

## SUMMARY OF SCIENTIFIC SESSIONS AND WORKSHOPS

### Science Board Symposium (S1)

#### *Boundary current ecosystems*

Conveners: Kuh Kim (SB), Michael J. Dagg (BIO), Gordon H. Kruse (FIS), John E. Stein (MEQ), Michael G. Foreman (POC), Jeffrey M. Napp (MONITOR), Igor I. Shevchenko (TCODE), Harold P. Batchelder (CCCC), Suam Kim (CCCC), Fangli Qiao (China) and Yukimasa Ishida (Japan)

#### Background

The North Pacific is surrounded by boundary currents (*e.g.*, Kuroshio, Tsushima, Oyashio, California, Alaska, Bering Slope) that support a diversity of ecosystems. These ecosystems are highly variable in space and time due to combinations of climate change, decadal “regime” shifts, ENSO and other interannual variability, seasonal and event mesoscale dynamics. This variability has led to dramatic changes at both low and high trophic levels, including productivity, range extensions, and species dominance. This theme provided opportunities to address questions such as: 1) How will climate variation and projected climate change influence the dynamics and variability of boundary currents? 2) How will boundary current ecosystems respond to these physical property and transport changes? 3) How does human activity (*e.g.*, fishing, hatcheries) alter the sensitivity of boundary current ecosystems to natural environmental forcing? and 4) What are appropriate management strategies to maintain healthy, sustainable living marine resources in boundary current systems that experience large environmental variations? Presentations that describe, compare and/or contrast physics, biology, fisheries, and geochemistry of boundary currents and the ecosystems they support were encouraged.

#### Summary of presentations

The session consisted of a Keynote Lecture, 5 invited talks and 8 contributed oral presentations. The Keynote Lecture by Akihiko Yatsu provided a broad review on climate and regime shifts affecting the population dynamics

of species in the Kuroshio and the Oyashio currents region and emphasized that proper understanding of ecosystem dynamics, linking both climate and human activities and taking into account ecosystem factors and uncertainties, are essential for wise management. The most plausible mechanisms for sardine/anchovy cycles in the Kuroshio/Oyashio system were presented to highlight the importance of these interconnections.

The invited paper by Ichiro Yasuda introduced a new mechanism for the cause of interannual variability in the formation of North Pacific Intermediate Water. Diapycnal tidal mixing around the Kuril straits and the Aleutian straits has an 18.6-year period that affects the Kuroshio and Oyashio currents and the Kuroshio Extension. Yasuda also showed that this long-term variability appears in the zooplankton of the Oyashio waters and in the species replacement of small pelagic fishes between Japanese sardine and Pacific saury. The invited paper by William Peterson presented results of monitoring the coastal ocean environment of Washington and Oregon since 1997. He showed that the northern California Current is a dynamic large marine ecosystem, varying at periods from daily to decadal time scales. The goal of this group is to communicate the status of salmon recruitment in the northern California Current ecosystem annually. The technical basis for the recruitment indices was presented and the approach for posting the state of the California Current on the web for managers to use was described. Arthur J. Miller’s invited paper presented analyses of the CalCOFI dataset in the southern California Current, revealing a significant surface-intensified warming and stratification changes across the 1976-77 climate

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regime shifts. The average depth of the thermocline has not changed, but the strength of stratification did, affecting the quality of the upwelled water and the depth from which it is drawn. These historical changes can be useful in anticipating the potential impact of global warming on oceanic circulation off the coast of California. The invited paper by J. Anthony Koslow described the uniqueness of the Leeuwin Current as a warm, nutrient-poor current, which suppresses upwelling. He introduced a recent hypothesis for a mechanism underlying the apparently paradoxical correlation between the strength of the Leeuwin Current and western rock lobster recruitment. The final invited paper by Kenneth F. Drinkwater reviewed the boundary currents system in the North Atlantic in comparison with the North Pacific and their responses to climate change and variability, and discussed the effects of fishing on the sensitivity of fish species to climate forcing with a question of whether any additional insights into the effects of climate forcing on marine ecosystems could be gained by comparing and contrasting responses in the two oceans.

It is particularly notable that most contributed oral papers presented recent findings providing new insights on ecosystems of the North Pacific. Robert M. Suryan reported results of satellite tracking of 19 albatrosses from their breeding colony on Torishima (Izu Islands) for three years, between 2002 and 2006, and identified prominent features of the Kuroshio-Oyashio current system that are important to foraging by this upper trophic level marine predator. Sanae Chiba reported on decadal changes in geographical distribution pattern of copepods in

the Kuroshio, Oyashio and Transition Zone using the historical zooplankton collection (Odate Collection), and suggested that the distributions of copepods were determined by the combined effects of lagged and un-lagged hydrographic variations that are closely related to the Pacific Decadal Oscillation. Jack Barth showed the importance of intra-seasonal oscillations (ISOs) in driving the California Current ecosystem. He found that upper-ocean temperature, phytoplankton and zooplankton in the Oregon coastal upwelling system varied principally on a 20- to 40-day time scale which correlated with the wind stress variations. Emanuele Di Lorenzo showed how the intrinsic mesoscale eddy field, arising from ocean internal dynamics without atmospheric coupling and stochastic forcing, develops in the California Current and leads to decadal variations in the temperature and salinity properties of the eastern subtropical mode waters. This research was based upon a multi-century long integration of an eddy-resolving ocean model of the Northeast Pacific. James Christian showed satellite images taken in the North Equatorial Countercurrent during the 1997-98 El Niño event, indicating phytoplankton blooms in a narrow meandering current against a backdrop of oligotrophic waters and discussed biological significance of this upwelling in the context of the world's largest underexploited oceanic fish populations. The final paper by Juergen Alheit explored the synchronous transition from an anchovy to a sardine regime that occurred in the Kuroshio and Humboldt Currents between 1969 and 1971, and raised a question of whether both systems are governed by basin-wide climatic teleconnection patterns.

### List of papers

#### *Oral presentations*

**Akihiko Yatsu** (Keynote)

Biological production, animal migration and ecosystem regime shifts in the Kuroshio and Oyashio Currents: Perspectives for sustainable use

**Ichiro Yasuda** (Invited)

The Kuroshio and Oyashio current system: Variability and impact on the ecosystem

**Robert M. Suryan, Fumio Sato, Gregory R. Balogh, Noboru Nakamura, Paul R. Sievert and Kiyooki Ozaki**

Kuroshio and Oyashio boundary currents: Critical foraging habitat for the short-tailed albatross (*Phoebastria albatrus*), one of Japan's natural monuments

**Sanae Chiba, Hiroya Sugisaki and Toshiro Saino**

Decadal changes of the Oyashio and Kuroshio affected spatio-temporal variation of the copepod community in the western North Pacific

**Edmundo Casillas and William T. Peterson** (Invited)

The Northern California Current Ecosystem: Variability, indicator development, and an ocean condition index for fishery management

**John A. Barth and John M. Bane**

Intraseasonal wind oscillations and their influence on northern California Current coastal ecosystems

**Arthur J. Miller** (Invited)

Long-term changes in the climate of the California Current, with biological impacts

**Emanuele Di Lorenzo and Niklas Schneider**

Intrinsic oceanic decadal variability in the North Pacific generated in the Eastern Boundary Current System

**James Christian**

The North Equatorial Countercurrent: An anomalous boundary current with biologically significant upwelling and a predictable response to climate forcing

**J. Anthony Koslow, Ming Feng, Stephane Pesant and Peter Fearn** (Invited)

The biophysical oceanography of the Leeuwin Current, a poleward-flowing eastern boundary current off the west coast of Australia

**Kenneth F. Drinkwater and Svein Sundby** (Invited)

The response of North Atlantic boundary currents and their ecosystems to climate change and variability - Contrasts and comparisons with the North Pacific

**Juergen Alheit**

Synchronous ecological regime shifts in the Kuroshio and Humboldt Currents

**BIO/FIS Topic Session (S2)**

*The human dimension of jellyfish blooms*

Co-convenors: Richard Brodeur (U.S.A.), Jiahua Cheng (China), Horoshi Iizumi (Japan) and Won Duk Yoon (Korea)

Background

Large, high-density jellyfish blooms are becoming increasingly common in many marginal seas in the North Pacific and in other regions of the world's oceans, and may be important regulators of marine ecosystems. These blooms may have direct effects on fish recruitment through predation on vulnerable early life stages of marine fishes, or indirect effects competing for limited food resources with exploited species. In addition, high concentrations of jellyfish influence humans in other ways like economic losses in tourism through beach closures, impeding commercial fishing through net clogging, and loss of energy production through clogging of power plant intakes. If jellyfish populations continue to increase in the coming decades, their impacts on human populations are also likely to increase. This session sought to understand the causes of the proliferation and expansion of these blooms

in coastal waters and whether climatic or anthropogenic changes have led to the recent blooms. In this regard, studies that examined the effects of these blooms on humans and their economies, and ways to predict their occurrence and spread were encouraged.

Summary of presentations

The session consisted of 13 oral and 7 poster presentations. The invited talks focused on factors that have led to increases in gelatinous zooplankton in a number of regions around the world. Jellyfish have replaced some major fish resources and have caused substantial damage to human endeavors such as fishing, aquaculture, the generation of electricity, and tourism. The economic implications of these blooms can be staggering, leading to complete loss of some very valuable fisheries. One of the more important ideas brought out at the session was the concept of a 'jellyfish spiral' where many

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factors acting synergistically cause jellyfish to increase, and once these jellyfish populations are established, reverting to fish dominated ecosystems is difficult. However, in several case studies including the Bering Sea and Black Sea, there can be decreases in jellyfish populations due to decreased production and by the introduction of jellyfish predators, respectively.

Many of the contributed papers discussed case studies in different regions of the world, with a substantial emphasis on the giant jellyfish that has been appearing in East Asian waters in the last decade. Three contributed talks and one poster covered North American studies in the Bering Sea, California Current and Northwest Atlantic. The subjects of talks covered not only the pelagic adult stage that is most visible but also the benthic polyp stage, about which we know relatively little for many species. Several presentations discussed ways of estimating jellyfish abundance by acoustics, examining the stomachs of predators, and by aerial photography. Numerical models of ocean circulation were shown to be an effective means of examining jellyfish dispersal in coastal waters. Several studies have started to use

ecosystem models to assess the effects of jellyfish on ecosystems, and some success has been achieved.

It became apparent during the session that jellyfish have been increasing in a number of ecosystems around the world and that with current scenarios of ocean change due to warming, overfishing, eutrophication, and habitat modification, we can expect to see this trend continue in the future. The fishing industry is beginning to adapt to these changes by employing jellyfish excluders on trawl nets and by finding new markets for jellyfish products. Some of the participants of the session met separately with representatives of the power generation industry to provide advice on ways to predict or control jellyfish ingress in power plant cooling systems. Cooperation between scientists and industry will be essential in averting what could become both an ecological and financial crisis in the future.

The convenors planned to produce a special issue of the journal, *Plankton and Benthos Research*, containing peer-reviewed papers from the session.

### List of papers

#### *Oral presentations*

**Jennifer E. Purcell** (Invited)

Interactions of multiple factors contribute to infestations of jellyfish

**Shin-ichi Uve** (Invited)

Bloom of the giant jellyfish *Nemopilema nomurai*: A threat to the East Asian Marginal Seas fisheries sustainability

**Tamara A. Shiganova** (Invited)

Comparative analyses of invasive gelatinous species blooms in the Black, Azov, Caspian and Aegean Seas and their effect on ecosystems and fisheries

**Hitoshi Iizumi, Osamu Katoh, Tatsuro Watanabe, Naoki Iguchi, Koh Nishiuchi, Toru Hasegawa, Kosei Komatsu, Kazufumi Takayanagi and Masaya Toyokawa**

Mass appearance of the giant jellyfish, *Nemopilema nomurai*, along the coastal area of Japan

**Joon-Yong Yang, Soo-Jung Chang, Jae Hong Moon, Won Duk Yoon and Donghyun Lim**

Distribution of *Nemopilema nomurai* in Korean waters in 2005 and its possible origin

**Jia-Hua Cheng, Feng-Yuan Ding, Sheng-Fa Li and Hui-Yu Li**

Study on the quantitative distribution pattern of macro-jellyfish in the East China Sea

**Jason S. Link, Michael D. Ford and Elizabeth Fulton**

Widespread and persistent increase of Ctenophora in the Northeast U.S. shelf ecosystem: Evidence from spiny dogfish (*Squalus acanthias*) and implications for large marine ecosystems

**Hye Eun Lee, Won Duk Yoon and Donghyun Lim**

Predator on polyps of *Nemopilema nomurai* (Scyphozoa, Rhizostomeae)

**Kristin Cieciel, Lisa Eisner, Angela Feldmann and Mary Courtney**

Size structure, distribution, and interaction characteristics of dominant jellyfish from surface trawls in the Eastern Bering Sea

**Haruto Ishii**

Adaptation to coastal environmental changes in the polyp stage in relation to jellyfish blooms in Tokyo Bay

**Richard D. Brodeur, Cynthia Suchman, Doug Reese, Todd Miller, Jim Ruzicka and Elizabeth Daly**

Spatial overlap and trophic interactions between fish and large jellyfish in the northern California Current

**Jing Dong, Chun-Yang Liu, Yang-Qing Wang and Bin Wang**

Laboratory observations on the life cycle of *Cyanea nozakii* (Semeostomida, Scyphozoa)

**Miyuki Hirose, Tohru Mukai, Kohji Iida and Doojin Hwang**

Acoustic observations on the jellyfish *Nemopilema nomurai* in the East China Sea

*Posters*

**Naoki Fujii, Akiko Fukushima, Yuta Nanjo and Hidetaka Takeoka**

Aggregations of *Aurelia aurita* in Uwa Sea, Japan

**Hye Eun Lee, Won Duk Yoon and Donghyun Lim**

The prey passage of *Nemopilema nomurai* (Scyphozoa, Rhizostomeae)

**Seok Hyun Lee, Won Duk Yoon and Dong Hyun Lim**

Effect of heavy metals on polyps of the *Aurelia aurita*

**Xiancheng Qu, Masaya Toyokawa, Ying Liu and Yasuaki Nakamura**

Molecular biological analysis of jellyfish (*Nemopilema nomurai kishinouye*) mitochondrial 18S ribosomal RNA

**James J. Ruzicka, Thomas C. Wainwright and Richard D. Brodeur**

Trophic interactions within the pelagic community of the Oregon and Washington upwelling ecosystem: A modeling study of the role of large jellyfish

**Jun Shoji**

Quantitative and qualitative changes in predator-prey relationship between moon jellyfish and fish larvae in summer hypoxia: Possible increase in trophic flow to jellyfish in coastal ecosystems

**Euikyung Kim, Seunghwan Lee, Jong-Shu Kim, Won Duk Yoon, Donghyun Lim, Andrew J. Hart and Wayne C. Hodgson**

Cardiovascular effects of *Nemopilema nomurai* (Scyphozoa, Rhizostomeae) jellyfish venom in rats

**BIO Topic Session (S3)**

***Interactions between biogeochemical cycles and marine food webs in the North Pacific Ocean***

Co-convenors: Angelica Peña (Canada), Hiroaki Saito (Japan/IMBER) and Sinjae Yoo (Korea)

Co-sponsored by IMBER

Background

Marine food webs and their components respond to, as well as influence, the abundance and distribution of biogenic elements in the ocean. A better understanding of the fundamental interactions between biogeochemical cycles and food webs is necessary to advance our understanding of the response of marine ecosystems to natural and anthropogenic perturbations, such as changes in physical dynamics and carbon cycle chemistry, dust events, eutrophication and marine harvest. The North Pacific and adjacent seas include a wide

range of ecosystems and some unique environmental conditions (*e.g.*, high silicic acid concentration relative to nitrate, iron-limited HNLC region), providing the opportunity to investigate and compare the role of biological processes on biogeochemical cycles under varying environmental conditions. The main goal of this session was to review existing knowledge on the interaction between biogeochemical cycles and marine food webs in the North Pacific Ocean and to identify gaps in current knowledge for eventual prediction of the effect of human activities and climate change on marine ecosystems.

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### Summary of presentations

There were 16 oral and 3 poster presentations in this session that was attended by about 75 persons. The presentations can be divided into four broad categories. There was a group that considered processes associated with nutrient supply, seasonal and recent decadal trends in nutrients, and micronutrient limitation. A second group of presentations described lower trophic level characteristics in the PICES region, including coastal and oceanic waters. Results from both field observation and modeling studies were presented. Three talks were related to the important topic of the effects of iron limitation in the North Pacific on marine food webs. Another set of presentations focused on vertical exchanges and processes, including new information of settling particles, phytoplankton resting spores, copepod ontogenetic migration and overall processes controlling vertical carbon transport. The last group of presentations discussed nutrient cycling in the context of

biological modeling, and presented information on a new free-floating oceanographic instrument for simultaneous tracking of water properties and large particles, including zooplankton. Presentations covered many biological and biogeochemical processes and served as a useful review and synthesis of present knowledge, but many addressed only one of either biogeochemical cycling or marine food webs. This session pointed out the challenges faced by the scientific community in linking biogeochemical cycling to marine food webs, especially to particular species or groups of organisms in higher trophic levels. On the other hand, several presentations clearly showed how marine food web processes drive specific aspects of biogeochemical cycling or flux. Overall, linkages between marine ecosystems and biogeochemical cycling were identified. Gaps highlighting a need for research were shown and discussed. We believe presentations in this session were inspirational for the future studies by attendees.

### List of papers

#### *Oral presentations*

**Kon-Kee Liu, Chun-Mao Tseng, I-I Lin, Hong-Bin Liu and Anond Snidvongs** (Invited)

Effects of photoacclimation of phytoplankton and benthic-pelagic coupling on primary production in the South China Sea: Recent observations and modeling

**Kazuaki Tadokoro, Tsuneo Ono, Akihiro Shiomoto and Hiroya Sugisaki**

Trends and bi-decadal oscillations in PO<sub>4</sub> concentration in the Oyashio and Kuroshio-Oyashio mixed waters

**Hernan E. Garcia, Tim P. Boyer, Sydney Levitus, Ricardo A. Locarnini, John I. Antonov, Daphne Johnson and Alexey Mishonov**

Climatological annual cycle of inorganic nutrient content anomaly in the Pacific Basin

**Andrew L. King and Kathy Barbeau**

Macro- and micronutrient limitation of phytoplankton standing stock in the southern California Current System

**Sinjaee Yoo, Man-Sik Choi, Sang-Hwa Choi, Jung-Ho Hyun, Hyung-Ku Kang, Dongseon Kim, Hyun-cheol Kim, Chang Rae Lee, Jeong-Ah Lee, Taehee Lee, Jae Hoon Noh, Chang-Woong Shin and Eun Jin Yang**

Productivity and structure of lower trophic level communities and carbon flux in the Ulleung Basin in the JES in the summer of 2005

**TaeKeun Rho, Sei-ichi Saitoh, Akihiro Shiomoto, Takahiro Iida and Toshiyuki Konish**

Variability of summer primary production in the Subarctic North Pacific and the southeastern Bering Sea shelf

**Hiroaki Saito, Takashi Ota, Koji Suzuki, Jun Nishioka and Atsushi Tsuda**

Role of heterotrophic dinoflagellate *Gyrodinium* sp. in biogeochemical cycles

**Koji Omori, Hidejiro Ohnishi, Toru Fukumoto, Shunsuke Takahashi, Hideki Hamaoka, Miyuki Ohnishi, Kenji Yoshino, Motomi Kato and Todd W. Miller**

Two sources of primary production of sand bank ecosystems in Seto Inland Sea, Japan

**Masahiko Fujii, Yasuhiro Yamanaka, Yukihiro Nojiri, Michio J. Kishi and Fei Chai**

Comparison of seasonal characteristics in biogeochemistry among the subarctic North Pacific stations described with a NEMURO-based marine ecosystem model

**George A. Jackson** (Invited)

Using coagulation theory to predict maximum particle concentrations and fluxes from the surface ocean

**Akira Kuwata**

Resting spore formation and sinking of bloom forming diatoms in the Oyashio region of the western subarctic Pacific

**Toru Kobari, Deborah K. Steinberg, Atsushi Tsuda and Minoru Kitamura**

Active carbon transport by the ontogenetically migrating copepods in the western subarctic gyre

**Atsushi Yamaguchi, Yuji Watanabe, Hiroshi Ishida, Takashi Harimoto, Kazushi Furusawa, Shinya Suzuki, Joji Ishizaka, Tsutomu Ikeda and Masayuki M. Takahashi**

Taxonomic and size composition of plankton community down to the greater depths in the western North Pacific

**Angelica Peña, M. Foreman and J. Morrison**

Modeling summer nutrient and phytoplankton dynamics off the entrance of Juan de Fuca Strait

**Lei Gao, Dao-Ji Li, Yan-Ming Wang, Li-Hua Yu, Ding-Jiang Kong, Mei Li and Yun Li**

Nitrogen and silicon cycling in sediment and porewater of Dongtan tidal flat in the Changjiang (Yangtze River) estuary

**David Checkley, Russ Davis, Alex Herman, George Jackson, Brian Beanlands, Jesse Powell and Lloyd Regier**

Simultaneous assessment of particles, including plankton, in the North Pacific by use of the SOLOPC

*Posters*

**Satoshi Kitajima, Fuminori Hashihama, Shigenobu Takeda and Ken Furuya**

Nitrogen fixation in the subtropical and tropical western North Pacific

**Taehee Lee and Dongseon Kim**

The cycling of organic carbon at the Ulleung Basin sediments, the East/Japan Sea

**Yuri Yu. Nikonov**

Numerical analysis of chlorophyll-*a* modification in the south-east region of Sakhalin Island

**Takeshi Okunishi, Michio J. Kishi, Ryuichiro Shinohara and Toshihiko Yamashita**

Impact of tidal mixing in the Kuril Strait on the surface nitrate distribution in the Okhotsk Sea and North Pacific during summer

**BIO Topic Session (S4)**

***Synthesis of in situ iron enrichment experiments in the eastern and western subarctic Pacific***

Co-Convenors: Maurice Levasseur (Canada), Shigenobu Takeda (Japan) and Atsushi Tsuda (Japan)

Background

Three successful meso-scale iron enrichment experiments have been conducted in the subarctic North Pacific (SEEDS-I & II and SERIES) over the last four years. The aim of this session was to synthesize the key findings of these experiments and to initiate the development of a common database. Of particular interest was contributions specifically comparing and contrasting the results obtained during the three experiments. This inter-comparison is especially important in regard to the unexpected response observed during the last experiment (SEEDS-II) which highlights our limited understanding of how iron affects biogeochemical cycles, and the complexity of ecosystem responses to iron in HNLC (High Nutrient Low Chlorophyll) waters. We also encouraged papers investigating how iron influences, and is in turn, influenced by ocean-atmospheric exchanges, plankton activities and

community structure, micronutrient chemistry, and other processes in the subarctic North Pacific.

