Summary of Scientific Sessions and Workshops

Science Board Symposium (S1)
Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions

Co-convenors: *Sinjae Yoo (SB), Atsushi Tsuda (BIO), Elizabeth Logerwell (FIS), Hiroya Sugisaki (MONITOR), Kyung-Il Chang (POC), Toru Suzuki (TCODE), Thomas Therriault (AICE), Hiroaki Saito (COVE), Robin Brown (SOFE), Igor Shevchenko (Russia), Fangli Qiao (China)*

Background

Human society depends on ocean ecosystems to meet many of its needs. The availability of marine ecosystem services to humans is important to sustain coastal communities and to ensure human health and well-being. Global warming, shoreline development, pollution, eutrophication, overfishing, non-indigenous species, and intensive mariculture are examples of anthropogenic stressors that affect marine ecosystems. These stressors can act alone or in combination to alter the structure, function, and productivity of marine ecosystems. Consequently, the potential for decline in the ability of the ocean to provide essential ecosystem services, as a result of synergies in natural and anthropogenic stressors, is a serious concern for human society. To advance ecosystem-based management and to mitigate the influence of stressors, there is a need to develop improved understanding of the mechanisms of change in marine ecosystems. Improved understanding of ecosystem structure, function, and resilience will aid the development of practical methods to maintain and monitor ecosystem health. These are challenging issues for marine science and PICES will continue to promote research to address these issues through FUTURE.

Summary of Presentations

This session was a departure from common themes explored in PICES meeting. It was well-attended and there was a great diversity of presentations, featuring many different ecosystems and at many different scales – from basin-wide impacts to intertidal and subtidal zones of bays and estuaries.

In his Keynote Lecture, Dr. Tokio Wada presented an overview of impacts (and recovery from) the Great East Japan Earthquake, which led nicely to some of the more detailed presentation in this session. Dr. Wada showed that major impacts to intertidal and subtidal zones were observed, but recovery seems to be rapid. In contrast, no significant changes in the migration and distribution of fishes were noted on the offshore areas after the earthquake. Radioactivity in seawater declined rapidly, and levels in most marine biota decreased rapidly, with a biological half-life of 50–140 days, but there are some areas where concentrations in sediment and some benthic species remain high. Dr. Wada concluded by noting the critical importance on longer term monitoring of the recovery, particularly in the coastal zone.

Dr. Hans Paerl and collaborators reported on the work of SCOR WG 137 on global patterns of phytoplankton dynamics and in coastal ecosystems, requiring the “teasing apart” of anthropogenic impacts (very large in some coastal ecosystems) from climate change impacts. These studies highlight the importance of understanding both the quality (species composition) and quantity (biomass) of coastal primary production. These changes also need to be evaluated in light of other factors, including grazing and in some cases, invasive species.

Dr. Ben Halpern reported on a global Ocean Health Index for assessing the condition of both the natural and human dimensions. This index has a “benefits to people” or ecosystem services focus. The Ocean Health Index has some key characteristics of good indices – it is consistent, transparent, quantitative and applicable at various scales. Additionally, it responds to management actions and allows for a variety of societal choices to achieve a given score of the index.

Dr. William Li (co-authored with Nancy Shackell) reviewed predictions made 25 years ago about the potential future trend in the Northwest Atlantic. They demonstrated how changes in the Arctic propagated down to temperate latitudes. They highlighted the complexity of ecosystem interactions and challenges in predicting ecosystem outcomes from mechanistic understanding of physical/chemical forcing.

Dr. Ian Perry (co-authored with Diane Masson) presented results from a study on an enclosed inland sea – the Strait of Georgia. This was a good treatment of both natural and anthropogenic drivers in explaining the changes in ecosystem status. The use of a variety of models and tools to develop future scenarios was demonstrated.

Dr. Kitack Lee and co-authors demonstrated the importance of atmospheric deposition of nitrogen in changing the nutrient regime of East Asian marginal seas, as a result of their position "downstream" of densely populated and industrialized Asian continent.

Dr. Anne Hollowed outlined a fairly complete and complex implementation of the Ecosystem-Based Management approach for Bering Sea pollock, but pointed out that this implementation may well reduce the resilience of the fishery to adapt to climate change. This highlighted the need to evaluate future harvest strategies within the context of multiple stressors and constraints.

