MacFadyen**

Ecology and oceanography of toxic *Pseudo-nitzschia* in the Pacific Northwest Coastal Ocean

##### **Chunlei Fan and Patricia M. Gilbert**

The importance of reduced nitrogen in a *Prorocentrum minimum* bloom – a model approach

##### **Baodong Wang, Xiu-lin Wang and Run Zhan**

Excess nitrogen in the Yellow Sea and East China Sea

##### **Yury I. Zuenko, Marina Selina and Inna Stonik**

On conditions of phytoplankton blooms in coastal waters of the northwestern Japan Sea

##### **Rencheng Yu, Qingchun Zhang, Yunfeng Wang, Jun Li, Tian Yan and Mingjiang Zhou**

Growth and toxin production of *Alexandrium minutum* with organic and inorganic nitrogen sources

**Su Mei Liu, J. Zhang**

Character of nutrient regeneration from sediments in the Bohai, Yellow and East China Seas

**Bangqin Huang**

Alkaline phosphatase activity and utilization of dissolved organic phosphorus by algae in subtropical coastal waters

*Posters:***Lingjian Ou, B. Huang, H. Hong and D. Wang**

Induced algal bloom by phosphate addition in mesocosm - variation of alkaline phosphatase activity

**Dazhi Wang**

Effects of nutrient status on growth and toxin production in two toxic *Alexandrium* species

**Yanhui Yang**

*In situ* daily growth rate of *Prochlorococcus* at the chlorophyll maximum layer at 6.3N, 110E in the South China Sea: An estimation for cell cycle analysis

**Yanhui Yang**

Distribution of viroplankton in the Kuroshio current and the adjacent and in the East China Sea as determined by flow cytometry

**Session S8 (POC/FIS)*****Detection of regime shifts in physics and biology***

Co-Convenors: Jacquelynne R. King (Canada) and James E. Overland (U.S.A.)

Background

Regime shifts are an organizing principle in North Pacific systems. Physical systems might act as a broad-banded oscillator driven by external forcing or internal feedbacks, or as a stochastic system driven by multiple scale processes. Biological systems can act as filters for the noisy physical system. The responses of individual species will vary with life history strategies and trophic level. Some species respond to extremes in interannual variability while others appear tuned to decadal scales. Previous Topic Sessions at PICES Annual Meetings have dealt with the description of regime shifts, outlining the signals observed in physical and biological systems. As advancement to our understanding of decadal-scale processes, this session focused on retrospective and numerical models describing the nature of regimes or the early detection of regime shifts and on conceptual models on the underlying mechanisms connecting physical dynamics to biota. Plans are made to publish

selected papers from this session in a special issue of *Journal of Marine Systems* (Elsevier).

Summary of presentations

The issues considered by presenters ranged from transitions in atmospheric circulation and sea surface temperatures, mechanisms for changes in coastal oceanography to linkages between physical processes and marine productivity and variability in lower and higher trophic levels. The geographic areas focused on in the papers included the Northern Hemisphere, the whole North Pacific, the northeast or northwest Pacific and regional areas such as the Yellow, Japan/East and Bering Seas, the Kamchatka, Kuroshio and California Current systems.

The first invited speaker (Masuda) presented an ocean-atmosphere model to investigate mechanisms of regime shifts in the North Pacific. Model results produced two atmospheric stable states during each the ocean acts as a “restoring force” for the atmospheric state. Decadal-scale shifts occur when the

“restoring force” exceeds a threshold. These transitions can be simulated without modelled ENSO variability, but the interval between transitions can be modified by introducing ENSO variability. The second invited speaker (Swartzman) examined the diffusion of regime shift signals across trophic levels, with particular reference to the 1998 regime shift. Zooplankton respond more directly to changes in current flow, upwelling and primary production, which means that regime shift signals are stronger in biota such as euphausiids and dissipates compared to higher trophic levels.

Two papers examined climate changes in the Northern Hemisphere. One (Yasunaka) analysed the connection between tropical sea surface temperature and regime shift signals in the North Pacific sea surface temperatures and the Arctic Oscillation. It noted that regime shifts can be divided into two groups: one in which the shift is closely linked with tropical Pacific variation, and another which is independent. The second paper (Krovnin) also revealed connections between the winter climate in the North Pacific and North Atlantic.

Konstantin Rogachev presented evidence of a major thermohaline transition during 1990-1997 within the Kamchatka Current and Oyashio regions. Evidence of a link between the timing of regional freshwater fluxes and the Arctic Oscillation suggested that the transport and distribution of freshwater components influences climate variability in high latitudes of the western subarctic Pacific.

Chuanlan Lin reported changes in the Huanghai Sea and reported that several oceanographic parameters (temperature, salinity, dissolved oxygen, phosphate, silicate and dissolved inorganic nitrogen) have changed significantly with implications for nitrogen limitation and phytoplankton production.

Two species in the northwest Pacific, Pacific saury (*Cololabis saira*) and Japanese common squid (*Todarodes pacificus*), were suggested as possible bioindicators of regime shifts. Regime shift signals in the Kuroshio current are variable, and stronger signals (1989 and 1998 regime

shifts) in the northwestern waters of the current resulted in significant changes in Pacific saury abundance (Tian). Within the Japan Sea, changes in the mean mantle length of Japanese common squid were coherent with ocean-climate regime shifts (Yatsu).

A paper (Aydin) used integrated food web models (ECOPATH) of the eastern and western subarctic Pacific gyres produced by the PICES BASS Task Team along with lower trophic level models (NEMURO) produced by the PICES MODEL Task Team to examine the nature of large-scale changes in the biomass of Pacific salmon (*Oncorhynchus* spp.) biomass. Observed patterns in historical data were best explained by a direct relationship between climate and salmon biomass, rather than by propagation of bottom-up signals from gyre primary or secondary production, suggesting coastal or regional-scale processes are determinants in salmon productivity. Additional papers investigated linkages between climate variability and Pacific salmon abundance and marine survival in the northeast Pacific (Pyper, Irvine). These papers found that abundance seemed to be related to decadal-scale climate processes, while analyses of survival rates suggested that salmon productivity is driven by regional-scale processes and interannual variation.

Several papers were presented on the California Current system. One paper (Peterson) reported that in the northern California Current system, persistent changes in productivity have increased the carrying capacity of the ecosystem confirming that a regime shift did occur in 1998. Two papers (Rodriguez-Sanchez, Chavez) examined the population dynamics of small pelagic fishes in the southern California Current system. Typically these species have exhibited the first signals of ocean-climate shifts, but recent regime shifts have not resulted in population changes similar to historical observations, suggesting that dynamics of these species has been altered.

Three papers focused on the Bering Sea. One paper (Bond) suggested that the climate variability of the Bering Sea is driven by episodic weather events on time scales shorter

than one month. A second paper (Ladd) also suggested that evidence for regime-like behaviour in summer stratification in the Bering Sea is weak. Interannual variability in spring winds and heat fluxes were important in determining summer stratification patterns and the timing of spring phytoplankton blooms. The third paper (Wang) hypothesized that major multi-year adjustments in the marine ecosystem of the Bering was directly linked to air-sea interactions on time scales of a season or shorter, and provided mechanisms underlying walleye pollock recruitment, tanner crab recruitment and coccolithophorid blooms as examples.

