SUMMARY OF SCIENTIFIC SESSIONS AND WORKSHOPS

Science Board Symposium (S1)

The changing North Pacific: Previous patterns, future projections, and ecosystem impacts

Co-Conveners: Kuh Kim (SB), Michael J. Dagg (BIO), Gordon H. Kruse (FIS), Glen Jamieson (MEQ), Jeffrey J. Napp (MONITOR), Michael G. Foreman (POC), Igor I. Shevchenko (TCODE), Harold P. Batchelder (CCCC), Michio J. Kishi (CCCC) and Fangli Qiao (China)

Background

The PICES Special Publication, "*Marine Ecosystems of the North Pacific*", concluded that "during the past five years profound changes have occurred in the North Pacific climate system, in the composition, abundance and distribution of its living marine resources, and in the human societies that depend on the North Pacific Ocean and its resources". This symposium has built on studies of climate variability and other anthropogenic impacts in the North Pacific and its marginal seas, the latest North Pacific climate projections (whose results have been summarized in the Fourth Assessment Report of the Inter-governmental Panel for Climate Change), future scenarios for direct human forcing by population growth and fishing, and the combined impacts that these changes have already had, and can be expected to have, on North Pacific ecosystems. The symposium addressed issues such as: 1) trends *versus* variability; 2) synergisms between climate and direct human forcing; 3) ecosystem indicators and their applicability in the future; 4) impacts arising from regional changes (*e.g.*, less ice-cover in the Bering Sea and Sea of Okhotsk, aquatic bioinvasions); 5) the effects of terrestrial climate change (*e.g.*, river discharge); 6) how projected global change and anthropogenic impacts may alter sustainability of the North Pacific; and 7) what the key messages should be for policy makers regarding sustainability of the North Pacific. Talks describing links with climate change in the Arctic and the International Polar Year Projects were also welcome.

Summary of presentations

The Science Board Symposium was held on Monday, October 29, 2007 and consisted of 14 oral presentations (including 1 keynote and 6 invited talks) plus 9 posters. It was intended to build on studies of climate variability and other anthropogenic impacts in the North Pacific and its marine seas, including the latest North Pacific climate projections, future scenarios for direct human forcing by population growth and fishing and the combined impacts that these changes have already have or can be expected to have on the North Pacific marine ecosystems. The keynote talk by Kenneth Denman (also recipient of the 2007 Wooster Award) set the stage for the session by introducing the core observations and projections from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Included in his presentation were the key results of many of the talks that followed in this session. Dr. Denman demonstrated the connectedness of the many components in a marine ecosystem and he urged the audience to consider them as a system, not as isolated components. He also compared the time course of global change to that of evolution and asked if organisms would be able to adapt given the magnitude of change expected during the next 100 years.

The remaining talks were very diverse in their approach and focus, and reflected the breadth of PICES interest and national representation. Richard Feely focused on how absorption of atmospheric CO_2 by the oceans has begun to change the chemical buffering of the oceans, how rapidly some of these changes have occurred, and what changes in ocean chemistry may be expected in the future. He speculated on how fundamental changes to the pH and carbonate systems may change the structure and function of a variety of marine ecosystems from

deep water corals to coastal food webs. He also emphasized that while the chemical equations governing the state of the oceans were well known, the subtle effects on the biological systems will be difficult to predict. Issues such as how genetics, physiology of individual species, community responses and biological feedbacks will respond to acidification are uncertain. Greg Flato provided background information necessary to understand the evolution of the IPCC reports and gave a summary of results from the Fourth Assessment Report, which included the many different leading indicators used by the panel. One observation to note is that the disappearance of sea ice from the Arctic is occurring more rapidly than predicted by the suite of IPCC global models. William Merryfield focused on how changing climate has altered the structure of the upper water column through changes to the mixed layer depth. Mixed layer depth is a fundamental property of the upper oceans, and it affects processes such as exchange of heat and gas with the atmosphere and nutrient replenishment for biological production. Observed decreases in the mixed layer depth at Ocean Station Papa are comparable to the change predicted by the ensemble of models used by the previous speakers. The models projected about a 20% decrease in the mixed layer volume that will be available to interact with the atmosphere between 1990 and 2090. This may act as a negative feedback, slowing the rate at which oceans absorb new CO_2, resulting in a faster rate of increase of atmospheric carbon dioxide. Muyin Wang used the IPCC - A1B scenario to predict the future climate of the North Pacific Ocean. They focused on several leading indicators or processes: sea ice, upwelling, PDO–Aleutian Low and uncertainty. In their projections the Aleutian Low will deepen and move slightly northward between 2050 and 2100 altering the storm tracks across the North Pacific Ocean and the patterns of precipitation across North America. Yasunori Sakurai took a different approach. He began with the life history of a single, commercially important species (Japanese common squid, *Todarodes pacificus*) and speculated on how hypothesized changes in the temperature and currents around Japan would affect the survival and recruitment of this important species. Included in his presentation was a new method to predict recruitment and catch of squid one year prior to recruitment. Steven Murawski explained how the major fisheries agency in the United States was proposing to use integrated ecosystem assessments as a first step towards ecosystem-based management of living marine resources. He discussed the objective of having knowledge of the state of ecosystems on equal footing with population assessments and the necessity to develop ecosystem governance systems that would be equipped to manage tradeoffs, and apply adaptive approaches. The United States National Oceanic and Atmospheric Administration (NOAA) will begin two pilot projects on the west coast of North America, in the California Current and Alaska large marine ecosystems, to try to apply Integrated Ecosystem Assessment. Chang-Ik Zhang, in a talk later in the session, presented a parallel case for application of Ecosystem-Based Management (EBM) for the Republic of Korea. They emphasized the dual action of anthropogenic (fishing) and climate change threats to the sustainability of fisheries, particularly when an ecosystem is already stressed or damaged. They presented the recent actions taken by the Republic of Korea to help implement EBM and institute environmentally sound management practices. Francisco Werner focused on tools for examining future changes to lower trophic levels and individual fish species through coupled physical–biological models such as NEMURO. He urged the audience to consider ways to link quantitative models directly to whole ecosystems and human use of those systems. They proposed the following three goals: 5 years – models are fully integrated; 10 years – models will bridge ecology and biogeography; 15 years – quantitative predictions for ecosystems, including human uses of ecosystems through incorporation of bio-economic models. David Preikshot found that their assessment models for North Pacific salmon worked best when climate and environmental indices were added to the assessment. Emmanuele DiLorenzo investigated mechanisms to explain sources of variability in observations of nutrients, salinity, and chlorophyll in the eastern North Pacific Ocean.

Their new index, the North Pacific Gyral Oscillation (NPGO) is related to the strength of the subarctic and subtropical gyres in the North Pacific. Yaqu Chen documented the anthropogenic pressures placed on the Yangtze River estuary in China. They presented methods used successfully to restore the health of the system. Gregory Ruiz provided the audience with background information on patterns and trends in bio-invasions along the west coast of North America and then speculated on how those patterns and trends might respond to the effects of climate change in the future such as opening of the Arctic to year round shipping. Lastly, Thomas Okey closed the session with a presentation on Imaginative Synthesis Groups as a strategic collaboration among scientists of various disciplines to assess climate impacts. He asked for input from the audience on innovative tools and assessments that included both western science and traditional education and knowledge that could be used in the future to assess impacts and vulnerability of ecosystems to climate change.

List of papers

Oral presentations

Gregory M. Flato (Invited)
A brief summary of results from the IPCC Fourth Assessment Report

Emanuele Di Lorenzo and Niklas Schneider
A North Pacific gyre-scale oscillation: Mechanisms of ocean's physical-biological response to climate forcing

Gregory M. Ruiz (Invited)
Biogeography of marine invasions: Current status and future predictions

William J. Merryfield and Suelji Kwon
Changes in North Pacific mixed layer depth in the 20th and 21st centuries as simulated by coupled climate models

Dave Preikshot and Nathan Mantua
Comparisons of modeled climate and lower trophic level time series for the North Pacific from 1950 to 2002

Francisco E. Werner, Bernard A. Megrey, Michio J. Kishi, Kenneth A. Rose, Shin-ichi Ito, Yasuhiro Yamanaka, Maki Noguchi-Aita and Taketo Hashioka
Extensions of the NEMURO models for use in studies of future climate scenarios

Muyin Wang and James E. Overland
Future climate of North Pacific projected by IPCC models

Steven A. Murawski (Invited)
Integrated ecosystem assessments: The first step in ecosystem-based management of living marine resources

Yaqu Chen, Zhijie Hu, Weifeng Gu, Yonghua Jiang, Weimin Quan and Liyan Shi
Long-term change and ecological restoration of the Yangtze River estuarine ecosystem in past decades

Chang-Ik Zhang, Suam Kim and Jae Bong Lee (Invited)
Marine ecosystems, fisheries and the ecosystem-based resource management in Korea

Richard. A. Feely, Christopher L. Sabine, Victoria Fabry, Robert Byrne, J. Martin Hernandez-Ayon, Debby Ianson and Burke Hales (Invited)
Ocean acidification: Present status and future implications for marine ecosystems in the North Pacific

Yasunori Sakurai and Michio J. Kishi (Invited)
Prediction of life strategy and stock fluctuation of the Japanese common squid, *Todarodes pacificus*, related to climate change during the 21st century

Thomas A. Okey
The changing Pacific: A strategic collaboration for assessing climate impacts and developing effective policy for adaptation

Kenneth Denman (Keynote)
The North Pacific, human activity, and climate change

Posters

Valentina V. Kasyan
Bioaccumulation of heavy metal in zooplankton (Copepoda) from the Amursky Bay, Japan/East Sea

Vladimir I. Ponomarev and Elena V. Dmitrieva
Changing global-regional linkages in the Northwest Pacific and Northeast Asia

K. David Hyrenbach, Ken H. Morgan, Mike F. Henry, Chris Rintoul, Gary Drew, John Piatt and William Sydeman
Documenting changes in the distribution and abundance of warm-water gadfly petrels (*Pterodroma* spp.) in the subarctic North Pacific using vessels of opportunity (2002 - 2006)

Inga A. Nemchinova
Impact of towed airgun arrays, used in seismic exploration, on marine zooplankton from the northeastern Sakhalin shelf coastal waters

Alexander V. Moshchenko, Anastasia S. Chernova and Tatyana S. Lishavskaya
Long-term changes in the marine environment in apex parts of Amur Bay (Peter the Great Bay in the Japan/East Sea)

Olga N. Lukyanova, Margarita D. Boyarova and Andrey P. Chernyaev
Seabirds as bioindicators of POPs in the marginal seas of northwestern Pacific

BIO/POC Topic Session (S2)
Decadal changes in carbon biogeochemistry in the North Pacific

Co-Convenors: *James Christian (Canada) and Toshiro Saino (Japan)*

Background

This session was the first effort by the PICES Section on *Carbon and Climate* to synthesize the current understanding on inter-relationship between the carbon cycle and climate in the Pacific. Emphasis was placed on decadal change in carbon cycling, *e.g.*, anthropogenic carbon, air–sea exchange of CO_2, the biological pump, impacts of increasing levels of carbon dioxide on carbonate chemistry and marine biota, and possible feedbacks to atmospheric greenhouse gases. We expected that the session will enable us to update our understanding of the relationships between the carbon cycle, marine biota, and climate in the Pacific, and to identify gaps in our knowledge for future research in areas of importance for the PICES Section on *Carbon and Climate*.

Summary of presentations

This session focused on decadal ("low-frequency") variability of biogeochemical cycles in the North Pacific. Topics ranged widely covering pCO_2, DIC (dissolved inorganic carbon), nutrients, phytoplankton, models and observations, and coastal and open ocean areas. The keynote speaker was Taro Takahashi (U.S.A.), who described the progressive construction of a global surface pCO_2 data set and trends observed in the data as more timeseries information becomes available. The global mean rate of growth of ocean surface pCO_2 is similar to the growth of atmospheric CO_2. C.S. Wong and Sophia Johannessen (Canada) showed a detailed time series for the Northeast Pacific (Gulf of Alaska) where the oceanic trend is similar to the global mean, although in some parts of the northern North Pacific the trend is very different from the global mean. Kitack Lee (Korea) showed that uptake of anthropogenic CO_2 by the Japan/East Sea has all but stopped in recent years due to reduced efficiency of the mechanisms that transport CO_2 to the deep ocean. Tsuneo Ono (Japan) examined regional trends in surface silicate and phosphate concentrations and concluded that up to half of currently nutrient-replete surface waters in the North Pacific could become nutrient depleted this century if these trends continue. There were four modelling talks and an excellent integration of modelling with observationally based presentations. Anand Gnanadesikan (U.S.A.) presented a provocative hypothesis about the ventilation of the North Pacific thermocline, based on modelling studies, but apparently robust to exactly which ocean model is used. Chun-Ok Jo (Korea) was given the best poster award (selected from among all posters contributed to the POC Paper Session and several other POC-sponsored sessions) for her poster "Decadal changes of phytoplankton activity during spring in the southern East/Japan Sea". This was a very successful inaugural topic session for the Carbon and Climate Section (CC-S) and the research presented shows that CC-S objectives are being addressed by scientists in PICES nations.

List of papers

Oral presentations

Debby Ianson, Richard A. Feely, Chris L. Sabine and J. Martin Hernandez-Ayon
Annual carbon fluxes in the coastal Northwest Pacific

Taro Takahashi, Stewart C. Sutherland, Rik Wanninkhof, Colm Sweeney, Richard A. Feely, Burke Hales, Gernot Friederich, Francisco Chavez, Andrew Watson, Dorothee C.E. Bakker, Ute Schuster, Nicolas Metzl, Hisayuki Yoshikawa-Inoue, Masao Ishii, Takashi Midorikawa, Christopher Sabine, Mario Hopemma, Jon Olafsson, Thorarinn S. Arnarson, Bronte Tilbrook, Truls Johannessen, Are Olsen, Richard Bellerby, Hein J.W. de Baar, Yukihiro Nojiri, C.S. Wong, Bruno Delille and N.R. Bates (Invited)
Climatological mean and decadal change in surface ocean pCO_2, and net sea–air CO_2 flux over the global oceans

Yutaka W. Watanabe
Decadal change in N/P/Si ratio over the North Pacific subpolar region

Christopher L. Sabine, Richard A. Feely, Frank Millero, Andrew Dickson, Chris Langdon, Sabine Mecking, Jim Swift and Dana Greeley
Decadal changes in Pacific Ocean inorganic carbon

Tsuneo Ono and Akihiro Shiomoto
Decadal trend of summer nutrient content in the North Pacific HNLC region

Makio Honda (presented by Shuichi Watanabe)
Interannual variability of the biological pump in the northwestern North Pacific

Akira Nakadate, Hitomi Kamiya, Takashi Midorikawa, Masao Ishii and Toshiya Nakano
Interannual variability of winter oceanic CO_2 along 137°E in the western North Pacific

Kitack Lee and Guen-Ha Park
No recent uptake of anthropogenic CO_2 by the East/Japan Sea

Kimio Hanawa and Shusaku Sugimoto
Reemergence of winter SST anomalies and spring chlorophyll-a concentration in the central North Pacific

Hernan E. Garcia, Tim P. Boyer, Sydney Levitus, John I. Antonov and Ricardo A. Locarnini
Seasonal to decadal variability in phosphate in the upper ocean

Nobuo Tsurushima, Koh Harada and Yutaka W. Watanabe
Spatial distribution and temporal change of dissolved inorganic carbon in the western North Pacific

Masahide Wakita, Shuichi Watanabe, Akihiko Murata, Nobuo Tsurushima, Makio Honda, Yuichiro Kumamoto, Hajime Kawakami and Kazuhiko Matsumoto
Temporal variability of dissolved inorganic carbon at the K2 and KNOT time-series stations in the western North Pacific

Shinichi S. Tanaka and Yutaka W. Watanabe
The effect of bubble injection on concentrations of N_2 and Ar in the western North Pacific

James R. Christian, Kenneth L. Denman and Konstantin Zahariev
The North Pacific Ocean in the enhanced greenhouse

C.S. Wong, Shau-King Emmy Wong, Sophia Johannessen, Liusen Xie and John Page
Time-series of pCO_2 (partial pressure of CO_2) at Station P / Line P in the sub-arctic Northeast Pacific Ocean

Hiromichi Tsumori and Yukihiro Nojiri
Trend analysis of ocean pCO_2 and the air–sea CO_2 flux in the North Pacific

Fei Chai, Guimei Liu, Huijie Xue, Lei Shi and Yi Chao
Variability of the carbon cycle and productivity in the China Seas during 1960-2006: A three-dimensional physical-biogeochemical modeling study

Anand Gnanadesikan and Keith B. Rodgers
Ventilation variability in the North Pacific as simulated by a coupled climate model

Posters

Masahiko Fujii, Yasuhiro Yamanaka, Yukihiro Nojiri, Michio J. Kishi and Fei Chai
Comparison of seasonal characteristics in carbon biogeochemistry among the subarctic North Pacific stations described with a NEMURO-based marine ecosystem model

Chun-Ok Jo and Kyung-Ryul Kim
Decadal changes of phytoplankton activity during spring in the southern East/Japan Sea

Akihiko Murata, Yuichiro Kumamoto, Ken'ichi Sasaki, Shuichi Watanabe and Masao Fukasawa
Decadal increases of anthropogenic CO_2 in the subtropical and tropical oceans along the WOCE P10 line

Yukihiro Nojiri, Hitoshi Mukai, Hiromichi Tsumori, Takeshi Egashira, Katsumoto Kinoshita and Hideshi Kimoto
Development of pCO_2 measuring buoy in the surface ocean

Takayuki Tokieda, Masao Ishii, Shu Saito, Daisuke Sasano, Takashi Midorikawa and Akira Nakadate
Evaluation of changes in ocean circulation and anthropogenic CO_2 storage based on CFCs age in the western North Pacific

Pete Davison, David M. Checkley, Jr. and Tony Koslow
Is diel vertical migration important to oceanic carbon export flux?