Summary of presentations

The session was well attended and attracted many scientists who had not been involved in the experiments. The session consisted of 17 talks and 7 posters showcasing results from the three successful iron enrichment experiments conducted in the subarctic North Pacific: SEEDS-I (2001), SERIES (2002) and SEEDS-II (2004). These international collaborative experiments were initiated under the auspices of the PICES Advisory Panel on *Iron Fertilization Experiment in the Subarctic Pacific Ocean* (IFEP-AP).

Philip W. Boyd, in his invited talk, presented an insightful synthesis of the 12 meso-scale iron-enrichment experiments conducted so far in the

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various HNLC regions of the world, and reviewed the few studies that focused on natural iron fertilization events. He concluded with recommendations for future studies. The following talks summarized the key results obtained in SEEDS-I, -II and SERIES, and highlighted the major differences observed in the biological and geochemical responses during these experiments. SEEDS-I differed from the two others by its massive bloom of a neritic diatom species. SERIES, on the other hand, provided unique information on the fate of carbon after the decline of the iron-induced phytoplankton bloom. SEEDS-II was conducted in the same area as SEEDS-I, but resulted in a much smaller build-up of phytoplankton biomass. Several hypothesis were proposed by the participants to explain the relatively small response of diatoms in SEEDS-II as compared to

SEEDS-I. These included: a higher initial mesozooplankton biomass and grazing pressure, a deeper surface mixed layer depth, and iron limitation induced by organic iron-complexing ligands. Other papers presented the physical conditions during the experiments, the biogeochemistry of iron, carbon, nitrogen and silicon, the physiological and ecological responses of phytoplankton and zooplankton, and the cycling of dimethylsulfide (DMS) inside and outside the iron patches.

The session was very useful in providing a comprehensive view of the role of iron as a limiting nutrient for primary production in the subarctic North Pacific, in identifying weaknesses and gaps in our understanding of the functioning of this ecosystem, and in setting the base for future experiments.

### List of papers

#### *Oral presentations*

**Philip W. Boyd** (Invited)

Mesoscale iron enrichments - A valuable tool to understand how Pacific HNLC waters function

**Atsushi Tsuda, Shigenobu Takeda, Hiroaki Saito, Jun Nishioka, Yukihiro Nojiri and Isao Kudo**  
SEEDS I summary

**Paul Harrison, Maurice Lévassieur, Philip Boyd, C.S. Wong, Richard Rivkin and Tom Pedersen**

Mesoscale Fe enrichment produces a large diatom bloom, draws down CO<sub>2</sub>, but with limited production of DMS and carbon export in the NE Subarctic Pacific

**Hiroaki Saito and SEEDS II participants**

SEEDS II summary

**Daisuke Tsumune, Jun Nishioka, Akifumi Shimamoto, Yutaka Watanabe, Shigenobu Takeda and Atsushi Tsuda**

The physical behavior of the iron patches detected by SF<sub>6</sub> tracer during SEEDS-I and SEEDS-II

**S. Takeda, J. Nishioka, C.S. Wong, W.K. Johnson, M. Kinugasa, Y. Kondo, K. Kuma, S. Nakatsuka, H. Obata, E. Roy, M. Sato, N. Sutherland, Y. Sohrin, H. Takata, H. Tani, A. Tsuda and M.L. Wells**

Iron geochemistry of SEEDS-I, -II and SERIES

**Jun Nishioka, Tsuneo Ono, Hiroaki Saito, Takeshi Nakatsuka, Shigenobu Takeda, Takeshi Yoshimura, Koji Suzuki, Kenshi Kuma, Shigeto Nakabayashi, Humio Mitsudera and Atsushi Tsuda**

Iron supply to the western subarctic Pacific: Importance of lateral iron transport from the Sea of Okhotsk and winter mixing

**Yukihiro Nojiri, Keiri Imai and Takafumi Aramaki**

Analysis of changes in water and particulate material chemistry during iron-enrichment experiments in the subarctic North Pacific (SEEDS, SERIES and SEEDS-II)

**Takeshi Yoshimura, Hiroshi Ogawa, Keiri Imai and Jun Nishioka**

The dynamics of dissolved organic matter during *in situ* iron enrichment experiments in the subarctic North Pacific

**Koji Suzuki, Hiroaki Saito, Akira Hinuma, Hiroshi Kiyosawa, Akira Kuwata, Kyoko Kawanobe, Toshiro Saino and Atsushi Tsuda**

Comparison of community structure and photosynthetic physiology of phytoplankton in two mesoscale iron enrichment experiments in the NW subarctic Pacific

**Charles G. Trick, William P. Cochlan, Mark L. Wells and Julia N. Betts**

Complexity of grow-out experiments: Further iron stimulation of planktonic communities from the iron-fertilized mesoscale patch during SEEDS



**Isao Kudo, Yoshifumi Noiri, Jun Nishioka, Yousuke Taira, Hiroshi Kiyosawa and Atsushi Tsuda**

Phytoplankton community response to Fe and temperature gradients in the NE (SERIES) and NW (SEEDS) subarctic Pacific Ocean

**Mark L. Wells, Charles G. Trick, William P. Cochlan and Julian Herndon**

The persistence of iron limitation during the SEEDS-II mesoscale iron enrichment experiment

**Atsushi Tsuda, Hiroaki Saito and Akash R. Sastri**

Meso- and microzooplankton responses in the iron-enrichment experiments in the subarctic North Pacific (SEEDS, SERIES and SEEDS-II)

**Maurice Levasseur, Anissa Merzouk, Martine Lizotte, Michael Scarratt, Sonia Michaud, Yvonnick Le Clainche, Chi Shing Wong and Richard Rivkin**

Impact of iron enrichment on DMS cycling in the subarctic Pacific: A synthesis of SERIES and SEEDS-II

**Ipppei Nagao, Shinya Hashimoto, Shuji Toda, Shungo Kato, Yoshizumi Kajii, Yasushi Narita, Mitsuo Uematsu, Atsushi Tsuda, Hiroaki Saito and Koji Suzuki**

Seawater and atmospheric DMS concentrations during SEEDS-II (Western North Pacific)

**Yoko Iwamoto, Yasushi Narita and Mitsuo Uematsu**

Single particle analysis of oceanic suspended matters during SEEDS-II

### *Posters*

**Takafumi Aramaki, Yukihiro Nojiri and Keiri Imai**

Variations in total mass flux, nutrients and particulate matters during SEEDS-II

**Yoshiko Kondo, Shigenobu Takeda, Jun Nishioka, Hajime Obata, Ken Furuya, William Keith Johnson, Agnes Sutherland and C.S. Wong**

Behavior of organic iron (III) complexing ligands during SEEDS-II experiment

**Isao Kudo, Yoshifumi Noiri, T. Aramaki, William P. Cochlan, Koji Suzuki, Tsuneo Ono and Yukihiro Nojiri**

Primary production, bacterial production and nitrogen assimilation dynamics during the SEEDS-II experiment

**Seiji Nakatsuka, Masatoshi Kinugasa, Yoshiki Sohrin, Jun Nishioka, Shigenobu Takeda and Atsushi Tsuda**

Dynamics of bioactive trace metals during the mesoscale iron enrichment in the Subarctic Western North Pacific Gyre (SEEDS-I and -II)

**Yasushi Narita, Yoko Iwamoto, Kentaro Yoshida, Masaki Kondo and Mitsuo Uematsu**

Contribution of biogenic sulfur to the marine lower atmosphere in the Northwestern Pacific

**Hajime Obata, Yasuko Hara, Takashi Doi, Yayoi Hongo, Toshitaka Gamo, Shigenobu Takeda and Atsushi Tsuda**

Rare earth elements during an iron fertilization experiment in the western subarctic North Pacific (SEEDS-II)

**Mitsuhide Sato, Shigenobu Takeda and Ken Furuya**

Responses of pico- and nano-phytoplankton to artificial iron infusions during SEEDS-II

## **BIO Topic Session (S5)**

### ***Advances in epi- and meso-pelagic ecosystem research***

Co-Conveners: Alexei M. Orlov (Russia), Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan)

#### Background

Micronekton is recognized as an important component of epi- and meso-pelagic ecosystems for its role in transferring mesozooplankton production to higher trophic levels. Due to its mobility, quantitative sampling of micronekton has long been regarded as virtually impossible. Recent advances in acoustic devices and efforts to standardize sampling gears have made the sampling of micronekton more precise. The session aimed to synthesize existing and new

knowledge on micronekton biology including distribution, life history and vertical migrations, relationships with commercial species and its functional role in the North Pacific boundary currents and open ocean ecosystems.

#### Summary of presentations

A total of 13 oral papers and 12 posters were presented during the session. Invited speakers, Richard D. Brodeur and Hiroaki Saito, reviewed micronekton activities in two North Pacific

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regions, namely in the Northern California Current off Oregon (U.S.A.) and in the northwestern Pacific (Japan). In both presentations, the history of micronekton research, micronekton diversity and distribution, and its importance in epi- and meso-pelagic food webs were highlighted.

The theme of adaptive diversity and ratios between two main groups of mesopelagic micronekton (as potential estimates of mesopelagic micronekton community status) were brought up in presentations by Suntsov, Radchenko and Miller & Tsukamoto. Furthermore, a detailed analysis of micronekton and nekton distribution and an array of environmental parameters was provided in presentations by Orlov & Gruzevich, Yamamoto *et al.* and several posters (*e.g.*, Ivanov & Sukhanov, Savinykh, Tanimata *et al.*, Velikanov *et al.*)

By far, the predominant theme during the session was dealing with trophic interactions among micronekton and between micronekton and epi-pelagic fish species of commercial interest (*e.g.*, presentations on this theme included Kubota *et al.*, Miller *et al.*, Sugisaki *et al.*, Takagi *et al.*, and posters by Kosenok & Sviridov).

Only a few presentations covered other major groups of micronekton that have been largely ignored in the past due to logistical difficulties of collecting the data. These included diversity and distribution of squid (Katugin *et al.*, Zuev, Watanabe *et al.*) and the vertical distribution of

gelatinous micronekton (Toyokawa *et al.*). Only two presentations were devoted to both reproductive ecology (Belova & Savinykh) and growth (Shelekhov & Savinykh) of micronektonic fish.

Overall, the presentations at the session showed that the research on mesopelagic micronekton is more prominent than was previously believed. A measurable volume of research has been conducted in the North Pacific in particular. There is a growing interest in this type of research as the importance of mesopelagic processes for fisheries and global climate change is recognized. At this moment, arguably the majority of research is concentrated on a single group of micronekton, the fishes, and particularly on myctophids. This is, perhaps, due to possible competition of this group with species of commercial interest, and their significance as prey for a variety of these species and top predators, and their potential importance for future harvests. There was a strong feeling that more fundamental research should be conducted on other micronektonic groups, including crustaceans, gelatinous plankton and squid. Furthermore, more research should be directed to linking micronekton and top predators. Finally, the participants felt that the results of micronekton research should be communicated generally among the PICES research community as it has relevance for several major PICES themes including climate change, ecosystem responses to such changes, and biogeochemical processes in the North Pacific.

### List of papers

#### *Oral Presentations*

**Richard D. Brodeur** (Invited)

Micronekton and their importance in the northern California Current Ecosystem

**Andrey V. Suntsov**

Adaptive radiations in mesopelagic fishes: The role of key innovations

**Vladimir I. Radchenko**

Ratio of myctophid and bathylagid fish biomasses as an index of mesopelagic fish community status

**Michael J. Miller and Katsumi Tsukamoto**

Distribution and ecology of leptocephali in the western North Pacific gyre ecosystem

**Hiroshi Kubota, Yoshioki Oozeki and Ryo Kimura**

Factors responsible for the differences in feeding habits of mesopelagic fishes (Myctophidae and Gonostomatidae) and larval and juvenile Japanese anchovy

**Todd W. Miller, Richard D. Brodeur and Greg H. Rau**

Trophic relationships of nekton and zooplankton in the northern California Current: Insights from diet and stable isotope analysis

**Hiroya Sugisaki, Masatoshi Moku, Kazuhisa Uchikawa, Kotaro Tsuchiya, Yuji Okazaki and Makoto Okamoto**

Vertical distribution and feeding habit of mesopelagic fishes and squids off northeastern Japan

**Oleg N. Katugin, Gennady A. Shevtsov and Mikhail A. Zuev**

Distribution and life cycle patterns of the squid *Gonatopsis octopedatus* and *Gonatopsis japonicus* (Cephalopoda: Gonatidae) in the northwestern Pacific Ocean

**Kaori Takagi, Akihiko Yatsu, Hiroshi Itoh, Masatoshi Moku, Ken Mori and Hiroshi Nishida**

Distribution and prey composition of juvenile small epipelagic fishes and myctophids in the Kuroshio-Oyashio Transition Zone in spring, 2002-2004

**Hiroaki Saito** (Invited)

Dynamic linkage between epipelagic and mesopelagic ecosystems by horizontal and vertical migrations of myctophids

**Alexei M. Orlov and Anatoly K. Gruzevich**

Distribution of micronekton within lower mesopelagic layers of the Sea of Okhotsk and the Bering Sea in relation to hydrological and hydrochemical environmental parameters

**Galina V. Belova and Vadim F. Savinykh**

Reproductive biology of the mesopelagic fishes *Tarletonbeania crenularis* and *Ceratoscopelus warmingii* (Osteichthyes: Myctophidae) from the northwestern Pacific

**Jun Yamamoto, Mio Tateyama, Yoshihiko Kamei, Keiichi Sakaoka, Naoto Kobayashi and Yasunori Sakurai**

Interannual variability of the community structure of epipelagic nekton along 155°E longitude in early summer

### Posters

**Yoshinari Endo and Fuhito Yamano**

Diel vertical migration of *Euphausia pacifica* in relation to molt and reproductive processes, and feeding activity

**Oleg A. Ivanov and Vitaly V. Sukhanov**

Species structure of epipelagic nekton in the northwestern part of the Japan/East Sea

**Gennady A. Shevtsov, Oleg N. Katugin, Mikhail A. Zuev and Gennady V. Khen**

Distribution of cephalopods in the western Subarctic Boundary in the autumn of 2001

**Natalia S. Kosenok and Vladimir V. Sviridov**

Feeding behavior and vertical migration of some common mesopelagic fish species in the Bering Sea during autumn of 2004

**Vladimir A. Shelekhov and Vadim F. Savinykh**

Age and growth of the Highsnout bigscale, *Melamphaes lugubris*

**Vadim F. Savinykh**

The micronekton community of the epi- and mesopelagic layers of the Kuroshio Current zone

**Boyoung Sung, Hyoung-Chul Shin, Donhyug Kang and Suam Kim**

Characterizing krill aggregations and linking them to some environmental factors in the Southern Ocean: Relevant to other krill-bearing marine ecosystem studies?

**Masanori Takahashi, Noritaka Mochioka, Sekio Shinagawa, Hiroshi Nishida and Akihiko Yatsu**

Fluctuations of epipelagic leptocephalus assemblages in the Kuroshio-Oyashio transition region

**Naoki Tanimata, Orio Yamamura, Yasunori Sakurai and Tomonori Azumaya**

Relationship between the inhabited environment and the distribution of *Stenobrachius leucopsarus* in the Bering Sea

**Masaya Toyokawa, Hiroya Sugisaki and Hiroshi Morita**

Vertical distribution of cnidaria and ctenophores in the A-Line

**Anatoliy Ya. Velikanov, Dmitriy Yu. Stominok and Alexander O. Shubin**

Interannual changes in fish communities of the Aniva Bay upper epipelagic zone (Sakhalin Island) and adjoining areas of the Okhotsk Sea in summer

**Hikaru Watanabe, Tsunemi Kubodera and Masatoshi Moku**

Diel vertical migration of squid in the Kuroshio-Oyashio transition region

**Oleg G. Zolotov**

Atka mackerel, *Pleurogrammus monopterygius*, larvae and fry in the upper epipelagic of the north-western Pacific Ocean

**Mikhail A. Zuev**

Squids of the family Eupoloteuthidae in the epipelagic layer of the Kuroshio Current

**CCCC/MODEL Topic Session (S6)**

***Modeling and historical data analysis of pelagic fish, with special focus on sardine and anchovy***

Convenors: Shin-ichi Ito, Michio J. Kishi (Japan), Bernard A. Megrey and Francisco E. Werner (U.S.A.)

Background

During the synthesis phase of the CCCC Program, comparisons of life-history strategies in relation to climate change are underway for pelagic species. This session focused on modeling and analyses of processes affecting growth, survival and recruitment of small pelagics including sardine, anchovy and saury. Presentations included models and historical data analysis on the temporal and spatial variability of recruitment processes of the target fish, their linkages to changes in climate/environment. Advances in general spatially explicit modeling approaches that couple pelagic fish population dynamics with lower trophic ecosystems were also discussed.

Summary of presentations

*Data*

Historical data analyses and comparison of sardine and anchovy catch records from different regions of the world have resulted in the notion of synchrony occurring between widely separated ecosystems, independently of the effect of fishing pressure and management strategies, and the oceanographic domain and local forcing. Furthermore, it has been proposed that mechanisms underlying abundance changes must be simple and controlled by the same background climate signal. Biological processes have yet to be resolved to explain the out-of-phase oscillations of anchovy and sardine and their synchrony/asynchrony among ecosystems. Direct pathways to link climate changes and species alternations, were presented focusing on species-specific temperature optima. The idea proposed was that the “*optimal growth temperature*” hypothesis, based on differential optimal temperatures for larval growth rates of Japanese anchovy and sardine and temperature shifts between these values. Contrasting spawning temperature optima of anchovy and sardine between opposite sides of the Pacific

was suggested as an explanation for the synchronous alternations despite the reversed temperature regimes across the Pacific. Another study discussed the effect of advection of larval anchovy (*Engraulis japonica*) in Kashima-nada off eastern Japan. There is a remarkable inter-annual variability in larval anchovy catch. A relationship between the position of the Kuroshio’s axis relative to the Kashima-nada coastal region was suggested as explaining larval anchovy catch.

*Models*

A description of the next step in the evolution of the NEMURO.FISH coupled modeling approach – namely the simulation of Sardine and ANchovy population dynamics (NEMURO.SAN) was presented. The approach is a general two-dimensional framework that uses an individual-based approach for simulating the daily growth, mortality, reproduction, and movement of sardines and anchovy. Fish growth was based upon bioenergetics, with fish daily consumption dependent on the zooplankton and phytoplankton concentrations generated by NEMURO in each spatial cell. By making mixed layer depth, nutrients, and other inputs to NEMURO specific to each model grid cell, it was possible to simulate spatial heterogeneity in fish habitat.