During discussion it was noted that the fact that there are synchronous global patterns is

compelling, but the detail on regional scales becomes complex. Often the broad scale pattern falls apart at the regional scale. The fact that mechanisms for the transfer or amplitude of long-term variability have yet to be identified suggests that we need to approach research on ecosystem processes in a radical and new way.

It was agreed that there is a need to move from a research focus of correlative pattern recognition to the determination of mechanisms. The research community should try to explain the patterns that are observed and identify the drivers underlying the patterns. This will require active and creative research and should be encouraged by PICES Science Board, perhaps in a workshop format.

#### List of papers

##### *Oral presentations:*

**Shuhei Masuda and Kazunori Akitomo** (invited)

A model of regime transitions in the North Pacific

**Kerim Y. Aydin, Gordon A. McFarlane, Jacquelynne R. King and Bernard A. Megrey**

Signatures of biotic regime shifts and their propagation through trophic webs – historical data and food web models in the eastern and western subarctic Pacific gyres

**Sayaka Yasunaka and Kimio Hanawa**

Regime shifts found in the Northern Hemisphere SST field

**Andrei S. Krovnin and George Moury**

Variations in Pacific and Atlantic salmon stocks in association with recent climate changes in the northern hemisphere

**Gordon Swartzman** (invited)

To shift or not to shift: Biological response to the 1997-1998 regime shift in the California Current Ecosystem

**William T. Peterson and Franklin B. Schwing**

Recent changes in climate and carrying capacity in the northern California Current shelf waters suggest a regime shift was initiated in July 1998

**Brian J. Pyper, Milo D. Adkison and Steve Ignell**

Comparison of alternative measures of salmon productivity for quantifying spatial and temporal scales of climate-induced variation

**James R. Irvine, D.G. Chen and J.R. King**

Regime shifts and British Columbia salmon – linkages between physical processes and ocean survival

**Viktoria A. Platonova, L.N. Vasilevskaya and N.I. Savelieva**

Connection of the cold periods in the east of Russia with the centers of atmospheric action

**Yongjun Tian, Yasuhiro Ueno, Maki Suda and Taturu Akamine**

Decadal variability in the abundance of Pacific saury and its response to climatic/oceanic regime shifts in the northwestern subtropical Pacific during the last half century

**Chuanlan Lin, Jilan Su, Yian Lin and Bingrong Xu**

Changes of the ecological environment in the Yellow Sea during 1976-2000

**Akihiko Yatsu and Hideaki Kidokoro**

Coherent low frequency variability in biomass and in body size of Japanese common squid, *Todarodes pacificus*, during 1964-2000

**Konstantin A. Rogachev and Eddy C. Carmack**

Rapid thermohaline transition in the western subarctic Pacific: Evidence for the role of freshwater flux in the variability of coastal currents and fresh-core eddies

**Ruben Rodríguez-Sánchez, D. Lluch-Belda, H. Villalobos and S. Ortega-García**

Large-scale low-frequency response of small pelagic fishes in the California Current system to major regime shifts

**Francisco P. Chavez, John Ryan, Salvador Lluch-Cota and Miguel Niquen C.**

Multi-decadal climate variations, fish abundance, oceanic productivity, and atmospheric carbon dioxide

**Nicholas A. Bond and James E. Overland**

Is the marine ecosystem of the Bering Sea Shelf driven by episodic weather events?

**Carol Ladd, George L. Hunt, Jr. and Phyllis J. Stabeno**

Climate, mixing, and phytoplankton on the southeast Bering Sea shelf

**Muyin Wang, James E. Overland and Nickolas A. Bond**

Is the climate of the Bering Sea influenced by hemispheric teleconnections?

*Posters:*

**James E. Overland, Donald B. Percival and Harold O. Mofjeld**

A model of North Pacific atmospheric variability on scales of 1-100 years

**Brian J. Pyper, Randall M. Peterman and Milo D. Adkison**

Use of the Kalman filter and state-space models of stock and recruitment to estimate trends in productivity of 120 stocks of Pacific salmon

**Brian J. Pyper, Randall M. Peterman and Milo D. Adkison**

Multi-stock state-space models for estimating trends in stock-recruit parameters of Pacific salmon

**Jake Schweigert**

Detecting the effects of regime switching on Pacific herring in British Columbia

**Elena I. Ustinova, G.V. Khen and Yu.D. Sorokin**

Large-scale fluctuations in physical oceanography at Far-Eastern seas of Russia in the late 1900s

**Session S9 (CCCC/GLOBEC)**

***ENSO and decadal scale variability in North Pacific ecosystems***

Convenor: R. Ian Perry (Canada)

Background

ENSO-scale (4-7 years) variability strongly influences North Pacific ecosystems, with perhaps the most marked effects having occurred in the 1990's. Decadal-scale variability has been recognized over the past decade to also have major impacts on North Pacific ecosystems. It is unclear how processes

on these two scales interact, and whether they are coupled somehow to amplify impacts (i.e. cause major changes, or "Regime Shifts") to marine ecosystems. This session examined how ecosystems in the North Pacific respond to variability on these scales, and whether some systems are structured so that they are resilient (or perhaps more susceptible) to variability on these scales.

### Summary of presentations

The session consisted of three invited presentations, discussing conditions in the Northeast Pacific, around the Korean peninsula, and in the Kuroshio Current region off Japan. All presentations indicated the importance of climate forcing on marine systems, in particular at ENSO temporal scales. However, climatic changes affect various components of marine systems in different ways, presumably because of structural differences in these systems. In the Northeast Pacific, species with strong relationships between recruitment and climate variability (such as flatfishes and pelagic fishes) appear influenced by changes in transport or habitat quantity/quality. In contrast, species

with weak relationships to climate, such as gadoids, appear to have multiple causes of variability. The marine ecosystem around Korea is influenced by El Niño variability in the tropics, but at different lags for different components: 1-3 years for pelagic fishes; 2-3 and 4-5 years for SST, zooplankton and mackerel. In the Kuroshio region in winter, the copepod community has a size-dependent response to climate variability: large copepods respond to ENSO (likely mediated through their diatom food supply), whereas small copepods respond negatively to variations in SST. Variations of small copepods in turn can directly affect the recruitment success of Pacific saury in this region.

### List of papers

#### **Kaoru Nakata**

Decadal scale variability in marine ecosystem in Kuroshio in winter

#### **Jin-Yeong Kim, Kangseok Hwang and Young-Sang Suh**

ENSO and decadal-scale variability of pelagic fish population in the southwestern North Pacific Ocean

#### **Anne B. Hollowed**

A comparison of hypotheses linking climate and marine fish production

### **Session S10 (CCCC/GLOBEC)**

#### ***Coupled biophysical processes, fisheries, and climate variability in coastal and oceanic ecosystems of the North Pacific***

Co-Convenors: Harold P. Batchelder (U.S.A.), Makoto Kashiwai (Japan) and William T. Peterson (U.S.A.)

### Background

The past decade has shown renewed scientific investigations in coastal regions on both sides of the North Pacific. New interdisciplinary programs have foci ranging from phytoplankton and harmful algal blooms, recruitment of benthic invertebrate larvae, wind-driven cross-shelf exchange, and the mechanisms that regulate the success of holozooplankton and fish. These programs supplement established longer-term observation programs in both coastal and oceanic regions (KNOT, Stn. Papa) and examine

the responses of coastal ecosystems to forcing over broad spatial and temporal scales. A common goal of these programs is to elucidate the biological-physical mechanisms responsible for correlative changes that have been observed in the North Pacific. This session provided a forum for investigators from a number of disciplines -- climatologists, physicists, plankton biologists and fisheries scientists -- to present recent findings from the North Pacific.