Ruixiang Li, Yan Li and Mingyuan Zhu
Long term variation of phytoplankton in the Yellow Sea in spring

Takeshi Yoshimura, Jun Nishioka, Koji Suzuki, Hiroshi Hattori, Hiroshi Kiyosawa, Daisuke Tsumune, Kazuhiro Misumi and Takeshi Nakatsuka
Responses of phytoplankton assemblage and organic carbon dynamics to CO_2 increase

Hongbo Li, Tian Xiao, Wuchang Zhang, Sanjun Zhao and Ruihua Lv
Spatial and temporal variation of bacterioplankton population in the southern Yellow Sea, China

CCCC/FIS Topic Session (S3)
Towards ecosystem-based management: Recent developments and successes in multi-species modeling

Co-Convenors: Vera Agostini (U.S.A.), Shin-ichi Ito (Japan), Jae-Bong Lee (Korea) and Jake Schweigert (Canada)

Background

Ecosystem-based management is becoming a focus for many fisheries and their management agencies worldwide. Much of the success of this initiative will require improvements in understanding the interactions and linkages among species at both the lower trophic level (LTL) and higher trophic level (HTL) within regional ecosystems. The recent success of modeling tools such as NEMURO.FISH in linking LTL forcing to the forecasting of fish growth for a number of pelagic forage species is encouraging. Ecosystem-based management will require the extension of this and/or similar approaches to multi-species systems. A variety of modeling tools is already in wide use to address this issue, including Ecopath/Ecosim, NEMURO, various IBM models, and others. This session focused on contrasting different approaches to multi-species modeling and evaluating their performance as a vehicle for assessing and forecasting the effects of climate change on ecosystem function. Presentations that highlighted critical ecosystem interactions relevant for fishery management were encouraged, as well as discussions on how knowledge of these interactions will move us closer to ecosystem-based fishery management.

Summary of presentations

The session had three invited speakers who provided overviews of different approaches to ecosystem description and modelling. They ranged from Ecopath/Ecosim to an individual-based model (IBM) approach in OSMOSE to a small scale, two-species model without lower trophic level (LTL) inputs. The contributed papers described approaches that are attempting to model ecosystems, with the ultimate goal of providing management advice. Approaches ranged from complex network models that include several trophic levels to simpler approaches that focus on interactions between two to many species of fish. The models were either coupled or uncoupled from LTL inputs. Increasingly, there have been efforts to incorporate more complex geophysical forcing in the models with bottom-up LTL inputs. A common theme in the discussion was the need to include more data fitting (in a statistical sense) rather than driving the models with fixed or assumed parameter values. It was evident from the session discussion that no individual approach was preferred and each had strengths and weaknesses, depending on the question that was being addressed. A few papers presented results of comparing ecosystem indicators

generated from a couple of different ecosystem models in the vein of the IPCC approach to climate modelling. It is likely that future research in this area will include further inter-comparison of ecosystem modelling tools that will ultimately lead to more accurate and useful descriptions of ecosystem processes.

List of papers

Oral presentations

Takeshi Okunishi, Yasuhiro Yamanaka and Shin-ichi Ito
A migration model of Japanese sardine using artificial neural network

Jake Rice
"Charmingly simple models" – Adding climate to size-based fish community models

Motomitsu Takahashi, Hiroshi Nishida, Akihiko Yatsu and Yoshiro Watanabe
Contrasting growth responses to climate-ocean regimes develop alternative population dynamics between anchovy and sardine in the western North Pacific

Yunne Shin and Morgane Travers (Invited)
Coupling ROMS-NPZD and OSMOSE models for an end-to-end modelling of the Benguela upwelling ecosystem

Villy Christensen, Joe Buszowski, Robyn Forrest, Fang Gao, Carie Hoover, Joe Hui, Sherman Lai, Jeroen Steenbeek, William Walters and Carl Walters (Invited)
Ecopath with Ecosim 6: New generation ecosystem modeling package

Zach A. Ferdaña and Michael W. Beck
Ecosystem-based management for the seas: A planning application using spatial information on marine biodiversity and fishery production

Ivonne Ortiz, Robert Francis and Kerim Aydin
Effects of space and scale in the marine food-web structure of the Aleutian Archipelago

Jeremy S. Collie, Kiersten L. Curti and John H. Steele
End-to-end models of the Georges Bank ecosystem: Implications for ecosystem-based fisheries management

Kray Van Kirk, Terrance J. Quinn II and Jeremy Collie
Estimating predation mortality with a three-species model in the Gulf of Alaska

Jason S. Link, Laurel Col, William Overholtz, John O'Reilly, Vincent Guida, Jack Green, David Dow, Debra Palka, Chris Legault, Joseph Vitaliano, Carolyn Griswold, Michael Fogarty and Kevin Friedland
Evaluating the role of small pelagics in the Gulf of Maine: EMAX scenarios of energy flow

Shin-ichi Ito, Taizo Morioka, Yasuhiro Ueno, Satoshi Suyama and Masayasu Nakagami
Experimental approaches to improve the accuracy of NEMURO.FISH saury growth model

Sarah Gaichas, Garrett Odell, Robert Francis and Kerim Aydin
Fishing the Gulf of Alaska marine food web: Do predator prey interactions imply ecosystem thresholds?

Michio J. Kishi, Kenneth A. Rose, Shin-ichi Ito, Bernard A. Megrey, Francisco E. Werner, Maki Noguchi-Aita, Taketo Hashioka, Yasuhiro Yamanaka, Yasuko Kamezawa, Kazuto Nakajima and Daiki Mukai
Overview of application of the NEMURO-bioenergetic coupled model on north-western Pacific fishes

Young Il Seo, Joo Il Kim, Taek Yun Oh, Sun Kil Lee, Chang Ik Zhang, Jae Bong Lee and Jung Hwa Choi
Stock assessment of small yellow croaker considering the impact of yellow goosefish predation in the East China Sea of Korea

N. Taylor, D. Preikshot, N. Mantua, R. Peterman, B. Dorner, G. Ruggerone, C. Walters, K. Myers, T. Walker and R. Hilborn
The effects of ocean carrying capacity, density-dependent growth and mortality on Pacific salmon

Maki Suda (Invited)
Two-species population dynamics model for Japanese sardine and chub mackerel using object oriented modelling

Posters

Fumitake Shido, Yasuhiro Yamanaka, Shin-ichi Ito, Taketo Hashioka, Daiki Mukai and Michio J. Kishi
A two-dimensional fish model simulating biomass and population of Pacific saury

FIS Topic Session (S4)
Ecosystem approach to fisheries: Improvements on traditional management for declining and depleted stocks

Co-Convenors: Yukimasa Ishida (Japan), Gordon H. Kruse (U.S.A.), Ted Perry (Canada), Vladimir I. Radchenko (Russia) and Chang-Ik Zhang (Korea)

Background

An ecosystem approach to fisheries (EAF) recognizes the complexity of ecosystems and the interconnections between its component parts and is being advocated by many fisheries management bodies. In PICES countries, some fisheries resources are healthy and in high abundance, but others are decreasing or already depleted. Most causes of stock declines can be ascribed to climate change and overfishing. Stocks in declining or depleted conditions require prompt appropriate management actions, perhaps including ecosystem approaches. This session considered papers that examined: (1) major factors responsible for the status of fish stocks, particularly those that are decreasing or depleted; (2) limits to traditional fishery management measures to address causes of stock declines; (3) new perspectives on fishery management that promote sustainable fishery management from an ecosystem perspective; and (4) case studies of rebuilding plans for depleted stocks – their successes and failures.

Summary of presentations

The session consisted of 13 oral and 15 poster presentations. The invited paper by Stratis Gavaris (Canada) described the steps in fisheries management planning and decision making and the science needed to support planning and decisions, in order to conserve productivity, biodiversity and habitat. There are many strategies to work on and priority should be given to fishing mortality, incidental mortality and habitat disturbance. He also pointed out that the ecosystem approach is about managing human activities, not the ecosystem. The second invited paper by Alan Sinclair (Canada) showed that Atlantic cod in eastern Canada recovered rapidly from a low level during the 1970s due to high juvenile survival rates and high growth rates. However, recovery since low population levels in the early 1990s has been poor due to a low recruitment and growth rates, and high natural mortality rates. Consequently, the stocks may not be sustainable even at zero fishing mortality. Other species, especially crab and shrimp, have increased in the absence of cod. Natural mortality can change over time. Fishing, especially high exploitation rates, can affect fish size at age and productivity.

Ian Perry (Canada) reviewed a number of studies that illustrated how the combined effects of fishing and climate change are multiplicative rather than additive. He concluded that fishing can simplify population, community and ecosystem structure, making them more susceptible to climate change. Management approaches need to maintain the resilience of the ecosystem and its components to the interacting effects of climate and fishing.

Other contributed papers reported case studies in different species and different regions of the North Pacific. For example, Hee Park (Korea) described an approach to move toward ecosystem-based assessment and management for Korean fisheries by 2010. He outlined the use of indicators for sustainability, biodiversity and habitat reference points to evaluate improvements in fisheries management, and to compare the state of species, fisheries, and ecosystems. Inja Yeon reported that Korean blue crab declined dramatically from the late 1980s through 2006 despite traditional fishery management measures. Broader ecosystem considerations are now being applied, including habitat improvement especially by removal of ghost fishing gear, an extended spawning period closure and better enforcement of closures. Tetsuichiro Funamoto (Japan) described the benefit of increasing the spawning stock biomass in order to rebuild two Japanese walleye pollock stocks, one for which declines are related to recruitment rate per spawner, the

other for which declines are related to recruitment rate per spawner as well as the spawning stock biomass. Gordon Kruse (U.S.A.) showed how a fishery closure in 1983 for Bristol Bay red king crab due to low abundance failed to maintain a healthy stock through the mid 1990s. A rebuilding plan was developed in 1996 to include an effective spawning biomass target, and a fishery threshold above which exploitation could be increased as abundance increased. Additional ecosystem-based management actions included limits on crab bycatch in other fisheries and habitat protection by banning mobile bottom-contact gear in an area important for juvenile red king crab rearing and another important for adult crabs. The convenors are planning to publish a special issue of the journal, *Fisheries Research*, containing peer-reviewed papers from the session.

List of papers

Oral presentations

Ashleen J. Benson, Sean P. Cox and Aaron Springford
An evaluation of stock structure in Pacific herring

Hiroshi Nishida, Masayuki Noto, Atsushi Kawabata and Chikako Watanabe
Assessment of the Japanese sardine (*Sardinops melanostictus*) stock in the northwestern Pacific for Japanese management system

Alan Sinclair and Doug Swain (Invited)
Collapse and lack of recovery of cod (*Gadus morhua*) in the Northwest Atlantic: Lessons for fisheries management

Jae Bong Lee, Anne B. Hollowed and Chang-Ik Zhang
Comparing ecosystem variations between eastern and western North Pacific using ecosystem indicators

Kevin T. Hill
Decline and recovery of Pacific sardines along the Pacific coast of North America: The roles of climate and fishing

Hee Won Park, Chang-Ik Zhang, Suam Kim, Donald Gunderson, Jae Bong Lee and Jong Hee Lee
Ecosystem-based fisheries resource assessment and management system in Korea

Thomas C. Wainwright, William T. Peterson, Peter W. Lawson and Edmundo Casillas
Environmental indicators and Pacific salmon conservation

Melissa A. Haltuch, André E. Punt and Martin W. Dorn
Evaluating biomass reference points in a variable environment

Inja Yeon, Mi Young Song, Myoung Ho Shon, Hak Jin Hwang and Yang Jae Im
Possible new management measures for stock rebuilding of blue crab, *Portunus trituberculatus* (Miers), in western Korean waters

Vladimir I. Radchenko
Problems of TAC forecast development for multi-species fisheries in the Sakhalin-Kuriles region

Gordon H. Kruse and Jie Zheng
Recovery of the Bristol Bay stock of red king crabs under a rebuilding plan

Stratis Gavaris (Invited)
Science support for fisheries management decisions in an Ecosystem Approach context

R. Ian Perry, Benjamin Planque, Simon Jennings, Keith Brander, Philippe Cury and Christian Möllmann
Sensitivity of marine systems to climate and fishing: Concepts, issues and management responses

Tetsuichiro Funamoto, Satoshi Honda, Keizo Yabuki and Akihiko Yatsu
Suggestion of management measures for two walleye pollock stocks around northern Japan

Masahide Kaeriyama and Hideaki Kudo
Sustainable fisheries management of Pacific salmon (*Oncorhynchus* spp.) based on the ecosystem approach

Ronald W. Tanasichuk
The effects of variations in euphausiid and Pacific hake biomasses on the productivity of British Columbian stocks of Pacific herring (*Clupea pallasi*)

Weimin Quan, Liyan Shi and Yaqu Chen
The food web in the Yangtze River estuary: A synthesis of existing knowledge

Posters

Peter S. Rand, Peter A. McHugh and Matthew Goslin
A global assessment of sockeye salmon (*Oncorhynchus nerka*) status using IUCN criteria

Toyomitsu Horii and Yoshiyuki Nakamura
An approach to recover abalone resources by TAC control based on RPS trends calculated with production model

Inja Yeon, C.I. Zhang, M.H. Shon, Y.J. Im and H.J. Whang
An ecosystem-based assessment of the blue crab stock and management strategy in the Yellow Sea

William R. Bechtol and Gordon H. Kruse
Environmental constraints to rebuilding of Kodiak red king crab

Liyan Shi, Weimin Quan and Yaqu Chen
Faunal utilization of created inter-tidal oyster reef in the Yangtze River estuary

Carrie A. Holt, André Punt and Nathan Mantua
Incorporating climate information into rebuilding analyses for overfished groundfish stocks

Yongjun Tian
Interannual-interdecadal variations in the abundance of spear squid *Loligo bleekeri* in the southwestern Japan/East Sea: Impacts of the late 1980s climatic regime shift and trawl fishing with recommendations for management

Todd W. Miller, Koji Omori, Hideki Hamaoka and Hidejiro Onishi
Marine versus terrestrial sources of production to the Seto Inland Sea, Japan

Sun Kil Lee, Young Il Seo, Joo Il Kim, Taek Yun Oh and Won Seok Yang
Rebuilding stock of the Yeo-Ja Bay ecosystem in the Southern Sea of Korea – Dominant group and ecosystem structure of the Yeo-Ja Bay

Yukimasa Ishida, Tetsuichiro Funamoto, Satoshi Honda, Keizou Yabuki, Hiroshi Nishida and Chikako Watanabe
Review of Japanese sardine, chub mackerel, and walleye pollock fisheries management from the view point of ecosystem approach

Caihong Fu, Beiwei Lu and Jake Schweigert
Searching for major factors responsible for the decline of the eulachon population in the Fraser River using artificial neural networks

Chang-Ik Zhang, Jae Bong Lee, Sun Kil Lee and Bernard A. Megrey
Structure and function of three marine ecosystems in Korea: A comparative study

FIS/CCCC/BIO Topic Session (S5)
Fisheries interactions and local ecology

Co-Convenors: Kerim Y. Aydin (U.S.A.), Masahide Kaeriyama (Japan), Jason Link (U.S.A.) and Elizabeth A. Logerwell (U.S.A.)

Co-sponsored by ICES

Background

Ecosystem models are often employed to evaluate the effects of fishing and to distinguish natural variability from human impacts. These models typically operate at large spatial and temporal scales, which are appropriate for their goals and objectives. However, these models would benefit from better information on local-scale processes as there are likely to be bottlenecks at short time scales and small spatial scales that are critical to understanding recruitment variability. Similarly, there may be critical foraging interactions that happen at local scales, particularly for central place foragers such as marine mammals and seabirds. Small-scale effects of fishing such as "localized depletion" may have ecosystem-level consequences. More information on local-scale survival, foraging, movement, reproduction and pelagic habitat selection would allow food-web and population dynamics modelers to make better scenarios of the effects of natural variability and/or fishing on ecosystems. Papers were solicited on the following topics: (1) current ecosystem models and the assumptions that require further research; (2) techniques for assessing climate impacts on predator-prey interactions at top trophic levels; (3) techniques for assessing local-scale dynamics of survival, foraging, movement, reproduction and pelagic habitat selection; and (4) techniques for assessing prey field response to fishing.