Existing studies of NEMURO.FISH for Pacific saury with realistic climate forcing suggested the importance of competition for zooplankton prey between saury and sardine in the Northwestern Pacific. A study was presented where NEMURO.FISH was applied to Japanese sardine as a first step toward examining competition between these two species. Modeled sardine body length compared well with observed growth of Japanese sardine, with modeled fish reaching 20 cm within 4 years.

Another application of the NEMURO model examined the feeding environment of sardine

and saury and a hypothesis for the species replacement between Japanese sardine and Pacific saury was suggested. Since 1988, the shallow mixed layer depth in winter in the Kuroshio Extension has led to early phytoplankton blooms, and zooplankton populations have appeared earlier in the year. Consequently, winter zooplankton increased while spring zooplankton decreased. Pacific saury in the Kuroshio Extension in winter can take advantage of the early blooms, but the Japanese sardines that migrate to the Kuroshio Extension in spring could not survive because of low food density. This match/mismatch with the bloom was suggested as a possible explanation for the late 1980s species replacement from Japanese sardine to Pacific saury in the Northwestern Pacific.

An alternative spatially explicit model using an Eulerian approach focused on Pacific saury. The model assumed that saury hatch in southern Japan and are advected by the Kuroshio and its extension during their larval or juvenile stages. Then during summer, they migrate west against the current as the young or adult stages, and then from fall to winter, they migrate back to their original spawning area during the adult stage. The model successfully simulated the observed wet weight of Pacific saury over a 2-year period that included the observed seasonal migration.

A study that extended the NEMURO model to include subtropical groups of plankton (*i.e.*, small-size phytoplankton, zooplankton, and

bacteria) was presented. The extended **NEMURO** (eNEMURO) was applied to two stations, A7 and B1, in the subarctic and subtropic western North Pacific and successfully simulated the seasonal changes in plankton biomass observed at the both stations, and those of the small size plankton at each station.

Anchovy in the East China Sea have nearly disappeared in recent years. A model of anchovy was presented where modeled phytoplankton and zooplankton densities on a two-dimensional grid were used as background for the anchovy simulation, and individual-based models (IBMs) simulated the life history of anchovy. Two attributes of every individual anchovy (or egg) included genotype and phenotype.

An empirical multiple regression model of the sardine stock in the Japan/East Sea was proposed. Environmental factors included consideration of Cushing-like match/mismatch hypothesis, whereby the winter SST determines the time of hatching, but the spring-summer SST determines the time of spring plankton bloom: a match of these terms was found to be favorable for larval survival and a mismatch was unfavorable. Excluding environmental factors from the model worsens the model considerably. Generally, lower SSTs both in winter and spring-summer are favorable for sardine because of the higher plankton abundance in the feeding grounds and coincide with the times of larvae hatching and plankton bloom.

### List of papers

#### *Oral presentations*

**Salvador E. Lluch-Cota, Daniel Lluch-Belda and Daniel Lluch-Cota** (Invited)

Eastern North Pacific sardine spawning through climate, latitudinal, and inshore-offshore gradients

**Akinori Takasuka, Yoshioki Oozeki, Hiroshi Kubota, Hiroshige Tanaka, Ichiro Aoki and Salvador E. Lluch-Cota** (Invited)

Potential biological mechanisms of anchovy and sardine alternations: Species-specific temperature optima and synergistic factors

**Kenneth Rose, Vera Agostini, Larry Jacobson, Carl van der Lingen, Salvador Lluch-Cota, Shin-ichi Ito, Bernard Megrey, Michio Kishi, Akinori Takasuka, Manuel Barange, Francisco Werner, Yunne Shin, Lucho Cubillos, Yasuhiro Yamanaka and Hao Wei** (Invited)

Towards coupling sardine and anchovy to the NEMURO lower trophic level model

**Tadaaki Kuroyama, Akira Nihira and Sei-Ichi Saitoh**

Larval anchovy catch distributions in the Kashima-nada relative to environmental features observed by satellite remote sensing

**Xiangxin Li**

Individual-based models of anchovy

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**Shin-ichi Ito, A. Takasuka, Y. Oozeki, A. Yatsu, M. Noto, M. Kishi, Y. Yamanaka, T. Hashioka, M. Aita, K. Rose, B. Megrey, F. Werner, C. Lingen, M. Barange, Y. Shin, L. Cubillos, L. Jacobson, V. Agostini, S. Lluch-Cota, G. Onitsuka and Y. Kamezawa**

A sardine growth model coupled with the NEMURO lower trophic level ecosystem model

**Haruka Nishikawa and Ichiro Yasuda**

Species replacement between Japanese sardine and Pacific saury in relation to variations in feeding environment

**Yury I. Zuenko and Svetlana V. Davidova**

Empirical modeling the stock fluctuations of sardine in the Japan/East Sea

**Naoki Yoshie and Yasuhiro Yamanaka**

Development of a lower trophic ecosystem model representing prey of juvenile pelagic fish in the subtropical western North Pacific

**Fumitake Shido, Yasuhiro Yamanaka, Shin-ichi Ito, Taketo Hashioka, Daiki Mukai and Michio J. Kishi**

A two-dimensional fish model simulating the biomass of Pacific saury

### FIS/CCCC Topic Session (S7)

***Key recruitment processes and life history strategies: Bridging the temporal and spatial gap between models and data***

Convenors: Kerim Y. Aydin (U.S.A.), Shin-ichi Ito (Japan), Jacob Schweigert (Canada), Paul Spencer (U.S.A.), Akihiko Yatsu (Japan) and Yury I. Zuenko (Russia)

#### Background

Stock-recruitment relationships for exploited fishery stocks quite often show large deviations from theoretical curves. This results from the tremendous variability in survival rates in the early life stages of marine species. In the synthesis phase of the PICES CCCC Program, comparison of life-history strategies in relation to climate changes are recommended for pollock, pink salmon, capelin, sardines, anchovies, saury, euphausiids, squids, and others. Among the potential causes of succession of different life-history strategists, recruitment variability is one of the most important factors. To perform scientific management for target species, appropriate modeling of recruitment processes, including environmental effects, is needed. The session reviewed the temporal and spatial variability of recruitment processes of key species, their linkages to climate changes, human impacts and regional ecosystem structure, and explored new methodologies to plug the gaps between data and the current state of modeling.

#### Summary of presentations

A total of 16 oral talks and 6 posters were presented at the session. Recent progress in

studies of recruitment of marine fishes in the PICES region is significant and the knowledge is being applied in models. It was also recognized that recruitment processes are complex, consisting of constraining or activating factors that can be variable in both time and space. Therefore, further studies are needed. The major findings of each presentation are described below.

Deviations from spawner-recruitment curves such as the Ricker curve or the Beverton-Holt curve were shown along with environmental and maternal effects by Bulatov, Smirmov, and Spencer, who also advocated the use of a larval index in addition to spawning stock biomass to analyze recruitment. Ciannelli and Aydin reviewed mechanisms of recruitment of groundfishes in the eastern Bering Sea, and stressed that different factors are responsible for a series of “switches”, and factors can be either constraining or activating. Based on IBM-type life history model of the Japanese sardine, Suda concluded that species interactions were most influential. Wainwright constructed prediction models of recruitment of salmon stocks in the California Current using various physical and biological factors, and found that sectioning a long-term data into 10-year span give successful

predictions, since recruitment mechanisms may vary over time.

Beamish reviewed the life history, prevalence and intensity of parasitic copepods on the Pacific salmon in the British Columbia waters and discussed their implications. Hsieh compared variability of larval fish abundance between commercial and non-commercial species using CalCOFI data, and found that fishing increased the variability of recruitment, suggesting importance of diversity of biological traits such as age structure. Shaw reported that survival after recruitment of *Euphausia pacifica* off Oregon was stable and similar to what was found in a rearing experiment, but growth was affected by environmental condition. Oozeki showed results of the fine-scale field survey of saury larvae on their patchiness and natural mortality (30-40% per day in average). Ichii raised three questions on different migration and growth of autumn cohort and winter-spring cohort of the neon flying squid in the central North Pacific, and gave answers based on seasonal differential in latitudinal distribution of optimum spawning SST and productive feeding grounds in the Transition Zone. Lee analyzed recruitment of Japanese common squid and jack mackerel, and found three regimes in stock-recruitment relations since 1968 to present in Korean waters, where zooplankton and temperature condition were key factors for jack mackerel. Sakurai proposed comprehensive mechanisms of fluctuations in the stock size of Japanese common squid. Wind stress caused the mixed layer depth to change, and this was the critical factor for retention of the egg mass. Optimum temperature (19-23°C) for survival of larvae was based on tank rearing experiments. Zheng reported shifts in spatial and temporal

distribution of snow crab in the eastern Bering Sea, and discussed their effects on setting location and survival of larval through transport (southward is preferable). Using a bioenergetic model, Harvey compared four different life history strategists (sole, rockfish, sablefish and dogfish) for the effects of temperature on: 1) first year consumption, 2) lifetime consumption, 3) relative consumption to reach age of 50% maturity, and 4) lifetime egg production.

Takahashi compared early growth of sardines and anchovies from the Kuroshio and California Currents, and found that optimum temperature differs by species and that growth in the Kuroshio is faster than that of California for both species. Kubota detected no substantial difference in prey composition among larvae of Japanese sardine, anchovy and round herring in Tosa Bay, southern Japan, suggesting prey composition is not a key factor of species replacement, and match/mismatch between spawning season and plankton blooms may be the key. Nakatsuka examined the stomach contents of skipjack tuna in the Kuroshio area, and found that they consumed mainly anchovy larvae whose body size was slightly larger than those collected by nets. Kamezawa showed how the reduced size of Japanese chum salmon during the 1990s was more affected by zooplankton density than by SST. In contrast, Sugiyama reported opposite trend in early growth of sandlance in northern Honshu Island. Using 3-D NEMURO.FISH, Mukai indicated that growth of Pacific saury increased after the 1976/77 regime shift owing to increased zooplankton. Tian reported significant effect of fishing on stock abundance of loliginid squid in the Sea of Japan.

### List of papers

#### *Oral presentations*

**Lorenzo Ciannelli and Kerim Avdin** (Invited)

Relating recruitment mechanisms to life-history strategies for Alaskan groundfish populations

**Maki Suda, Tatsuro Akamine and Hiroshi Nishida** (Invited)

A population dynamics model for Japanese sardine, *Sardinops melanostictus*, off the Pacific coast of Japan, consisting of spatial early-life stage and age-structured adult sub-models

**Brenda L. Norcross, Sean-Bob Kelly, Peter-John Hulson and Terrance J. Quinn II**

An early life history model for Pacific herring in Prince William Sound, Alaska

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### **Oleg Bulatov**

The Ricker model and the pollock recruit abundance

### **Anatoly V. Smirnov**

Parent-progeny relationships in the Okhotsk Sea walleye pollock

### **Paul D. Spencer**

The effect of spawner age on stock productivity: Influences of life-history pattern and recruitment variability

### **Thomas C. Wainwright, Richard D. Brodeur, Robert L. Emmett, Peter W. Lawson, William T. Peterson, James J. Ruzicka and Laurie A. Weitkamp**

Climate variation and salmon recruitment: Comparing climate indices for predicting salmon marine survival in the Northern California Current ecosystem

### **Motomitsu Takahashi, David M. Checkley Jr., Akihiko Yatsu and Yoshiro Watanabe**

Growth of larval and early juvenile sardine (*Sardinops* spp.) and anchovy (*Engraulis* spp.) in the eastern and western North Pacific Ocean

### **R.J. Beamish, C.M. Neville and R.M. Sweeting**

Life history strategies of sea lice in the subarctic Pacific

### **Chih-hao Hsieh, Christian S. Reiss, John R. Hunter, John R. Beddington, Robert M. May and George Sugihara**

Fishing elevates variability in the abundance of exploited species

### **C. Tracy Shaw, Leah R. Feinberg, Hongsheng Bi and William T. Peterson**

Analysis of key recruitment processes for *Euphausia pacifica* off the Oregon coast

### **Yoshioki Oozeki, Ryo Kimura, Hiroshi Kubota and Hiroshi Hakoyama**

Patchiness structure and mortality of Pacific saury, *Cololabis saira*, larvae in the northwestern Pacific Ocean

### **Taro Ichii, Kedarnath Mahapatra, Mitsuo Sakai and Denzo Inagake**

Life cycle characteristics of the neon flying squid associated with the oceanographic regime in the North Pacific

### **Jae Bong Lee, Chang Ik Zhang, Anne Hollowed, Dong Woo Lee and Sang Cheol Yoon**

Variations in recruitment of small pelagic species around Korean waters

### **Yasunori Sakurai, Jun Yamamoto, Ken Mori, Tsuneo Goto and Hideaki Kidokoro**

Can we explain and predict stock fluctuations of Japanese common squid, *Todarodes pacificus*, related to climatic regime shifts?

### **Jie Zheng and Gordon H. Kruse**

Crab larval advection and recruitment in the Eastern Bering Sea

### **Chris J. Harvey**

Using bioenergetics models to estimate sensitivity of California Current groundfish to temperature anomalies

## *Posters*

### **Yasuko Kamezawa, Tomonori Azumaya, Toru Nagazawa and Michio J. Kishi**

Bioenergetics model of Japanese chum salmon (*Oncorhynchus keta*) growth

### **Hiroshi Kubota, Tatsuya Kaji, Nobuhiro Saito, Akinori Takasuka and Yoshioki Oozeki**

Seasonal variability in feeding habits in the larval stage of three clupeoid species in Tosa Bay, southern Japan

### **Daiki Mukai, Michio J. Kishi, Shin-ichi Ito, Yasuhiro Yamanaka and Fumitake Shido**

Interdecadal variability on the growth and migration trajectory patterns of Pacific saury: A model-based study

### **Sayaka Nakatsuka, Akinori Takasuka, Hiroshi Kubota and Yoshioki Oozeki**

Predation on larval and juvenile anchovy by skipjack tuna in the Kuroshio - Oyashio transition region

### **Kai Sugiyama, Tetsuya Takatsu, Yasuyoshi Fukui and Mikimasa Joh**

Comparison of growth rate between hatching months of Pacific sandlance *Ammodytes personatus* in early life stages

### **Yongjun Tian**

Impact of the late 1980s regime shift on the abundance and distribution of loliginid squid *Loligo bleekeri* in the southwestern Japan Sea



**FIS/MEQ Topic Session (S8)*****Aquaculture and sustainable management of the marine ecosystem***

Co-Convenors: Toyomitsu Horii (Japan), Jie Kong (China) and Michael B. Rust (U.S.A.)

Background

Activities associated with aquaculture can result in both positive and negative impacts on the marine ecosystem. The environmental, ecological and genetic capacities of the marine environment need to be considered to maintain sustainable aquaculture development and a healthy wild ecosystem. At various levels of aquaculture production, environmental hazards can be assessed and management measures developed to minimize those hazards to the marine ecosystem and/or their probability (risk) of occurrence. PICES WG 18 has begun to consider environmental and ecological impacts associated with aquaculture. These include ecological hazards associated with nutrient release, escaped or released cultured organisms (predation, competition), and the potential for disease transfer. In addition, the escape of genetic selected species used for aquaculture may have harmful effects on the genetics of wild populations of native species. Genetic risks should be evaluated based on potential impacts to biodiversity and ecosystem conservation using proper evaluation techniques. These techniques should be consistent among researchers where possible. Moreover, it is necessary to consider the influence on ecosystem and genetic diversity when artificially produced seedlings are released for stock enhancement or rebuilding. To promote responsible aquaculture in a healthy marine

ecosystem, it is critical to continuously evaluate and manage the aquaculture activity. Clearly defining the potential hazards to the ecosystem, assessing the probability that hazards will occur and implementing mitigation strategies to reduce or eliminate hazards can facilitate this oversight. The goal of this session was to identify and establish evaluation techniques and models for potential hazards which aquaculture exerts on genetic diversity, ecosystem function and/or the marine environment. The intent was also to explore the potential for standardization of methods and models that deal with interactions between aquaculture and wild organisms.

Summary of presentations

The session included 14 oral presentations. Twelve of these presentations dealt explicitly with the topic described above and two focused on invasive species issues in Canada and Russia. In addition, 9 posters were presented, including two on invasive species. Approximately 25-30 scientists participated in the session. Topics considered were: methods for mitigating impacts of aquaculture and determining associated risks (8 talks and 3 posters), details of environmental impacts associated with current aquaculture practices, both positive and negative (2 talks and 1 poster), descriptions of aquaculture technology (1 talk and 3 posters), and a study on socio-economic regulation of aquaculture (1 oral).

List of papers*Oral presentations*

**J.E. Jack Rensel, Dale A. Kiefer and Frank J. O'Brien** (Invited)

AquaModel: Mariculture model development and testing

**Zhaohui Zhang, Zongling Wang and Mingyuan Zhu**

Ecosystem services valuation of marine aquaculture

**Colin E. Nash and William T. Fairgrieve**

Ecological risk assessment of marine fish aquaculture in the coastal zone

**Michael B. Rust**

Risk and risk management for feed and seed for carnivorous marine fish aquaculture

**Galina S. Gavrilova**

Shellfish mariculture in the Russian Far East

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**R.J. Beamish, C.M. Neville and E. Gordon**

Sea lice production on farmed salmon – Not what you read in textbooks

**Joseph S. Paimpillil**

Eco-friendly shrimp culture with Pokkali paddy – Sustainable coastal resource management practice

**Hee Won Park and Chang Ik Zhang**

A study on the ecosystem-based resource management system of self-regulatory community fisheries in Korea

**Yoh Yamashita and Yutaka Kurita**

Carrying capacity of nursery grounds for Japanese flounder in relation to stocking densities

**Tomohiko Kawamura, Hideki Takami and Toyomitsu Horii**

Factors affecting recruitment fluctuations of abalone – Assessment of the stock management and enhancement activities in the last 30 years in Japan

**Naoaki Tezuka and Masami Hamaguchi**

Biological impacts caused by the release of the imported manila clam, *Ruditapes philippinarum*, in Japan

**Tetsuo Fujii**

Conservation of the genetic diversity of Japanese flounder *Paralichthys olivaceus* under successive mass release of hatchery-reared juveniles

**Graham E. Gillespie, Antan C. Phillips, Debbie M. Paltzat and Tom Therriault**

Distribution of non-indigenous intertidal species on the Pacific Coast of Canada

**Vasily Radashevskiy**

Alien polychaete worms (Annelida, Polychaeta) in the North Pacific

### Posters

**Eugene I. Barabanshchikov, Nikolay V. Kolpakov and Victor A. Nazarov**

Invasion of non-indigenous animal species into the Russian Far East marine and estuarine ecosystems

**Motoyuki Hara and Hiroshi Hoshikawa**

Genetic analysis for reproduced contribution of released hatchery-produced abalone

**Sergey I. Maslennikov and Victor V. Ivin**

Environmental impact of scallop mariculture on coastal ecosystems in Russia

**Chul Won Kim, Dae Hee Kim, Kyung Hyun Park, Seock Jung Han and Choon Goo Jung**

Technology development for intermediate rearing of the sulf clam, *Tresus keenae*, in Korea

**Dae-Hyun Kim, Jung Hwa Choi, Kwang Ho Choi and Sung Tae Kim**

Relationship between nucleic acids and artificial gonad maturation of swimming crab (*Portunus trituberculatus*) by manipulating water temperature, photoperiod, and eyestock ablation

**Sung Il Lee, Hyung Kee Cha, Young Seop Kim, Sang Cheol Yoon, Jae Hyoung Yang and Kyunk Chan Know**

Study on stock rebuilding plan for *Arctoscopus japonicus* in the East/Japan Sea of Korea

**Won Chan Lee, Hyun Taik Oh, Sung Eun Park, Jun Ho Koo, Sok Jin Hong and Rae-Hong Jung**

Ecosystem modeling for improvement the water quality in a eutrophic marine environment of Chinhae Bay, Korea

**Xuezheng Lin, Kaoshan Chen and Xiaohang Huang**

Advances in marine alien species invasion in China

**Kyung Hyun Park, Chul Won Kim, Dae Hee Kim, Seock Jung Han and Choon Goo Jung**

Growth and survival of the sulf clam, *Tresus keenae*, larvae according to rearing condition in Korea

### MEQ Topic Session (S9)

*Harmful algal blooms in the PICES region: New trends and potential links with anthropogenic influences*

Convenors: William P. Cochlan (U.S.A.) and Ichiro Imai (Japan)

#### Background

The goal of this session was to highlight recent advances in the understanding of the ecology and physiology of harmful algal bloom (HAB)

species in the coastal waters of the PICES region. Of particular interest were laboratory and field research where anthropogenic factors have been studied in order to elucidate if links exist between the apparent increase in the

duration, distribution and impact of HABs, and environmental factors associated with human activities, including urban and agricultural runoff, climatic change and mariculture. This session complemented the continuing series of annual MEQ workshops where two new HAB genera found in the PICES region, *Dinophysis* and *Cochlodinium*, were examined in detail, but encouraged studies of other HAB genera of interest in the coastal waters of the North Pacific Ocean.