List of papers

*Oral presentations:*

**Shoshiro Minobe** (invited)

Atmospheric circulation changes in 1998/99 over the North Pacific

**Ernesto A. Chávez Ortiz and José Luis Castro-Ortiz**

Impact of climate change on fisheries of the eastern Pacific Warm-temperate Transition Zone

**Jack A. Barth, Timothy J. Cowles, Stephen D. Pierce and William T. Peterson**

Mesoscale physical and biological variability in the northern California Current System

**Julie E. Keister and William T. Peterson**

Relationships between zooplankton communities and mesoscale physical features during two cruises off the Oregon coast, U.S.A., during early and late summer 2000

**Ya-Qu Chen, Zhaoli Xu, Yunlong Wang and Mei Jiang**

Study on change of zooplankton to biomass in passing 50 years in the East China Sea

**Xian-Yong Zhao, Johannes Hamre, Fuguo Li, Xianshi Jin and Qi-Sheng Tang**

Recruitment, sustainable yield and possible ecological consequences of the sharp decline of the anchovy stock in the Yellow Sea

**Keita Kodama, Ichiro Aoki, Toru Taniuchi and Makoto Shimizu**

Long-term changes in the assemblage of demersal fishes and invertebrates in relation to environmental variations in Tokyo Bay, Japan

**Yoshioki Oozeki, Yoshiro Watanabe, Yutaka Kurita, Kaoru Nakata and Daiji Kitagawa**

Growth rate variability of Pacific saury *Cololabis saira* larvae in the Kuroshio Waters

**Fei Chai, M.-S. Jiang, R.T. Barber, R.C. Dugdale and Y. Chao**

Modeling ecosystem response to interdecadal climate variability in the Pacific Ocean

**Phyllis J. Stabeno, Nicholas A. Bond, Nancy B. Kachel and Calvin W. Mordy**

The response of the Alaska Coastal Current (ACC) to regional atmospheric forcing

*Posters:*

**Richard D. Brodeur, T.W. Miller, D.C. Reese and R.L. Emmett**

Community structure of surface nekton and plankton in the northern California Current in relation to oceanographic conditions

**Steven J. Bograd, Ronald J. Lynn and John A. McGowan**

Interdecadal physical-biological coupling in the southern California Current System

**Louis W. Botsford, M.F. Hill, A. Hastings and K. McCann**

Spatial and temporal scales of variability in California Current salmon and crabs

**Miriam J. Doyle, Janet Duffy-Anderson and Susan J. Picquelle**

Interannual trends in abundance of ichthyoplankton species in the Gulf of Alaska during spring, 1978 through 2000: Exploring linkages between pelagic ecosystem dynamics and the early life history of fish

**Albert J. Hermann, D.B. Haidvogel, E.L. Dobbins and P.B. Stabeno**

Interannual variability of SST and cross-shelf transport in the coastal northeast Pacific

**George L. Hunt, Jr., Phyllis J. Stabeno and Kenneth O. Coyle**

Energy flux to top predator in the eastern Bering Sea: The roles of climate change and biophysical coupling

**Nianzhi (George) Jiao and Yanhui Yang**

Ecological studies on prochlorococcus in China seas

**Nianzhi (George) Jiao, Jinjie Yang, Heyang Li and Yanhui Yang**

Viability of bacterioplankton in the Chinese coastal waters and west Pacific

**Xian-Shi Jin**

Yearly changes of community structure in the Bohai Sea

**Yi'an Lin, Mingming Jin, Shengquang Gao, Renyou Tang and Jianming Pan**

Cycling and regeneration of nitrogen and phosphorus as well as its significance on ecosystem environment of the Yellow Sea

**Xiuren Ning, Yuming Cai, Chenggang Liu and Fei Chai**

Size-fractionated phytoplankton standing stock and primary production in Bohai Sea during late spring

**Tsuneo Ono, Kazuaki Tadokoro, Takashi Midorikawa, Sanae Chiba and Toshiro Saino**

Decadal oscillations of net primary production in the spring Oyashio region

**William T. Peterson, Jaime Gomez-Gutiérrez, Tracy Shaw and Leah Feinberg**

Abundances of eggs, brood size, molting rates and production by the euphausiids *Thysanoessa spinifera* and *Euphausia pacifica* in the northern California Current

**Thomas C. Royer, Chester E. Grosch and Nandita Sarkar**

Ocean climate conditions during GLOBEC Northeast Pacific Program (NEP) Long Term Observation Program (LTOP)

**Norman Silverberg**

Sediment trap information from San Lazaro and Alfonso Basins, off Baja California Sur

**Kazuaki Tadokoro, S. Chiba, T. Ono, T. Midorikawa and T. Saino**

Interannual variations of *Neocalanus* copepod biomass in the Oyashio water, western subarctic North Pacific

**Ernesto Torres-Orozco, A. Trasviña and A. Muhlia-Melo**

Interannual variation of the yellowfin tuna catches (*Thunnus albacares*) at the entrance to the Gulf of California

**Igor A. Zhigalov and V.A. Luchin**

Interannual variability of the bottom water temperature on western Kamchatka Shelf

**Session S11 (CCCC/GLOBEC)**

*Climate change and carrying capacity of the North Pacific: Recent results of GLOBEC and GLOBEC-like programs in the North Pacific (Poster session)*

Co-Convenors: Harold P. Batchelder (U.S.A.) and Makoto Kashiwai (Japan)

Background

The purpose of this session was to highlight recent results of GLOBEC and GLOBEC-like programs in the North Pacific. Posters on modelling, retrospective studies, observational programs and process-oriented research

addressed how climate change affects ecosystem structure and productivity of coastal and oceanic populations.

List of posters

**David G. Ainley, L.B. Spear, C.T. Tynan, J. Barth, T. Cowles and S. Pierce**

Biological and physical factors explaining occurrence patterns of seabirds in the California Current

**Susan E. Allen, T. Bird, K.L. Denman, J.F. Dower, S. Harris, R.G. Ingram, R.S. Lee and R. Pawlowicz**

Biophysical coupling in the Strait of Georgia

**Valentina D. Budaeva, Vyacheslav G. Makarov, Valery and P. Tunegolovets**

Interannual variability of water regime in the Tatar Strait

**Sanae Chiba, Kazuaki Tadokoro, Tsuneo Ono and Toshiro Saino**

Has lower trophic level ecosystem changed in the western subarctic North Pacific? - a 30 year retrospective study

**Hyo Choi**

Response of sea temperature in fishing grounds to wind driven current induced by wind in the mountainous coastal sea

**Valery I. Chuchukalo and Larisa N. Bokhan**

Seasonal distribution of net plankton in the southern part of the Okhotsk Sea and the Kuril region of the Pacific Ocean

**William R. Crawford and Sonia D. Batten**

The influence of coastal-origin eddies on oceanic plankton distributions in the eastern Gulf of Alaska

**Jaime Färber-Lorda, Ignacio Romero-Vargas and Cesar Almeda-Jauregui**

Summer trophic conditions in the Southern California Current

**Jaime Färber-Lorda, M.F. Lavin, M. Guerrero-Ruiz and J.M. Robles**

Trophic conditions in the Gulf of Tehuantepec during wind forcing

**Sergio Hernández-Trujillo, G. Esqueda-Escárcega, R. Pacheco-Chávez, A. Zárate-Villafranco and R. Avendaño-Ibarra**

Seasonal abundance of *Acartia clausi* and *Paracalanus parvus* (Copepoda: Calanoida) in relation to hydrography in a subtropical lagoon of Mexico