Summary of presentations

The session consisted of 13 oral presentations and 15 posters describing both field and modeling studies. Field studies examined ecological interactions, such as habitat use, predation mortality, survival and local fishing impacts. The modeling studies addressed the effects of climate on processes such as survival and predator-prey interactions. One presentation on use of habitat by fish showed how artificial habitat modifications can break down habitat isolation and lead to inter-specific hybridization. Another emphasized how the extent to which fishing disturbs fish habitat depends on habitat type, species, and changing climatic conditions. Self-organizing maps indicated patterns of species diversity that could be driven by different habitat or environmental conditions among regions. Pelagic habitat use was the focus of a study of the physical processes that drive variability in fur seal foraging areas. Studies of predation mortality showed that mortality for the species of interest (pollock and shrimp) was higher than previously expected and could have important implications for recruitment and abundance. A study of salmon survival indicated that long periods of low water temperatures in coastal areas is associated with lower survival of salmon. Water temperature, along with zooplankton biomass was also found to influence the catch of Pacific cod off Korea. Diurnal changes in vertical distribution of zooplankton were found to be important for the feeding ecology of Pacific salmon. Studies of the effects of fishing on prey availability for top predators (*i.e.*, sea lions) indicated that localized trawl exclusion zones would prevent prey depletion for locally abundant and non-mobile fish but for other more mobile fish species local management measures would be less effective. Two modeling studies described innovative approaches to study ecological interactions. One study examined basin-scale climate forcing but narrowed the observed local response and model dynamics to reflect local conditions and minimize differences in model formulations in each region. The other used path analysis to arrive at a "middle ground" between correlative models and complete understanding of all mechanisms driving ecological responses (such as reproductive success).

List of papers

Oral Presentations

Motoko R. Kimura and Hiroyuki Munehara (Invited)
A breakdown of habitat isolation among coastal fish by artificial habitat modification

Ikue Mio, Hideaki Kudo and Masahide Kaeriyama
Are foraging habits of Pacific salmon (*Oncorhynchus* spp.) reflected in food habits in the North Pacific?

Orio Yamamura (Invited)
Assessment of predation mortality of juvenile pollock in the coastal area

Jung Hwa Choi, Jong Hwa Park, Dae Soo Chang, Jung Nyun Kim, Hak Jin Hwang, Mi Young Song, Joo Il Kim, Young Il Seo, Sung Il Lee and Sang Chul Yoon
Designing fish management boundaries in Korean waters using Self-Organizing Maps (SOM)

Susanne F. McDermott, Elizabeth A. Logerwell, Ivonne Ortiz and V. Haist
Fishery interaction and availability of Atka mackerel prey for Steller sea lions: Results from local abundance and movement study of Atka mackerel

Michel J. Kaiser, Jan G. Hiddink and Hilmar Hinz (Invited)
Fishing and climate modifies habitat use and availability for fish

M. Elizabeth Conners and Peter T. Munro
Localized depletion experiment for Bering Sea Pacific cod

Jason S. Link and Josef Idoine
Mortality of shrimp *Pandalus borealis*: Local influence of predation in the Gulf of Maine

Sangdeok Chung and Suam Kim
Relationship between Pacific cod (*Gadus macrocephalus*) catch and environmental factors off eastern Korea

Mitsuhiro Nagata, Yasuyuki Miyakoshi, Takanori Iwao and Masahide Kaeriyama
Survivals of Hokkaido chum salmon affected by coastal seawater temperature during their early ocean life

Jeremy T. Sterling, Rolf R. Ream, Devin S. Johnson and Thomas S. Gelatt
The role of physical processes in the summertime life of the northern fur seal

B.K. Wells, J.C. Field, J.A. Thayer, C.B. Grimes, S.J. Bograd, W.J. Sydeman, F.B. Schwing and R. Hewitt
Untangling the relationships between climate, prey, and top predators in an ocean ecosystem

Bernard A. Megrey, Kenneth A. Rose, Shin-ichi Ito, Douglas E. Hay, Francisco E. Werner, Michio J. Kishi, Yasuhiro Yamanaka, Maki Noguchi-Aita, Jake F. Schweigert and Matthew B. Foster
Using model experiments to explore the impact of basin-scale climate forcing on localized upper-trophic-level marine ecosystem production

Posters

L. Godbout, M. Trudel, J. Irvine, C. Wood, K. Larsen, K. McKeegan, M. Grove and A. Schmitt
A stable isotope method to discriminate the orgin of nerkids (*Oncorhynchus nerka*) in BC lakes

Sung Il Lee, Hyung Kee Cha, Sang Chul Yoon, Young Seop Kim, Dae Soo Chang and Jae Hyeong Yang
Age and growth of *Arctoscopus japonicus* in the East/Japan Sea

Paige Drobny, Brenda Norcross and Nate Bickford
Age, growth and movement of the squid species *Berryteuthis magister* in the Eastern Bering Sea

Jarrod A. Santora, Christian S. Reiss and Richard R. Veit
Annual spatial variability of krill influences seabird foraging behavior near Elephant Island, Antarctica

Shusaku Kobayashi, Takaomi Arai, Kentaro Honda, Yuji Noda and Kazushi Miyashita
Brown trout (*Salmo trutta*) movements between a stream and the sea in Hokkaido, northern Japan

Sungtae Kim, Sukgeun Jung and Jinyoung Kim
Distribution, feeding and growth of Japanese Spanish mackerel (*Scomberomorus niphonius*) in the southern Korean sea

Zhaohui Zhang, Shufeng Ye and Mingyuan Zhu
Ecosystem services valuation of coastal aquaculture

Kimberly Rand
Longitudinal growth differences in Atka mackerel (*Pleurogrammus monopterygius*): Using a bioenergetic model to identify underlying mechanisms

Kenji Konishi, Tsutomu Tamura and Koji Matsuoka
Recent feeding habits of sei whale *Balaenoptera borealis* in pelagic waters of the western North Pacific based on data collected from 2002 to 2006

Sandi Neidetcher and Elizabeth A. Logerwell
Spatial and temporal patterns in Pacific cod reproductive maturity in the Bering Sea

Oleg A. Ivanov and Vitaly V. Sukhanov
Species structure of epipelagic nekton of the Okhotsk Sea

Feng-ao Lin and Jingfeng Fan
The analysis of reasons for mass-death of culturing pufferfish (*Fugu rubripes*) caused by 0# light oil spilled on the sea

V.F. Bugaev, B.B. Vronsky, L.O. Zavarina and Zh. Kh. Zorbidi
The analysis of the interactions between generations of the Kamchatka River salmons including sockeye, chinook, chum and coho

Richard D. Brodeur and Cheryl A. Morgan
The Columbia River plume as an ecotone and habitat for juvenile chinook salmon

V.F. Bugaev
The correlation between the abundance of sockeye salmon *Oncorhynchus nerka* of the Kamchatka River by periods of different state of stock abundance dynamics of Kamchatkan pink salmon *Oncorhynchus gorbuscha*

MEQ Topic Session (S6)
The relative contributions of off-shore and in-shore sources to harmful algal bloom development and persistence in the PICES region

Co-Convenors: Hao Guo (China) and Vera L. Trainer (U.S.A.)

Background

There is increasing recognition that some harmful algal blooms (HABs) affecting coastal waters may not have local origins but are advected from offshore waters. This session highlighted recent advances in studying the processes involved in near-shore *versus* off-shore development and transport of harmful algal blooms in the coastal waters of the PICES region. Of particular interest were field studies where the relative importance of local *versus* remote development of HABs has been assessed. The session invited papers describing known off-shore and near-shore initiation sites, seedbeds, and the physical factors that facilitate transport of HABs to coastal sites where they may impact fisheries.

Summary of presentations

This session highlighted what is known about initiation and transport processes that result in HAB impacts on coastal fisheries. Off the coast of Washington State, the Juan de Fuca eddy is an initiation site for toxigenic *Pseudo-nitzschia* blooms. This unique upwelling site is a retentive feature that is formed by estuarine flow, winds and tides. Use of models allows us to determine which physical, biological and chemical factors are important in the development of the Juan de Fuca eddy and in its ability to retain particles (cells). In the eastern Pacific, HAB species retention in frontal zones was a mechanism for overwintering. Such overwintering allowed HAB species to survive until the next growing season. Moderate upwelling conditions during the summer followed by late season storms were conditions leading to shellfish closures due to HABs in Washington State. In China, physical processes such as the timing of the monsoon, water column stability and the advance of currents play an important role in the formation of dinoflagellate blooms. Anthropogenic factors are thought to influence HAB occurrence in the Philippines. Possible impacts of climate change on the development of certain HABs were discussed. Because estuarine flow and upwelled water properties may change, the intensity of HABs will also be influenced by climate change in the future.

List of papers

Oral presentations

Angelica Peña and Michael Foreman
Biophysical modeling of the Juan de Fuca Eddy in the Pacific Northwest

Douding Lu and Dedi Zhu (Invited)
Blooms of dinoflagellates in the East China Sea – Possible linkages to physical processes

Mingyuan Zhu, Mingjiang Zhou and Ruixiang Li (Invited)
HAB process in the coastal water of Zhejiang province, East China Sea

Xuelei Zhang, Z.J. Xu and M.Y. Zhu
Impact of atmospheric dust on phytoplankton growth in the Yellow Sea and western Pacific

Michael Foreman, Wendy Callendar, Amy MacFadyen, Barbara Hickey, Vera Trainer, Angelica Peña, Richard Thomson and Emanuele Di Lorenzo (Invited)
Juan de Fuca Eddy generation and its relevance to harmful algal bloom development along the outer Washington coast

Luzviminda M. Dimaano, Lewelen A. Arcaya, Joseph Chester M. Malaca, Francis Martin M. Mirasol and Mark Joseph D. Tan
The distribution of three toxic epiphytic dinoflagellates as potential bioindicators of anthropogenic pollutants in the reefs of San Fernando, La Union, Philippines

Amoreena MacFadyen, Barbara Hickey, Vera Trainer and William Cochlan
The Juan de Fuca Eddy – An initiation site for toxigenic *Pseudo-nitzschia* blooms impacting the Washington coast

Posters

Chunjiang Guan, Hao Guo and Wen Zhao
Accumulation and elimination of *Alexandrium tamarense* toxins by the scallop, *Argopectens irradias*

Zongling Wang, Ruixiang Li, Mingyuan Zhu, Xiao Liu, Yanju Hao and Xihua You
The density-dependent interspecific competition between *Prorocentrum donghaiense* and *Alexandrium tamarense*

Yaobing Wang, Binxia Cao, Yan Yin and Hao Guo
The relationship between algical bacteria and *Alexandrium tamarense*

MEQ/FIS Topic Session (S7)
Coldwater biogenic habitat in the North Pacific

Co-Convenors: Glen S. Jamieson (Canada), J. Anthony Koslow (U.S.A.) and Jin-Yeong Kim (Korea)

Background

Some of the marine fauna that are most vulnerable to physical disturbances are the long-lived, slow growing and physically fragile species (corals and sponges) that provide biogenic habitat in deep water. It is increasingly recognized worldwide that deep-water biogenic habitat protection needs protection, so its consideration by PICES is timely. Conservation of such habitat has become a high priority in the eastern North Pacific in particular, and large areas have recently been established to exclude bottom trawling to protect deep-water corals and sponges. Considerable effort is being expended in American waters at least to identify and determine coral distributions and to assess their ecological role as fishery habitat.

Summary of presentations

This session included presentations that described: 1) distributions of deep-water biogenic habitat in the Pacific and particularly, the eastern North Pacific; 2) the ecological role of biogenic structures such as habitat for commercial and other species; and 3) some of the management measures currently applied or being considered to conserve these species and the habitat they provide. The invited speaker, Alexander Rogers (United Kingdom) discussed factors influencing overall coral spatial distribution – aragonite saturation, oxygen concentration and % saturation, depth, temperature, and high nutrient levels (negative influence). Deep-water corals are concentrated on the peaks of sea mounts and on continental margins and slopes, down to about 1000 m. Locations are likely largely determined by the presence of current jets (moderate to high) along continental margins, internal wave influences, iceberg plow tracks, and the availability of hard substrata. Association of deep-water corals and sponges with other species seems to be largely mutalistic to accidental, but studies are few. The application of fishery management measures to vulnerable marine ecosystems (VMEs) was discussed by a number of papers, and it was pointed out that many gear types can have negative impacts, and that a coral or sponge bycatch is often the first indicator of the presence of deep-water biogenic habitat. Other papers listed known regional coral species and their distributions, and fishing stressors affecting their distribution. The only paper from the western North Pacific considered dominant biogenic habitat species in Korean communities, the importance of biogenic structure there, and ongoing efforts to recover biogenic habitat. Nearshore barren areas were observed to be abundant, so seaweed bed recovery is now a particular priority.

List of papers

Oral presentations

Edward J. Gregr and Glen S. Jamieson
An ecological classification of sponge and coral habitat in Pacific Canadian waters

Alex D. Rogers (Invited)
Biogenic habitats in the deep sea: Biodiversity and interactions with fisheries

Curt E. Whitmire and M. Elizabeth Clarke
Census of deep-sea/cold-water corals off the western coast of the United States

Glen S. Jamieson
Deep-water biogenic habitat in Pacific Canada: Challenges to its conservation

W. Waldo Wakefield and Brian N. Tissot
Ecological associations between structure-forming invertebrates and demersal fishes on Heceta Bank, Oregon

Jeffrey B. Marliave and Donna M. Gibbs
Ecological function as rockfish nursery habitat of cloud sponges in Howe Sound and Strait of Georgia, British Columbia

Jin-Yeong Kim, Hyung-Kee Cha, Kwang-Ho Choi, Jong-Hwa Park and Sukgeun Jung
Long-term change in dominant fishery species and their cold-water habitats in the Korean coastal waters

Doug Woodby, Dave Carlile and Lee Hulbert
Predictive modeling of coral and sponge distribution in the central Aleutian Islands

Malcolm Clark, Derek Tittensor and Alex D. Rogers
Seamounts, deep-sea corals, and fisheries in the Pacific Ocean

Posters

Sung Eun Park, Won Chan Lee, Hyun Taik Oh, Sok Jin Hong, Rae-Hong Jung and Sang Pil Yoon
Numerical experiments on the stably stratified flow over a shallow seamount in a channel

Jessica L. Finney, E.J. Gregr, Glen S. Jamieson and S. Patton
Predicting suitable habitat for deep sea coral in British Columbia

MONITOR/TCODE Topic Session (S8/S10)

Recent advances in ocean observing systems: Scientific discoveries, technical developments, and data management, analysis and delivery

Co-Convenors: John (Jack) Barth (U.S.A.), Kyu Kui Jung (Korea), S. Allen Macklin (U.S.A.), Young Jae Ro (Korea) and Verena Tunnicliffe (Canada)

Background

Given the rapid development of ocean observing systems across the North Pacific, it is timely to discuss their use for scientific discovery and ecosystem research, and to describe the technical advancements in ocean sensors, observational platforms, and improvements in data management and exchange. By providing sustained interdisciplinary observations of atmospheric and oceanic processes, observing systems can capture important events influencing ocean ecosystems. Advanced sensors and platforms are creating new opportunities for deciphering ecosystem dynamics. With the increase in data return across observatories, it is critical that data management and interchange be addressed. Papers were welcomed on: scientific discoveries made possible by ocean observing systems; observed climate impacts on ocean ecosystems and fisheries; advanced ocean sensors including optical, acoustic and genomic devices; autonomous platforms including underwater vehicles and vertical profilers; data management and exchange; and interoperability among ocean observatories. The intention was to have a mixture of scientific and technical talks on ocean observing systems.

Summary of presentations

This session combined the ocean observing topics originally proposed as Topic Session S8 with the data management topics proposed under S10. The combination was mutually beneficial and led to much interest at PICES XVI. Bernard A. Megrey (U.S.A) ably stood in as a co-convenor in Allen Macklin's absence. The S8/S10 session included 16 oral presentations, five of which were invited, and there were 16 posters, four of which were electronic ("E-

posters"). The session was also accompanied by week-long displays by AXYS Technologies Inc., the Victoria Experimental Network Under the Sea (VENUS), the Canadian Scientific Submersible Facility, NEPTUNE Canada and Roper Resources, Ltd. John Dower (Canada) led off the session by reviewing the advantages of real-time, continuous ("always on") ocean observing *versus* previous, mostly ship-based (weather limited) and satellite remote sensed (surface only). He pointed out that ocean observing is interdisciplinary and that continuous sampling allows the detection of events and adaptive sampling. As an example, Dr. Dower reviewed the VENUS observing system, in particular the use of a high data volume Zooplankton Acoustic Profiler (ZAP). This system was recently used to detect "bioturbulence." He concluded by saying that recent ocean observing efforts will be a "revolution," but will we be ready for it? Mairi Best and Benoit Pirenne (Canada) reviewed the science and data management, respectively, of the NEPTUNE Canada ocean observatory presently being installed off the shelf and deep ocean to the west of Vancouver Island. Dr. Best pointed out how the scientific community contributed to the design of the NEPTUNE Canada network. Dr. Pirenne described the three tasks for a data management system: data acquisition and storage; data access; and instrument and infrastructure control and monitoring. The latter is linked to the event detection and reaction, intended to be performed automatically with computers as much as possible in the era of "always on" ocean observing. Dr. Pirenne concluded by pointing out that it was perfectly reasonable to store (two copies in different locations!) data from the observatory (~100 Terabytes/year), but that a close look was needed at data compression. David Foley (U.S.A.) described the use of satellite remote sensed data to create ocean "products," for example, maps of preferred fish habitat based on temperature. He pointed out that we are in the "Golden Age" of satellite remote sensing, but that after 2012 it cannot be guaranteed which satellites will still be in orbit. Dr. Foley described data access methods that transparently deliver data to "clients" like Matlab, R, IDL, GIS and Linux programs. He concluded by asking for advice on potential products and assessing methods.