#### Summary of presentations

The session consisted of 10 oral presentations and 6 posters, representing authorship from all six PICES member countries and two non-PICES nations: Thailand and India. There was one last-minute cancellation. Attendance at the session was excellent, and the audience always exceeded 50 people throughout the day-long session.

After brief introductory remarks by one of the co-convenors (William Cochlan), the first invited speaker (Theodore Smayda) discussed whether the rise in harmful algal blooms is symptomatic of an emergent disequilibrium in phytoplankton dynamics, in particular the dynamics of flagellates species. He reviewed several theories to explain the HAB epidemic: the “changing environment” theories linking the HAB increase to anthropogenic habitat modification (including eutrophication, climate change and top-down, bottom-up modification); the “emigration” hypotheses attributing the HAB increase to the geographic dispersal of HAB species vectored in ballast water and shellfish transplantation; and the “natural variation” hypotheses of climate-driven oscillations and intrinsic rhythmicity. An underlying question addressed during his presentation was that the HAB epidemic is primarily the coincidence of isolated, regional blooms developing in response to different local causes, but that a global synchrony is occurring in this phenomenon, independent of, but enhanced by local and regionally variable anthropogenic factors.

The following two speakers discussed regional studies in two western Pacific locations, and the phytoplankton response to increases and decreases in nutrient loading. Paul Harrison showed evidence of dramatic reductions in Red Tide events in Hong Kong waters as a consequence of revised sewage abatement practices, and noted that when nutrients are limiting, nutrient ratios are a reflection of the community response, not a factor controlling HABs. Ichiro Imai provided a detailed review of the relationship between eutrophication and HABs in the Seto Inland Sea, and noted that the number of red tide events in this major fishing and aquacultural region is now relatively stable at ~100 events per year. Red tide events appear to have increased for *Cochlodinium polykrikoides* and *Chatonella* spp. (with *C. ovavta* being a new HAB species), whereas long-term decreasing trends for *Heterosigma akashiwo* and *Noctiluca scintillans* were observed. In-Seong Han discussed the relationship between physical factors and summertime HABs in Korean waters, in particular the large-scale blooms of *Cochlodinium polykroides* that have occurred since 1995. He noted that relatively lower surface water temperatures (and consequently weakened stratification) and relatively large Kuroshio upstream volume transport were frequently related to large-scale outbreaks of HABs, whereas elevated nitrate concentrations, although common, were not always necessary for such blooms to occur. Kanako Naito next presented a laboratory study on the role of iron and the growth of HAB species, specifically on the multiple forms of iron available for microalgal utilization, showing that various Red Tide species could use insoluble (particulate Fe, possibly from bottom waters), soluble organic Fe, ligand-bound Fe, and siderophore-mediated Fe for growth. She also demonstrated that high concentration of siderophores can inhibit the growth of various phytoplankton species, and speculated that this could be a possible mitigation strategy for HAB events. Tamiji Yamamoto discussed the role of dam construction on harmful algal blooms. Using a competition numerical model for three species

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(*Gymnodinium catenatum*, *Chattonella antiqua* and *Skeletonema costatum*) they concluded that continuous nutrient supply (which is induced by dam construction) will favor the growth of flagellates, decrease species diversity, and enhance the growth of harmful flagellates as a result of suppressing diatom growth (through reduction of dissolved Si supply).

The final presentation before the lunch break by Ken Furuya was an intriguing laboratory and field study on *Noctiluca scintillans*, the most frequent causative organism of red tides in southeast Asian waters, and its photosynthetic endosymbiont, *Pedinomonas noctilucae*. Based on physiological studies, they postulated that despite the low growth rate of *N. scintillans*, its high photosynthetic performance and the internal ammonium accumulation within the cell (from its endosymbiont) provide competitive advantages for *N. scintillans*, and that once it becomes dominant in Manila Bay, Philippines, its active grazing on potential competitors prevents population growth of co-existing phytoplankton.

The final two oral presentations of the session outlined the role of viruses on HAB dynamics, a topic never previously discussed in the PICES HAB Section, but receiving increasing attention in marine microbial ecology. Janice Lawrence, our “Young Scientist” invited speaker, outlined the lytic virus life cycle and its effect(s) on algal blooms, specifically those of the raphidophyte, *Heterosigma akashiwo*. She concluded that there is no general response of a host algal cell

to viral infection, that infected cells are not generally sampled in healthy host populations (due to enhanced sinking from infection), and finally there is a need to better characterize known viruses and isolate novel viruses from marine systems in order to more fully understand the role of viruses in HABs. Keizo Nagasaki discussed the molecular differences between viruses infecting marine eukaryotic microalgae, and the specific relationship between the bloom-forming dinoflagellate *Heterocapsa circularisquama* and its infectious viruses in western Japan over a five-year period, including their novel finding that the abundance of sediment viruses was an important factor in determining the length and size of a bloom of *H. circularisquama*.

The session was concluded by a discussion led by convenors, which benefited greatly by the comments and observations of our invited speakers to this session and the MEQ workshop on selected HAB species in the PICES region. One conclusion evident in the discussion was the complexity of HAB dynamics, and the lack of a single or common anthropogenic cause for HABs, particularly as fewer “plant-like” and more “insect-like” behaviorisms become evident in some HAB species, particularly flagellates. As summarized by Theodore Smayda, our current attempts to understand the factors responsible for HABs and their apparent global increase, may be akin to characterizing the structure of a “layer cake”, while still exploring the icing. There is much work to be done.

### List of papers

#### *Oral Presentations*

**Theodore J. Smayda** (Invited)

Harmful algal blooms: Global spreading or global synchrony?

**Paul J. Harrison, Alvin Ho, Kedong Yin and Xu Jie**

Nutrient and phytoplankton dynamics in Hong Kong and their response to sewage abatement

**Ichiro Imai, Mineo Yamaguchi and Yutaka Hori**

HAB occurrences and eutrophication in the Seto Inland Sea, Japan

**Tatiana Yu. Orlova and Inna V. Stonik**

Long-term changes in the phytoplankton of the coastal waters off Vladivostok (the north-western part of the Japan/East Sea)

**In-Seong Han, Hee-Dong Jeong and Ki-Tack Seong**

Physical oceanic conditions on summer time related with harmful algal blooms around the Korean Peninsula

**Kanako Naito and Ichiro Imai**

Iron and harmful algal blooms

**Tamiji Yamamoto and Gen Hatta**

Does dam construction induce harmful algal blooms?

**Ken Furuva, Takuo Omura and Thaithaworn Lirdwitayaprasit**

*Noctiluca scintillans* with endosymbiont, successful red tide species in SE Asian waters

**Janice E. Lawrence** (Invited)

The role of viruses on harmful algal bloom dynamics

**Keizo Nagasaki, Yuji Tomaru, Hiroyuki Mizumoto, Yoko Shirai and Yoshitake Takao**

Viral impact on the population dynamics of HABs

*Posters*

**Seung Ho Baek, Shinji Shimode and Tomohiko Kikuchi**

The role of temperature, salinity, light intensity and photoperiod for dinoflagellates, *Ceratium furca* and *Ceratium fusus*, in the temperature coastal water of Sagami Bay, Japan

**Boris M. Borisov**

Basic factors determinative phytoplankton bloom in the western subarctic Pacific and the adjacent deep area of the Bering Sea in spring of 2005

**Lalit P. Chaudhari, A.G. Bhole, S.P. Yavalkar and N.K. Choudhary**

Application of biotechnology for monitoring harmful algae in marine food resources

**Maureen E. Auro, William P. Cochlan and Vera L. Trainer**

Growth and toxicity of *Pseudo-nitzschia cuspidata* from the U.S. Pacific Northwest

**Tomotaka Shiraishi, Kiyohito Nagai, Jyoji Go, Takashi Yamamoto, Michinori Yamakawa, Misa Inoue, Isao Kuriyama, Seiya Taino, Tetsu Ishikawa, Yoshihiro Hayashi, Shingo Hiroishi and Ichiro Imai**

Population dynamics and overwintering of the shellfish killing dinoflagellate *Heterocapsa circularisquama* in the western coastal Sea of Japan

**Wataru Takahashi, Hiroshi Kawamura, Takuo Omura and Ken Furuya**

Detecting red tides in the eastern Seto Inland Sea with satellite ocean color imagery

**POC/Monitor/CCCC Topic Session (S10)**

***Synchronous and asynchronous responses of North Pacific boundary current systems to climate variability***

Co-Convenors: Jack Barth, Steven Bograd (U.S.A.), Shin-ichi Ito, Kosei Komatsu (Japan) and Vyacheslav B. Lobanov (Russia)

Background

This session was held to provide a comparative review of the physical and ecosystem variability of the boundary currents, to discuss the degree of synchronicity of this variability, and facilitate understanding of the connectivity between North Pacific boundary current systems. A more comprehensive understanding of the boundary current systems requires modeling approaches, although the data for model validation is often limited. This session also provided consideration of observing system requirements and techniques for monitoring boundary current circulation and ecosystems, in particular the necessary combination of data and models.

Summary of presentations

A total of 9 physical and 6 ecosystem aspect papers were given as oral presentation, and also two posters were provided. Two talks and 1 poster presentations were on basin-scale comparison, five oral presentations focused on variability in the eastern boundary currents and six oral presentations showed variability in the western boundary currents.

*Physical aspects*

The North Pacific Ocean circulation produced by an eddy-resolving global physical model was presented. It shows a systematic change of the

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North Pacific Ocean currents response to the Aleutian Low strength. In response to the Aleutian low enhancement, Oyashio became strong, and cooler temperature anomalies propagated along the Subarctic Front, the Kuroshio migrated southward, the Alaska Gyre was enhanced in the southern part and weakened in the northern part, and the California Current was weakened largely except for the CalCOFI region. A new methodology state-space model was applied to long-term sea surface temperature data in the North Pacific, and the results suggested the existence of local processes modulating a global signal asynchronously, while it also suggested the overall warming trend synchronously accelerated and decelerated in the whole North Pacific. Other studies investigated the mechanism of major current systems (Kuroshio Extension, Kuroshio, Oyashio, California Current, Alaskan Gyre *etc.*) variation were also presented.

### *Ecosystem aspects*

An idea was presented that steep multi-year changes (like regime shift) afforded distinct advantage to “active-opportunist” species (of which sardine might be a good example) to temporarily break out from normal biological constraints since they can migrate widely and utilize broad spectrum of acceptable food sizes. This idea may explain the paradox in the 1970s to mid-1980s, which showed synchronized variation of productivity while the ocean circumstances showed asynchronicity.

A recent abrupt change in 2005 in the California Current System was also presented. The result showed a similar decrease of zooplankton

biomass with El Niño events, however it persisted longer than previous phenomena. Inverse production of salmon between Alaska and the Pacific Northwest was reported. Although the inverse production correlated with Pacific Decadal Oscillation, the relation was modified recently accompanied with warming trends. Ecosystem responses in other regions were also presented in the session.

### Recommendation

One outcome of the session was the realization of the value of long-term physical, chemical and biological data sets in the North Pacific for understanding, and eventually forecasting, ecosystem response to climate variability. Enormous progress has been made in using long-term remotely sensed (*e.g.*, satellite sea-surface temperature, ocean color and sea-surface height) and *in situ* data (*e.g.*, repeat hydrographic, plankton and fish survey lines) to understand mechanisms of ocean response to climate variability. The session conveners propose that PICES send letters of support for the continuation of the important long-term monitoring activities to the relevant agencies of the member nations. For example, there is no guarantee that the incredibly valuable satellite remotely sensed data sets will continue to be available for ecosystem research. The session conveners also propose to work with the POC, MONITOR committees and the CCCC Program to draft such letters, including sufficient detail linking important long-term data sets to progress in North Pacific ecosystem research. These letters would then be presented to the Science Board for consideration for official issuance by PICES.

### List of papers

#### *Oral presentations*

**Masami Nonaka, Hisashi Nakamura, Youichi Tanimoto, Takashi Kagimoto and Hideharu Sasaki** (Invited)

Interannual-to-decadal variability in the Oyashio Current and its influence on the subarctic frontal region in an eddy-resolving OGCM

**Harold P. Batchelder and Brie J. Lindsey**

Modeling interannual variation of spring-summer transport of plankton and juvenile salmon in coastal regions of the northeast Pacific

**Elena I. Ustinova and Yury D. Sorokin**

Spring thermal conditions in the Northwestern Pacific boundary current systems

**Steven J. Bograd, Roy Mendelssohn, Franklin B. Schwing and Cindy Bessey**

On the (a)synchrony of long-term sea surface temperature trends in the western and eastern North Pacific

**Andrew Bakun** (Invited)

“Active opportunist” species and opportune multi-annual-scale events

**Hiroshi Ichikawa and Xiao-Hua Zhu**

Relation between the quasi-biennial variations of northeastward volume transport southeast of Okinawa Island and the Aleutian Low Pressure Index

**Shoshiro Minobe**

Anomalous SST warming over Kuroshio-Oyashio Extension from 1999 to 2001 and its possible ocean to atmosphere influence

**George Shevchenko and Valery Chastikov**

The influence of East Sakhalin Current on the South Kuril Region ecosystem

**Bo Qiu** (Invited)

Decadal variability of the Kuroshio Extension jet, recirculation gyre and mesoscale eddies, and its connection to PDOs

**Shin-ichi Ito, Hiroshi Uchida, Yugo Shimizu and Shigeho Kakehi**

Synchronous and asynchronous variability of the North Pacific western boundary currents: Kuroshio and Oyashio

**David L. Mackas, William T. Peterson, Mark D. Ohman and Bertha E. Lavaniegos**

Zooplankton anomalies in the California Current System before and during the warm ocean conditions of 2005

**Jin Woo Kim and Im Sang Oh**

A study of the Kuroshio in the South of Japan islands using remote sensing data

**Igor A. Zhabin** (Invited)

Large-scale and meso-scale variability in the East Kamchatka Current/Oyashio Current region

**William T. Peterson and Robert L. Emmett**

An investigation into time lags between recent high-frequency changes in the PDO and response of various components of the ecosystem in the northern California Current

**Peter W. Lawson, Robert C. Francis, Steven R. Hare, Nathan J. Mantua and Laurie Weitkamp**

Patterns in salmon production in the Northeast Pacific: Inverse production regimes revisited

**Kiyotaka Hidaka and Kaoru Nakata**

Climate effects on interannual variation in winter-spring plankton community in the slope water and Kuroshio

*Posters*

**Gennady V. Khen, Elena I. Ustinova and Jury. D. Sorokin**

Interannual variation of sea surface temperature in different areas of the northern Pacific

**Victor I. Kuzin, Aleksandr N. Man'ko and Aleksandr D. Nelezin**

Diagnosis of the Kuroshio Current on the basis of hydrological measurements during 1980-1990

**Ryan R. Rykaczewski**

Decadal-scale variability in upwelling processes in the California Current Ecosystem and potential biological responses

**CCCC Paper Session**

Convenors: Harold P. Batchelder (U.S.A.) and Suam Kim (Korea)

Background

The goal of this session was to describe patterns and processes of North Pacific ecosystem responses to physical forcing and climate change.

Summary of presentations

The session consisted of 10 oral and 5 poster presentations. Diverse topics across the North Pacific ecosystems were addressed in oral

presentations. The changes in various ecosystem components such as hydrography, phytoplankton, zooplankton, fish and mammals were examined with respect to different environmental conditions. From the eastern Pacific ecosystems, the responses of fish community to the climate/ocean variability were investigated in the California Current system and the Gulf of Alaska, focusing on hake distribution and fish community interactions, respectively. Also the level of fatty acids in various marine organisms was compared to

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elucidate sources of nitrogen to the eastern Bering Sea ecosystem. In the western Pacific Ocean, the role of changing oceanographic conditions was hypothesized to reveal differences in planktonic production and nektonic abundances. The relationship between sea ice coverage and phytoplankton blooms in the southern Okhotsk Sea was investigated. Long-term variations of the East China Sea ecosystem were related to decadal-scale changes in meteorological phenomena and shifts in the path of the Kuroshio. ECOPATH modeling was used to examine interannual changes in the

porpoise population and its trophic level in the Yellow Sea during the early 2000s, and to synthesize fisheries resources and their dynamics in the western Japan/East Sea. Papers used hydrodynamic models to evaluate transport of phytoplankton and zooplankton, and to determine the relative contribution of local production vs. advection in creating observed patterns of LTL production in the Kuroshio and Kuroshio Extension regions, and to evaluate transport of eggs and juvenile stages of jack mackerel and their interannual variability in survival in the East China Sea.

### List of papers

#### *Oral presentations*

**John A. Holmes and Kenneth D. Cooke**

Changes in the distribution of Pacific hake (*Merluccius productus*) in response to climate and ocean variability in the California Current

**Hyoung-Chul Shin, Kang Hyun Lee, Kyung Ho Chung and Sung-Ho Kang**

Zooplankton distribution off Sakhalin Island during summer and comparison with other sub-arctic waters

**Anne B. Hollowed, Elizabeth Logerwell, Rebecca Isquith and Chris Wilson**

The impact of regime shifts on the oceanography of the northern Gulf of Alaska and its influence on the species interactions between walleye pollock, capelin, and Steller sea lions

**Jeffrey M. Napp, Lawrence E. Schaufler, George L. Hunt Jr. and Kathy L. Mier**

Summer food web structure in the eastern Bering Sea: Fatty acid composition of plankton, fish, and seabirds around the Pribilof Islands

**Elena Dulepova and Svetlana Glebova**

An East-West comparison of plankton communities of the northern Okhotsk Sea

**Muzzneena Ahmad Mustapha and Sei-Ichi Saitoh**

Interannual variations of sea ice and spring bloom occurrences at the Japanese scallop farming area in the Okhotsk Sea

**Vadim Navrotsky, T. Zadonskaya, V. Darnitsky, V. Chuchukalo, L. Bokhan and V. Napazakov**

Hydrophysical and biological characteristics in the Kuril-Kamchatka Current and Oyashio region of the Northwestern Pacific

**Hyejin Song and Young-shil Kang**

Variations in zooplankton and oceanographic condition in the southwestern East/Japan Sea after the late 1990s

**Takashige Sugimoto, H-Y. Kim, K. Tadokoro, K. Kuroda and N. Nagai**

Stepwise increase of water temperature and zooplankton biomass after the mid-1980s in the East China Sea and their possible effect on the recovery of jack mackerel

**Kyum Joon Park, Chang Ik Zhang, Zang Geun Kim, Seok Gwan Choi and Yong Rock An**

Abundance of finless porpoise (*Neophocaena phocaenoides*) and their role in the eastern Yellow Sea ecosystem

**Andrei Krovnin and G. Moury**

The state of the climate system of the North Pacific and North Atlantic in 2000-2005 in comparison with the 2nd half of the XX century

#### *Posters*

**Young Seop Kim, Hyung Kee Cha, Sung Il Lee, Seon Jae Hwang, Sang Cheol Yoon, Kyunk Chan Know and Jae Houn Yang**

Application of the ecosystem structure model (Ecopath) to the East/Japan Sea in Korea

**Kosei Komatsu and Akihide Kasai**

Modeling annual variation of transport of eggs and larvae of jack mackerel in the East China Sea

**Kosei Komatsu, Kaoru Nakata and Takahiko Kameda**

3D modeling of size-dependent variation of phyto- and zooplankton biomass caused by advective processes around the Kuroshio and the Kuroshio Extension



**Carol Ladd**

Interannual variability of the Gulf of Alaska eddy field

**Jong Hee Lee and Chang Ik Zhang**

Analysis of the lower trophic level of the northern East China Sea ecosystem based on the NEMURO model

**Ken-Ichi Sato, Atsushi Yamaguchi, Naonobu Shiga and Tsutomu Ikeda**

Fine-scale vertical habitat separation among four grazing copepods (*Neocalanus cristatus*, *N. flemingeri*, *Eucalanus bungii* and *Metridia pacifica*) in the Oyashio region, western subarctic Pacific Ocean

**Yulia N. Tananaeva and Marat A. Bogdanov**

Interannual variability in development of the seasonal processes and their influence on fishery resources of the North Pacific

**FIS Contributed Paper Session**

Convenor: Gordon H. Kruse (U.S.A.)

Background

Fishery science is a broad field in the PICES region, owing in part to the diversity of species, water masses, and fisheries of the North Pacific Ocean. Therefore, a specific Topic Session sometimes does not fully cover the science communication needs of fisheries scientists of PICES member countries. A FIS Contributed Paper Session enhances FIS activities in PICES by allowing participation by more fisheries scientists with different interests. This session is also a good way to provide opportunities to give presentations by young scientists including students.