**Masahide Kaeriyama, R.R. Edpalina, R.V. Walker and K.W. Myers**

Effects of long-term and temporal climate changes on the population dynamics and life history of Pacific salmon

**Natalia V. Klovatch and O.F. Gritsenko**

Self-regulation of Japan chum salmon abundance

**Salvador E. Lluch-Cota, M.O. Nevárez-Martínez, D. Lluch-Belda, A. Parés-Sierra and D. Lluch-Cota**

Towards and ecosystem status report for the Gulf of California

**Juana López-Martínez, M.O. Nevárez Martínez, D.B. Lluch Cota, E. Herrera Valdivia and A.R. García**

Effects of the interannual and long temporal variability, in the brown shrimp fishery in the Gulf of California, Mexico

**Wieslaw Maslowski and Stephen R. Okkonen**

The influence of mesoscale eddies on biophysical exchanges across the shelf break in the Aleutians and Bering Sea

**Ludmila V. Milovskaya**

The influence of climate changes on the ecosystem carrying capacity in Kuril Lake

**Manuel O. Nevárez Martínez, G.I. Rivera Parra, E. Morales Bojórquez, J. López Martínez, D.B. Lluch Cota, E. Miranda Mier and C. Cervantes Valle**

Effects of interannual environmental variability on the jumbo squid (*Dosidicus gigas*) fishery of the Gulf of California

**Jun Nishioka, Shigenobu Takeda, Daisuke Tsumune, Takeshi Yoshimura, Isao Kudo, Kenshi Kuma and Atsushi Tsuda**

Processes of iron limitation in the subarctic NW Pacific – higher particulate iron concentration than that in the subarctic NE Pacific

**Takeshi Okunishi and Michio J. Kishi**

A three dimensional ecosystem-physical model including sea ice effect in the Sea of Okhotsk

**Olav M. Ormseth and Brenda L. Norcross**

Interannual variability in the distribution of spawning Pacific cod in Alaska: The influence of ocean temperature

**Chul Park and Chang Rae Lee**

Variation in zooplankton assemblages in the Asan Bay, Korea, during the last decade

**R. Ian Perry and Stewart M. (Skip) McKinnell**

PICES North Pacific Ecosystem Status Report: An update

**Vladimir M. Pishchalnik and A.V. Leonov**

Modelling of processes of biotransformation of organogenic substances in the La Perouse (Soya) Strait

**S. Lan Smith, Yasuhiro Yamanaka and Michio J. Kishi**

A version of NEMURO including C, N and P cycles applied to Station ALOHA: Impact of the microbial loop on organic matter stoichiometries and carbon export

**Yehui Tan**

Assessing long-term changes in early summer zooplankton community construction of the Pearl River Estuary

**Jia Wang and Meibing Jin**

A 3-D coupled physical-biological model and its application to the spring plankton bloom of 1996 in Prince William Sound, Alaska

**C.S. Wong, Liusen Xie and William Hsieh**

Variations of nutrients and carbon due to regime shift in subarctic NE Pacific

**Jie Zheng, Gordon H. Kruse, James D. Schumacher and Doug Woodby**

Spatial and recruitment patterns of eastern Bering Sea crabs in relation to decadal oceanographic variability

**Session S12 (TCODE)**

*Data systems to support technological advances in observation systems*

Co-Convenors: Allen Macklin (U.S.A.), Igor I. Shevchenko (Russia) and Ling Tong (China)

Background

This session presented computer-based demonstrations of data systems that support technological advances in observing systems for marine scientific research. Electronic poster displays focused on innovative data acquisition systems, web pages, databases and tools for data analysis and visualization. The goal of this electronic poster session was to improve awareness of new data sources and systems that work with new technologies to advance scientific activities conducted by PICES researchers. This session was purposefully designed to accent the oral presentations and posters of the Science Board Symposium on

*Technological advances in marine scientific research.*

Summary of presentations

The 16 presentations in this session fell into four broad categories: (i) collection, archival and service of information by electronic means; (ii) GIS (Geographic Information System) analysis; (iii) sampling and imaging; and (iv) prospective pan-Pacific observing systems.

Innovative techniques in wireless communication are enabling inexpensive telemetry of real-time coastal ocean data over large distances (Kim, Park, Ro). Such systems make it possible to distribute data to researchers

and data centers quickly. National data centers and research institutions continue to expand the amount of information served to the public and improve the interfaces used to access it (Jeong, Oguma, I. Rostov, V. Rostov). A good example is the Russian oceanographic atlas of the Bering Sea, Okhotsk Sea and Japan/East Sea, available on CD-ROM and through the web at <http://www.pacificinfo.ru> (I. Rostov). A new data rescue project for the western Pacific will identify, digitize, quality control, and serve to the public data that might otherwise be lost (Baba). Researchers having knowledge of data at risk should contact their respective national data centers.

GIS continues to be a valuable tool for organization, display and analysis of spatial data because of its ability to integrate data from various sources with common geographic characteristics (Golik, Merati, Moiseenko, Vance). The latest advances permit GIS access and manipulation of data through the web, and offer conversion techniques for ocean data in other formats to a GIS basis.

The session presented new methods for treatment of net samples and for underwater imaging of zooplankton (Gorsky). A non-destructive method for enumeration, measurement and identification of zooplankton from net samples allows scanning of historical

or new collections. An Underwater Video Profiler is used for *in situ* image acquisition of macroplankton, especially of fragile forms frequently damaged using net sampling. Virtual holotyping of fragile organisms allows distribution of images to a larger number of experts for identification.

There is growing interest in collecting, archiving, and distributing ocean information for the complete North Pacific Ocean marine system. Such activities would promote understanding, detection and forecasting of climate change and resulting ecosystem regime shifts, and aid in analyses of ecosystem status. To that end, a North Pacific Data Buoy Advisory Panel (McLaren) was formed by PICES and the Data Buoy Cooperation Panel in the fall of 2001, and a call was issued for formal creation of a North Pacific component to the Global Ocean Observing System (Macklin). The presentation for the latter was cited as an excellent example of how marine scientific ideas can be presented to decision makers and the public. A North Pacific Ocean Observing System would contribute to and enhance PICES' ability to develop a North Pacific Ecosystem Status Report.

All electronic posters are published on the TCODE website (<http://tcode.tinro.ru/tcodes12.html>).