The next three talks described ocean observing systems in Japan and Korea aimed at improving our understanding and ability to predict the behavior of ocean ecosystems. Hidekatsu Yamazaki (Japan) described a system for observing and modeling red (and blue!) tide in Tokyo Bay. Toshiro Saino (Japan) presented results using a new profiling mooring system equipped with bio-optical sensors for the study of primary production. Young Jae Ro (Korea) detailed an ocean observing system for the southern coast of Korea targeted at societally important questions about aquaculture and hypoxia in semi-enclosed seas.

Jack Barth (U.S.A.) summarized the use of new autonomous underwater vehicle gliders to continuously sample coastal waters for physical, chemical and bio-optical properties. The gliders allow vertical sections of ocean properties to be returned in near real-time for monitoring of ocean conditions and inclusion in data-assimilating coastal circulation and ecosystem models. Two talks focused on underwater acoustics, led off by an excellent overview by Svein Vagle (Canada). He described the bio-acoustics system deployed on VENUS and emphasized the importance of event detection to trigger the full capabilities of a high-bandwidth acoustic system. David Welch (Canada) reviewed the Pacific Ocean Shelf Tracking (POST) program, in particular its high degree of success in both maintaining hydrophone nodes and in tracking acoustically tagged fish in coastal waters.

Steven Rumrill (U.S.A.) reviewed an estuarine observing system in South Slough National Estuarine Research Reserve, southern Oregon, U.S.A, and emphasized the importance of designing a science-driven observatory. Two talks focused on using long, cross-Pacific transects to monitor ocean ecosystems. Sonia Batten (representing SAHFOS) reviewed the status of the North Pacific Continuous Plankton Recorder observing effort and Michael Henry (U.S.A.) described the repeated seabird observations made from a voluntary observing

ship transiting the North Pacific between Canada and Asia.

Graduate students contributed to the session including Hanna Na, from Seoul National University, who investigated the accuracy and utility of land-based coastal radar for measuring ocean currents, and Liying Wan, from the Chinese National Marine Environmental Forecasting Center, who described the use of an advanced Kalman filter for combining data with ocean circulation models. The session benefited from a number of excellent poster presentations, including descriptions of new technology (underwater cabled observatories, vertical profilers) and electronic-posters demonstrating data management systems, ocean atlases and the visualization of three-dimensional, time-dependent ocean model output.

List of papers

Oral presentaions

Liying Wan, Jiang Zhu, Changxiang Yan, Hui Wang, Laurent Bertino and Zhanggui Wang
A "dressed" ensemble Kalman filter for data assimilation using the Hybrid Coordinate Ocean Model

Steven S. Rumrill
A question-based approach to environmental monitoring within the South Slough National Estuarine Research Reserve, Oregon, USA

Hanna Na, Kuh Kim and Kyung-Il Chang
Accuracy of surface current velocity measurements obtained from HF radar along the east coast of Korea

Toshiro Saino (Invited)
An ocean observing system for carbon cycle studies

John A. Barth, R. Kipp Shearman, Anatoli Erofeev, Tristan Peery, Murray D. Levine, Walt Waldorf and Craig Risien
Autonomous underwater glider observations off central Oregon and the Oregon Coastal Ocean Observing System (OrCOOS)

Svein Vagle (Invited)
Continuous monitoring of marine mammals, natural and man made noise in Georgia Strait and Saanich Inlet using the VENUS observatory

David G. Foley
Delivery and application of oceanographic satellite data in the era of integrated ocean observing systems

Hidekatsu Yamazaki, Yuji Kitade and Yusaku Kokubu (Invited)
Developing a diagnostic system to assess red tide of Tokyo Bay

John Dower, Ian Beveridge and Richard Dewey (Invited)
Drinking from the fire hose: Moving from the limitations of under-sampled field data to the prospect of "always on" data streams

Young Jae Ro and Kwang Young Jung
Integrative approach for the coastal dynamics and ecosystem in the Kangjin Bay, South Sea, Korea

Todd D. O'Brien, David L. Mackas, Mark D. Ohman and remaining WG-125 members
Issues and methods for analyzing zooplankton time series – Sample applications of the SCOR WG125 toolkit

Mairi M.R. Best, B.D. Bornhold, S.K. Juniper and C.R. Barnes
NEPTUNE Canada regional cabled observatory: Science plan

David W. Welch and George Jackson
POST – A permanent continental-scale ocean observing array for fisheries research: Performance and scientific relevance

Sonia D. Batten
The CPR: Antique technology observing today's oceans

Mike F. Henry, Sonia D. Batten, K. David Hyrenbach, Ken H. Morgan and Bill J. Sydeman
The meso-scale response of subarctic North Pacific seabird community structure to lower trophic level abundance and diversity

Benoît Pirenne (Invited)
The NEPTUNE Canada Cabled Observatory Data Management System: Capturing and delivering terabytes of data each day

Posters

Joon-Yong Yang, Kyu-Kui Jung, Hee-Dong Jeong, Young-Sang Suh and Chang-Su Jung
A real-time coastal information system for aquaculture environmental monitoring

John A. Barth, Murray D. Levine, Walt Waldorf, Andrew Barnard, Bruce Rhoades, Alex Derr, John Koegler and Daniel Whiteman
A vertical profiling mooring for coastal observations: Coastal Autonomous Profiling and Boundary Layer System (CAPABLE)

Susan Banahan
An overview of the Ocean Observatories Initiative (OOI) network

Yong Yao and Shenglin Ye
Application of satellite altimeter data in analysis and prediction of the sea surface wind and wave fields over the China Sea and Western Pacific Ocean

John A. Barth, R. Kipp Shearman, Anatoli Erofeev, Tristan Peery, Murray D. Levine, Walt Waldorf and Craig Risien
Autonomous underwater glider observations off central Oregon and the Oregon Coastal Ocean Observing System (OrCOOS)

Thomas C. Royer and Chester E. Grosch
Coastal freshwater discharge in the Northeast Pacific using an updated hydrology model

Elena Dmitrieva, Vladimir Ponomarev, Natalia Rudykh, Nina Savelieva and Igor Rostov
Data integration from different sources for the study of long-term variability in the ocean - Atmosphere system over the Japan/East Sea (E-Poster)

Yoshiyuki Kaneda
Dense Ocean floor Network system for Earthquakes and Tsunamis (DONET)

Chuanlin Huo, Zhengxian Yang, Quan Wen and Daoming Guan
Development and implementation of a multi-sectoral marine environmental monitoring programme for Bohai Sea

Gitai Yahel, Ruthy Yahel, Timor Katz, Boaz Lazar, Barak Herut and Verena Tunnicliffe
Fish activity, a major mechanism for nutrient and carbon recycling from coastal marine sediments

Albert J. Hermann, Christopher W. Moore, Sarah Hinckley, Carolina Parada, Elizabeth L. Dobbins and Dale B. Haidvogel
Immersive visualization online: A modern approach for the rapid exploration of Eulerian and individual-based models (E-Poster)

E.D.Vjazilov, N.N. Mikhailov, I.D. Rostov, N.I. Rudykh, V.I. Rostov and E.V. Dmitrieva
National unified system of information on the World Ocean condition of Russia: Improvement and operational details (E-Poster)

Igor Rostov, Natalia Rudykh, Vladimir Rostov, Alexander Pan, Anton Gavrev, Elena Dmitrieva, Valentina Moroz and Olga Trusenkova
New electronic atlases on oceanography of the Eastern Asia seas (E-Poster)

S. Allen Macklin, Bernard A. Megrey, Kimberly Bahl and Ruguang Yin
Pacific-wide marine metadata management and delivery: The PICES Metadata Federation

Jie Su, Yaobing Wang and Di Yang
Research on the stability of Escherichia coli as an indicator for detecting fecal pollution in seawater

Peter G. Phibbs and Stephen Lentz
Technology for cabled ocean observatories and their vertical profiler systems

POC/CCCC/MONITOR Topic Session (S9)
Operational forecasts of oceans and ecosystems

Co-Convenors: Michael G. Foreman (Canada), Shin-ichi Ito (Japan), Skip McKinnell (PICES) and Francisco E. Werner (U.S.A.)

Background

Numerical models of ocean dynamics are becoming increasingly sophisticated and are now used to forecast future ocean states. The forecasts vary in geographic scale from local embayments to the global ocean, and on temporal scales, from one day to several years. Improvements in ocean forecasting will contribute directly to forecasts of fisheries where the linkages between ocean dynamics, fish migration, and fishery ground formation are understood. Likewise, lower trophic level (LTL) ecosystem models have been coupled to numerical models of ocean circulation and tested at many sites. LTL models can now anticipate the production of planktonic prey and biomass when the state of the ocean is captured accurately by ocean circulation models. Moreover, fish growth and recruitment models are starting to be coupled to LTL ecosystem models. The growing interest in ecosystem-based management, and the need to develop a management/decision policy will no doubt rely

upon forecasts from coupled physical–ecosystem models. To fully realize the potential of model-based products for ecosystem-based management, a relatively high predictability of ocean structures is essential. This session will review the current status of operational ocean prediction models, discuss the ability of physical models to forecast ecosystem state and clarify the approaches needed for future studies and improvements. Ideally, we seek papers describing operational forecasts of oceans and/or ecosystem-state and, more importantly, evaluations of their performance. Operational forecasts can be based on numerical or statistical models, and comparisons of these two approaches are welcome.

Summary of presentations

From the presentation by invited speaker Masafumi Kamachi of the Japan Meteorological Research Institute, the participants learned how changes in the path of the Kuroshio along the Pacific coast of Japan can be forecast from numerical models with lead times of one to two months. The development of a major meander in this current has significant effects on the catches of fishes such as skipjack and mackerel. Sensitivity tests with this model indicated that the inclusion/exclusion of hydrographic data from Project Argo had the greatest influence on the accuracy of the forecast. Assimilation of hydrographic data from prefectural fisheries institutes in Japan provided important improvements to the model results in the Japan Coastal Ocean Predictability Experiment (JCOPE) and JCOPE2. These data had not traditionally been assimilated into coastal models but a data system has now been established to facilitate this. It was interesting to note, however, that an intimate connection to current data is required to keep the models on track. Research activities and modeling by University of British Columbia scientists from the Strait of Georgia Ecosystem Modelling (STRATOGEM) project have seen the development of a capacity for accurate forecasts of the timing of the spring bloom in the Strait of Georgia during the last two years. Invited speaker, Alain Vézina from the Bedford Institute of Oceanography, Canada, discussed general issues associated with developing complexity and simplicity in modeling frameworks. We learned from William Crawford (Canada) how the classical global warming signal for the northern hemisphere is not strongly evident in all parts of the hemisphere; it is relatively weak in the northeastern Pacific as a consequence of changing wind patterns. The progress of operational oceanography and forecasting varies significantly among regions. In some locations, program objectives have focused on the generation of hypotheses but elsewhere, greater advances have been made in the implementation of operational strategies. Einar Svendsen from Norway/ICES described in an invited presentation the current state of operational infrastructure in European countries, complementing the presentation by Masafumi Kamachi of Japan. Taken in combination, these discussions suggest that greater cooperation between ICES and PICES in developing operational oceanography might lead to the accelerated development of capacity in this area.

List of papers

Oral Presentations

Alain F. Vézina, Charles Hannah and Mike St. John (Invited)
A top-down approach to modelling marine ecosystems in the context of physical-biological modelling

Masafumi Kamachi, Toshiya Nakano, Satoshi Matsumoto, Norihisa Usui, Yosuke Fujii and Shiroh Ishizaki (Invited)
An example of operational ocean data assimilation and prediction

William Crawford and Ian Perry
Eastern Gulf of Alaska: Climate variability, future projections and ecosystem impacts

Hiroaki Tatebe, Ichiro Yasuda and Hiroaki Saito
Horizontal transport of *Neocalanus* copepods in the subarctic and northern subtropical North Pacific

Wei Cheng, Al Hermann, Sarah Hinckley and Ken Coyle
Interannual variability in the Gulf of Alaska: A perspective based on a coupled bio-physical model

George V. Shevchenko and George G. Novinenko
Monitoring of temperature conditions in the Sea of Okhotsk

Einar Svendsen (Invited)
Operational oceanography and the ecosystem approach

Albert J. Hermann, Thomas M. Powell, Wei Cheng and Sarah Hinckley
Performance of NEMURO with the Regional Ocean Modeling System (ROMS) for the Coastal Gulf of Alaska

Shin-ichi Ito, Shigeho Kakehi, Yasumasa Miyazawa, Takashi Setou, Kosei Komatsu, Manabu Shimizu, Akira Kusaka, Kazuyuki Uehara, Yugo Shimizu, Akira Okuno and Hiroshi Kuroda
Predictability of location of the Kuroshio Extension and the Oyashio First Branch by JCOPE

Susan E. Allen, A. Kathleen Collins, Douglas J. Latornell and Rich Pawlowicz
Predicting the timing of the spring bloom in the Strait of Georgia

Edmundo Casillas and William Peterson
Recent high-frequency variability in the PDO and ocean conditions in the northern California Current: Impacts on ecosystem structure and salmon growth and survival

Elena I. Ustinova and Yury D. Sorokin
Statistical forecasting of ice cover in the Far-Eastern Seas

Yury I. Zuenko, E.I. Ustinova, V.N. Vdovin, V.A. Nuzhdin, Z.G. Ivankova and N.T. Dolganova
Temporal lags between changes of climatic indices and some components of the Japan/East Sea ecosystem

Yasumasa Miyazawa, Takashi Kagimoto and Kosei Komatsu
Water mass structure in the Kuroshio-Oyashio mixed water region reproduced by JCOPE2

Posters

Yong-Kyu Choi, Young-Sang Suh, Ki-Tack Seong, Sang-Woo Kim, Won-Deuk Yoon, Woo-Jin Go, In-Seong Han and Joon Yong-Yang
Bimonthly variation of synoptic features in hydrography and nutrient in the Southern Sea of Korea

J.J. Colbert, Thomas C. Wainwright and Bernard A. Megrey
Linking the NEMURO suite into the Earth Systems Modeling Framework

BIO/FIS/POC Topic Session (S11)

Phenology and climate change in the North Pacific: Implications of variability in the timing of zooplankton production to fish, seabirds, marine mammals and fisheries (humans)

Co-Convenors: Elizabeth A. Logerwell (U.S.A.), David L. Mackas (Canada), Shoshiro Minobe (Japan) and William J. Sydeman (U.S.A.)

Background

Ecosystems of the North Pacific Ocean are characterized by strong seasonal variability in productivity. The Inter-governmental Panel on Climate Change (IPCC) projections indicate that substantial changes in phenology (timing events) and the biological interactions that depend on the seasonal cycle are likely. Several mechanistic hypotheses have been set forth to explain changes in fish production in relation to phenology, including "match-mismatch" and "optimal environmental window", yet there have been few tests of these ideas. In light of climate change predictions and recent changes in phenology in some North Pacific ecosystems (*e.g.*, late upwelling in the California Current in 2005/2006), the session focused on the implications of changes in the timing of seasonal zooplankton production to upper trophic level organisms through changes in their trophic ecology, physiology and behavior. Physical environmental changes that influence phenology also were within the scope of this session. Papers which test hypotheses, present new theoretical treatments, and/or provide models of life history variation were encouraged. In particular, integrated, multi-trophic level, multi-disciplinary analyses were sought. We anticipate publication of the papers from this topic session in primary literature.

Summary of presentations

On November 2, 2007, as part of the PICES Sixteenth Annual Meeting and under the auspices of the BIO/FIS/POC Committees, we held a topic session entitled "*Phenology and climate change in the North Pacific: Implications of variability in the timing of zooplankton production to fish, seabirds, marine mammals and fisheries (humans)*". The underlying reason for hosting this topic was that most marine ecosystems of the North Pacific Ocean are characterized by strong seasonal variability in productivity. IPCC projections indicate that one of the likely consequences of climate change and global /ocean warming may be substantial changes in "phenology" (*i.e.*, timing) of key ecological events. If climate change causes changes in the relative timing of productivity between trophic levels, many of the biological interactions that depend on synchronicity in abundance, availability and/or spatial distribution may be disrupted. Several mechanistic hypotheses have been put forth that deal with within-season variation in ocean climate, primary and secondary productivity and trophic interactions between predators and prey. Such hypotheses, including "match-mismatch" (Cushing, Lack) and "optimal environmental window" (Cury and Roy), have been used to explain variability in the fish and seabird recruitment, yet there have been comparatively few tests of these ideas despite its apparent application to many temperate and sub-arctic seas.

In light of IPCC predictions and observations of remarkable and unprecedented phenological changes in many northern hemisphere marine ecosystems (*e.g.*, delayed upwelling in the California Current in 2005), we sought to address the possible ubiquitous nature of the match-mismatch hypothesis, in particular, in seasonal seas of the northern hemisphere. With substantial contributions for colleagues both within and outside the PICES community, we addressed patterns, causes, consequences, and management implications of changes in the timing of oceanographic process from primary production to top predators through changes in their trophic ecology, physiology and behavior. We sought and received a series of multi-trophic level, multi-disciplinary contributions that made for one of the most thought-provoking and dynamic topic sessions of PICES XVI. We are now in the process of collating manuscripts for a special volume in *Deep-Sea Research II*, based in large part on this topic session.