Summary of presentations

The session consisted of 14 oral presentations and 34 posters that covered a wide variety of fish species from five PICES member countries plus Mexico. The most common topics in both oral and poster sessions included presentations on the geographic distributions of fishes (*e.g.*, tunas) and squid, particularly with respect to sea surface temperature, chlorophyll, and water masses. Satellite tags have become increasingly useful to investigate the distributions of some large-bodied fishes (*e.g.*, swordfish) and turtles

at sea with respect to oceanographic conditions. However, traditional methods using tag-recapture techniques (*e.g.*, big skate), analysis of seasonal fishery bycatch patterns (*e.g.*, herring), and hydroacoustics (*e.g.*, anchovy post-larvae) remain very useful. Likewise, the value of process-oriented studies (*e.g.*, testing fishery competition with sea lions) is becoming more widely recognized. All of this research has benefited greatly from recent developments in the analysis of spatio-temporal data using Geographic Information Systems. Another common research topic during the session was ecosystem-based fishery management, particularly in the poster session. There were considerable efforts to develop ecosystem indicators based on metrics, such as mean trophic level, size based indicators and fish reproduction potential. Classical fishery research studies remain important, including studies of genetics (salmon), age and growth (minke whales, chub mackerel, shotted halibut, deep-sea fishes), reproduction (pollock, blue crab), and feeding (red king crab, salmon). Based on the number of presentations and posters, diversity of species, mix of topics, the high quality of the presentations, and large attendance, the FIS Contributed Paper Session at PICES XV was deemed to be very successful.

List of papers

*Oral presentations*

**Churchill Grimes, Daniel Goodman, Peter Lawson, Richard Marasco, Andre Punt and Terry Quinn**

Ecosystem-based fishery management; A pragmatic approach

**Chang-Ik Zhang, Jae Bong Lee and Sun-Kil Lee**

Size-based indicators to evaluate ecosystem variations in Korean waters

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### **Doug Hay and Tom Therriault**

Climate change: Important impacts on unimportant species?

### **Naoki Tojo, Gordon H. Kruse and Terrance J. Quinn II**

Environmental cues for herring spawning timing in northern Bristol Bay, Alaska

### **Jong-Hun Na, Zang Geun Kim and Chang Ik Zhang**

Estimation of growth parameters of minke whale, *Balaenoptera acutorostrata*, in Korean waters

### **Hidetada Kiyofuji, Evan Howell, Katsuya Saitoh, Sei-Ichi Saitoh and Jeffrey Polovina**

Spatial and temporal dynamics of albacore tuna (*Thunnus alalunga*) and blue shark (*Prionace glauca*) in the Kuroshio Extension area

### **Evan A. Howell, Donald R. Kobayashi and Jeffrey J. Polovina**

Identifying critical habitat of swordfish and loggerhead turtles from fishery, satellite tag, and environmental data

### **Nanami Kumagai, Hidetada Kiyofuji and Sei-Ichi Saitoh**

Distributions of squid fishing grounds and their relationship to sea surface temperature and chlorophyll-*a* concentration in the Japan Sea

### **Gordon A. McFarlane and Jacquelynne R. King**

Migration patterns of big skate (*Raja binoculata*) based on a large-scale tagging study in northern British Columbia waters: Preliminary results

### **Alexander I. Glubokov**

Status of fishes in the outer shelf and upper slope of the Northern and Western Bering Sea

### **Kazushi Mivashita, Atsumu Watanabe, Saho Morioka, Yoshihiro Ikewaki, Ryu-ichi Matsukura and Hiroki Yasuma**

Acoustic monitoring of Japanese anchovy (*Engraulis japonicus*) post-larvae “shirasu”

### **Min Ho Kang, Jung Youn Park and Suam Kim**

Genetic variations and differences of chum salmon (*Oncorhynchus keta*) collected from the Bering Sea and along the North Pacific region

### **You Jung Kwon, Chang Ik Zhang, Dae Yeon Moon and Jeong Rack Koh**

Stock assessment of southern bluefin tuna (*Thunnus maccoyii*) using MULTIFAN-CL

### **Elizabeth A. Logerwell, A.B. Hollowed, C.D. Wilson, P. Walline, P. Munro, M.E. Connors, S. McDermott, S. Neidetcher, D. Cooper and K. Rand**

Fish ecology plays a key role in understanding the potential for commercial fishing to impact prey fields of endangered Steller sea lions

## Posters

### **Elena N. Andreeva, Svetlana V. Davidova and Anatoly V. Smirnov**

Dynamics of the flounders spawning during the spring seasons 1984-2005 depending on hydrological conditions of the Okhotsk Sea

### **John R. Bower, Saya Shimura and Shuichi Abe**

Observations on the morphology and distribution of gonatid paralarvae in the northeast Pacific

### **Oleg Bulatov, Olga Moiseeva and Georgiy Moiseenko**

The Okhotsk Sea pollock stock assessment using GIS “Fishery”

### **Jung Hwa Choi, Dae Soo Chang, Kang-seok Hwang, Young-yull Chun and Jong Bin Kim**

Environmental effects on landings of penaeid shrimp in the Yellow Sea

### **Vladimir A. Belyaev, V.B. Darnitskiy, E.I. Ustinova and S.P. Bomko**

Dynamics of oceanographic conditions near the Japanese Archipelago: Fluctuations, processes in ecosystems and mass pelagic species

### **Yurii P. Diakov**

Geographic variations of seasonal spawning structure of *Pleuronectiformes* in the northern Pacific Ocean

### **Natalia T. Dolganova and A.E. Lazhentsev**

Feeding of mass nekton species in the epipelagic waters of the northwestern Japan Sea

### **Maria V. Eletskaeva, Vadim A. Shtrik and Minna I. Tarverdieva**

Feeding of red king crab (*Paralithodes camtschaticus*) juveniles in the North Pacific and Barents Sea

### **Elena V. Gritsay**

Geographical variability of walleye pollock maturation rate in the Bering Sea and Gulf of Alaska

### **Kazushi Kadomura, Makoto Sugihara, Sayaka Naruse, Takuji Nakashima, Kenichi Yamaguchi and Tatsuya Oda**

ROS (reactive oxygen species) generation by several marine fish species during embryogenesis

**Makoto B. Kashiwai**

Challenge of Hanasaki Program: Toward management of Hanasaki crab including taste quality

**Atsushi Kawabata**

Distribution and biomass of the Japanese common squid, *Todarodes pacificus*, estimated by acoustic survey in the Pacific coastal waters off the northern Japan

**Anastasia M. Khrustaleva, Alexander A. Volkov and Darya A. Zelenina**

Study of the population structure of Asian sockeye salmon (*Oncorhynchus nerka*) using microsatellite polymorphism analysis

**Hwa Hyun Lee, Min Ho Son and Suam Kim**

Distribution of common squid, *Todarodes pacificus* (Cephalopoda: Ommastrephidae), larvae in the East China Sea in the early 2000s

**Yeong Hye Kim, Kwang Ho Choi, Jin Goo Kim, Jong Bin Kim and Dong Woo Lee**

Age, growth and maturity of spotted halibut, *Eopsetta grigorjewi*, in the southern coast of Korea

**Toshiyuki Konishi, Hidetada Kiyofuji, Katsuya Saitoh and Sei-Ichi Saitoh**

Predictability of Pacific saury fishing grounds using satellite remote sensing and a statistical model

**Eugene V. Miheev and Nikolay N. Kovalev**

Adaptation of Cephalopoda: A biochemical approach

**Hideaki Kudo, Masakazu Shinto, Ikue Mio and Masahide Kaeriyama**

Histological study of the olfactory system of immature and maturing chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean

**Sun-Kil Lee, Jae Bong Lee, Chang-Ik Zhang and Dong Woo Lee**

Fish reproduction potential (FRP) index of marine ecosystems in Korea

**Yong-Woo Lee**

Bias in size distribution estimates for fish populations due to sampling gear selectivity and sample sizes

**Pablo del-Monte-Luna, Salvador E. Lluch-Cota, Jesus Bautista-Romero and Daniel Lluch-Belda**

Fishing down or just too many small pelagics?

**Kazushige Oishi, Akira Nihira, Tadaaki Kuroyama and Sei-Ichi Saitoh**

Predictable hotspots for Skipjack tuna, *Katsuwonus pelamis*, using multi-sensor satellite remote sensing off the east coast of Japan

**Alexei Orlov and C. Binohlan**

Length-weight relationships of deep-sea fishes from the western Bering Sea

**Alexei M. Orlov and Vasily A. Ul'chenko**

Seasonal changes of environmental conditions of the most abundant and common groundfish species in the Pacific off the North Kurils and South Kamchatka

**Gennady V. Avdeev, Evgeny E. Ovsyannikov and Svetlana L. Ovsyannikova**

Seasonal distribution of immature pollock in the northern Okhotsk Sea

**Yosuke Sagawa, Hideaki Kudo and Masahide Kaeriyama**

Feeding habits of Pacific salmon in the North Pacific Ocean in summer 2005

**Aida Sartimbul, Hideaki Nakata and Ikuo Hayashi**

Analysis of time series of coastal fishery catches in the Tsushima Warm Current region in relation to temperature changes

**Young Il Seo, Joo Il Kim, Sun Do Hwang, Taek Yun Oh, Sun Kil Lee, Won Seok Yang, Sung Tae Kim and Hyun Joo**

Coastal ecosystem of the Yeo-Ja Bay in the southern sea of Korea

**Kyung-Jun Song, Zang Geun Kim, Hawsun Sohn, Seok Gwan Choi, Yong-Rock An and Chang Ik Zhang**

The feasibility of photo-identification techniques for bottlenose dolphin (*Tursiops truncatus*) in Jeju Island, Korea

**Mikhail A. Stepanenko and Elena V. Gritsay**

Effect of biological and physical factors on recruitment variability of eastern Bering Sea pollock

**Naoki Tojo, Gordon H. Kruse and Fritz C. Funk**

Migration dynamics of Pacific herring (*Clupea pallasii*) and response to spring environmental variability in the southeastern Bering Sea

**Norio Yamashita, Masayuki Noto, Chikako Watanabe, Atsushi Kawabata and Hiroshi Nishida**

Distribution and growth of juvenile chub mackerel, *Scomber japonicus*, in the Kuroshio-Oyashio transition region

**Hak Jin Hwang, Yang Jae Im, Myoung Ho Sohn, Inja Yeon, Naek Joong Choi and Mi-young Song**

Spatio-temporal distribution of Pacific cod, *Gadus macrocephalus*, in the western sea of Korea

**Inja Yeon, Hak Jin Hwang, Yang Jae Im, Myoung Ho Shon, Sung Hyun Hong, Yoon-Seon Yang and Mi-Young Song**

The reproductive biology of blue crab, *Portunus trituberculatus* (Miers), in the western sea of Korea

### POC Contributed Paper Session

Convenor: Michael G. Foreman (Canada)

#### Background

Papers were invited on all aspects of physical and biogeochemical oceanography and climate in the North Pacific and its marginal seas.

#### Summary of presentations

The session consisted of 19 oral presentations (after two cancellations – Chen and Wang) and 21 posters covering a wide range of physical and biogeochemical oceanographic research. The first sub-session, chaired by Michael Foreman, started with an interesting presentation by William Crawford on the transport and mixing of nutrients into the Gulf of Alaska by eddies that largely originate on continental shelves. Masatoshi Sato used recent Argo observations to describe variations in the current structure of the North Pacific. Young-Gyu Park used output from the Japanese high-resolution Earth Simulator model to identify seasonal variations in, and sources of, the Tsushima Warm Current. Ye Yuan described and compared observations of suspended sediment from three different instruments that were deployed near major river mouths along the Chinese coast of the Yellow Sea. The final speaker of this sub-session, Svetlana Glebova, described her analyses of 2000-2006 atmospheric circulation patterns over the Asia-Pacific region.

The next sub-session was chaired by James Christian and comprised of biogeochemical presentations. Pavel Tishchenko analysed and sought to explain peculiarities in the nitrogen/phosphate ratio in the Japan/East Sea. The next two speakers, Melissa Chierici and Agneta Fransson, used ship of opportunity observations of pCO<sub>2</sub> across the North Pacific to look for trends in the Oyashio, Alaskan Gyre, southern Bering Sea, and western subtropical gyre regions. Relationships between CO<sub>2</sub> and temperature and salinity were explored, but the relatively short time series (1995-2001) limited the strength of their conclusions. The final speaker before lunch, Shigeo Kakehi, related

changes in AOU (apparent oxygen utilization) in the North Pacific to mixing, biological activities, and air-sea exchange and estimated proportions for each.

The third sub-session was chaired by Ichiro Yasuda and began with three papers relating to the 18.6-year nodal tidal cycle, a topic that was introduced by Prof. Yasuda in his Science Board presentation the previous day. Konstantin Rogachev attributed the cooling at specific banks in the Sea of Okhotsk and Oyashio region to strong diurnal tidal currents and showed that the 18.6-year modulation of these currents was correlated with air temperatures at two cities on the Sea of Okhotsk coast. Michael Foreman described his assimilating model for the Bering Sea, estimated the tidal energy entering the sea through each of the Aleutian Passes, showed regions of dissipation and mixing, and finally quantified how much that mixing should change over 18.6 years. Satoshi Osafune used salinity and temperature observations from the world data base to identify regions in the western North Pacific, including the Bering and Okhotsk Seas, where there have been significant changes over 18.6 years, and to estimate the vertical diffusion coefficient associated with these changes. Leaving this topic, Fangli Qiao presented the results of model sensitivity studies to identify the unconventional dynamics that cause seasonal upwelling in the East China Sea near the mouth of the Changjiang River. The final speaker, Ig-Chan Pang, described the distribution of Changjiang diluted water in the East China Sea, with particular emphasis on predicting low salinity events before they hit Cheju Island.

The fourth sub-session, chaired by Fangli Qiao, began with an extensive analysis (using over 230,000 profiles) showing that atmospheric forcing was the primary cause of spatial and temporal variations in the mixed layer depth in the East Sea (Se-Han Lim). Olga Trusenкова computed and described variability modes and typical patterns of surface winds of the

Japan/East Sea and nearby land masses. Tohikiro Kono related 1989-1995 observations of walleye Pollock eggs and their survival to variations in the Coastal Oyashio Current and described the results of preliminary simulations with a circulation model that will be used for further studies. Jae-Yul Yun demonstrated that atmospheric bridging between Siberian Highs and the Indian Ocean is the reason behind El

Niño teleconnections to isopycnal fluctuations in the southwestern Japan/East Sea. Chnagshui Xia, described improvements to the Mellor-Yamada mixing formulation via the development of a wave-tide coupled model and demonstrated that these changes lead to more accurate mixing layers in the Yellow and East China Seas.

### List of papers

#### *Oral presentations*

##### **William R. Crawford**

Transport and mixing of continental margin waters into mid-basin by anticyclonic eddies: An example from the Gulf of Alaska

##### **Masatoshi Sato and Tokihiro Kono**

Seasonal variation of current structure in the subarctic North Pacific from Argo data

##### **Young-Gyu Park, Chang-Hwan Park and Sang-Wook Yeh**

The formation of the Tsushima Warm Current in a high resolution ocean circulation model

##### **Ye Yuan, Wen-Sheng Jiang and Liang Zhao**

Estimating suspended sediment concentration using ADCP, LISST-100 and OBS in Jiaozhou Bay and Laizhou Bay, China

##### **Svetlana Yu. Glebova**

Features of atmospheric circulation over the Asian-Pacific region in 2000-2006

##### **Liqi Chen**

China's international polar year 2007-08 projects and CHINARE's SOLAS in polar regions

##### **Pavel Ya. Tishchenko, Sergey G. Sagalae, Vyacheslav B. Lobanov, Alexander P. Nedashkovskiy, Galina Yu. Pavlova and Lynne D. Talley**

Peculiarities in distribution of the N:P ratio in seawater of the Japan/East Sea

##### **Melissa Chierici, Agneta Fransson and Yukihiro Nojiri**

Evolution of the surface water carbon dioxide in relation to the annual trends in salinity and temperature in the Oyashio region

##### **Agneta Fransson, Melissa Chierici and Yukihiro Nojiri**

Comparison of interannual trends in the surface water  $p\text{CO}_2$ , salinity and temperature in the subarctic North Pacific

##### **Shigeho Kakehi, Kazuyuki Uehara, Shin-ichi Ito, Kosei Komatsu, Hiroaki Saito and Miwa Nakamachi**

The processes of AOU change in the North Pacific

##### **Konstantin Rogachev**

Cooling at hot spots: Amplification of tidal currents over banks and 18.6-year tidal cycle in the Oyashio and Sea of Okhotsk

##### **Michael G. Foreman, Patrick Cummins, Josef Cherniawsky and Phyllis Stabeno**

Tidal energy and the 18.6-year cycle in the Bering Sea

##### **Satoshi Osafune and Ichiro Yasuda**

Bidecadal variations of water properties around the Bering Sea and the relation with the 18.6-year period nodal tidal cycle

##### **Fangli Qiao and Xingang Lv**

The upwelling system in the East China Sea in winter and summer

##### **Ig-Chan Pang, Jae-Hong Moon, Takeshi Matsuno, John M. Klinck, Jin-Young Kim, Hee-Dong, Jeong, Ki-Tack Seong and In-Seong Han**

Distribution mechanism of Changjiang diluted water in the East China Sea

##### **Se Han Lim, Chan Joo Jang and Im Sang Oh**

Spatial and temporal variations of the mixed layer depth in the East Sea

##### **Olga O. Trusenkova, Sergey V. Stanichny and Yuri B. Ratner**

Variability modes and typical patterns of surface wind over the JES and adjacent land

##### **Tokihiro Kono, Tomonori Hamatsu, Keizo Yabuki, Kazutoshi Watanabe and Michael G. Foreman**

Transport of walleye pollock (*Theragra chalcogramma*) eggs between 1989 and 1995 and its causes on the southwest coast of Hokkaido, Japan

##### **Fan Wang**

Long-term variability of temperature in the Yellow Sea and the East China Sea in the past 40 years

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**Jae-Yul Yun, Kuh Kim, Kyung-II Chang, Yang-ki Cho and Lorenz Maggaard**

The El Niño teleconnection to the isopycnal fluctuations in the southwestern East Sea/Japan Sea

**Changshui Xia, Fangli Qiao, Yongzeng Yang and Yeli Yuan**

The development of a wave-tide-circulation coupled model and its application in the Yellow Sea and the East China Sea

### Posters

**Tatyana V. Belonenko and Alexey V. Koldunov**

Rates of steric sea-level variation for the Kuril area in the North Pacific

**Yongli Chen, Yongping Zhao, Fan Wang and Aiming Wu**

The pathway of interannual and interdecadal variability of the Pacific subsurface ocean temperature anomaly

**Yang Ho Choi, Young Jae Ro and Chang Su Jeong**

Development of a hydrodynamic and eutrophication model of the west coast of Korea

**Shan Gao, Fan Wang, Mingkui Li, Yongli Chen, Changxiang Yan and Jiang Zhu**

Application of altimetry data assimilation on mesoscale eddies simulation

**Hitoshi Kaneko, Hiroji Onishi and Ichiro Yasuda**

Formation processes of temperature inversions in the subarctic North Pacific

**Eung Kim, Young-Jae Ro, Yu-Hwan Ahn and Kwang-Young Jung**

Estimation of sea surface current vectors based on satellite images around the Korean Marginal Sea

**Yun-Bae Kim, Kyung-II Chang, Jae-Hun Park, Jong-Jin Park, D. Randolph Watts, Jae-Hak Lee and Kuh Kim**

Low-frequency deep flow variability in the Ulleung Basin

**Viktor V. Koldunov**

Research of interannual variability of the mean sea level in the North Pacific

**Kosei Komatsu, Takashi Setou and Yasumasa Miyazawa**

Abrupt change of mixed-layer structures caused by horizontal intrusion of the warm water mass from the Kuroshio into the coastal region off Enshu-nada, south of Japan

**Kosei Komatsu, Yasumasa Miyazawa and Takashi Setou**

Effects of wind and waves on the jet-leaving transport of surface materials around the Kuroshio and the Kuroshio Extension

**Kosei Komatsu, Yasumasa Miyazawa and Takashi Setou**

Modification processes of intermediate water around the Kuroshio region

**Mingkui Li, Fan Wang, Yongli Chen, Shan Gao and Fangli Qiao**

Parameterization of tidal current-induced vertical eddy viscosity

**Vyacheslav Lobanov, Vladimir Zvalinsky, Anatoly Salyuk, Pavel Tishchenko, Sergey Zakharkov, Svetlana Ladychenko, Boris Lee, Kyung-Ryul Kim, Jae-Young Lee and Victoria Nadtochiy**

Physical, chemical and biological structure of an anticyclonic eddy in the northwestern Japan Sea

**Valentina V. Moroz and Konstantin T. Bogdanov**

Variability of water characteristics in the Kuril-Oyashio Current system

**Hanna Na, Kuh Kim and Kyung-II Chang**

Application of high-frequency radar to the east coast of Korea

**Masayuki Noto and Ichiro Yasuda**

Bi-decadal variations in SST relating to a tidal cycle of 18.6-year periods around the Kuril and Aleutian Islands

**Sachiko Oguma, Tsuneo Ono, Akira Kusaka and Yutaka W. Watanabe**

Stable isotopes as chemical tracers in the coastal region around eastern Hokkaido

**Jong Jin Park and Kuh Kim**

Kinetic energy flux of inertial frequency motion out of the mixed layer and its balance with wind energy input in the global scale ocean

**Natalia I. Rudykh, Vladimir I. Ponomarev and Elena V. Dmitrieva**

Linkages of oceanographic characteristic variability in the Tatarskii Strait with the Amur River discharge

**Yugo Shimizu, Hiroaki Tatebe, Ichiro Yasuda, Shin-ichi Ito, Shigeo Kakehi, Akira Kusaka and Tomoharu Nakayama**

Southward Oyashio intrusion revealed by profiling floats set to drift in the intermediate layer

**Miyuki Tatesawa, Shin-ichi Ito, Yugo Shimizu and Shigeo Kakehi**

Seasonal variation of dissolved oxygen in the Oyashio

**Shuichi Watanabe, Masahide Wakita, Vyacheslav B. Lobanov and Igor Zhabin**

Distributions of chemical species in the subarctic North Pacific and the western Bering Sea during 2004 summer cruise

**Masahiro Yagi and Ichiro Yasuda**

Vertical eddy diffusivity at the Bussol' Strait in the Kuril Islands from CTD data

## BIO Contributed Poster Session

Convenor: Michael J. Dagg (U.S.A.)