#### List of e-posters

##### **Norio Baba**

Global Oceanographic Data Archaeology and Rescue Project for WESTPAC

##### **Andrew V. Golik and Vitaliy K. Fischenko**

Development of Geographic Information System of Pacific Oceanological Institute for the northwestern Pacific based on Internet/Intranet

##### **Gabriel Gorsky, Philippe Grosjean, Marc Picheral and Caroline Warembourg**

New methods for treatment of net samples and for underwater imaging of zooplankton

##### **Sung-Dae Kim, Ki-Cheon Jun, Dong-Young Lee and Soo-Young Park**

An interactive www service of wave data produced by numerical models

##### **S. Allen Macklin**

Planning a North Pacific Ocean Observing System

##### **Ron McLaren and Brian O'Donnell**

The North Pacific Data Buoy Advisory Panel: An initiative of PICES and the Data Buoy Co-Operation Panel

**Nazila Merati, Tiffany C. Vance, Jason Fabritz, Mick Spillane, Jon Callahan and Don Denbo**

Integrating oceanographic data into GIS - working with both *in-situ* and gridded data

**Georgiy Moiseenko**

Monitoring of annual catch spatial distributions using GIS

**Sachiko Oguma and Toru Suzuki**

A construction of data inventory of CO<sub>2</sub>-related data in the North Pacific

**Kwang-Soon Park, Soo-Young Park, Sung-Dae Kim and Jong-Kook Lee**

A real-time data service system using flash visualization and wireless Internet

**Young Jae Ro, Yang Ho Choi and Cha Kyum Kim**

Web-based real-time monitoring of water quality conditions in the Korean coastal waters

**Igor D. Rostov, N.I. Rudykh and V.I. Rostov**

Oceanographic atlas of the Bering Sea, Okhotsk Sea and Japan/East Sea: English version of CD-ROM

**Tiffany C. Vance and Nazila Merati**

Processing and visualization of oceanographic data in 2.5- and 3-D: Examples from the Bering Sea, Arctic and west coast of the United States

**Hee Dong Jeong, Bok Kee Kim, Kyu Kui Jung and Seung Heo**

Recent Improvements in the Oceanographic Data Base System of KODC (presented as poster)

**Igor D. Rostov, V.I. Rostov, E.V. Dmitrieva and N.I. Rudykh**

Development of a regional segment of the unified system of information on the World Ocean State (ESIMO) in Russia (presented as poster)

**Vladimir I. Rostov, N.I. Rudykh and I.D. Rostov**

Data base of archival observations of currents in the North Pacific (presented as poster)

## **MEQ Paper Session**

Convenor: John E. Stein (U.S.A.)

### Background

Papers were invited on all aspects of the effects of human activities on the quality of marine environment. The session focused on emerging chemicals of concern (endocrine disrupting chemicals), effects of dietary biotoxin on reproductive success of copepods, results of long-term biological monitoring, regional monitoring of sediment contamination, and review articles on technological advances in ecotoxicology, ecosystem-based management, integration of multiple ecological chemical techniques to relate health of individual organism to ecosystem status.

### Summary of presentations

There were seven presentations in this session, and all were consistent with the theme of the session and the overall theme of PICES XI. The

significant findings or major conclusions were as follows:

Analyses of water, surficial sediment, and sediment cores for an endocrine disrupting chemical, 4-nonylphenol were used to detect probable sources of this EDC in Korea (Li).

Monitoring of invertebrate species composition in the Seto Inland Sea, Japan, was used to detect improvements in marine environmental quality in the 1990s (Yuasa). This study further confirmed the value of long-term data sets in detecting alterations in the effects of human activities on the marine ecosystem.

Controlled laboratory studies were used to examine the effects of toxic phytoplankton on both the feeding rate and reproductive success of marine copepods of the South China Sea (Liu). Presence of biotoxin did not appear to

appreciably affect rate of ingestion of phytoplankton, however, there appeared to be a negative effect of biotoxin on number of eggs produced, and not on hatching success.

Monitoring of several classes of chemical contaminants in the southeastern Yellow Sea were used to determine spatial patterns in sediment contamination and to estimate flux to sediment (Yang). In general, the levels and estimated flux of contaminants in sediments of the southeastern Yellow Sea were relatively low compared to other marine regions.

Recent advances in biomedicine and advances on the horizon show promise in improving the ability to demonstrate that, for toxic chemical effects on mechanisms acting below the level of the individual, there can be consequences at the level of the population of marine fish species (Stein). These advances should increase the ability to better establish causality and generating quantitative data on fitness

parameters that can then be incorporated in population models.

There is increasing interest in taking an ecosystem approach to coastal marine resource and habitat management, and in sustaining marine environmental quality. Therefore, operationally defining how to express large conceptual goals of ecosystem health in terms of indicators is an emerging issue. In Canada, efforts are underway to define large ocean management areas, relate conceptual goals to ecosystem endpoints, and then measures can be monitored and regulated through management programs (Jamieson).

Similar to advances in biomedicine, advances in analytical chemical techniques for trace elements in otoliths and stable isotopes and biochemicals in tissues are showing great promise in defining ecological interactions and linking individual animal health and habitat use to ecosystem conditions (Parrish).

#### List of papers

##### *Oral presentations:*

##### **Zhengyan Li, Jong-Jeel Je, Donghao Li and Jae-Ryoung Oh**

Contamination of alkylphenolic compounds in Shihwa Lake, Korea

##### **Ichiro Yuasa**

Long-term changes of coastal fauna and the monitoring techniques of index for coastal fauna in the Seto Inland Sea, Japan

##### **Sheng Liu and W.-X. Wang**

Feeding and reproductive responses of marine copepods in South China Sea to toxic and nontoxic phytoplankton

##### **Dong Beom Yang, Jun Yu, Kyung Tae Kim, Chang Soo Chung, Young Il Kim and Gi-Hoon Hong**

PAHs, PCBs and organochlorine pesticides in the bottom sediments of the southeastern Yellow Sea. Results of observation made in 1999-2000

##### **John E. Stein**

Recent technological advances to answer old ecotoxicology questions

##### **Glen Jamieson, Brenda Bauer and Herb Vandermeulen**

Ecosystem-based management as part of a Marine Environmental Quality (MEQ) approach in the Central Coast, British Columbia, Canada

##### **Julia K. Parrish**

Tracing the path: Contaminants, elements and metabolites

*Posters:*

**Anastasia S. Chernova, T. Lishavskaya, A. Moshchenko and T. Konovalova**

Effect of physical and chemical properties of the bottom sediments on distribution of petroleum hydrocarbons, phenols and detergents contained in sediments of the northeastern shelf and in a number of other coastal water areas of Sakhalin Island

**Ludmila S. Dolmatova, A.L. Kovaleva, O.A. Shitkova and N.F. Timchenko**

Generation of reactive oxygen species by the coelomocytes of the holothurian eupentacta fraudatrix in response to bacterial toxin

**POC Paper Session**

Convenor: Kuh Kim (Korea)

Background

Contributed papers on bays of China and Sakhalin, the Japan/East Sea, the Okhotsk Sea, and the North Pacific Ocean were presented.

Summary of presentations

Examination of the water exchange time for the passive, conservative matter between the Jianzhou Bay and the Yellow Sea, adopting the concept of the half-life time for a box model and an Eulerian model, allows the estimation of the self-purification of water (Liu).

The air temperature along the east coast of Korea is affected by the East Korea Warm Current (Choi). Comparison of hydrochemical properties taken in summer of 1999, and late winter of 2000, in the Japan/East Sea revealed that the convective mixing in winter extends several hundred meters deep. The northern region is a source of carbon dioxide and the southern region is a sink (Tishchenko). Also analysis of historical data suggests a possibility that the Japan/East Sea Intermediate Water may originate from the East China Sea, flowing through the Korea Strait in summer (Watanabe). Direct measurements show a warm current west of Hokkaido, whose transport about 1.2 Sv for the baroclinic and 1.5 Sv for the barotropic part (Nakata). Satellite SAR images from ERS-1 and ERS-2 show eddies in the subpolar zone, upwelling along the Primorye coast, packets of

internal waves and ice eddies in the Japan/East Sea (Mitnik). Data assimilation of the circulation model with data from profiling floats in the East Sea opens a challenging opportunity (Eung Kim).