The topic session opened with a brilliant invited presentation by Joel Marcel Durant (University of Oslo, Norway), in which he provided a compelling overview of the match-mismatch hypothesis and its potential application in global climate change biology. Yutaka Watanuki (Hokkaido University, Japan) provided a second outstanding invited presentation on prey-switching in a seabird relative to climate variability in the Japan Sea. In total, 17 oral presentations and 1 poster presentation were contributed. Papers in the session covered many aspects of seasonal timings in the ocean, but the most striking characteristic of all contributions was the extent of vertical integration in each of the marine ecosystems under consideration, both of the overall session dimensions and within individual papers. A rough classification of the datasets and results among the six 'trophic levels' considered (temperature to other modes of the physical environment and physical forcing; phytoplankton; zooplankton; fish; seabirds) showed a minimum of two, an average of three, and a maximum of five trophic levels considered per paper. Multi-trophic level relationships between climate variability and the seasonality of phytoplankton and zooplankton production was considered in detail by about one third of the contributors (Sonia Batten and David Mackas, Sanae Chiba and Kosei Sasaoka, Rana El-Sabaawi *et al.*, Yulia Tananaeva and Marat Bogdanov, Kazuaki Tadakoro *et al.*, and Andrew Thomas *et al.*). Interrelationships for the upper trophic levels included work on jellyfish (Jennifer Purcell), cod (Benjamin Laurel *et al.*), salmonids (Christine Abraham *et al.*, Richard Beamish *et al.*, Ronald Tanasichuk, and William Peterson *et al.*), sardines (Rubén Rodriguez *et al.* and Atsushi Tsuda *et al.*), and seabirds (Steven Bograd *et al.*, Douglas Bertram *et al.*, Joël Durant, and Yutaka Watanuki *et al.*). Overall, this fortuitous balanced approach to complex material resulted in a highly successful

topic session; the convenors were delighted with every presentation.

Finally, it was noteworthy that while this topic session was held on the last day of PICES XVI, attendance was considerable. Approximately 70 conference participants filled the room to capacity, a testament to the general interest in the topic session and quality of the contributions. Indeed, with "standing room only" in the morning, the session was subsequently moved to a larger venue for the afternoon contributions.

List of papers

Oral presentations

Benjamin J. Laurel, Thomas P. Hurst and Lorenzo Ciannelli
An experimental examination of temperature interactions in the 'match-mismatch' hypothesis for Pacific cod larvae

Douglas F. Bertram, Anne Harfenist and April Hedd
Cassin's Auklet nestling diet reveals latitudinal variation in surface timing of *Neocalanus cristatus* prey biomass in BC: Mismatch likelihood is greater in warmer, southern waters

Sonia D. Batten and David L. Mackas
Changes in development timing and cohort width of *Neocalanus plumchrus* / *flemingeri* copepods in the eastern North Pacific

Sanae Chiba and Kosei Sasaoka
Climatic forcing and phytoplankton phenology over the North Pacific 1997-2006

Kazuaki Tadokoro, Yuji Okazaki and Hiroya Sugisaki
Decadal scale variations in developmental timing of *Neocalanus* copepod populations in the Oyashio waters, western North Pacific

Jennifer E. Purcell
Effects of temperature and light on the phenology of jellyfish

Atsushi Tsuda, Takumi Nonomura, Mitsuhiro Toratani and Sachihiko Itoh
Food availability for Japanese sardine larvae in the Kuroshio extension area

Andrew Thomas, Peter Brickley and Stephanie Henson
Large-scale time and space patterns of chlorophyll phenology in the NE Pacific

Richard J. Beamish, Ruston M. Sweeting and Chrys M. Neville
Managing a Strait of Georgia ecosystem

Joël M. Durant (Invited)
Match-mismatch, trophic interactions and climate change

William T. Peterson, Leah Feinberg, Tracy Shaw, Jennifer L. Menkel and Jay Peterson
Phenology of coastal copepod species: Implications for productivity at various trophic levels in the Oregon upwelling zone

Rubén Rodríguez-Sánchez, Marlene Manzano, Héctor Villalobos, Mati Kahru, Daniel Lluch-Belda and Sofía Ortega-García
Possible mechanisms underlying abundance changes of Pacific sardine (*Sardinops caeruleus*) in the California Current System during the last warming regime (1980-1997)

Rana W. El-Sabaawi, Akash R. Sastri and John F. Dower
Potential consequences of interannual variability in lower trophic level dynamics on energy transfer in the Strait of Georgia

Yulia N. Tananaeva and Marat A. Bogdanov
SST and ice conditions' variability in different parts of North West Pacific, its influence on phytoplankton production and fishery resources

Ronald W. Tanasichuk
The effect of variations in timing and magnitude of euphausiid productivity on return variability of Somass River sockeye (*Oncorhynchus nerka*) salmon

Steven J. Bograd, William J. Sydeman and Christine Abraham
The phenology of coastal upwelling in the California Current System

Yutaka Watanuki, Motohiro Ito, Tomohiro Deguchi and Shoshiro Minobe (Invited)
Timing of breeding and prey switching in Rhinoceros Auklets; match-mismatch of the phenology explains between year variation of chick growth

Posters

Christine L. Abraham, William J. Sydeman and G. Vernon Byrd
Seabird-sockeye salmon co-variation in the eastern Bering Sea: Phenology as an ecosystem indicator and salmonid predictor?

BIO Paper Session

Co-Convenors: Michael J. Dagg (U.S.A.), Michio J. Kishi (Japan) and Angelica Peña (Canada)

Background

The theme of PICES XVI is "*The changing North Pacific: Previous patterns, future projections, and ecosystem impacts"*. In this session, we welcomed papers on biological aspects of the PICES XVI theme as well as papers on other aspects of biological oceanography in the North Pacific and its marginal seas. Young scientists were especially encouraged to submit papers to this session.

Summary of presentations

The BIO Paper session this year was a full day of oral presentations on aspects of biological oceanography in the North Pacific Ocean, complemented by 12 poster presentations. Contributions were made from all PICES countries. As expected in such an open session, topics ranged widely across many aspects of biological oceanography. Presentations were made on iron limitation, on dimethyl sulphide (DMS) production and fates, on the Changjiang river plume, on long-term patterns in North Pacific surface chlorophyll, on the spatial and temporal variability of chlorophyll concentration and zooplankton biomass and composition in the western North Pacific and its relationship to physical characteristics, and on aspects of the biology of North Pacific biota, including copepods, euphausiids, fish, squid, and whales. Rounding out the total was a contribution on NPZ modeling and a presentation on an invasive sessile tunicate. The convenors made a special effort to encourage young scientists and this resulted in 8 of the 18 talks being given by persons with their PhDs awarded within the past 5 years. We will continue to encourage young marine biologists to present their science at the BIO session next year.

List of papers

Oral presentations

Brie J. Lindsey and Harold P. Batchelder
A *Euphausia pacifica* bioenergetic model for the California Current System

Shigenobu Takeda, Atsushi Tsuda, Philip W. Boyd, Paul J. Harrison, Isao Kudo, Maurice Levasseur, Jun Nishioka, Yukihiro Nojiri, Hiroaki Saito, Koji Suzuki, Mark Wells and C.S. Wong
Biogeochemical responses of planktonic ecosystems during three meso-scale iron enrichment experiments in the subarctic North Pacific

Ai Ueda, Toru Kobari and Deborah K. Steinberg
Body allometry and chemical composition of interzonally migrating copepods in the subarctic Pacific Ocean

Jeffrey J. Polovina, Melanie Abecassis and Evan A. Howell
Changes in oceanic surface chlorophyll in the North Pacific over the past decade: Is the North Pacific getting bluer?

Nadja Steiner and Ken Denman
Development of a mechanistic DMS model – Parameter sensitivities in a single column

Toru Kobari, Ai Ueda, Deborah K. Steinberg, Minoru Kitamura and Atsushi Tsuda
Development of ontogenetically migrating copepods in the Western Subarctic Gyre

Ryosuke Okamoto, Tsutomu Tamura, Kenji Konishi and Hidehiro Kato
Differences in foods and feeding habits in common minke and sei whales in the western North Pacific based on samples collected under the JARPN II survey project

Takumi Nonomura, Atsushi Tsuda, Ichiro Yasuda and Shuhei Nishida
Distribution patterns of *Calanus sinicus* and *C. jashnovi* (Copepoda: Calanoida) in the western temperate North Pacific: Relations with the Kuroshio Extension

Shin-ichi Ito, Kenneth A. Rose, Naoki Yoshie, Bernard A. Megrey, Michio J. Kishi and Francisco E. Werner
Evaluation of an automated approach for calibrating the NEMURO nutrient-phytoplankton-zooplankton food web model

Hiroshige Tanaka, Seiji Ohshimo and Ichiro Aoki
Feeding habits of mesopelagic fishes off the coast of western Kyushu, Japan

Suguru Okamoto and Sei-ichi Saitoh
Impact of the Kuroshio Extension on spatial and temporal variability of chlorophyll a concentration

Atsushi Yamaguchi, Naonobu Shiga, Tsutomu Ikeda, Yoshihiko Kamei and Keiichiro Sakaoka
Interannual/latitudinal variations in abundance, biomass, community structure and estimated production of epipelagaic mesozooplankton along 155°E longitude in the western North Pacific during spring

Olga Yu. Tyurneva, Vladimir V. Vertyankin, Yuri M. Yakovlev, Valery A. Vladimirov and Vladimir N. Burkanov
Occurrence of gray whales (*Eschrichtius robustus*) of the endangered western population off the east coast of the Kamchatka Peninsula

Oleg N. Katugin, Gennady A. Shevtsov, Mikhail A. Zuev and Anna V. Dakus
Patterns of size structure and ecology in the northern gonate squid (*Boreoteuthis borealis*) in the Okhotsk Sea and northwestern Pacific Ocean

Thomas W. Therriault, Leif-Matthias Herborg and Cathryn L. Clarke
Predicted changes in the distribution of the non-indigenous tunicate *Styela clava* along the west coast of North America with emphasis on Canadian waters

Jun Nishioka, Tsuneo Ono and Hiroaki Saito
Seasonal variability of micro-nutrient concentrations in the Oyashio region

Jinhui Wang, Yutao Qin, Caicai Liu, Haofei Zhang, Yawei Sun and Lian Cao
Variability of sand transport flux in the Changjiang River and its influence on the ecosystem and resources of the East China Sea

Posters

Alexander V. Zavolokin, Natalya S. Kosenok and Igor I. Glebov
Abundance, distribution and feeding habits of jellyfish in the upper epipelagical of the western Bering Sea

A. Jason Phillips, Richard D. Brodeur and Andrey Suntsov
Community structure of micronekton in the Northern California Current System

Hyung-Ku Kang, Chang Rae Lee and Sinjae Yoo
Comparison of vertical distribution of suspended fecal pellets and production of copepod fecal pellets in the Ulleung Basin between 2005 and 2006

Tatyana A. Belan, Elena M. Latkovskaya and Alexey V. Berezov
Composition and distribution pattern of benthic communities of Chayvo Bay (Northeast Sakhalin Island)

Goh Onitsuka, Itsushi Uno, Tetsuo Yanagi and Jong-Hwan Yoon
Effect of atmospheric nitrogen input on the lower trophic ecosystem in the Japan/East Sea

Vladimir I. Radchenko
Estimation of diurnal vertical migration rate of the Sea of Okhotsk zooplankton with assumption of net avoidance

Elena Dulepova and Vladimir Dulepov
Long-term fluctuation of zooplankton bioproductivity in the western Bering Sea

Pung Guk Jang, Kyoungsoon Shin, Dong Hyun Shon, Woong-Seo Kim and Dongsup Lee
Spatial and temporal distribution of inorganic nutrients and nutrient ratios as controls on composition of phytoplankton in the western channel of the Korea Strait

Guoying Du, Yunhee Kang, Moonho Son, Jaeran Hwang, Soonmo An and Ikkyo Chung
Spatio-temporal variation of intertidal microphytobenthos in the Nakdong Estuary, Korea

Koji Omori, Hidejiro Ohnishi, Toru Fukumoto, Shunsuke Takahashi, Hideki Hamaoka, Miyuki Ohnishi, Kenji Yoshino, Genkai Kato and Todd W. Miller
Two sources of primary production of sand bank ecosystems in Seto Inland Sea, Japan

CCCC Paper Session

Co-Convenors: Harold P. Batchelder (U.S.A.) and Michio J. Kishi (Japan)

Background

North Pacific ecosystems and their response to climate variability have experienced intense study through GLOBEC and similar programs over the past 10 years. The PICES Climate Change and Carrying Capacity (CCCC) Program addressed the question of "how do interannual and decadal variations in ocean conditions affect the species dominance, biomass and productivity of the key zooplankton and fish species in North Pacific ecosystems?". Ultimately, a goal of the CCCC Program was to forecast possible consequences of climate variability on the North Pacific ecosystem. As the CCCC Program nears completion, it is worthwhile to examine the program's successes on addressing the key elements: climate change, carrying capacity, and forecasting. This evaluation will provide useful information for moving forward with successor PICES integrative programs like FUTURE: Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Ecosystems. We invited abstracts that infer processes from patterns and link climate, ocean physics, populations and ecosystems. Provocative abstracts that retrospectively examine the successes and shortcomings of the CCCC Program were welcomed, as were more traditional presentations on climate, ecosystems and forecasting.

List of papers

Oral presentations

James J. Ruzicka, Thomas C. Wainwright and William T. Peterson
A simple production model for the Oregon upwelling ecosystem: Investigating the effect of interannual variability in copepod community composition

Richard D. Brodeur, William T. Peterson, Toby D. Auth, Heather L. Soulen, Maria M. Parnel and Ashley A. Emerson
Abundance and diversity of coastal fish larvae as indicators of recent changes in ocean and climate conditions in the Oregon upwelling zone

George D. Jackson, B.R. Ward, R.S. McKinley and D.W. Welch
Application of the POST acoustic array to a critical marine conservation problem for juvenile steelhead trout (*Oncorhynchus mykiss*) in British Columbia

William T. Peterson, Thomas C. Wainwright and James J. Ruzicka
Climate change scenarios for continental shelf waters of the Northern California Current: Potential impacts of changes in upwelling, stratification, seasonal cycles of production and the PDO on pelagic ecosystems

Suam Kim, Sukyung Kang, Hyunju Seo, Eunjung Kim and Minho Kang
Climate variability and chum salmon production and survival in the North Pacific

C. Tracy Shaw, Leah R. Feinberg and William T. Peterson
Interannual variability in abundance, growth and spawning of the euphausiids *Euphausia pacifica* and *Thysaonessa spinifera* off Newport, OR, USA

Sachihiko Itoh, Ichiro Yasuda, Haruka Nishikawa, Hideharu Sasaki and Yoshikazu Sasai
Modelling the transport and environmental variability of larval Japanese sardine (*Sardinops melanostictus*) and Japanese anchovy (*Englaulis japonicus*) in the western North Pacific

David L. Mackas and Jackie King
Multivariate classification of zooplankton life history strategies

Jennifer L. Menkel, William T. Peterson, Jesse F. Lamb, Julie E. Keister and T. O'Higgins
Northern California Current (WA, OR, northern CA) hot spots of abundance for *Euphausia pacifica* and *Thysanoessa spinifera*

Brigitte Dorner, Randall M. Peterman, Cindy Bessey and Franz J. Mueter
North-south location of the North Pacific Current and its influence on temporal variation in recruits per spawner in northeastern Pacific salmon (Oncorhynchus) populations

Tadanori Fujino, Kazushi Miyashita, Yasuma Hiroki, Tsuyoshi Shimura, Shinya Masuda and Tsuneo Goto
Regime shift of mesopelagic fish – Long-term biomass index change of *Maurolicus japonicus* in the Japan/East Sea

Harold P. Batchelder, Brie J. Lindsey and Brendan Reser
Retentive structures, transport and connectivity in coastal ecosystems: Using a quantitative particle tracking metric to describe spatio-temporal patterns

Nandita Sarkar, Thomas C. Royer and Chester E. Grosch
Seasonal and interannual variability of mixed layer depths along the Seward Line in the Northern Gulf of Alaska

Julie E. Keister, William T. Peterson and P. Ted Strub
Zooplankton populations and circulation vary interannually to effect cross-shelf advection of biomass in the northern California Current

Posters

Young-Shil Kang, In-Seong Han and Donghyun Lim
Climate-related variations in oceanographic condition and mesozooplankton in the southwestern East China Sea after the mid 1990s

Xan Augerot, Ray Hilborn, Nathan Mantua, Kate Myers, Randall Peterman, Dave Preikshot, Peter Rand, Greg Ruggerone, Daniel Schindler, Jack Stanford, Nathan Taylor, Trey Walker and Carl Walters
The salmon MALBEC project: A North Pacific scale study to support salmon conservation planning

FIS 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. The FIS Paper Session enhances FIS activities in PICES by fostering participation by more fisheries scientists with different interests in annual meetings. The FIS paper session invited topics in fisheries science and fisheries oceanography in the North Pacific and its marginal seas.