Posters on various aspects of biological oceanography in the North Pacific Ocean and its marginal seas (excluding S2-S5 topics) were

invited. Among 15 posters presented, 5 were from Russia, 6 from Korea, 3 from Japan and 1 from China.

### List of posters

**Tatyana A. Belan and Ludmila S. Belan**

Distribution of macrozoobenthos in the North-West part of the Japan/East Sea in 2006

**Andrew A. Bobkov and Kirill M. Petrov**

Bionomic criteria for large marine ecosystem identification

**Sachihiko Itoh and Shingo Kimura**

Biological transport and survival of larval pelagic fishes in the Kuroshio system region estimated with Lagrangian drifters

**Seung Jin Jeong, Ok Hwan Yu and Hae-Lip Suh**

Secondary production of *Jassa slatteryi* (Amphipoda, Ischyroceridae) on a *Zostera marina* seagrass bed in Southern Korea

**Young Shil Kang, Seung Heo and Hyungchul Kim**

Zooplankton distribution, abundance and biomass relative to oceanographic conditions in the Yellow Sea

**Valentina V. Kasyan**

Composition, distribution and interannual variability of zooplankton in the inner part of Amursky Bay (Japan/East Sea)

**Hyeok Chan Kwon, Sung Il Lee, Hyung Kee Cha, Seon Jae Hwang, Young Seop Kim and Jae Hong Yang**

Maturity and spawning of *Glyptocephalus stelleri* in the East/Japan Sea, Korea

**Chang Rae Lee, Chul Park, Sungyull Yang and Yongsik Sin**

Plankton distribution during the spring bloom in Asan Bay in the Yellow Sea, Korea

**Wen-Tseng Lo, Ya-Ling Pan and Li-Lian Liu**

Seasonal distribution of siphonophores in and near the Kuroshio Current off eastern Taiwan

**Jun Nishikawa, Hiroya Sugisaki and Ichiro Yasuda**

Increase in salp abundance during 1983-1993 in the western subarctic North Pacific

**Marina S. Selina, Olga G. Shevchenko, Tatiana V. Morozova, Inna V. Stonik and Tatiana Yu. Orlova**

Phytoplankton of the Amur River estuary and adjacent areas in July 2005

**Yugo Shimizu, Kazutaka Takahashi, Shin-ichi Ito, Shigeho Kakehi, Akira Kusaka and Tomoharu Nakayama**

Southward carbon transport of large subarctic copepods by the Oyashio current

**Dong Hyun Shon**

Differentiation of phytoplankton groups using in-water optical techniques

**Vladimir I. Zvalinsky and Pavel Ya. Tishchenko**

Natural and anthropogenic eutrophication of Amursky Bay (East/Japan Sea)

**Keiko Yamada, Sang-Woo Kim, Hee-Dong Jeong and Woo Jin Go**

Typhoon effects on the short-term variation of chlorophyll-*a* in the East/Japan Sea, derived by satellite remote sensing

## MEQ Contributed Poster Session

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

Posters on various aspects of marine environmental quality in the North Pacific and

its marginal seas (excluding S8 and S9 topics) were presented.

### List of posters

**Tatyana A. Belan and Alexander V. Moshchenko**

Near-bottom environmental conditions and state of benthos at the inner part of Amursky Bay (Peter the Great Bay, Japan/East Sea)

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**Andrey P. Chernyaev and Alexander A. Vostroknutov**

Determination of n-nonylphenol in the sea water

**Minkyu Choi, Gui-Young Kim, Hyo-Bang Moon, Hee-Gu Choi, Jun Yu and Jong-Soo Park**

Behavior and contamination of estrogenic nonylphenols in Masan Bay, Republic of Korea

**Yoon seok Choi, Jong hui Kim, Chang su Jeong and Hyeon Seo Cho**

Distribution and origins of PCBs and PAHs in sediments of Yellow Sea

**Daoji Li, Lei Gao and Ping Wang**

Nutrient exchange fluxes between water-sediment interface in tidal flat of Dongtan, Changjiang (Yangtze River) estuary

**Tatyana S. Lishavskaya and Alexander V. Moshchenko**

Contamination level and distribution of some pollutants in bottom sediments of the north-west part of the Japan/East Sea in 2006

**Renyan Liu, Daoyan Xu, Yuhua Dong, Bingjun Chen, Bing Liang, Yubo Liang and Sai Ye**

Preparation of monoclonal antibody against okadaic acid and development of ELISA to detect diarrhetic shellfish poisoning in shellfish from China

**Olga N. Lukyanova, Svetlana A. Aleshko and Sergey A. Cherkashin**

Mysids as sensitive bioindicators for coastal ecosystems monitoring

**Tatiyana V. Pavlova, Vasiliy F. Mishukov and Larisa C. Buzoleva**

Dynamics of number of oil oxidizing microorganisms in Golden Horn Bay of the Sea of Japan

**Dariush Mowlā and Majid Ahmadi**

Theoretical and experimental investigation of biodegradation of hydrocarbon polluted water in a three phase fluidized-bed bioreactor with PVC biofilm support

**Nadezhda E. Struppul, Olga N. Lukyanova and Yuri V. Prichod'ko**

Selenium accumulation in trophic net of the Japan/East Sea

**Anh Dieu Van, Jin Wang, Yoko Sano, Kentaro Uchida, Yoshishige Hayashi and Takuya Kawanishi**

Partition of polycyclic aromatic hydrocarbons (PAHs) between the river water and bottom sediments at the estuary of rivers in Kanazawa, Japan

**Haiyan Wang, Yusheng Zhang and Senming Tang**

Status of combined heavy metal and POP pollution in Razor clam from coastal areas of Quanzhou, China

**Maromu Yamada, Yasunobu Iwasaka, Guangyu Shi, Atsushi Matsuki, Dmitry Trochkin, Daizhou Zhang, Masahiro Nagatani, Hiroshi Nakata, Yoon-Suk Kim, Tetsuji Nagatani, Bin Chen, Shen Zhibao, Jingmin Li and Kazuichi Hayakawa**

Existence of background dust in the free troposphere over an Asian dust source region

**Xiao-Yang Yang, Yumi Okada, Ning Tang, Takayuki Kameda, Akira Toriba and Kazuichi Hayakawa**

Long-range transport of polycyclic aromatic hydrocarbons and nitropolycyclic aromatic hydrocarbons from China to Japan

## Observers Poster Session

Posters providing general information and highlighting scientific objectives and recent activities of scientific organizations, programs

and monitoring efforts of regional and global scale were presented.

### List of posters

**Norio Baba**

Current activities and future plans of Northwest Pacific Action Plan (NOWPAP)

**John A. Barth, Jan A. Newton and NANOOS Colleagues**

Northwest Association of Networked Ocean Observing Systems (NANOOS)

**Kenneth F. Drinkwater and George L. Hunt**

Ecosystem Studies of Sub-Arctic Seas (ESSAS)

**Julie Hall and Sylvie Roy**

IMBER: Integrated Marine Biogeochemistry and Ecosystem Research

**George L. Hunt Jr. and K. David Hyrenbach**

The Bering Ecosystem Study Program (BEST): A new program for the eastern Bering Sea

**Molly McCammon, G. Carl Schoch and Mark Johnson**

AOOS: Implementing an Ocean Observing System in Alaska



**Clarence Pautzke and Francis Wiese**

Bering Sea and Aleutian Islands integrated ecosystem research program of the North Pacific Research Board

**Howard J. Freeland, Nobuyuki Shikama and the Argo Steering Team**

Argo – An ocean observing system for the 21st century

**Usha Varanasi, William Fox, Elizabeth Clarke, Jonathan Phinney, Jack Barth, Russ Davis, John Hunter and Dolores Wesson**

The Pacific Coast Ocean Observation System: A new approach to integrating ecosystem-based science observations for management

**IFEP/MODEL Workshop (W1)**

***Modeling iron biogeochemistry and ocean ecosystems***

Convenors: Fei Chai (U.S.A.) and Jun Nishioka (Japan)

Background

The workshop aimed to enhance communication between experimentalists and modelers, and to examine the role of the iron cycle and its complexity in regulating biological productivity and structure of ocean ecosystems. A total of 28 scientists from Canada, Japan, United States of America, Hong Kong, France, and New Zealand attended the workshop. There were 7 oral presentations and 1 poster. Two talks focused on iron biogeochemistry based on observations, and 5 talks used numerical models to address the impact of iron on ecosystem dynamics.

An invited speaker, Marie Boye, reviewed recent advances in understanding the marine iron cycle, the role of organic ligand chemistry in the ocean, and datasets of basin-scale iron ligand concentrations. Atsushi Ooki presented data on dust-iron solubility in the seawater. Modeling talks examined several different approaches to treating the iron cycle and complexity in models. An ocean carbon cycle model indicated that it is important to have realistic iron distribution (Daisuke Tsumune). A couple of models tested iron fertilization and its impact on marine ecosystem structures (Masakiho Fujii and Fei Chai). One presentation compared simple with complex ocean ecosystem models, as well as the models with an iron cycle against models without an iron cycle (Albert Hermann). An iron cycle module has been incorporated in the NEMURO ecosystem model, and some preliminary results were presented (Naoki Yoshie).

A dynamic discussion covered a number of topics and issues. The following are point-summaries of the views of both experimentalists and modelers.

Summary of presentations

*Suggestions from experimentalist*

- Dust size, solubility, and its retention time are important factors for estimating bio-available iron in the surface layer, and these should be incorporated into models;
- Modelers should consider the significant differences in the concentrations of organic ligand among the ocean basins;
- Experiments are required on the bio-availability of organic iron species (dissolved, soluble and colloidal);
- There is a need to collect more data on the size-fractionated organic iron;
- Relationships between ligands and biogeochemical and environmental conditions should be investigated;
- Modelers should use the growing data sets of colloidal and soluble organic iron to examine meridional and zonal gradients of dissolved iron;
- Modelers should use available data sets of organic iron and the parameterizations provided by biogeochemists to develop and improve iron cycle models;
- Models should take into account species-specific bioavailability of organic Fe.
- A conceptual model focusing on iron chemistry should be established, and it

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- should include the remineralization and photochemical processes;
- Changes in the chemical form of iron occur during remineralization and scavenging process, and these transformation should be considered in the models;
- End members can be used to parameterize iron dynamics in model studies;
- There is a need to establish observational systems to collect long-term time series data.

### *Suggestions from modelers*

- Information on stoichiometry of phytoplankton is needed to improve iron distribution in the models;
- Iron dust deposition affects iron distribution, but current data are too sparse to quantify these relationships, and more data on this subject is needed;
- When only iron input from atmosphere is considered, the difference of iron concentration between basins could not be reproduced in the current models;
- Initial conditions (phytoplankton species, chemical and physical variables) are important factors for determining ocean ecosystem responses to iron enrichment;

- After iron enrichment in the equatorial Pacific, the ocean ecosystem needs about 60 to 90 days to return to the original state;
- Some comparison of iron cycle between subarctic and subtropical regions is needed;
- More information is required on interaction between phytoplankton and zooplankton functional groups, especially due to iron perturbations;
- Based upon comparative studies of different NPZ models, it appears that multiple classes of phytoplankton models with an iron cycle are needed to reproduce the basic characteristics of HNLC regions;
- There is a need for more information on organic-ligand chemistry and associated biogeochemistry from field observation in order to incorporate these processes into models.
- Long-term time series data are required for improving biogeochemical and ecosystem models.

The workshop recommended continuing the dialogue between experimentalists and modelers who work on iron biogeochemistry and ecosystem. A new working group consisting of experimentalists and modelers would be useful to examine the role of the iron cycle in regulating ocean productivity and marine ecosystem dynamics.

### List of papers

#### *Oral presentations*

**Marie Boye, Olivier Aumont, Constant M.G. van den Berg and Hein J.W. de Baar** (Invited)

The organic complexation in modeling the iron geochemistry and bioavailability

**Atsushi Ooki, Jun Nishioka and Tsuneo Ono**

Determination of iron solubility of Asian dust in the surface seawater

**Daisuke Tsumune, Keith Lindsay, Gokhan Danabasoglu, Scott C. Doney, Jun Nishioka, Takeshi Yoshimura, Frank O. Bryan and Nakashiki Norikazu**

Phosphate and iron concentrations in an ocean carbon cycle model

**Fei Chai, Lei Shi, M-S Jiang, Yi Chao, Francisco Chavez and Richard T. Barber**

Modeling responses of iron enrichment in the equatorial Pacific Ocean

**Masahiko Fujii and Fei Chai**

Influences of initial plankton conditions and mixed layer depth on the outcome of iron-fertilization experiments

**Albert J. Hermann, Thomas M. Powell, Elizabeth L. Dobbins, Sarah Hinckley, Enrique N. Curchitser, Dale B. Haidvogel and Kenneth Coyle**

A comparison of different NPZ models for the Northeast Pacific

**Naoki Yoshie, Katsunari Sato, Yasuhiro Yamanaka and Jun Nishioka**

Incorporating iron cycle into a lower trophic level marine ecosystem model, NEMURO

*Poster*

**Debby Ianson, Christoph Voelker, Kenneth L. Denman, Eric Kunze and Nadja Steiner**

The importance of iron in a biogeochemical patch model of the NE Pacific iron manipulation experiment, SERIES

**FIS Workshop (W2)*****Linking climate to trends in productivity of key commercial species in the sub-arctic Pacific***

Convenors: Richard J. Beamish (Canada), Anne B. Hollowed (U.S.A.), Masahide Kaeriyama (Japan), Suam Kim (Korea), and Vladimir Radchenko (Russia)

Background

The objective of the workshop was to review the evidence for climate impacts on production of commercial fish species and to discuss the feasibility of developing medium- to long-term forecasts of climate impacts on fish production, and the responses of fisheries to these changes in production. Participants in this workshop addressed three themes: (1) Evidence of climate change impacts, (2) Management implications, and (3) Techniques for comparing production trends of selected species across regions. Oral presentations were given that addressed each theme and participants discussed the implications of research findings with respect to recommendations for PICES forecasts of climate impacts on marine resources.

Summary of presentations

Scientists from five of the six PICES member countries participated in the workshop. They identified 30 important commercial species or species groups that could be included in forecasts of climate change and its affect on fish production. Participants acknowledged that the goal of forecasting fish responses to future states of nature is an ambitious task that will require collaboration between climatologists, oceanographers, fisheries biologists and modelers. Implementing periodic forecasts will require on-going collaboration between several PICES groups (FIS, POC, MONITOR, CFAME, and MODEL). While ambitious and far reaching, workshop participants identified several reasons why PICES should take the initiative to make forecasts of future fish production using climate scenarios and their associated ocean conditions. The following

summarizes the views on the importance of forecasting:

- Studies linking climate to fish production have relied primarily on retrospective analysis of data. While several mechanisms have been advanced to explain fish responses to climate change, the scientific method requires hypothesis testing. For marine ecosystems, one of the few tests available is a test of our ability to accurately predict how fish populations will respond to variations in ocean conditions. While developing the hypothesis is important step, there is a need to test the hypothesis by comparing observed and predicted outcomes.
- Parallel forecasts of fish responses to climate in several different PICES regions would help to determine whether fish stocks are responding to local events or basin-scale forces.
- The scientific community is calling for advances in sustainable fisheries management by taking into account the influence of a variable ocean ecosystem. A central element of this approach is the need to understand the impact of commercial fishing on ecosystems. If forecasts are based on inaccurate representations of fish population dynamics or inaccurate patterns of fishing, the projections of ecosystem impacts of fishing derived from these forecasts will not provide managers with useful results and could provide mis-leading information.
- With time and proven predictability, industry and governments may begin to utilize model output in forming management decisions. Linking annual trends in key species production with climate and ocean

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indices would also introduce a new dimension to PICES ecosystem status report that will attract a more general audience, including the popular press.

Workshop participants identified two types of forecasting approaches: index-based and quantitative modeling. Index-based forecasts involve the collection and comparison of time series of fish abundance, production, or condition. These data could be displayed as anomaly plots or charts in the North Pacific ecosystem status report. Tracking anomalies would serve as an early climate event detection system, and they would serve to provide a visual method for identifying similarities and differences between species in different PICES regions. If anomalies were used, scientists would need to agree on criteria for estimating means to ensure standardization across regions. It was noted that this type of forecasting tool could be applied to non-target and target species that are impacted by fishing. Participants felt this activity could be accomplished through collaboration with MONITOR.

The model-based forecasting approach would simulate functional responses of target species to expected future states of nature derived from climate forecasts and regional bio-physical models. To accomplish this task, members from each PICES nation would need to clarify the proposed mechanisms underlying the response of commercial fish to changes in climate. Members would prepare a list of core inputs necessary to develop a quantitative forecast. Fulfilling this request would require collaboration with members of POC to ensure requests are feasible. It is likely that the scenarios developed for CFAME models could also be utilized for projection of dynamic responses of commercial fish and fisheries.

It was noted that there are at least two types of quantitative forecasts that could be pursued. The first would involve forecasts based on coupled bio-physical models. Some progress has already been made in the development of this type of forecasting tool. For example, the MODEL Task Team has parameterized the NEMURO.FISH model for prediction of Pacific

herring and Pacific sardine recruitment. This modeling construct could be modified and adapted to other species, and linkages between annual fish production and future spawning stock biomass could be accomplished by extending the life cycle through adult life stages.

The second modeling construct would involve forecasts of future fish production using stock assessment projection models modified to incorporate climate forcing on core processes such as growth, maturation, production, predation mortality, catchability, availability, and fishing mortality. This modeling construct would require seasonal indices of climate/ocean conditions as well as indices of biological factors such as predator biomass and habitat volume (an index of competition). Functional responses of fish to climate would be developed to forecast changes in maturity schedule, growth, reproductive success, mortality, and selectivity of surveys or fisheries. We envision that over time, the FIS forecasting tools would be used to develop a decision tables for managers. Managers would use the decision tables to evaluate management strategies given probabilistic statements regarding expected ocean conditions over medium-term time periods. There are several advantages to this construct for forecasting. First, the framework would ensure continuity between changes in stock assessments and the forecasting tool. In several PICES countries, forecast models have been developed or are being developed to implement Management Strategy Evaluations (MSEs). These models could be modified to include climate forcing. Second, this type of modeling construct would facilitate rapid incorporation of new information for several managed species into ecosystem models providing improved whole ecosystem projections. Third, stock assessment authors throughout the PICES region are attempting to develop spatially explicit models. Utilizing a modeling construct that is consistent with stock assessment models would ensure rapid incorporation of spatial considerations into the forecast.

Participants discussed the spatial domain for the forecast and considered several candidates for

regional boundaries. Participants reviewed the PICES regions developed by the REX Task Team:

- California Current south
- California Current north
- Gulf of Alaska
- Bering Sea
- Sea of Okhotsk
- Japan/East Sea - Yellow Sea/East China Sea –Tsushima Warm Current (TWC)
- Kuroshio-Oyashio Current (KOC)
- Aleutian Islands
- Basin area

Upon review, it was noted that some stocks extend over multiple regions. To account for extended distributions, the Japan/East Sea and Yellow Sea/East China Sea regions could be combined into the TWC, and the Oyashio Current and Kuroshio Current regions could be combined into the KOC. Alternatively, it was indicated that quantitative forecasts might utilize the spatial domain used in stock assessments since this would be the primary source of detailed information on fish production. This option would provide consistency between assessments and forecasts.