Several papers describe a variety of ocean conditions in the northwestern Pacific Ocean and the northern Bering Sea. Observation of the maximum in winter and the minimum in summer in the absolute transport of Oyashio suggests intensification due to the atmosphere in winter (Kusaka). Decadal changes in dissolved inorganic carbon at station KNOT show trends consistent with those previously calculated by others (Wakita). The changes in dissolved oxygen content in subarctic intermediate water is due to fresh water and decreased ventilation in the Bering Sea (Andreev). Current and water property off southern Sakhalin are described with particular attention to two eddies, one of which was inertially driven, in Aniva Bay. Eddies in the Kamchatka Current are presented with surprisingly large estimates of the mass transport in both the eddies and the current itself (Shevchenko). A summary of techniques and preliminary estimates of transport through Bering Strait using Topex-Poseidon satellite altimetry are also presented (Crawford).

The fact that each paper generated several questions is an indication of continuing interest in physical oceanographic phenomena in the PICES region.

List of papers

*Oral presentations:*

**Zhe Liu, Hao Wei, Guangshan Liu and Jing Zhang**

Simulation of water exchange time in Jiaozhou Bay with the half-life time concept

**Hyo Choi**

Modification of air and sea temperatures in the coastal seas of the path of the East Korea Warm Current

**Pavel Ya Tishchenko, L.D. Talley, V.B. Lobanov, V.A. Luchin, A.P. Nedashkovskij, S.G. Sagalaev, R.V. Chichkin, E.M. Shkirnikova, I.A. Zhabin, V.I. Ponomarev, D. Masten, D.-J. Kang and K.-R. Kim**

Seasonal variability of hydrochemical properties of the Japan/East Sea

**Tatsuro Watanabe and Norinobu Ota**

A possible origin of Japan Sea intermediate water

**Akifumi Nakata, Mayumi Sawada, Tomomi Watanabe, Hideo Yoshida and Iori Tanaka**

Direct current measurements of the Tsushima Warm Current at the west of Hokkaido in the North Japan Sea

**Eung Kim and Young Jae Ro**

New opportunity for data assimilation in the circulation model in the East Sea with Argo float data

**Akira Kusaka, Shin-ichi Ito, Kazuyuki Uehara and Yasuhiro Kawasaki**

Seasonal variability of Oyashio velocity and volume transport, southeast of Hokkaido, Japan

**Masahide Wakita, Shuichi Watanabe, Nobuo Tsushima, Tsuneo Ono, Yutaka W. Watanabe and Shizuo Tsunogai**

Temporal change in dissolved inorganic carbon content in the western North Pacific water

**Andrey G. Andreev**

Temporal changes in dissolved oxygen of the intermediate water in the subarctic North Pacific

**George V. Shevchenko, Gennady Kantakov and Valery Chastikov**

Measurements of currents and water parameters in Aniva Bay, southern Sakhalin

**Leonid Mitnik and Vyacheslav Dubina**

Satellite SAR characterization of oceanic dynamic features in the Japan/East Sea

**Konstantin A. Rogachev, Eddy C. Carmack and Igor Gorin**

Mass and freshwater transport by mesoscale eddies in the Kamchatka Current

**William R. Crawford and Josef Cherniawsky**

Observations of sea level anomalies in Bering Strait and surrounding seas using satellite altimetry observations

*Posters:*

**Tatyana Bogdanovskaya**

Multi-year variability of AAC midpoint intensity and movement for the Asian Pacific region

**Liqi Chen, Zhongyong Gao and Weiqiang Wang**

Air-Sea Fluxes of CO<sub>2</sub> in the Polar Ocean

**Hyo Choi**

Effects of atmospheric circulation and sea surface temperature on sea fog formation

**Mikhail A. Danchenkov**

Subarctic gyre in the Japan Sea and stationary eddy in its eastern part

**Vyatcheslav G. Makarov and Valentina D. Budaeva**

Application of piecewise curve-fitting technique for reconstruction of the density CTD profiles near northeastern Sakhalin coast

**Leonid Mitnik and Vyacheslav Dubina**

Internal waves around Sakhalin: Preliminary mapping with ERS SAR

**Valentina V. Moroz**

Hydrological conditions of the Kuril Island zone and adjacent areas

**Eugene V. Samko and V.M. Petruk**

The characteristic of the Okhotsk Sea water dynamics near the western Kamchatka coast in 1996-2001

**Igor A. Zhigalov, V.A. Luchin and V.V. Plotnikov**

Estimation of the seasonal and interannual variability of the water temperature in the Okhotsk Sea

**Igor A. Zhigalov and Vladimir A. Luchin**

Classification of the thermal conditions of the bottom waters on the western Kamchatka shelf

**Workshop W1 (MONITOR)**

*Requirements and methods for “early detection of ocean changes”*

Co-Convenors: David L. Mackas (Canada) and Sei-ichi Saitoh (Japan)

Background

The goal of ocean monitoring is to provide an ongoing and reliable network of observations to detect and quantify changes in the physical, geochemical, and/or ecological “state of the ocean”. From a relatively limited set of paleoceanographic and observational time-series, we now know that such changes occur, and that at least some of them are significant to climate and ecological interactions, and also to human populations. However, there has often been a time lag between the onset of ocean change, and human recognition of, and response to, these changes. In practice, there is sometimes an enforced trade-off between the local intensity of sampling efforts, and their spatial extent and temporal duration. This workshop addressed questions such as: (i) How

can we best design our monitoring programs to reduce the time lag between event and detection? (ii) What are the relative costs of false alarms vs. missed detections? and (iii) How can we make our monitoring programs robust to new modes of change?

Summary of presentations

Seven papers were presented, ranging from design criteria and statistical methodologies (Overland, Radchenko, Batten) through excellent examples of long- and short-term time series sampling of both open ocean (Sugimoto) and continental margin/coastal sea systems (Wen, Oozeki, Suh). The presentations were followed by a wide-ranging group discussion (details can be found in the report of the MONITOR Task Team).

List of papers

**James E. Overland**

Formal and conceptual approaches to change detection

**Vladimir I. Radchenko**

What tools do integrated ecosystem studies give for the changes detection

**Takashige Sugimoto, K. Tadokoro, P. Mishra and E. Sawabe**

Use of intake water for monitoring zooplankton biomass and dominant species in the subarctic Pacific

**Sonia D. Batten and Warren S. Wooster**

Zooplankton detection of environmental change

**Quan Wen**

Marine environmental monitoring in the People's Republic of China - Status and trends

**Yoshioki Oozeki, Kaoru Nakata and Tomowo Watanabe**

New monitoring program for detecting global warming in the ocean around Japan

**Young Sang Suh, Lee-Hyun Jang, Na-Kyung Lee and Bok-Kee Kim**

Detection of low salinity water in the northern East China Sea in summer using ocean color remote sensing

## **Workshop W2 (MONITOR)**

### ***Monitoring from moored and drifting buoys***

Co-Convenors: David L. Mackas (Canada) and Sei-ichi Saitoh (Japan)

#### Background

There is an increasing demand for systematic monitoring of the ocean. At the same time, the costs of conventional manned research vessels continue to rise. Fleets and their operating calendars are shrinking in many countries. One possible remedy to this resource crunch is increased utilization of unmanned moored and drifting buoys as observation platforms. This workshop discussed present and future opportunities and constraints in areas such as: (i) diversity, sensitivity, and long-term reliability of sensors, (ii) on-board data processing, (iii) power requirements and sources, (iv) long range data telemetry, and (v) "smart" sampling platforms.