Summary of presentations

The FIS Paper Session in 2007 included 19 oral presentations and 24 posters that covered a wide variety of fish species from five PICES-member countries plus Mexico and Romania. Taxa covered during presentations included gadids, salmon, invertebrates (*e.g.*, crab, shrimp, squid), small and large pelagic fish species, and marine mammals. Novel methods included the use of fractals to study time series of fish catches, a Geographic Information System approach toward stock assessment, integration of environmental data into marine mammal stock assessment, acoustic measurements of *Sargassum* beds, and whole ecosystem comparisons. Processes that were investigated included spawning migrations (*e.g.*, sockeye salmon), larval drift (*e.g.*, squid paralarvae, Greenland halibut), age and growth (*e.g.*, spiny dogfish, Pacific cod, salmon), predator–prey interactions (*e.g.*, pollock), range extensions (*e.g.*, Pacific hake), and environmental effects on the distribution of species and fisheries (*e.g.*, tuna, saury, northern anchovy, sea lion prey). Classical fishery research studies remain important, but this session represented a continuing trend in recent years toward ecosystem-based research of exploited fish and invertebrates in the PICES region. Based on the number of presentations and posters and the high quality of the presentations, the FIS paper session at PICES XVI was very successful.

List of papers

Oral presentations

Sarah Gaichas, Georg Skaret, Jannike Falk-Petersen, Jason S. Link, William Overholtz, Bernard A. Megrey, Harald Gjøsæter, William Stockhausen, Are Dommasnes and Kerim Aydin
A comparison of community and trophic structure in four marine ecosystems based on energy budgets and system metrics

Marc Trudel, David L. Mackas and Asit Mazumder
Assessing the effects of ocean conditions on the growth and survival of Pacific salmon in British Columbia and Alaska

Franz J. Mueter, Cecilie Broms, Ken Drinkwater, Kevin Friedland, Jon Hare, George Hunt Jr., Webjørn Melle and Maureen Taylor
Comparison of 4 Northern Hemisphere regions: Ecosystem responses to recent oceanographic variability

Toby D. Auth
Distribution and community structure of ichthyoplankton from the northern and central California Current in May 2004–2006

Sayaka Nakatsuka, Akinori Takasuka, Hiroshi Kubota and Yoshioki Oozeki
Estimating daily ration of skipjack tuna on larval and juvenile anchovy in the Kuroshio–Oyashio transition region in early summer

Woo-Seok Gwak
Genetic approach for the assessment of a stock enhancement of Pacific cod (*Gadus macrocephalus*)

Mikhail A. Stepanenko, Elena V. Gritsay and Svetlana Yu. Glebova
Impact of environment and exploitation on the interannual variability eastern Bering Sea pollock: Abundance and distribution

John R. Brandon, André E. Punt, Paul R. Wade, Wayne L. Perryman, Richard D. Methot, Mark N. Maunder and George M. Watters
Integrating environmental data into marine mammal stock assessments: Application to the eastern North Pacific gray whale

Naoki Tojo, Akira Nishmura, Satoshi Honda, Tetsuichiro Funamoto, Seiji Katakura and Kazushi Miyashita
Marine environment induced spatial dynamics of recruited walleye pollock juveniles (*Theragra chalcogramma*) and interactions with prey and predators along the Pacific coast of Hokkaido, Japan

Rodrigo M. Montes, R. Ian Perry, E.A. Pakhomov and J.A. Boutillier
Novel time series methods (fractals) applied to Eastern Pacific fisheries

Alexander I. Glubokov
Population structure of the Bering Sea pollock and functional structure of it range in recent decades

Edward J. Gregr, Rowenna Flinn, Mathew Bermann and Gaku Ishimura
Predicting the relative abundance of pinniped prey in the Gulf of Alaska

Nanami Kumagai, Hidetada Kiyofuji, Hideaki Kidokoro and Sei-Ichi Saitoh
Prediction and of Japanese common squid (*Todarodes pacificus*) fishing grounds using generalized additive models in the Japan/East Sea

Inja Yeon, Myoung Ho Sohn, Mi Young Song, Hak Jin Hwang and Yang Jae Im
Research program for stock rebuilding of blue crab, *Portunus trituberculatus*, in the western sea of Korea

Leonardo Huato-Soberanis and Martha J. Haro-Garay
Spawning migrations in fish: A case study of the sockeye salmon from the Fraser River in British Columbia

You Jung Kwon, D.H. An, C.I. Zhang and D.Y. Moon
Standardization of CPUE for bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) tunas of Korean longline fishery in the Indian Ocean

Jung Jin Kim, Suam Kim and Hwa Hyun Lee
Summer occurrence and transport process of common squid (*Todarodes pacificus*) paralarvae in the East China Sea

Michael J. Schirripa
Testing two methods of including environmental factors into stock assessments

Oleg Bulatov, Boris Kotenev, Georgiy Moiseenko and Vladimir Borisov
The GIS method application for the stock assessment of the walleye pollock and the Northeast Arctic cod

Posters

Jong Hee Lee and Chang-Ik Zhang
A study on the assessment of the large purse seine fishery off Korea based on principles of the Marine Stewardship Council

Kenji Minami, Kazushi Miyashita, Akira Hamano, Takeshi Nakamura, Yuta Maruoka and Hiroki Yasuma
Acoustic measurement of *Sargassum* beds in coastal area of western Honshu, Japan

Yeong Hye Kim, Dong Woo Lee, Seon Jae Hwang, Byung Kyu Hong, Soo Ha Choi
Age and growth of Pacific cod, *Gadus macrocephalus* in the East/Japan Sea

Cindy A. Tribuzio and Gordon H. Kruse
An alternative approach to estimating worn annuli for aging of spiny dogfish (*Squalus acanthias*) spines

Eugene V. Samko, Nafanail V. Bulatov and Alexander V. Kapshiter
Anticyclonic eddies of various origin southeastward from Hokkaido and their influence on saury fishery

Joo-il Kim, Young-il Seo and Sukgeun Jung
Daily biomass and production of Pacific anchovy, *Engraulis japonicus*, in the southern coastal area of Korea

Masakazu Shinto, Hideaki Kudo and Masahide Kaeriyama
Development of the olfactory organ in chum salmon (*Oncorynchus keta*) during migration

Dongwha Sohn, Lorenzo Ciannelli, Janet Duffy-Anderson, Ann Matarese and Kevin M. Bailey
Distribution and drift pathways of Greenland halibut, *Reinhardtius hippoglossoides*, during early life stage in the eastern Bering Sea

Marisa N.C. Litz, Robert L. Emmett, Selina S. Heppell and Richard D. Brodeur
Ecological considerations for northern anchovy abundance and distribution in the northern California Current

Yuya Yokoyama, Hideaki Kudo and Masahide Kaeriyama
Estimating escapement and spawning capacity of pink salmon (*Oncorhynchus gorbuscha*) at rivers in the Shiretoko World Natural Heritage area

Sukgeun Jung, Sun-do Hwang, Joo-il Kim, Young-il Seo and Jin-yeong Kim
Fecundity and growth-dependent mortality of Pacific anchovy (*Engraulis japonicus*)

Andrey Suntsov and Richard Brodeur
Feeding ecology of three dominant lanternfish species (Myctophidae) off Oregon

Ryota Yokotani, Naotaka Imai, Hideaki Kudo and Masahide Kaeriyama
Genetic differentiation between early-run and late-run populations of the Yurappu River chum salmon *Oncorhynchus keta* using the mitochondrial DNA analysis

Carrie J. Johnson, Robert L. Emmett and Gordon McFarlane
Jack mackerel (*Trachurus symmetricus*) abundance, distribution, diet, and associated relationships to oceanographic conditions in the northern California Current

Rodrigo M. Montes, R. Ian Perry, E.A. Pakhomov and J.A. Boutillier
Long-term patterns in sea surface temperature (SST) and smooth pink shrimp (*Pandalus jordani*) catches off the west coast of Vancouver Island, Canada

Nikolina Petkova Kovatcheva
Maintenance of red king crab stocks in the North Pacific using mariculture methods

A. Jason Phillips, Stephen Ralston, Richard D. Brodeur, Toby D. Auth, Robert L. Emmett, Carrie J. Johnson and Vidar G. Wespestad
Recent pre-recruit Pacific hake (*Merluccius productus*) occurrences in the northern California Current suggest a northward expansion of their spawning area

Bernard A. Megrey, Jon Hare, Are Dommasnes, Harald Gjøsæter, William Stockhausen, William Overholtz, Sarah Gaichas, Georg Skaret, Jannike Falk-Petersen, Jason S. Link and Kevin Friedland
Recruitment variation in functionally equivalent fish stocks: A cross-ecosystem comparison

Richard D. Brodeur, E. Howell, J. Polovina, L. Ciannelli, W.G. Pearcy, R.M. Laurs and J. Childers
Spatial and temporal variations in albacore habitat in the Northeast Pacific using remotely-sensed environmental data

Galina V. Belova
Spawning and fecundity of highly abundant fishes of the family Bathylagidae in the Russian Far Eastern seas and adjacent waters of the northwestern Pacific Ocean

Dae Sun Son, Chae Woo Ma and Wongyu Park
Survival rate and growth of larval swimming crab, *Portunus trituberculartus*, in the laboratory

Jie Zheng
Temporal changes in size at maturity and their implications for fisheries management for eastern Bering Sea Tanner crab

Jun Yamamoto, Miyuki Hirose, Tetsuya Ohtani, Katashi Sugimoto, Kazue Hirase, Nobuo Shimamoto, Tsuyoshi Shimura, Natsumi Honda, Yasuzumi Fujimori and Tohru Mukai
Transportation of organic matter to the sea floor by carrion falls of the giant jellyfish (*Nemopilema nomurai*) in the Japan/East Sea

Sukgeun Jung
Yield-per-recruitment of Pacific anchovy (*Engraulis japonicus*) in Korean coastal waters

POC Paper Session

Co-Convenors: Michael G. Foreman (Canada) and Ichiro Yasuda (Japan)

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 33 oral presentations and 15 posters covering a wide range of physical and biogeochemical oceanographic research. Ichiro Yasuda, Steven Bograd and Fangli Qiao assisted Mike Foreman in chairing sub-sessions over the 2-day presentation period. The first day included interesting talks related to 1) climate changes in the North Pacific (James Overland, Howard Freeland) and sub-Arctic seas (Kenneth Drinkwater), 2) the role of surface wave-induced mixing in climate models (Fangli Qiao), 3) effects of the 18.6 year nodal tidal cycle in the Kuril Island passages (Ichiro Yasuda, Satoshi Osafune), 4) breathing and bifurcation modes in the North Pacific (Patrick Cummins), 5) features off the Kuril Islands (Alexander Rabinvich, George Shevchenko) and Sakhalin (Viachesalv Makarov), 6) eddies in various regions of the North Pacific (Konstantin Rogachev, Hiromichi Ueno, and Carol Ladd), 7) the structure of the California Undercurrent (Maxim Krassovski), and viii) seasonal variability off the west coast of Baja California (Oleg Zaitsev).

Apart from one presentation on Ekman pumping along the Seward line off Alaska (Isaac Schroeder), another on the role of wind stress errors in data assimilation (Tsuyoshi Wakamatsu), and a third on gas exchanges at Station Papa, the second day of talks focused on the eastern Pacific. It included talks on 1) turbulence measurements in Bussol Strait and the Kuroshio/Oyashio confluence region (Masahiro Yagi, Hitoshi Kaneko), 2) various features in the Japan/East (Young-Gyu Park, Oleg Trusenkova, Natalia Rudykh) and Yellow and East China (Ig-Chan Pang, Byung-Ho Lim) Seas, 3) aggregation mechanisms in Academy Bay (Konstantin Rogachev), 4) the role of Siberian Rivers and Bering Strait water in the circulation of the Arctic Ocean (Victor Kuzin), 5) physical features of harmful algal blooms off southern Korea, 6) Argo data and the baroclinic structure of the subarctic gyre (Masatoshi Sato), 7) mixing in the Oyashio (Tokihiro Kono), 8) internal tide generation (Dejun Dai), and 9) possible roles of biota in climate change (Vadim Navrotsky).

All speakers were commended for interesting presentations and posters.

List of papers

Oral presentations

Tokihiro Kono, Masatoshi Sato and Tsutomu Ikeda
A mixing process of the Oyashio water as revealed by sequential observations off southeast Hokkaido, Japan (OECOS-WEST)

Hiromichi Ueno, H.J. Freeland, W.R. Crawford, H. Onishi, E. Oka and T. Suga
Anticyclonic eddies in the Alaskan Stream

Masatoshi Sato and Tokihiro Kono
Baroclinic structure in the subarctic gyre of the North Pacific from the Argo float CTD data

Satoshi Osafune and Ichiro Yasuda
Bidecadal variation in the region south of Japan and relation between the large meander of the Kuroshio and the 18.6-year period nodal tidal cycle

Richard E. Thomson, Georgy V. Shevchenko and Alexander B. Rabinovich
Coastally trapped diurnal waves observed along the South Kuril Islands

Kenneth F. Drinkwater, Cecilie Broms, Kevin Friedland, Jon Hare, George Hunt Jr., Webjørn Melle, Franz J. Mueter and Maureen Taylor
Comparison of 4 Northern Hemisphere regions: Physical oceanographic responses to recent climate variability

Hitoshi Kaneko and Ichiro Yasuda
Current and turbulence observations of North Pacific intermediate water in the Kuroshio-Oyashio confluence region

Carol Ladd, W.R. Crawford, W.K. Johnson, N.B. Kachel, P.J. Stabeno and F. Whitney
Eddies in the eastern Gulf of Alaska

Isaac D. Schroeder, Thomas C. Royer and Chester E. Grosch
Ekman pumping along the Seward Line in the Northern Gulf of Alaska

Nadja Steiner, Svein Vagle, Ken Denman and Craig McNeil
Gas exchange at Station Papa – Simulated and observed O_2, N_2 and CO_2 cycling

Konstantin A. Rogachev, Eddy C. Carmack and Michael Foreman
Mechanisms of lateral circulation in Academy and other bays of the Shantar Archipelago, Sea of Okhotsk

Howard J. Freeland, P.G. Myers and M. Li
Mixed-layer depths along Line-P - The annual cycle and recent variability

Byung-Ho Lim, Kyung-Il Chang, Mark Wimbush, Jae-Hun Park, Magdalena Andres and JongJin Park
Near 60-day variation of the Kuroshio observed in the East China Sea

Phyllis J. Stabeno and James E. Overland
New climate states during the last decade in the North Pacific

Victor I. Kuzin, Elena N. Golubeva and Gennady A. Platov
Numerical simulation of the propagation of the Bering Sea and Siberian river waters to the Arctic – North Atlantic

Tsuyoshi Wakamatsu, Michael Foreman, Patrick Cummins and Josef Cherniawsky
On the influence of random wind stress errors on the four-dimensional, mid-latitude, ocean inverse problem

Vadim V. Navrotsky
On the World Ocean as the primary natural cause of Global Climate Change

Hee-Dong Jeong, Yeong Gong, Yang Ho Choi and Chang Su Jeong
Physical oceanographic features of HABs in the southern coast of Korea

Natalia Rudykh
Salinity variability in the Japan/East Sea

Ig-Chan Pang and Jae-Hong Moon
Seasonal circulation in the Yellow Sea and the East China Sea

Oleg Zaitsev, Carlos J. Robinson and Orzo Sanchez-Montante
Seasonal variability of oceanographic conditions on the Pacific continental shelf of the southern Baja California peninsula

Gennady I. Yurasov and Natalia I. Rudykh
Some features of Peter the Great Bay hydrological regime in the fall–winter period

Olga Trusenkova, Vyacheslav Lobanov and Dmitry Kaplunenko
SST anomalies related to wind stress curl patterns in the Japan/East Sea

Viacheslav G. Makarov, Valentina D. Budaeva and Oleg V. Zaitsev
Summer density distribution near the north-eastern coast of Sakhalin based on the parametric modeling of vertical structure

Ichiro Yasuda
The 18.6-year nodal tidal cycle and bidecadal ENSO/PDO

Maxim V. Krassovski and Richard E. Thomson
The California Undercurrent off the west coast of Vancouver Island

Young-Gyu Park and Sang-Wook Yeh
The effects of the Tsushima Warm Current on the East/Japan Sea

Fangli Qiao, Yongzeng Yang, Zhenya Song, Guohong Fang and Yeli Yuan
The role of the ocean in East Asian climate change

Dejun Dai, Fangli Qiao and Yeli Yuan
Using the transform method to study the generation of internal tides

Patrick Cummins and Howard Freeland
Variability of the North Pacific Current and its bifurcation

Masahiro Yagi and Ichiro Yasuda
Variability of vertical diffusivity at the eastern gap of the Bussol' Strait

George V. Shevchenko and Alexander A. Romanov
Wave structure of tidal motions near the North Kuril Islands as revealed from the satellite altimetry measurements

Konstantin Rogachev
Zonal jet streams in the Pacific western subarctic

Posters

Vladimir Ponomarev, N.I. Savelieva and E.V. Dmitrieva
Amur River discharge, ice cover of the Okhotsk Sea, Tatar Strait and the atmospheric indices of the Asia-Pacific region – The assessment of relationships

Nandita Sarkar, Thomas C. Royer and Chester E. Grosch
Are deepening mixed layers responsible for transporting deep nutrients into surface waters in the northern Gulf of Alaska?