Participants also discussed the schedule for implementing forecasts. Dr. Jeffrey M. Napp (MONITOR Chairman) informed participants that they plan to provide web accessible time series of ecosystem indicators in 2007. He mentioned that MONITOR plans to hold an inter-sessional meeting in 2007 to prepare for the next North Pacific Ecosystem Status Report to be published in 2009. Based on this input, workshop participants felt that the timing was sufficient to make progress on the development of a more formal construct for ecosystem

forecasting that could contribute to the next North Pacific Ecosystem Status Report in 2009.

#### Recommendations

FIS should attempt to forecast climate impacts on fish production and the responses of fisheries to these shifts.

Both empirical and numerical models should be considered and evaluated at an inter-sessional workshop. The workshop will discuss the details of each modeling approach. Convenors should seek to obtain consensus on how/if common models should be developed to ensure comparability of forecasts from different PICES regions.

An inter-sessional planning meeting should take place. The workshop would be 2–3 days in duration and would include a 25-member interdisciplinary team of scientists representing the fields of climatology (global climate modeling), oceanography (coupled bio-physical models, and physical oceanography, and biological oceanography), fisheries oceanography, fish population dynamics, fisheries assessment, fisheries economics and ecosystem modeling. Participants recognized the logistical difficulties of holding an inter-sessional meeting in June. Two options were discussed. The first option would be to convene the workshop in conjunction with the ESSAS workshops scheduled in June 2007, in Hakodate, Japan. The second option would be to hold the meeting in May, in Seattle, U.S.A. PICES is requested to provide some funds to support travel to this meeting. Participants also recognized that an external funding source will be needed to ensure the appropriate participation.

#### List of papers

##### *Oral presentations*

##### **Richard J. Beamish**

The impact of future climate trends on the key species and their fisheries off the Pacific coast of Canada

##### **Vladimir I. Radchenko**

Trends in Russian fisheries in the North Pacific in relation to basic stock conditions and their variability under the climate change

##### **Yeong Gong, Hee-Dong Jeong, Jong-Hwa Park, Ki-Tack Seong, Sang-Woo Kim and In-Seong Han**

Fluctuations of fish populations in the waters off Korea and its adjacent regions

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### **Masahide Kaeriyama**

Long-term fluctuations of chum salmon and Pacific herring populations in Hokkaido during 1883-2000

### **Anne B. Hollowed and Jennifer Boldt**

An overview of evidence for climate impacts on Northeast Pacific marine fishes and recommendations for a framework for forecasting annual marine production

### **Z.T. A'mar, A.E. Punt and M.W. Dorn**

The Management Strategy Evaluation approach and the Gulf of Alaska walleye pollock fishery

### **Michael J. Schirripa**

The potential effects of including/excluding environmental factors into stock assessments

### **Jae Bong Lee, Suam Kim, Chang-Ik Zhang, Jin-Yeong Kim and Sukyung Kang**

Evidences of climate-induced impacts on key commercial species around Korean waters

### **Andrea Belgrano**

Linking multi-species fisheries to climate variability: A phenomenological approach

## **MEQ/FIS Workshop (W3)**

### ***Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area***

Convenors: Glen Jamieson (Canada), Patricia Livingston (U.S.A.) and Chang Ik Zhang (Korea)

#### Background

The management of human activities that affect ocean ecosystems requires planning and the engagement of stakeholders to meet the objectives of ecosystem-based management. This, in turn, requires identification of areas to determine which stakeholders must be involved in each specific process. Area boundaries are typically based upon science (*i.e.*, eco-regions), human community (*i.e.*, coastal community composition), administrative (*i.e.*, historical resource management areas) and international considerations (*i.e.*, transboundary issues). This workshop considered the science requirements for eco-region identification in the PICES area, and presentations were solicited to: 1) highlight national or regional experiences or frameworks for delineating marine sub-regions or eco-regions; 2) demonstrate the use of a variety of physical and/or biological criteria for region identification; or 3) explain the specific management purposes behind various sub-regional identification schemes. Discussion involved participants in reviewing the existing Large Marine Ecosystem boundaries of the PICES area and in developing recommendations for criteria to be used in sub-regional identification in the North Pacific.

#### Summary of presentations

The workshop had 11 presentations, 2 of which were invited, that focused on the science requirements for eco-region identification in the PICES area. Presentations highlighted national or regional experiences or frameworks in place for delineating marine sub-regions or eco-regions (Jamieson, Lee *et al.*); demonstrated the use of a variety of physical and/or biological criteria for region identification (Fluharty, Harvey *et al.*, Shtrik, Sydeman *et al.*); and/or explained the specific management purposes behind various existing sub-regional identification schemes (Kishida, Livingston and Piatt, Seki and Makaiiau). Invited speakers discussed: 1) a hierarchical classification scheme that has been successfully applied across multiple scales and in many system types and whose output is becoming an accepted component of management support packages – both as maps for use in defining coherent management areas, but also as part of ecosystem-level modeling tools (Fulton), and 2) issues associated with reconciling overlapping biogeochemical and fisheries-based ecosystem typologies, and the mesh of fisheries management and reporting areas which may, or may not, in turn be related

to marine ecosystem typologies (Perry). The workshop concluded with a plenary discussion

of issues raised from the presentations with respect to criteria for ecoregion determination.

#### List of papers

##### *Oral presentations*

**Elizabeth Fulton, Vincent Lyne and Donna Hayes** (Invited)  
Bioregionalisation and ecosystem-based management in Australia

**Glen S. Jamieson**  
Canada's ecoregion determination approach

**Jae Bong Lee, Chang Ik Zhang, Dong Woo Lee, Jong Hwa Park and Jong Hee Lee**  
Marine sub-regions determined with physical and biological criteria in Korean waters

**Chris J. Harvey, Isaac C. Kaplan and Phillip S. Levin**  
Selecting model domains and boundaries in ecosystem modeling of the U.S. West Coast: Process determines scale

**David L. Fluharty**  
Aligning institutions with ecosystems for marine science

**Patricia A. Livingston and John F. Piatt**  
Progress in U.S. ecoregion definitions for ocean ecosystems and an Alaskan example

**R. Ian Perry** (Invited)  
Ecosystem typologies in the North Pacific – A useful concept for ecosystem-based management?

**Michael P. Seki and Jarad Makaiau**  
Archipelagic fishery ecosystem plans for the U.S. central and western Pacific islands

**William J. Sydeman, Sonia D. Batten, Michael Henry, Chris Rintoul, David W. Welch, Ken H. Morgan and K. David Hyrenbach**  
Meso-marine ecosystems of the North Pacific: Application to ecosystem-based management

**Vadim A. Shtrik**  
Use of the classification and structure of coastal zone macro-vegetation for global and local eco-regional identification of coastal areas in the North Pacific

**Tatsu Kishida**  
Physical and biological criteria for region identification around Japan

#### **MEQ Workshop (W4)**

##### **Review of selected harmful algae in the PICES region: II. *Dinophysis* and *Cochlodinium***

Co-convenors: Charles Trick (Canada) and Yasunori Watanabe (Japan)

#### Background

This workshop was the second of an annual series of workshops on Harmful Algal Bloom (HAB) species that affect all or most countries in the North Pacific. In 2006, the focus was on two genera, *Dinophysis* and *Cochlodinium*. *Dinophysis*, including DSP (Diarrhetic Shellfish Poisoning) producing species such as *D. acuminata*, *D. acuta*, *D. caudata* and *D. fortii*, is distributed in the PICES region. The integration of the information from each country advanced our understanding of these genera. *Cochlodinium polykrikoides* causes serious damage to finfish aquaculture in Korea and

Japan, and it has potential to spread to other countries. Topics included detection methods, ecosystem comparisons, and new advancements in physiology and ecology from each of the member countries. Emphasis was on factors which need additional study in order to develop a predictive capacity for these HABs. The workshop was preceded by a half-day laboratory demonstration on detection techniques for algal toxins.

#### Laboratory demonstration

The laboratory demonstration was organized by Drs. Yasunori Watanabe and Ichiro Imai and

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held on October 13, 2006, at the National Research Institute of Fisheries Science (FRIFS) of the Fisheries Research Agency. In total, 28 scientists from 7 nations (Canada-3, China-6, France-1, Japan-10, Russia-2, Spain-2, U.S.-4) were in attendance. Two demonstrations were carried out. The first demonstration on “Protein Phosphate 2A (PP2A) inhibition assay for okadaic acid and its analogs in shellfish” was conducted by Dr. Reiji Sekiguchi, Ms. Natsuki Takahashi and Dr. Toshiyuki Suzuki. They introduced a new toxin determination kit, based on the principle that okadaic acid and its analogs (OAs) strongly and specifically bind to PP2A and inhibit its dephosphorylation activity. If OAs is absent, PP2A hydrolyze a colorless substrate pNPP and produce a yellow product. But in the presence of OAs, the substrate remains colorless. Therefore, OA concentration is determined by measuring the intensity of yellow color. This newly developed determination kit is expected to be used for on-site monitoring of OAs in shellfish.

The second demonstration on “Simple, rapid, specific and cost-effective method for identifying *Alexandrium tamarense* and *A. catenella* using the LAMP method” was conducted by Drs. Shigeru Itakura and Satoshi Nagai. LAMP, which stands for Loop-mediated Isothermal **A**mplification, is a simple, rapid, specific and cost-effective nucleic acid amplification method developed by the Eiken Chemical Co., Ltd in Japan. The advantages of LAMP are:

- There is no need to denature DNA from a double- to single-stranded form;
- The whole amplification reaction takes place continuously under isothermal conditions (~65°C);
- The amplification efficiency is extremely high, with DNA being amplified  $10^9$ - $10^{10}$  times in 15-60 minutes;
- By designing 4 primers to recognize 6 distinct regions, the LAMP method is able to specifically amplify the target gene;
- The total cost can be reduced as LAMP does not require special reagents or sophisticated equipment such as a thermal cycler and other basic apparatus needed for molecular biological experiments; and

- The amplification can be checked by eye through the presence of amplified product (the turbidity of magnesium pyrophosphate, a by-product of the amplification reaction).

Drs. Itakura and Nagai, along with Dr. Yukihiko Matsuyama have developed LAMP primers to detect *A. tamarense* and *A. catenella*, and it is possible to identify each species from a single cell within 1 hour (starting from isolation of the cell to the detection of the amplification). This method can be performed using standard equipment needed in other molecular biological experiments.

### Summary of presentations

The workshop was held on October 14, 2006, and attended by 22 scientists from 9 nations (Canada-2, China-1, France-1, Japan-8, Korea-1, Norway-1, Russia-1, Spain-2, and U.S.-5). The ecology, physiology, taxonomy and toxicity of two very important harmful algal species, *Cochlodinium* and *Dinophysis* spp., were discussed and compared. Ideas regarding these common themes were summarized in the three invited talks provided by Kazumi Matsuoka, Patrick Gentien and Beatriz Reguera. The invited presentations were very clear and complete and resulted in considerable discussion among the participants. As PICES had hoped, much of the discussion focused on two major themes: (1) Why does the distribution and toxicity of these two genera reside in the PICES countries of the Western Pacific, yet are not (as yet) detrimental to the PICES countries of the PICES countries in the eastern North Pacific? and (2) What are the environmental situations that enhance or stimulate toxin production?

The invited lectures were complemented by a series of presentations concerning these genera in the individual PICES countries. Vera Trainer and Charles Trick reviewed the low level of these two genera in waters adjacent to the North American coast. These were in stark contrast to the deep and profound negative impact of these genera in Korea (Hak Gyoon Kim), Japan (Kazutaka Miyahara and Ichiro Imai) and China (Jinhui Wang). More specific methodologies were also presented. Toshiyuki Suzuki



described modern methods of analyzing lipophilic toxins, and Takafumi Yoshida documented the activities of CERAC (NOWPAP) on developing a regional HAB database. The details of each topic were

summarized in an “enthusiastic” hour-long discussion aimed at establishing a list of “what is known”, “what is unknown” and “what sort of information is required next”.

### List of papers

#### *Oral presentations*

**Reiji Sekiguchi, Natsuki Takahashi, Toshiyuki Suzuki**

Protein phosphatase 2A inhibition assay for okadaic acid and its analogs in shellfish

**Satoshi Nagai, Yukihiro Matsuyama and Shigeru Itakura**

Simple, rapid, specific and cost effective method for identifying *Alexandrium tamarense* and *A. catenella* using “LAMP” method

**Kazumi Matsuoka** (Invited)

Recent progress of the study on a harmful dinoflagellate - *Cochlodinium polykrikoides*

**Hak-Gyoon Kim, Chang-Kyu Lee, Kyong-Ho An, Wol-Ae Lim, Sook-Yang Kim and Young-Tae Park**

The known and unknown on the initiation of *Cochlodinium polykrikoides* blooms in Korean waters

**Kazutaka Mivahara, Ryosuke Uji and Mineo Yamaguchi**

Harmful blooms of *Cochlodinium polykrikoides* in the southwestern Sea of Japan (San-in coastal waters)

**Changkyu Lee, Youngtae Park, Kyeongho An and Yoon Lee**

Impact of yellow clay on respiration and phytoplankton uptake of benthic shellfish

**Takafumi Yoshida and Takashi Ogawa**

Activity of CEARAC about Harmful Algal Blooms in the NOWPAP region

**Tatiana Yu. Orlova, Marina S. Selina and Galina V. Konovalova**

Species of the genera *Cochlodinium* and *Dinophysis* from the east coast of Russia

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

*Cochlodinium* and *Dinophysis* in western U.S. and Canada

**Patrick Gentien** (Invited)

The rare marine protist *Dinophysis acuminata*

**Beatriz Reguera, L. Escalera, S. Gonzalez-Gil, G. Pizarro, L. Velo and J.M. Franco** (Invited)

What we know and what we do not know about *Dinophysis*

**Ichiro Imai and Goh Nishitani**

Are *Dinophysis* spp. always responsible for DSP toxicity of bivalves?

**Toshiyuki Suzuki, Akira Miyazono, Yutaka Okumura and Takashi Kamiyama**

LC-MS/MS analysis of lipophilic toxins in Japanese *Dinophysis* species

**Jinhui Wang, Yutao Qin, Caicai Liu, Xiangshen Chen and Ren Xu**

*Dinophysis* spp.: The abundance, distribution and the toxicity of DSP in the East China Sea

**Vera Trainer and Hak-Gyoon Kim**

Welcome, goals of HAB Section meeting

**Hao Guo**

The Monitoring System on HABs in China

**Vera L. Trainer, Barbara M. Hickey and Michael G. Foreman**

A regional U.S. west coast observing system for toxigenic *Pseudo-nitzschia*

**Henrik Oksfeldt Enevoldsen and Monica Lion**

Progress in the development of an international collaborative harmful algal event data base: The joint IOC-ICES-PICES HAE-DAT

**Yasunori Watanabe**

Country Reports/HAE-DAT (year 2002) reports: Japan

**Jinhui Wang**

Country Reports/HAE-DAT (year 2002) reports: China

**Hak-Gyoon Kim**

Country Reports/HAE-DAT (year 2002) reports: Korea

**Tatyana Yu. Orlova**

Country Reports/HAE-DAT (year 2002) reports: Russia

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### **Charles G. Trick**

Country Reports/HAE-DAT (year 2002) reports: Canada

### **Vera L. Trainer**

Country Reports/HAE-DAT (year 2002) reports: U.S.A.

## **POC Workshop (W5)**

### ***Evaluation of climate change projections***

Convenors: Michael G. Foreman (Canada) and Yasuhiro Yamanaka (Japan)

#### Background

The most recent set of global climate model projections has been submitted to, and is being analyzed by, the Intergovernmental Panel on Climate Change (IPCC) for the publication of their Fourth Assessment Report in 2007. PICES Working Group 20 was created to evaluate these projections for the North Pacific and its marginal seas, and to compute products such as ensemble averages, that would assist PICES groups like the Climate Forcing and Marine Ecosystem Response Task Team (CFAME), in their analysis of climate effects on marine ecosystems, and ecosystem feedbacks to climate. In this workshop, presentations and discussions focused on ongoing research that addresses the terms of reference of the Working Group, and on strategies for future work that are needed to fill the gaps. Presentations related to the direct analysis of global climate projections and the calculation of ensemble averages; results from higher-resolution regional ocean and coupled atmosphere-ocean models that are forced by, and take their boundary conditions from the IPCC models; and the development of local and regional data sets (*e.g.*, SST, river flow, sea ice cover) based on either model projections or historical observations were solicited. The development of work/action plans, liaisons with other PICES groups and outside organizations (*e.g.*, CLIVAR), and future activities were discussed.

#### Summary of presentations

This workshop consisted of 3 invited talks, 11 oral presentations, and a brief business meeting that discussed future activities of the Working Group 20. In a brief introduction, Michael

Foreman welcomed all participants, outlined the agenda for the day, and reviewed the Terms of Reference of WG 20. Yoshiro Yamanaka then introduced all speakers for the morning part of the session.

The first invited speaker, Curtis Covey, briefly described his experience in managing and using the archive of climate model output created by the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory for the IPCC Fourth Assessment Report (AR4). He summarized the IPCC objectives, including the release of their upcoming report and plans for adding biogeochemistry to the next generation of climate models, and gave two interesting examples of analyses arising from the model output. The next speaker, Hiroyasu Hasumi, presented an overview of results from two CCSR/NIES/FRCGC (Japan) climate models, one of which has the highest spatial resolution of all the IPCC models. His presentation focused on analyses aimed at understanding the different results that arise from this finer resolution. His ongoing comparison among high and medium resolution ocean general circulation models (OGCMs) with the same atmospheric forcing will provide useful information for constructing regional high resolution models forced by one, or an ensemble, of IPCC global climate model scenario runs. Muyin Wang next presented results from an analysis of IPCC models showing that a basin wide warming signal under the IPCC SRES A1B scenario is predicted to surpass the Pacific Decadal Oscillation as the leading mode of variability in the North Pacific in the next forty years. The spatial pattern of the model-projected temperature trends is more uniform than the east-west dipole pattern of the

PDO. Michael Foreman briefly summarized the major results of 11 recently published papers, each of which presented direct or derived results from individual or ensembles of climate models for the North Pacific. The results covered changes in oceanic properties ranging from sea surface temperature and salinity to the Rossby radius of deformation and shoaling of the depth at which calcifying organisms dissolve. However, there was not always consensus among the models. The final speaker before the morning coffee break, Rong-Shuo Cai, described observed climate changes in the East and South China seas over the last 50 years. These included a weakening of the summer and winter winds, increases in the sea surface temperature, and more frequent occurrences of red tides.

The morning session after coffee began with a second invited speaker, Michio Kawamiya, describing the positive feedback that arises when carbon cycle interactions are included in climate change models, and the inter-comparison project, Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP), that seeks to understand the differing results among various models that incorporate this cycle. Another invited speaker, Keith Rodgers, followed with description of his modelling study of variability in equatorial Pacific biogeochemistry and ecosystems, for which a major result was a decoupling of the pycnocline and nutricline. He pointed out a difference in simulated iron supply associated with equatorial upwelling between two re-analyse data sets: National Centers for Environmental Prediction (NCEP) and European

Centre for Medium-range Weather Forecasts (ECWMF), especially after the 1970s. Sang-Wook Yeh next described differences in observed sea surface temperatures warming trends in the North and Equatorial Pacific over epochs extending from the early 1900s to the present. The final speaker of the morning, Zhenya Song, demonstrated the importance of including the mixing from surface waves in global model simulations by comparing climatological observations with model results.

The first speaker in the afternoon, Elena Ustinova, described spectral analyses of, and correlations between, time series of sea ice extent and air and water temperature in the Okhotsk and eastern Bering Seas. William Crawford followed with an analysis of 50 years of salinity and temperature observations along Line-P. His main result was that many changes are strongly related to changes in the predominant wind direction. Hee-Dong Jeong carried out a similar analysis of 37 years of temperature observations around the Korean Peninsula, finding different trends in three sub-regions and in different depth ranges. Masao Ichii then described analyses of observations of total inorganic carbon and dissolved oxygen along the 165°E transect between 28°N and 50°N. His results suggested that changes were more likely due to variability in the circulation or biogeochemistry rather than the uptake of CO<sub>2</sub>. The final speaker, Dong-Young Lee, described the problems associated with estimating design wave heights in light of climate change.

### List of papers

#### *Oral presentations*

**Curtis Covey** (Invited)

Managing, using and expanding the IPCC database of climate model output

**Hiroyasu Hasumi and Takashi T. Sakamoto**

Overview of the present state and future projection of North Pacific climate simulated by CCSR/NIES/FRCGC global coupled models

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

What will the North Pacific look like in the next 40 years?