#### Summary of presentations

Presentations included an overview of time-series network (Dickey), Argo buoy operations (Ando, Riser), real-time buoy system (Nam), conventional moored buoy observation (Shevchenko), bio-optical drifting buoy and satellite validation buoy development (Iida, Saino), and recent activities of the North Pacific Data Buoy Advisory Panel (O'Donnell, McLaren). The presentations were followed by a wide-ranging group discussion (details can be found in the report of the MONITOR Task Team).

#### List of papers

**Tommy D. Dickey**

Toward the development of a global interdisciplinary time-series network

**Kentaro Ando, Yoshifumi Kuroda, Hideaki Hase, Shinya Minato, Keisuke Mizuno, Taiyo Kobayashi, Nobuyuki Shikama and Kensuke Takeuchi**

Current status of the triton buoy project and the JAMSTEC Argo project

**Stephen C. Riser**

Monitoring the global ocean using profiling floats

**SungHyun Nam, Ki-Wan Kim, Hyung-Rok Kim, Chang-Bong Cho, Sang Jin Lyu, Young-Gyu Kim and Kuh Kim**

Development of ESROB (East Sea Real-time Ocean Buoy)

**Takahiro Iida, Sei-chi Saitoh and Kohei Mizobata**

Phytoplankton distribution as observed from bio-optical drifter and SeaWiFS images in the Bering Sea green belt

**George V. Shevchenko and Gennady Kantakov**

Monitoring of currents on the southwestern shelf of Sakhalin Island

**Toshiro Saino**

A profiling buoy system for real time monitoring of the ocean primary productivity

**Ron McLaren and Brian O'Donnell**

The North Pacific Data Buoy Advisory Panel: An initiative of PICES and The Data Buoy Co-operation Panel

**Workshop W3 (PICES/GLOBEC)**

***GLOBEC data management: Exchange, inventory and archival of GLOBEC data***

Co-Convenors: Igor I. Shevchenko (PICES TCODE) and Hester Willson (GLOBEC IPO)

Background

This workshop discussed the goals and objectives of GLOBEC data management and reviewed status of GLOBEC data inventories in PICES countries, and role of the GLOBEC International Project Office, national GLOBEC Committees and PICES Technical Committee on Data Exchange in this effort. The workshop developed an Action Plan for PICES participation in GLOBEC data management.

Summary of presentations and discussion

The PICES/GLOBEC Data Management Workshop was held on October 19, 2002, as part of PICES XI. The workshop was attended by 28 people from Canada, Denmark, Japan, Korea, the People's Republic of China, United Kingdom, Ukraine, and U.S.A. The convenors were pleased with the number of attendees, an indication that Data Management is being recognized as an essential part of successful science.

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

Phil Williamson was invited to give a talk on Data Management for UK GLOBEC and the Marine Productivity Thematic Programme as an example of the best practice in National Data Management. Research leaders for UK

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

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

distributed Ocean Station Data (OSD) casts, sampled from the early 1800s to the present.

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

The coffee break was followed by presentations on the status of GLOBEC Data Management in PICES countries. Robin Brown gave a presentation on the Canadian GLOBEC metadata inventory for the North Pacific, Igor Shevchenko talked about the metadata inventory of biological data collected by Russian Fisheries Research Institutes, Elena Dulepova described the data collected and the databases at TINRO Center for the North Pacific. Robert Groman was the last of the scheduled talks with a presentation on US GLOBEC Data Management. The group was also fortunate to receive talks from Toru Suzuki on archives of plankton datasets in Japan, from Sung-Dae Kim and Xianshi Jin on Korea and China GLOBEC Data Management, respectively. These excellent presentations set the scene for the lively discussion session that followed in the afternoon.

The discussion session was very productive with several interesting ideas being voiced and actions to be undertaken discussed. The discussion was divided into 3 sections: 1) GLOBEC Data Management and Data Management issues/problems; 2) roles and responsibilities of those involved in Data Management: the GLOBEC Data Manager, PICES TCODE, GLOBEC National and Regional Representatives and the GLOBEC Data Management Task Team; and 3) development of an action strategy and a

Workplan. A full report of the meeting will be available at the PICES TCODE (<http://tcode.tinro.ru/>) and the GLOBEC ([www.globec.org](http://www.globec.org)) websites.

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

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

especially as funding agencies are increasingly focused on multi-disciplinary science. Steps must be taken to increase the confidence of biologists in sharing their data so that the full benefits of multi-disciplinary studies can be realized.

The group recommended that the following proposals be considered:

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

#### List of papers

**Hester Willson**

GLOBEC Data Management

**Phil Williamson and Gwenaëlle Moncoiffé**

Data management for UK GLOBEC and the marine productivity thematic

**Todd D. O'Brien**

Expansion and quality control of a global plankton database

**Sergey Piontkovski**

Potential of archived data

**Robin M. Brown and Stephen J. Romaine**

Canadian GLOBEC metadata inventory for the North Pacific

**Igor I. Shevchenko, Victoria Khan, Lilia Miromanova and Georgiy Moiseenko**

Metadata inventory of biological data collected by Russian Fisheries Research Institutes

**Elena P. Dulepova, Igor Volvenko, Anatoly F. Volkov, Valery I. Chuchukalo and Victor A. Nadtochy**

Data collected and databases at TINRO Center for the North Pacific (zooplankton, nekton, zoobenthos, trophic levels bioproductivity databases for the North Pacific)

**Robert C. Groman**

US GLOBEC data management

**Toru Suzuki and Sachiko Oguma**

Archives of Plankton dataset in Japan

**Kim Sung Dae**

Korea GLOBEC Data Management

**Xianshi Jin**

GLOBEC Data Management and Exchange in China

## **Workshop W4 (PICES/CLIVAR)**

### ***Climate variability in the Pacific and its impact on the marine ecosystem***

Co-Convenors: Kimio Hanawa (PICES) and Kelvin Richards (CLIVAR)

#### Background

The Pacific sector is influential in a wide range of climate phenomena on interannual to decadal timescales. Climatic variations in both the atmosphere and ocean affect primary productivity and higher trophic levels of the marine ecosystem, and the cycling of important biogeochemical constituents such as carbon. Improved understanding of the physics of these climatic phenomena and their predictability is the remit of the WCRP's CLIVAR project. PICES is concerned with the marine ecosystem from physical forcing to primary production, biochemical cycles and fisheries in the North Pacific Ocean. The purpose of this joint PICES/CLIVAR workshop was to bring together these two scientific communities.

The workshop explored our present understanding of the climate phenomena in the PICES area and their links to the ecosystems of the region. The hoped-for outcome was the identification of ways in which collaboration between CLIVAR and PICES can further our understanding and aid the implementation of observational and modelling activities in the PICES area and over the wider Pacific.

Funding for invited speakers came from WCRP, NSF, NOAA, NASA and PICES. We are grateful to these organizations for their support.

#### Summary of presentations and discussion

The workshop was held over one day. The subject matter attracted a large audience. A number of keynote speakers were invited to give overviews on particular topics related to climate variability and changes to the biological and chemical marine system. In order to give speakers enough time to elaborate on their theme each speaker was allotted 30 minutes. A series of shorter presentations were also given to further extend the topics under discussion. A list of speakers is given at the end of this report.