Antonina M. Polyakova
Atmospheric circulation over the Northern Pacific

Tsuyoshi Wakamatsu and Michael Foreman
Data assimilation studies at the Institute of Ocean Sciences for estimating the North Pacific Ocean circulation

Antonina M. Polyakova
Extreme distribution of floating ice in the NW Pacific

Galina A. Vlasova
Influence of atmospheric processes on water circulation in the 200-m layer of the Sea of Okhotsk on the basis of modelling

Sachiko Oguma, Tsuneo Ono and Akira Kusaka
Interannual variation of the water mass mixing ratio in spring revealed by δ13C-δ18O distribution in the coastal region off eastern Hokkaido

Viacheslav G. Makarov and Sergei N. Bulgakov
Modeling of barotropic eddy evolution near a chain of islands

Larisa S. Muktepavel
Spatial-temporaral variability of shore polynias in the northern Sea of Okhotsk

Alexander A. Nikitin and Genady I. Yurasov
Surface thermal fronts in the Japan/East Sea

Valentina V. Moroz and K.T. Bogdanov
The water structure and circulation variability in the Komandor-Kamchatka area

Ichiro Yasuda, Sachihiko Itoh, Masahiro Yagi, Satoshi Osafune, Hitoshi Kaneko, Hideo Nagae, Takeshi Nakatsuka and Jun Nishioka
Turbulence observations around the Kuril Straits

Sung-Tae Jang, Jae Hak Lee, Chang-Woong Shin and Chang-Su Hong
Vertical mixing in the Ulleung Basin in the East/Japan Sea

Talgat R. Kilmatov and Vera A.Petrova
Why and when is the jet of the Kuroshio Extension destroyed?

Hong Sik Min, Young Ho Kim and Cheol-Ho Kim
Year-to-year variability of cold water in the southwestern region of the East/Japan Sea

Posters from International Organizations/Programs

Howard J. Freeland
Argo – An ocean observing system for the 21st century

Kenneth F. Drinkwater and George L. Hunt Jr.
Ecosystem Studies of Sub-Arctic Seas (ESSAS)

Clarence Pautzke, W. Wiseman and F. Wiese
North Pacific Research Board and National Science Foundation partner in comprehensive study of eastern Bering Sea ecosystem

George L. Hunt Jr. and K. David Hyrenbach
The Bering Sea Ecosystem Study (BEST): A new program for the eastern Bering Sea

Observer 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

Howard J. Freeland and the Argo Steering Team
Argo – An ocean observing system for the 21st century

Kenneth F. Drinkwater and George L. Hunt, Jr.
Ecosystem Studies of sub-Arctic Seas (ESSAS)

Clarence Pautzke, W. Wiseman and F. Wiese
North Pacific Research Board and National Science Foundation partner in comprehensive study of eastern Bering Sea ecosystem

George L. Hunt, Jr. and K. David Hyrenbach
The Bering Sea Ecosystem Study (BEST): A new program for the estern Bering Sea

BIO Workshop (W1)
Lessons learned during MIE-1 and MIE-2: Reconciling acoustics and trawl data

Co-Convenors: Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan).

Background

Micronekton is one of the important but largely understudied components of marine ecosystems functionally linking small zooplankton and higher trophic levels. Recent advances in acoustic devices and efforts to standardize sampling gears undertaken by both PICES and ICES communities have made the sampling of micronekton more precise. Nevertheless, the issue of inter-calibrating the growing number of micronektonic gears is still unresolved. The PICES Advisory Panel on *Micronekton Sampling Inter-calibration Experiment* (MIE-AP) organized two field experiments (off Hawaii in 2004 and off Japan in 2005) to collect comparative data for several micronekton sampling gears and a wealth of acoustic information. The main objective of this workshop was: (1) to finalize the analysis and to compare MIE-1 and MIE-2 data sets; (2) to present and discuss acoustic data sets from both cruises; (3) to compare ICES and PICES inter-calibration experiments; and finally (4) to discuss new developments in the field of micronekton quantitative techniques.

Summary of presentations

Two contributions on the analysis of acoustic data described attempts to compare acoustic data with the densities of micronekton estimated by trawling during MIE-1 and MIE-2 cruises. The main conclusion was that the acoustic data represented an important technique to quantify micronekton. While showing some significant progress, both failed to reconcile the acoustic and trawl data. The main problems were associated with:

- additional noise induced by other acoustic systems during the MIE-1 experiment;
- absence of target strength measurements for the micronekton species (particularly for MIE-1); and
- undersampling the micronekton due to net avoidance or loss of gelatinous zooplankton (both MIE-1 and MIE-2).

J-Quest technology for observing and quantifying micronekton using acoustics and video appeared to be very advantageous for resolving some outstanding issues between acoustic and trawl density assessments, although it still has some difficulties in species identification of micronekton. AP-MIE concluded that using acoustics in a diverse community (*e.g.* MIE-1) requires numerous measurements of the individual species target strengths. The absence of such measurements translates into large discrepancies between acoustic and trawl density estimates. At the same time, when only a few species dominate the micronekton community (*e.g.* MIE-2), it is possible to achieve reasonable agreement between acoustic and trawl density estimates. It was concluded that a newly developed MOHT net appears to be consistently the best sampling

gear for micronekton and perhaps should be recommended as a standard gear for use by PICES nations to collect micronekton.

After looking at the intercomparison of gears used during the MIE-1 and MIE-2 cruises, MIE-AP concluded that when a small number of species (or a single species) was dominant in micronekton community, the intercalibration between gear types appeared to be a relatively straight forward exercise. The catchability ratios between gear types produced comparable densities. However, in a highly diverse community, as it was during MIE-1, only the size composition data of large taxonomic groups lumped into 10-mm size intervals can be compared quantitatively with any success. This approach allowed the calculation of intercalibration coefficients between three gear types used during MIE-1 and yielded relatively accurate (within 12–30%) intercomparison of micronekton densities obtained by different gears.

List of papers

Oral presentations

Réka Domokos, Evgeny A. Pakhomov, Michael P. Seki and Jeffrey J. Polovina (Invited)
Acoustic characterization of the mesopelagic community off the Leeward coast of Oahu, Hawaii

Hiroki Yasuma, Kazushi Miyashita and Orio Yamamura
Acoustic monitoring of a lanternfish *Diaphus theta* in the northwestern Pacific

Evgeny A. Pakhomov, M.P. Seki, A.V. Suntov, R.D. Brodeur and K.R. Owen
Inter-comparison of three sampling gears during the first Micronekton Intercalibration Experiment (MIE-1): Size composition approach

Hiroya Sugisaki and Koichi Sawada (Invited)
Introduction to J-QUEST research project: Quantification of micronekton using an integrated system of echosounder and stereo TV cameras

FIS Workshop (W2)
Methods for standardizing trawl surveys to ensure constant catchability

Co-Convenors: David A. Somerton (U.S.A.), Jin-Yeong Kim (Korea) and Greg Workman (Canada)

Background

Standardization in the gear and methodology used to conduct pelagic and bottom trawl surveys is essential for a correct interpretation of catch per unit effort as a measure of relative abundance. In the United States, standardization problems stemming from inaccurate measurement of the towing warps on a NOAA survey vessel resulted in a thorough review of standardization methodology and the development of the National Bottom Trawl Survey Protocols (http://spo.nmfs.noaa.gov/tm/tm65.pdf) governing the operation of all NOAA-sponsored surveys. Subsequently, ICES formed the Study Group on *Trawl Survey Standardization* to examine the same issue for ICES-sponsored multinational surveys, and to formulate a similar set of standardized operating protocols expected to be published in the fall of 2007. The proposed workshop will review the various pelagic and bottom trawl surveys conducted by PICES member countries, with a focus on the operational protocols used to ensure that survey catchability remains constant over time. Topics to be discussed likely would include a consideration of various instruments to monitor trawl performance, such as acoustic trawl measurement systems, bottom contact sensors and speed through water sensors, as well as trawl design and operation procedures that allow trawl catchability to be robust to environmental variation.

Summary of presentations

The workshop had 27 participants representing all PICES countries. Initial talks described the efforts by the U.S. (David Somerton) and ICES (David Reid) to standardize trawl design and trawling procedures to minimize changes in catchability over time and differences in catchability between vessels. This was followed by descriptions of the standardization protocols used by various surveys conducted around the Pacific, including: California to Washington (Aimee Keller), Canada (Greg Workman), Alaska coastal (Dan Urban), Alaska offshore (Kenneth Weinberg), Russia (Mikhail Stepanenko) and Korea (Jung Hwa Choi). This was followed by talks describing ongoing research intended to reveal additional methods for trawl survey standardization including statically analyses of trawl performance (Stan Kotwicki), experiments on the affect of scope ratio on footrope contact (Yasuzumi Fujimori) and methodology to estimate relative catchability of alternate survey fishing gear (Yamamura).

The discussion following these talks focused on the need to ensure sampling consistency over time and the advantages of standardization in multinational surveys. The experience of ICES in its support of several international surveys was considered, especially with respect to the difficulty to control the tendency of individual nations to differ in their interpretation of trawl construction plans and sampling methodology. Such divergence in national style has led to divergence in the catchabilities of the various vessels employed and greater variance in the relative abundance estimates produced from the survey data. It was emphasized that, if PICES countries developed cooperative surveys in the future, attention to standardization at the outset would lead to better consistency and might eliminate the need for extensive and expensive inter-vessel calibration experiments.

The subject of the workshop then turned to the estimation of survey catchability so that swept area estimates of relative abundance can be used as estimates of absolute abundance. Examples were provided for flatfishes in Alaska (Somerton) and monkfish in Scotland (Reid). Discussion was focused on the issue that catchability estimation is important in situations when either the survey time series is short or when the commercial catch data is too poor to support catch-at-age models, both of which are common in the North Pacific.

Several participants expressed interest in continuing a dialogue on issues related to surveys and fishing gear. One possibility is the formation of a working/study group patterned after the ICES Working Group on *Fishing Technology and Fish Behaviour*, which focuses on issues such as bycatch reduction and size selection in commercial fishing operations, and the impacts of fishing gear on the bottom, as well as stock assessment, surveys. It was recommended that the Fishery Science Committee should consider options about how the theme of fishing gear research and survey technology can be continued by PICES in the future.

List of papers

Oral presentations

Dan Urban, Nicholas Sagalkin and Kally Spalinger
Alaska Department of Fish and Game trawl surveys in the Gulf of Alaska and eastern Aleutian Islands

M.A. Mizyurkin (presented by Mikhail A. Stepanenko)**, A.I. Shevchenko and S.E. Astafyev**
Approach of research trawl surveys certification

Orio Yamamura
Catch efficiency of a small-sized Danish seine

Yasuzumi Fujimori, Kazushi Miyashita and Satoshi Honda
Consideration of bottom contact effect on the catch of demersal species in a trawl survey in Japan

Greg Workman, Norm Olsen and Rick Stanley
Development of a standardized Fisheries Independent bottom trawl Survey program (FIS) off the west coast of Canada

David A. Somerton
Development of the NOAA national bottom trawl survey protocols

D.G. Reid, R.J. Kynoch, I. Penny and K. Peach
Estimation of catch efficiency in a new angler fish survey trawl

Jung Hwa Choi, Hui Chun An and Bong Jin Cha
Introduction of Korean survey bottom-trawl and catchability method

Aimee Keller, Victor Simon and Beth Horness
Methods for standardizing the U.S. west coast groundfish trawl survey

Kenneth L. Weinberg
Protocols for conducting Alaska Fisheries Science Center bottom trawl surveys

Dave Reid (Invited)
Survey trawl standardization

Stan Kotwicki and Michael H. Martin
The effects of improving accuracy and precision of area swept estimates on relative biomass estimation and stock assessment

David A. Somerton, Peter T. Munro and Kenneth L. Weinberg
Whole-gear efficiency of a benthic survey trawl for flatfish

FIS/MEQ Workshop (W3)

Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation

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

Background

An ecosystem-based approach to management (EBM) is an integrated approach to management of land, water, and living resources that promotes conservation and sustainable use over a broad range of human activities in an ecosystem. Implementation of an EBM for marine ecosystems in the North Pacific Ocean requires a number of steps and activities. An explicit framework that outlines the objectives, legal mandates, and institutional roles and responsibilities is essential. Data requirements and analytical tools need to be developed. This workshop invited papers to: 1) highlight existing national and international frameworks for implementation of an ecosystem approach to management; 2) outline the data requirements for such an approach; 3) describe the analytical tools being developed; 4) show the progress in communicating results of EBM activities; and 5) discuss outstanding research gaps for making progress. The workshop was organized to allow time for keynote summaries of PICES Working Group 19 results, invited contributions from other PICES groups, insights by other organizations involved in providing integrated ecosystem advice, talks on governance issues and difficulties, socioeconomic issues, *etc*. During a discussion period, participants were welcomed to advise the convenors on the desirability of publishing the results of the workshop in a leading primary scientific journal.

Summary of presentations

The workshop made progress in highlighting issues related to the implementation of EBM in PICES member countries. It was clear from the presentations that member countries are in different stages of implementation with respect to EBM. Some countries are still working on incorporating an ecosystem approach to fisheries management while others have national legislation that provides a mechanism for implementing a cross-sectoral approach to the management of marine activities to ensure environmental protection. The degree of advancement might be partly related to the nature of the different human pressures being exerted on the marine environment. Even where some countries appeared to be more advanced in their implementation, there were problems in actually making cross-sectoral management

work in marine ecosystems. The need for overarching legislation that requires action may be needed. It was clear that more than one agency was involved in EBM activities in each country and a challenge is to get agencies to work together in implementation. It was also noted that the main type of legislation that forced cross-sectoral implementation was species-at-risk legislation.

Data requirements for EBM were discussed to some extent. The Australian experience demonstrated that implementation could involve both highly quantitative approaches and models if data are available but the framework could also include methods to evaluate ecosystem status and potential impacts even in qualitative ways. The ICES experience demonstrated how highly evolved data gathering for EBM advice could be, although it was noted that highly evolved advice did not necessarily translate into the political will to follow such advice. The Technical Committee on Monitoring outlined some of the data requirements that would require its involvement along with the involvement of all the PICES committees. The workshop particularly noted the lack of socio-economic data to aid in decision-making in an EBM context.

Analytical tools are being developed to aid in establishing EBM frameworks. Highly structured risk assessment frameworks in Australia allow both quantitative and qualitative evaluation of risks and definitions of when actions are needed. The MODEL Task Team described a suite of modeling tools that might be used to understand impacts of climate variability on marine ecosystems. Models, such as Atlantis, to aid in the evaluation of management strategies seem to be important tools to help EBM decision-making.

Communicating the results of EBM activities is ongoing in member countries. Some are using highly structured reporting instruments such as ecosystem assessment documents. ICES advisory structure for communicating EBM advice in a tactical way is highly evolved although reporting its success in implementing EBM might not be so advanced. Reporting of ecosystem status is important but it was recognized that identification and reporting of ecosystem pressures and ecosystem responses to management are important pieces of communication of EBM progress. Communicating measures of human health was noted to be important in this regard. The PICES role in communicating EBM was seen to be more of a strategic one. There seemed to be a variety of scales that are potentially useful for reporting results.

A major outstanding research gap is the need for social science indicators and information. The advancement of risk assessment frameworks and tools seemed particularly important. Perhaps working groups on the human dimensions of implementing EBM or evaluation of risk assessment tools and frameworks might be important to consider in the future.

List of papers

Oral presentations

R. Ian Perry, William R. Crawford and Alan F. Sinclair
Comparative analysis of Canadian Pacific North Coast and Strait of Georgia marine ecosystems

Phil R. Mundy
Data requirements for implementing an ecosystem approach to management from a PICES perspective

Jake Rice
Ecosystem approaches to management – Where to start?

Mitsutaku Makino and Tatsu Kishida
Ecosystem-based management in Japan: Its status and challenges

Vladimir I. Radchenko
Ecosystem-based principles in the contemporary fisheries management on the Russian Far East

Jake Rice
ICES frameworks and processes for science advice in an ecosystem approach

Glen S. Jamieson
Integrated management in Canada's Pacific North Coast: Challenges in determining ecological objectives

Bernard A. Megrey, Michio J. Kishi, Shin-ichi Ito, Kenneth A. Rose, Francisco E. Werner and members of the MODEL Task Team and the NEMURO Mafia
Modeling multi-trophic level marine ecosystems using the NEMURO family of models: Climate change applications in the boreal North Pacific and scientific potential for ecosystem-based management

Chang Ik Zhang, Suam Kim, Donald Gunderson, Jae Bong Lee, Inja Yeon, Hee Won Park and Jong Hee Lee
Progress in the development of an ecosystem-based approach to assess and manage fisheries resources in Korea

David L. Fluharty
Realizing ecosystem based management through integrated ecosystem assessment and regional collaboration in the United States

Keith Sainsbury (Invited)
Sustainable use of marine ecosystems – The search for practical ways to support and implement ecosystem-based fisheries management and regional development

Inja Yeon, H.J. Whang, M.H. Shon, Y.J. Im, J.G. Myoung and WWF YSEPP project partners
Yellow Sea marine ecoregion for implementation of ecosystem-based management in marine capture fisheries

MEQ Workshop (W4)
Review of selected harmful algae in the PICES region: III. Heterosigma akashiwo and other harmful raphidophytes

Co-Convenors: Charles G. Trick (Canada) and Ichiro Imai (Japan)

Background

This workshop was the third of an annual series in which harmful algal bloom (HAB) species that impact all or most countries in the North Pacific were discussed in detail. In 2007, we focused on one species of raphidophytes, in particular, *Heterosigma akashiwo*. This species is distributed throughout the PICES region and has caused serious damage to finfish aquaculture, resulting in severe economic losses in PICES member countries. The integration of information from each country will advance our understanding of this organism. Topics included modes of toxicity, distribution, impact (differences between toxic and nontoxic strains), as well as physiology and ecology in each of the member countries. In particular, we wanted to identify additional studies needed specifically to define *H. akashiwo*'s mode of toxicity. Comparison with similar raphidophytes, namely *Chattonella* and *Fibrocapsa*, were also included. The workshop was preceded by a half-day laboratory demonstration on *Heterosigma* cell and toxin detection.