**Michael G. Foreman**

Highlights from recent publications describing climate projections for the North Pacific

**Rong-Shuo Cai, Ji-Long Chen and Rong-Hui Huang**

The response of marine environment in the offshore area of China and its adjacent ocean to recent global climate change

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**Michio Kawamiya, Chisato Yoshikawa, Tomomichi Kato and Taroh Matsuno** (Invited)

Significance of ocean's response to climate warming in the global carbon cycle

**Keith B. Rodgers, Christophe Menkes, Thomas Gorgues, Laurent Bopp and Olivier Aumont** (Invited)

A modeling study of interannual to decadal variability in Equatorial Pacific biogeochemistry and ecosystems

**Sang-Wook Yeh, Cheol-Ho Kim, Young-Gyu Park and HongSik Min**

Characteristics of Pacific sea surface temperature variability associated with global warming during the 20th century

**Zhenya Song and Fangli Qiao**

The establishment of the atmosphere-surface wave-ocean circulation coupled numerical model and its applications

**Elena I. Ustinova**

Evaluation of climatic variability in the Far-Eastern Seas using regional data sets

**William Crawford, Jake Galbraith and Nick Bolingbroke**

Temperature and salinity along Line-P: Fifty years of observations

**Hee-Dong Jeong, In-Seong Han, Ig-Chan Pang, Ki-Tack Seong, Woo-Jin Go, Sang-Woo Kim, Won-Deuk Yoon, Yong-Kyu Choi and Jun-Yong Yang**

Seasonal long-term variation of temperature in Korean waters

**Masao Ishii, Takayuki Tokieda, Shu Saito, Takashi Midorikawa, Shinji Masuda and Akira Nakadate**

Decadal trend of dissolved oxygen in the North Pacific along 165°E – A preview

**Dong-Young Lee and K.C. Jun**

Estimation of design wave height through long-term simulation of sea states for the North East Asia regional seas

### MONITOR/TCODE Workshop (W6)

#### *Data management, delivery and visualization of high-volume data products*

Convenors: David L. Mackas (Canada), Sei-Ichi Saitoh (Japan) and Thomas C. Royer (U.S.A.)

#### Background

Long-term monitoring of multidisciplinary data in boundary currents is a high priority for PICES nations. Boundary currents are locations where many monitoring activities now take place. These regions are very important economically, and are highly variable in both space and time. Dense, near real-time data from many disciplines are vital to describe the systems for timely management of coastal resources. Rapid analysis of the data is also essential. However, increased data rates and their diversity provide challenges for both data managers and data users. Cabled arrays, satellite altimeters, ocean color and scatterometer (wind) measurements are examples of these new dense data sets. This workshop discussed the availability of such data and how they can be used effectively, focusing especially on availability, uses, GIS applications and other methods of display and analysis tools.

#### Summary of presentations and discussions

Oral presentations at this workshop included 14 papers, plus summaries of 6 posters and e-

posters. Two additional posters were presented at the Thursday evening Poster Session. Topics were wide and overlapping, including:

- issues and promising new tools for data management and “data serving” (9 talks);
- goals and products of continental margin (9) and offshore (2) monitoring programs; and
- approaches to reaching and serving non-scientist “clients” (7).

An invited speaker, Lynn DeWitt, noted that ocean science programs have traditionally provided more-or-less adequate funds and intellectual effort for data collection and in-house analysis, and are beginning to budget for web-based display of the analysis results (a form of advertisement of “what was done”). But there is still too little being allocated to make source data accessible to future users. Provision for “data transport” to users and into alternative formats is a key step. Many commercial and open-source software tools are now becoming available to make this step easier.

Other speakers covered a broad range of input and output data products, from conventional (but

greatly improved) temperature and salinity maps, to pin-pointing of economic opportunities (*e.g.*, predicted distributions of fish) and hazards (*e.g.*, predicted distributions of algal toxins or hypoxia).

After the presentations, attendees (~40) discussed future directions in terms of both accomplishments/opportunities (good news) and impediments/obstacles (bad news). A brief (and somewhat subjective) summary follows:

#### *High points*

- Lots of progress toward inter-operable formats and software for data access and visualization;
- Improving profile of and tools for “data transport”;
- Wide range of new sensors and platforms (especially for biology and chemistry) but many are considered prototypes under development;
- Strong commitment by PICES nations to “ocean monitoring”, especially of the ocean margins, creates opportunities to integrate observations across jurisdictional borders. (Can we come up with a basin-scale array for climate/ocean/ecosystem interactions in the North Pacific?)
- Consistent global physical context provided by ARGO and WMO;
- More “data owners” are becoming willing to contribute, and more clients want to use data [raw] or data products [processed toward “information”];
- Growing list of socio-economic applications: HAB, hypoxia, *etc.*;
- Could produce tools for “conservation” as well as for “exploitation” and “adaptation”;
- Still need progress toward ways to integrate across data and meta-data types.

#### List of papers

##### *Oral presentations*

**Lynn M. DeWitt** (Invited)

Simplifying data integration and interoperability through standardized data access and transport protocols

**Takashi Yoshida**

NEAR-GOOS and Japanese operational oceanographic observations

##### *Issues and obstacles*

- Dissimilarity of clients & variables/sampling designs among “regional” Ocean Observing System modules (as yet, no set of standard ingredients). This disparity is in part driven by region-to-region differences in client profiles;
- Possibly large changes over time of remote sensing and *in situ* observation and archival systems (removals, not just additions);
- Data archives serve multiple functions: complete and safe archival, quality assessment and control, and accessibility/transparency. These are all important but can be in competition when resources are scarce;
- Parallel developments of “toolkits” (OBIS, GLOBUS). Are they interoperable?
- Long term preservation of information is a concern. (*e.g.*, media obsolescence). Can we avoid “obsolete” or “unsupported orphan” archives? An obsolescence issue for interpreted results (*e.g.*, the disappearance of print journals);
- Some archives have “mandatory formats”, others offer “translation services”. Too many and too strict mandatory formats may discourage participation;
- As real-time information becomes more available and useful, they also become more valuable and “sensitive”. Will economic (individual or collective), political, or security interests begin to block data sharing?
- Increased dependence on high-bandwidth exchanges. Is this risky, given that some clients continue to use low-bandwidth connections?

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**Gongke Tan, D.Y. Lee, X. Hu and M. Li**

Design and operation of offshore observing platform in the Yellow Sea

**Molly McCammon, G. Carl Schoch and Mark Johnson**

AOOS: Implementing an Ocean Observing System in Alaska

**John A. Barth, Jan A. Newton and NANOOS Colleagues**

Northwest Association of Networked Ocean Observing Systems (NANOOS)

**M. Elizabeth Clarke, Bob Gref, Frank Schwing, Chris Goldfinger, Chris Romsos and Jonathan T. Phinney**

A pilot data system for the Pacific Coast Ocean Observing System (PaCOOS)

**Vera L. Trainer, Barbara M. Hickey and Michael G. Foreman**

A regional U.S. west coast observing system for toxigenic *Pseudo-nitzschia*

**Nobuyuki Shikama**

Japanese Argo Program

**S. Allen Macklin, Bernard A. Megrey, Kimberly Bahl and Toru Suzuki**

A federation of PICES member country metadatabases

**Clarence Pautzke and Molly McCammon**

The Alaska Marine Information System – A collective database for Alaska's large marine ecosystems

**Takashi Setou, Kosei Komatsu and Yasumasa Miyazawa**

Modification of the OI parameters for effective introduction *in situ* data obtained by Japanese local fisheries research institutions into the JCOPE Ocean forecast system

**Katsuya Saitoh, Hitoshi Iizumi, Osamu Kato, Tatsuro Watanabe, Kosei Komatsu, Shi-ichi Ito, Kaoru Nakata and Kouji Aoyagi**

Giant jellyfish monitoring system in Japan

**Sei-Ichi Saitoh, Fumihiko Takahashi, Daichi Tachikawa, Motoki Hiraki, Masami Yoshida, Teruaki Hiura and Hidetada Kiyofuji**

Research and development of ubiquitous information services for sustainable fisheries operation and management in the offshore around Japan

**Young Jae Ro and Kwang Young Jung**

Real-time monitoring experiences in the coastal waters in Korea: Implementation and scientific application

### Posters

**Stepan G. Antushev, Vitaly K. Fischenko and Andrey V. Golik**

Implementation of distributed oceanographic data management and data processing technologies in FEBRAS

**Hernan E. Garcia, Tim P. Boyer, Sydney Levitus, Ricardo A. Locarnini, John I. Antonov, Daphne Johnson, Igor Smolyar, Olga Baranova and Alexey Mishonov**

The World Ocean Database and Atlas 2005

**Andrey V. Golik, Stepan G. Antushev and Vitaly K. Fischenko**

About scope of OpenGIS technology in oceanographic data management and visualization

**Alex Kozvr and Misha Krassovski**

Web-Accessible Visualization and Extraction System (WAVES) for oceanographic data

**Dmitry D. Kaplunenko, Vyacheslav B. Lobanov, Olga O. Trusenkova and Svetlana Y. Ladychenko**

Web-based system to study mesoscale water dynamics and structure by merging satellite and *in situ* data

**Jee-Eun Min, Joo-Hyung Ryu, Yu-Hwan Ahn and Kyu-Sung Lee**

Optical properties of marine particles around the Southwest Sea of the Korean peninsula

**A. Gavrev, A. Pan, V. Plotnikov, V. Rostov and I. Rostov**

Web-based sea ice data bases application

**Joon-Yong Yang, Hee-dong Jeong, Kyu Kui Jung and Ki-Tack Seong**

Real-time oceanographic information for pelagic fishery based on Argo data

**CCCC Workshop (W7)**  
***Climate forcing and marine ecosystems***

Convenors: Kerim Y. Aydin (U.S.A.), Jacquelynne R. King (Canada) and Akihiko Yatsu (Japan)

Background

The CFAME (Climate Forcing and Marine Ecosystems) Task Team is developing new theoretical and mathematical frameworks to extend the traditional single species concept of carrying capacity into the multi-species and ecosystem domains. Three major ecosystems of the North Pacific were selected for this approach: Sea of Okhotsk, California Current System and East China/Yellow Sea. For each ecosystem the Task Team is reviewing the physical processes that define an ecosystem, build an overview of dominant species across trophic levels, and describe how the population dynamics of these species have changed over time. The conceptual linkages between the physical processes and food-web structures will allow a comparison of varying responses of the different North Pacific marine ecosystems to basin-wide climate forcing events. This workshop was a continuation of work that was initiated at a CFAME workshop in January 2006 (Tokyo, Japan). It focused on key species data for the East China/Yellow Sea and Sea of Okhotsk regions to facilitate inter-comparisons among the three target ecosystems.

Summary of presentations

The workshop was attended by 21 participants, from all PICES member countries, and included presentations from China, Korea, Russia and the United States. This workshop represents the first stage of the ecosystem research outlined in the CFAME workplan. For each ecosystem, conceptual mechanisms of climate-forcing were identified. Participants noted that each ecosystem had different dominant features of climate forcing mechanisms: boundary current upwelling (California Current); sea ice (Sea of Okhotsk) and freshwater input (East China/Yellow Seas). The afternoon focused on methods of classifying and comparing ecosystems. Overall, the method employed will depend on the researchers involved and the level of data available for the ecosystems of interest. However, participants agreed on the general themes captured by various ecosystem indicators and methods of comparison: food web structure, life history composition, structural stability, size composition, and change in rates (*e.g.*, PB vs. B, PB diversity pathways; predation load). It was suggested that such a list of specific comparison types could be made, and data obtained to make these comparisons from each ecosystems, giving a strong basis for an inter-sessional meeting in 2007 on ecosystem-level carrying capacity and other ecosystem properties

List of papers

*Oral presentations*

**Vera Agostini, G.A. McFarlane and J.R. King** (Invited)  
 An overview of the California Current ecosystem

**Victor Lapko** (Invited)  
 An overview of the Okhotsk Sea ecosystem

**Young Shil Kang, Seung Heo, Jae-Kyoung Shon and Gyung Soo Park** (Invited)  
 Variations of zooplankton and oceanographic conditions in response to climatic changes in the East China/Yellow Sea

**Xiuren Ning, Chuanlan Lin, Jilan Su, Chenggang Liu and Junxian Shi**  
 Environmental changes and the responses of the ecosystems in the Bohai Sea during 1960-1996

**Sarah K. Gaichas, Kerim Y. Aydin and Vera N. Agostini**  
 Quantitative methods for comparative ecosystem analysis: Relationships and thresholds in the Gulf of Alaska and the California Current

**BIO/POC Workshop (W8)**

***Responses of marine mammals and seabirds to large-scale and long-term climate change: Mechanisms of environmental forcing***

Conveners: Yutaka Watanuki, Shoshiro Minobe (Japan), Rolf Ream and William J. Sydeman (U.S.A.)

Background

Low-frequency climate changes sometimes result in profound effects on marine ecosystems, yet the influence on seabirds and mammals has not been adequately quantified. In the North Atlantic, the breeding performance and population dynamics of some species has been related to changes in the NAO. The workshop solicited papers that examine responses by these taxa to interannual to interdecadal climate variability in the North Pacific. A variety of studies describing patterns and testing mechanisms of environmental forcing, from physics to prey to predators, were presented.

Summary of presentations

Approximately 25 people attended the workshop. Using an elaborate modeling approach based on NEMURO.FISH, Shin-ichi Ito showed how growth of fishes (herring and saury) varies between regions of the North Pacific relative to ocean climate, suggesting that different physical and biological limiting factors are dominant in the eastern and western Pacific. Regional differences in primary production (Sei-ichi Saitoh) and responses of marine birds (Sarah Wanless, Julie Thyer, Shoshiro Minobe and Motohiro Ito) and mammals (Arthur Miller, Keiko Kato, Andrew Trites, Shiroh Yonezaki and Hyun Woo Kim) to variation in temperature and regime shifts were described. The potential mechanisms of responses (changes in foodwebs, diets, nutritional condition of prey, *etc.*) were discussed. Spatial correlation analyses between SST and breeding performance of marine birds and mammals (suggested by Shoshiro Minobe), rather than using a specific climate index (e.g.,

PDO), may be useful for providing mechanistic understanding.

During general discussion, the following points were elaborated:

- Collaboration between climatologists, oceanographers, and marine bird and mammal (MBM) experts is essential to developing the science of climate change and climate effects on seabirds and marine mammals;
- Whereas MBM specialists may offer local mechanistic hypotheses, climate scientists and oceanographers often provide a larger-scale physical context, and coupling these scales of analysis is likely to be critical to understanding the effects of climate on these top predators;
- Marine birds and mammals should be considered in developing PICES ecosystem models, including NEMURO. MBM-AP can provide parameters of interest;
- Correlations between climate indices and the food habits, breeding success and population parameters of marine birds and mammals are, in some cases, well known, but understanding of the mechanisms driving correlative relationship is lacking;
- Spatial and temporal scales, and species-specific life history differences, should be considered in analyzing the relationships between climate factors and responses of marine birds and mammals;
- Due to their visibility, and rapid and substantial responses, marine birds and mammals may be good indicators of marine ecosystem change, but to use them fully, calibration of climate-predator responses is needed.



List of papers

*Oral presentations*

**Shin-ichi Ito, Kenneth A. Rose, Bernard A. Megrey, Francisco Werner, Douglas Hay, Maki Noguchi Aita, Yasuhiro Yamanaka, Michio J. Kishi, Jake Schweigert, Matthew Birch Foster, Dan Ware, David Eslinger, Robert Klumb and S. Lan Smith** (Invited)

Responses of fish growth to large-scale and long-term climate change: A comparison of herring and saury in the North Pacific using NEMURO.FISH, a coupled fish bioenergetics and lower trophic level ecosystem model

**Sei-Ichi Saitoh, Takahiro Iida, Suguru Okamoto, TaeKeun Rho and Toru Hirawake** (Invited)

Temporal and spatial variability of primary production in the sub-arctic North Pacific using satellite multi-sensor remote sensing

**Arthur J. Miller** (Invited)

The climate-ocean regime shift hypothesis of the Steller sea lion decline in Alaska

**Andrew W. Trites, Pamela M. Lestenkof and Erin Ashe**

Responses of northern fur seals to large-scale and long-term climate change

**Julie A. Thaver, Scott A. Hatch, Mark Hipfner, Leslie Slater, Yutaka Watanuki and William J. Sydeman** (Invited)

Forage fish prey of a piscivorous seabird in the North Pacific: Synchrony and relationships with ocean climate

**Shoshrio Minobe, William J. Sydeman, Yutaka Watanuki and Vernon Byrd**

Climate influences on seabirds in the Japan and Bering Seas and California Current

**Sarah Wanless and Morten Frederiksen** (Invited)

Climate responses of avian predators in a heavily exploited shallow sea ecosystem: Effects on trophic interactions and consequences for ecosystem control in the North Sea

**Hyun Woo Kim, David W. Weller, Amanda L. Bradford and Zang Geun Kim**

Body condition of western gray whales in relation to environmental change in the North Pacific

*Posters*

**Keiko Kato, Takeomi Isono, Kaoru Hattori, Orio Yamamura and Yasunori Sakurai**

Winter movement of Steller sea lions (*Eumetopias jubatus*) to the northern coast of Japan related to sea-ice conditions in the Sea of Okhotsk during 1989-2004

**Motohiro Ito, Hiroshi Minami and Yutaka Watanuki**

Quick prey switching in a seabird: Seasonal changes of diet for adults and chicks of Rhinoceros Auklets

**Shiroh Yonezaki, Masashi Kiyota, Hiroshi Okamura and Norihisa Baba**

Possibility of diet selection of northern fur seals in the Northwestern Pacific

**MIE-AP Workshop (W9)**

***Micronekton sampling gear inter-calibration experiment***

Convenors: Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan)

Background

The PICES Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) was established to evaluate efficacy of sampling gears and the procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world's oceans. MIE-AP carried out their first 8-day cruise from October 6-13, 2004, aboard the NOAA ship *Oscar Elton Sette* in Central North Pacific waters off the west side of Oahu Island (MIE-1). The second cruise (MIE-2) took place from September 27 to October 3, 2005, on board

R/V *Hokko Maru* in Oyashio waters off Japan. The workshop reviewed data and findings from both cruises.

Summary of presentations

Pakhomov *et al.* recommended pursuing the use of larger size-classes of micronekton (10 mm instead of 5 mm) for inter-comparison of gears. They noted that the Cobb trawl mouth area should be adjusted according to the mesh size, which really catches micronekton. The use of total mouth area can result in underestimating plankton and micronekton densities. It was

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suggested that perhaps acoustic data should be encouraged to become an “ideal” universal gear.

Suntsov *et al.* provided a remarkable overview of ichthyoplankton and an inter-comparison of their diversity between different gears. It also appears from their research that the Hokkaido net was the best gear for the quantitative and qualitative sampling of fish larvae. Two important questions were raised in this presentation: (a) What kind of analysis (*e.g.* community structure analysis) could be conducted with the data sets? and (b) Would further analysis of the adult population be beneficial for the community analysis of larvae?

Yamamura *et al.* compared six different sampling gears during their MIE-2 cruise. Sample composition, to a large extent, was mono-specific, which simplified the inter-calibration. Their experiment revealed that the

MOHT gear is among the most reliable and cost-effective micronekton gear developed to date, providing high quality and quantity micronekton samples. The development (in progress) of a closing/opening mechanism could put this gear in the position to become a standard micronekton gear in the North Pacific and elsewhere in the world. It was also found that towing speed matters, *e.g.* MOHT had the fastest towing speed, which raises standardization issues.

Yasuma *et al.* presented very encouraging results of developing a technique for an acoustic identification of myctophid fishes. The inter-comparison between acoustic and gear estimates of micronekton was highly recommended as the next step. Concern was raised on how organism orientation affects the target strength estimates. Authors were strongly encouraged to continue their analyses.

### List of papers

#### *Oral presentations*

**Evgeny A. Pakhomov, M.P. Seki, A.V. Suntsov, R.D. Brodeur and K.R. Owen**

Comparison of three sampling gears during the first Micronekton Intercalibration Experiment (MIE-1): Size composition of selected taxonomic groups and total macroplankton and micronekton

**Andrey V. Suntsov, Michael P. Seki, Evgeny A. Pakhomov and Richard D. Brodeur**

Diversity and abundance of Hawaiian ichthyoplankton: Comparison of three types of midwater nets

**Orio Yamamura, Hiroya Sugizaki, Shin-suke Abe, Kazuhiro Sadayasu, Ryu-ichi Matsukura, Kazushi Miyashita, Akihiro Hino and Tadashi Tokai**

Inter-calibration of micronekton sampling gear during the 2005 MIE-2 cruise

**Hiroki Yasuma, Kazushi Miyashita and Orio Yamamura**

Acoustic identification and density estimate of a lanternfish, *Diaphus theta*, off Hokkaido, Japan