Without diminishing the contribution by other speakers this report will focus on the keynote talks.

The morning was spent primarily on the physical aspects of climate variability. An excellent overview of what we know about seasonal to decadal variability of the physical environment was given by Stephen Riser. Over the last few decades our knowledge of how the ocean is changing on decadal timescales has increased remarkably. However, there is still much to be learnt about what causes the observed changes. Providing a good estimate of the state of the ocean was the topic of the talks by Neville Smith and Tony Lee. Dr. Smith gave an update on the progress of GODAE, a programme designed to provide an ocean prediction system for the global ocean. Progress towards this goal has been better than expected, and the programme will move shortly to its operational demonstration phase. Dr. Lee talked about constraining ocean models with data, and the ECCO programme designed to provide a near operational tool to understand climate variability of the ocean. Again results to date are encouraging but point to the need for ways of estimating the impact of model deficiencies in model solutions. The progress achieved in climate research is in no small part due to the massive increase in computer power over the last few decades. Akimasa Sumi reported on Japan's latest effort to increase the computing power available for climate research still further. The Earth Simulator is the result. Plans are to run a high resolution coupled atmosphere/ocean model for O (1,000yrs) and have the capacity to run the model several times allowing numerical experimentation.

The afternoon talks were devoted to biogeochemical cycles and the marine ecosystem. The problem of distinguishing anthropogenic CO<sub>2</sub> from that occurring naturally makes it difficult to not only provide estimates of the ocean's uptake of CO<sub>2</sub> since the industrial

revolution, but also to study naturally occurring changes to that uptake caused by changes to variations in the atmosphere/ocean system. Christopher Sabine discussed the methodologies of estimating anthropogenic CO<sub>2</sub> in the ocean and the most recent estimates. We now have a global estimate of anthropogenic CO<sub>2</sub> distributions based on high-quality WOCE, JGOFS and OACES data. He also described the Global Carbon Project which is designed to coordinate and synthesise global carbon observations. The most direct impact on the marine ecosystem of a variable climate is through primary production. Daniela Turk described a multi-sensor approach to monitor the inter-annual variations of production applied to the equatorial Pacific. Ways of extending this approach to higher latitudes were discussed. Arthur Miller concentrated on the organized basin-scale patterns of variability observed in the Pacific and how these may relate to the response of the ecosystem. Zooplankton are often quoted as being key indicators of climate change because of their reliance on food supply and transport by ocean currents. This was clearly shown by David Mackas for zooplankton communities along the NE Pacific continental margin. Records going back to the 1970's show regime shifts in population abundance and community structure. Richard Beamish highlighted that only relatively recently did scientists accept the fact that climate variability also impacts upon higher predators and fisheries. Variations in pink salmon stocks, for instance, can quickly shift to a new regime following changes in the physical environment. He concluded by remarking that climate variability needs to be taken into account in the management of fisheries.

#### List of keynote papers

**Stephen C. Riser**

Seasonal to decadal variability of the North Pacific Ocean

**Neville R. Smith**

Ocean state estimation for the Pacific

**Tony Lee**

Ocean state estimation for climate studies

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

The convenors hope this workshop is the first step to establish a strategic consortium between the PICES and CLIVAR communities in the future. To this end, at the POC Committee meeting following the workshop it was agreed to hold a further session on a joint CLIVAR/PICES theme at PICES XIII (2004) in Honolulu, focusing on the mechanisms of climate-induced decadal variability of the marine ecosystem. Such a session needs careful planning and it would be useful to hold discussion at PICES XII in preparation for the session.

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

**Akimasa Sumi**

Model developments in the era of the Earth Simulator

**Christopher L. Sabine, Richard A. Feely, Robert M. Key, Ben McNeil, Kitack Lee and Niki Gruber**

Estimates of anthropogenic CO<sub>2</sub> uptake in the Pacific Ocean: A comparison of three methods

**Daniela Turk**

Interannual variability of biological production in the Pacific

**Arthur J. Miller**

Decadal variability in the Pacific and its effects on the marine ecosystems

**David L. Mackas and William T. Peterson**

Interannual to decadal variability of zooplankton communities along the continental margin of the northeastern Pacific

**Richard J. Beamish**

Climate and fisheries

List of shorter contributions

**Kelvin Richards**

CLIVAR in the Pacific Ocean

**Shoshiro Minobe**

A review of decadal variability over the North Pacific and some ideas for further studies

**James E. Overland**

Atmospheric connections across ecosystems

**Masao Fukasawa**

Some “operational” field plans in the Pacific

**Humio Mitsudera, K. Levedev, M. Yaremchuk, I. Nakano and G. Yuan**

Monitoring Kuroshio Extension through dynamically constrained synthesis of the acoustic tomography, altimetry and in situ data

**Ichiro Yasuda, Emiri Takeuchi and Masayuki Noto**

Variability of the mixed layer in the North Pacific Transition area and its relation to biological productivity and Japanese sardine

**Toshiro Saino**

Effects of climate variation on lower trophic level ocean environment in the western North Pacific

**Yasunori Sakurai, Jun Yamamoto, Hideaki Kidokoro and Ken Mori**

How the winter wind stress might effect the stock size of Japanese common squid (*Todarodes pacificus*)

**Workshop W5 (CKJORC/PICES)**

*Regional cooperation for the conservation and management of the marine environment and resources in the Yellow Sea*

Co-Convenors: Dong-Young Lee (CKJORC) and Stewart (Skip) M. McKinnell (PICES)

Background

The China-Korea Joint Ocean Research Center (CKJORC) hosted a workshop at PICES XI to consider the present status of international cooperation and research in conserving and

managing the living marine resources of the Yellow Sea and their environment. Topics included the availability of necessary technologies and suggestions for new areas of bilateral and regional cooperation. The goal of the workshop was to provide a forum for

exchange of ideas among scientists. The workshop consisted of several invited speakers followed by a stimulating panel discussion.

#### Summary of presentations

The success of the PICES/CREAMS workshop on the Japan/East Sea (Seoul, August 2002) is an example that might be applied to the Yellow Sea. Topics of interest and relevance include the increasing use of satellite data for monitoring SST, turbidity and ocean colour, and the need to integrate observations in modeling and data assimilation techniques. Regional issues

involve: environmental protection, disasters, fisheries and bioresources, and development and megaprojects in coastal areas. The region is interesting for oceanographers because of the shallow marginal sea. Scientists are concerned about inadequate funding for real-time operational and research programs, and the PICES approach to developing regional studies can be an appropriate way to proceed. CKJORC has initiated some cooperation plans to establish YOOS (Yellow Sea Ocean Observing System). The interests and issues in the Yellow Sea are somewhat similar to those being considered in NEAR-GOOS.

#### List of papers

##### **Yu Zhong Liu**

Present status and future plans for the ocean observing system in China for the Yellow Sea

##### **Hee-Dong Jeong**

Overview of the long-term oceanographic survey in the North East Asia Regional Seas and discussion of future improvements

##### **Chang S. Kim**

How can we establish an operational marine environment and ecosystem prediction system for the Yellow Sea through China-Korea cooperation?

##### **Fangli Qiao**

Research activities in the marine environment and ecosystem modeling in China

##### **Dong-Young Lee**

Regional cooperation to improve the ocean observing system in the Yellow Sea

##### **Stewart (Skip) M. McKinnell**

PICES North Pacific Ecosystem Status Report and regional cooperation