Summary of presentations

A summary of raphidophyte taxonomy helped to clarify some recent changes in nomeclature among the raphidophytes and will in future, assist with indentification of some morphologically similar species. This workshop featured primarily *Heterosigma* and *Chattonella*, species that are present in both the eastern and western Pacific. However, while *Heterosigma* is known to kill fish reared in aquaculture in both British Columbia and Washington State, no known fish mortalities have occurred in the western Pacific. The life cycles of *Heterosigma* and *Chattonella* were described, highlighting the possibility that some of the more toxic small *Heterosigma* cells observed in Washington State might be recently excysted cells.

The mechanism of raphidophyte toxicity was discussed and also whether *Heterosigma* and *Chattonella* are toxic by the same means. Toxicity may occur through synergistic effects of reactive oxygen species, nitric oxide, and a hemolytic toxin. The action of reactive oxygen species might affect the gill surface that discharges glycocalyx during a toxic event. The hemorrhagic toxin may be a porphyrin derivative. However, it is likely not involved in fish killing activity because ruptured *Chattonella* cells don't kill fish. The expression of hemolytic activity and exoprotease activity in *Heterosigma* appear to be linked.

Heterosigma's nutrient requirements were discussed, including that importance of iron availability on the level of exoenzyme (a possible toxin) release. The nitrogen requirements of *Heterosigma* may give it a competitive advantage over other phytoplankton in that this cell can grown well on ammonium sources. Hemolytic activity, peroxidase activity, grazer defense and anti-algal activity all appeared to be related to nutrient availability.

Sites in Washington State and British Columbia waters that are important in *Heterosigma* bloom initiation were described. Blooms in the Strait of Georgia and north Puget Sound are believed to be associated with their proximity to the Fraser River. Another initiation site is believed to be in central Puget Sound. In Japan, the use of the MPN (most probably number) method for cyst detection has been used as an important tool to determine potential initiation sites for raphidophyte blooms. This tool may be helpful in further pinpointing *Heterosigma* initiation sites in the eastern Pacific, leading to better forecasting of these harmful events.

Finally, remote detection of *Heterosigma* (and other harmful species) blooms is now possible using a moored observing system called the Environmental Sampling Platform (ESP). The ESP uses specific molecular probes to *Heterosigma* in a sandwich hybridization format for remote and sensitive detection of this organism. Use of this platform will allow for further warning of potential fish-killing blooms.

List of papers

Oral presentations

Jack E. Rensel and K. Bright
Bloom dynamics of *Heterosigma akashiwo* in Puget Sound and the Strait of Juan de Fuca

Jinhui Wang and Yutao Qin
Blooms of *Heterosigma akashiwo* and *Chattonella marina* in Chinese coastal waters

Desmond J. Johns and Patricia Glibert
Characterization of nitrogen uptake by *Heterosigma akashiwo* grown in turbidostat culture under two light intensities

Takashi Kamiyama
Effects of *Heterosigma akashiwo* blooms on planktonic food webs: Responses of microbial loop components

Charles G. Trick, M. Klein and C. Ling
Environmental parameters regulate exoenzyme and haemolysin production in *Heterosigma akashiwo*

Tatsuya Oda (Invited)
Generation of ROS (reactive oxygen species) by *Chattonella marina* as a possible factor responsible for the fish-killing mechanism

Ichiro Imai, Shigeru Itakura and Mineo Yamaguchi (Invited)
Life cycle strategies and occurrences of red tides of *Heterosigma akashiwo* and *Chattonella* spp. in temperate coastal sea

Carmelo R. Tomas
Microscopic observations and detailed analysis of raphidophyte taxonomy

Julian Herndon and William P. Cochlan
Nitrogen utilization by the raphidophyte *Heterosigma akashiwo*: Growth and uptake kinetics in unialgal cultures and natural assemblages of San Francisco Bay

Roman Marin III, Nilo Alvarado and Christopher A. Scholin
Rapid detection of *Heterosigma akashiwo* in natural samples using DNA probe based assay

Roman Marin III, Scott Jensen, Brent Roman, Eugene Massion, Christina Preston, Dianne Greenfield, William Jones, Gregory Doucette, Tina Mikulski, Kristen King, Mike Parker, Mark Brown and Chris Scholin
Routine rapid detection of *Heterosigma* in natural samples using DNA probes

Carmelo R. Tomas (Invited)
The Raphidophyceae: Enigmas in taxonomy, identification and morphology

Hakgyoon Kim, Samgeun Lee, Changkyu Lee, Kyongho An, Wolae Lim, Sookyang Kim, Youngtae Park and Yoon Lee
Two decadal changes of *Heterosigma akashiwo* blooms in Korean coastal waters

Poster

Li Zheng, Xiaotian Han, Xiuchun Guo, Ping Han, Zhiming Yu and Xiaoru Wang
Study on algicidal activity of marine bacteria to two HAB species *Heterosigma akashiwo* and *Prorocentrum micans*

MONITOR/BIO Workshop (W5)
Measuring and monitoring primary productivity in the North Pacific

Co-Convenors: Paul J. Harrison (Canada/Hong Kong) and Sei-Ichi Saitoh (Japan)

Background

Marine net primary productivity is a key metric of ecosystem health and carbon cycling and is commonly a function of plant biomass, incident solar flux, and a scaling parameter that accounts for variations in algal physiology. Net primary productivity is defined as the amount of photosynthetically fixed carbon available to the first heterotrophic level and is the relevant metric for addressing environmental questions ranging from trophic energy transfer to the influence of biological processes of carbon cycling. Long-term monitoring of primary productivity is a high priority for PICES nations because it is one of the essential parameters for the understanding of marine ecosystems and biogeochemistry. Recently, measurement technology of primary production has become extremely advanced through the application of fast repetition rate fluorometers, satellites, buoys, *etc*. However, inconsistencies between *in situ* measurements and satellites still exist and there are some differences between the values obtained with ^{13}C and ^{14}C isotopic methodology. This workshop discussed the state-of-the-art of primary productivity measurement technology and its application to understanding primary productivity in the North Pacific. Presentations at this workshop addressed techniques for measuring primary productivity, comparing *in situ* and satellite measurements of primary productivity, demonstrating the utility of long time series measurements in understanding ecosystem variability, and describing the application of primary productivity studies to marine ecosystems and biogeochemistry.

Summary of presentations

The workshop had 2 invited speakers and 4 contributed speakers and 1 poster. Michael Behrenfeld (U.S.A.) gave an excellent overview of the uncertainties in converting chlorophyll to net primary productivity. Three environmental parameters influence the chl:C ratio: light, nutrients and temperature, and of these, light appears to be the most important factor. He raised a number of questions for future studies which are highlighted in the recommendations of the workshop, below.

Toshiro Saino (Japan) explained his new *in situ* ocean primary productivity profiling system that was developed to measure ocean primary productivity for real time validation of satellite-derived primary productivity estimations. The system uses fast repetition rate flourescence (frrf) installed on a profiling buoy tethered to an underwater winch. The frrf measurements of gross primary productivity were compared with the oxygen-17 anomaly in dissolved oxygen. It reflects the net primary productivity over time scales of weeks.

Sinjae Yoo (Korea) reported on the challenges of measuring chlorophyll and primary productivity in the very turbid Yellow Sea. He divided the Yellow Sea into different zones and seasons. In the center of the Yellow Sea in summer, estimates were more accurate than in winter when the Yellow Sea is very turbid due to wind mixing which produces a large over estimate of chlorophyll. Sei-Ichi Saitoh (Japan) showed that typhoons increase primary productivity several weeks after the passage of the typhoon. Slow passage of a typhoon and strongest winds give the highest primary productivity. The number of typhoons has increased in the last 15 years and average primary productivity has increased also. This increase may be related to the warming of the sea surface. Typhoons appear to be more frequent in warmer El Niño years. Akihiro Shiomoto (Japan) discussed primary productivity in the North Pacific. He reported that primary productivity in winter was 2 to 3 times lower at Station KNOT (NW Pacific) due to lower light, compared to Station P. The depth of the photic zone at Stn. P is deeper (80 m *vs* 55 m at Stn. KNOT). Primary productivity saturated at about 3 Ein m^{-2} d^{-1} at Stn. P and

around 18 Ein m^{-2} d^{-1} at Stn. KNOT. In summer, Stn. P has about 1.6 times greater primary productivity than Stn. KNOT. Paul Harrison reviewed the variability in chlorophyll and primary productivity in the NE Pacific. While chlorophyll appears to be relatively constant at about 0.4 μg/L over the annual cycle, small blooms greater than 1 μg/L have been observed in June and August/September and some of the blooms are sub-surface. Blooms of coccolithophores also occur and cause problems for remote sensing estimates of chlorophyll. While the NE Pacific appears to have a relatively constant chlorophyll and only a factor of 2 or 3 seasonal increase in primary productivity, larger episodic variations could be caused by eddies moving offshore and injections of iron from dust deposition and some vertical mixing.

Recommendations and research questions

1) The operational lifespan of SeaWiFS is uncertain. MODIS could take over from SeaWiFS if it fails, but beyond MODIS there are no other satellites planned with similar capabilities to SeaWiFS and MODIS. Therefore, there is a serious need to develop a satellite to continue the time series started in the 1980s with the coastal zone color scanner.
2) How good is the chlorophyll to net primary productivity conversion? Temperature should not be used as a proxy for the physiology of phytoplankton.
3) A carbon-based approach is needed. Is it possible to use back scattering to get the chl:C ratio.
4) How much variability is occurring under the clouds and during the long periods when there are no images?
5) Is it necessary to know remotely-sensed information of species/functional groups and their particle size to have a better understanding of the ecosystem?
6) Re-evaluating the utility of frrf measurements as a proxy for primary productivity measurements in required.
7) Time series measurements in the western and eastern Pacific are required since these data can provide valuable ground-truthing for satellites and observations of episodic events that may occur during cloud cover.

List of papers

Oral presentations

Michael Behrenfeld (Invited)
A satellite view of North Pacific primary production

Akihiro Shiomoto
Comparison of daily primary production between east and west in the subarctic North Pacific: A review from a new angle

Paul J. Harrison, Michael Lipsen and Adrian Marchetti
Phytoplankton biomass and primary productivity at Stn P and along Line P: Long-term variability over decades and during episodic events

Sinjae Yoo and Jisoo Park
Primary productivity of the Yellow Sea

Toshiro Saino (Invited)
Satellite monitoring and *in situ* validation of ocean primary productivity

Eko Siswanto, Joji Ishizaka, Mitsuhiro Toratani, Toru Hirawake and Sei-Ichi Saitoh
The effect of tropical cyclones on primary production enhancement – Some results from the W-PASS (Western Pacific Air-Sea interaction Study) project

Poster

Jeong-Min Shim, Suk-Hyun Yun, Jae-Dong Hwang, Hyun-Gook Jin, Yong-Hwa Lee, Young-Suk Kim and Un-Gi Hwang
Seasonal variability of picoplankton in the middle part of East/Japan Sea

POC/CCCC Workshop (W6)
Climate scenarios for ecosystem modeling

Co-Convenors: Jacquelynne R. King (Canada) and Michael G. Foreman (Canada)

Background

The objective of this workshop was to facilitate discussion between CFAME and Working Group on *Evaluations of Climate Change Projections* (WG 20) on potential future collaborative research on forecasting the impacts of climate change (as represented by IPCC projection scenarios) on regional ecosystems and species of the North Pacific. The workshop began with overviews of the Terms of Reference and workplans for CFAME and WG 20 by their Co-chairmen, Kerim Aydin (CFAME) and Michael Foreman (WG 20). The overviews provided the context for overlap in research foci between these two groups. CFAME has focused on three North Pacific ecosystems that represent different dominant physical processes: 1) California Current System (boundary current with upwelling); 2) Kuroshio/Oyashio Current System (boundary currents); 3) Yellow Sea/East China Sea Region (freshwater input). For each ecosystem, CFAME has developed conceptual models of the mechanisms relating climate forcing to the population dynamics of key species and to ecosystem processes. One of the goals of WG 20 is to facilitate analyses of climate effects on marine ecosystems and ecosystem feedbacks to climate by, for example, computing an ensemble of the IPCC model projections for the North Pacific and making these projections available to other PICES groups such as CFAME. The analyses could provide forecasts of regional parameters (such as sea surface temperature, sea ice cover, and river discharge) relevant to ecosystem processes identified within CFAME's conceptual models.

Summary of presentations

Thirteen talks were presented by CFAME and WG 20 members from Canada, Japan, Korea and the United States. Presentations were organized by the three ecosystems that CFAME has focused on. For each ecosystem a brief overview was presented by a CFAME member, providing a summary of the key processes that define the seasonal or temporal variability in physical parameters. In addition, each presentation quickly introduced some of the key species in the lower and higher trophic levels of each system.

CFAME members presented the conceptual models that they have developed for the mechanisms linking physical processes to population dynamics. Following these presentations, WG 20 members presented results of recent climate and oceanographic modelling efforts relevant to each of the three ecosystems. To wrap up the information portion of the workshop, a presentation on synthesis, and summary of the key climate and oceanographic factors required for ecosystem projections given climate change, was made, followed by a presentation on the uncertainties in climate model ensemble projections.

Discussion on the first day highlighted the need for CFAME to define geographic regions (*e.g.*, spawning areas, zone within an ecosystem) and to provide the important physical parameters that affect population dynamics (*e.g.*, stratification in the California Current System). Despite the broad definitions used in the ecosystem conceptual models, key processes were identified for each ecosystem. For the California Current System, temperature and its spatial variability, stratification, transition timing to upwelling, upwelling intensity, and eddies/meanders in the alongshore current. Characteristics of upwelling could be represented by upwelling favourable winds. Characteristics of currents will be a difficult feature to provide from existing climate/ocean modelling efforts because of their coarse resolution. In the Kuroshio/Oyashio System, key physical processes included temperature and its spatial variability, location of the southern branch of the Oyashio, location of the Kuroshio and its eddies/meanders. In addition, a key predator (Japanese common squid) is impacted

by temperature and salinity (*i.e.*, pycnocline) in the East China Sea. High resolution climate models have been developed for the Kuroshio/Oyashio System and these parameters, including characteristics in the Kuroshio (*i.e.*, extent of meanders), could be forecasted. The East China Sea is not well represented by climate models, mainly because of the dominant influence of freshwater input. Key processes identified for the Yellow Sea/East China Sea system included temperature and salinity. On the second day of the workshop CFAME and WG 20 met separately to discuss the previous days' discussion and to formulate workplans, and the outcomes are reported in the annual reports of each group.

List of papers

Oral presentations

Emanuele Di Lorenzo (WG 20 member, Invited) **and Niklas Schneider**
A North Pacific gyre-scale oscillation: Mechanisms of ocean's physical-biological response to climate forcing

Gordon McFarlane (CFAME member, Invited)
Conceptual mechanisms linking physical and biological oceanography to population dynamics of key species in the California Current System

Akihiko Yatsu, Yoshiro Watanabe (CFAME members, Invited)**, M. Kaeriyama, Y. Sakurai and A. Nishimura** (Presented by Jacquelynne King)
Conceptual mechanisms linking physical and biological oceanography to population dynamics of key species in the Kuroshio/Oyashio Current System

Yeong Hye Kim (Invited)
Conceptual mechanisms linking physical and biological oceanography to population dynamics of key species in the Yellow Sea/East China Sea

Jinhee Yoon, K.-I. Chang, Takashi T. Sakamoto, Hiroyasu Hasumi and Young Ho Kim
Effects of global warming on the East/Japan Sea heat balance using a global climate model (MIROC3.2-hires)

Enrique Curchitser (WG 20 member, Invited)
Embedding a high-resolution California Current climate model into the NCAR global climate model

Taketo Hashioka, Yasuhiro Yamanaka, Takashi T. Sakamoto and Maki N. Aita
Future projection with a 3-D high-resolution ecosystem model

Michael Foreman (WG20 member, Invited)
Future winds off the BC coast

Vera Agostini (CFAME member, Invited)
Overview of the California Current System

Akihiko Yatsu (CFAME member, Invited)**, Tsuneo Ono, Kazuaki Tadokoro** (CFAME member)**, Akira Nishimura, Shin-ichi Ito, Sanae Chiba and Yasunori Sakurai**
Overview of the Kuroshio/Oyahsio Current System

Young Shil Kang (CFAME Co-Chairman, Invited)
Overview of the Yellow Sea/East China Sea

James Overland (CFAME member, Invited)
Synthesis and summary of key climate and oceanographic factors identified by CFAME and required for ecosystem projections given climate change

Muyin Wang (W20 member, Invited)
Uncertainties in climate model ensemble projections