Dr. Yury Zuenko provided a very interesting example of how climate change (weakening of winter monsoon) reduced primary production but this did not result in declines in production at higher trophic levels (fish). This highlighted the importance of considering ecosystem efficiency and the limitation of models which include growth and consumption, but exclude consideration of reproductive success.

Dr. Jilong Wang and co-authors reported very interesting results demonstrating that different climate change factors can have very different impacts on components of the marine ecosystem. Changes in monsoon, typhoons and SST were shown to have negative impacts on pelagic species, but positive impacts on benthic populations.

Dr. Hiroaki Saito and co-authors presented very interesting data on the economic impacts on the loss of the sardine stock. They reviewed the mismatch between phytoplankton/zooplankton and the arrival of sardine larvae as the cause of the decline and raised the possibility of predicting the success/failure of sardine growth and recruitment. They went on to explore the efficacy of different management strategies to minimize the economic disruption resulting from large fluctuations in abundance of this stock.

Dr. Staci Simonvich showed that long range transport of persistent organic pollutants (POPs) and polycyclic aromatic hydrocarbons (PAHs) from Asia and across the North Pacific and highlighted the importance of understanding the processes at work in the source region.

Dr. Catharina Phillipart and co-authors described an integrated monitoring and data management/distribution network in the Wadden Sea, which is a coastal UNESCO World Heritage site. They pointed out the importance in engaging stakeholders in the design of the network so that objectives of these stakeholders can be met.

Dr. Reiji Masuda presented a very interesting study of the impacts of water temperature and the Great East Japan Earthquake, revealed through visual surveys of fish populations in the subtidal zone at high temporal and spatial resolution. The Great East Japan Earthquake provided an opportunity to document recovery after dramatic changes (tsunami wave impacts on the benthic environment and shutdown of discharge of warm water from nuclear power plants).

Dr. Xuelei Zhang and collaborators reported on the onset and development of a "green tide" of *Enteromorpha* in the Yellow Sea observed since 2007. The authors provided evidence that expanded *Porphyra* cultures are a source for the floating filamentous algae. They also suggested that the floating *Enteromorpha* mats may have outcompeted other harmful algal bloom (HAB) species, resulting in a reduction of some common HABs that are common in this region.

Dr. Takeo Kurihara and collaborators reported on surveys of mollusk assemblages before and after the earthquake and tsunami. Given the remarkable physical changes (including subsidence of up to 2 metres), the observed impacts on density, richness and composition was surprisingly modest.
Some overall comments:

- Importance of good background or "before" data to evaluate impacts and recovery. Contrast the quite good long term data on radionuclides in ocean waters with the lack of background data to assess the recovery from the *Exxon Valdez* oil spill in Prince William Sound.
- Notwithstanding the comment above, evidence was presented that ecosystems may not always "recover" to their original state.
- While there were several presentations that demonstrate quite rapid recovery of ecosystems to dramatic changes, this was not the case in all circumstances.
- The linkage between activities on land and impact on marine ecosystems was highlighted in several presentations.
- We are seeing an increasing amount of integration of biophysical aspects of ecosystems and socio-economic impacts in PICES presentations. This is a good sign for the FUTURE program

List of Papers

Oral presentations

Tokio Wada (Keynote)
Resilience and sustainability of the human-ocean coupled system – Beyond the Great East Japan Earthquake

Hans W. Paerl, Kedong Yin, James E. Cloern, Paul J. Harrison, Jacob Carstensen and Todd D. O'Brien (Invited)
Global patterns of phytoplankton dynamics in coastal ecosystems: Utilizing long-term data to distinguish human from climatic drivers of ecological change

Benjamin S. Halpern (Invited)
The Ocean Health Index: Global assessment and future priorities

William K.W. Li and Nancy Shackell (Invited)
Ecosystem change in the North Atlantic: Impacts, vulnerabilities, and opportunities

R. Ian Perry and Diane Masson (Invited)
Understanding ecosystem structure, function, and change in the Strait of Georgia, Canada: A human-dominated marine ecosystem

Kitack Lee, Tae-Wook Kim, Raymond G. Najjar, Hee-Dong Jeong and Hae Jin Jeong (Invited)
The anthropogenic impacts on ocean nutrients and carbon systems in the marginal seas of northwestern Pacific Ocean

Anne Hollowed
Projecting future status and trends of commercial fish and fisheries under shifting management strategies and climate change

Yury I. Zuenko
Ecosystem reconstruction of the Japan/East Sea under recent climate change: Lowered productivity *vs* enhanced efficiency

Jilong Wang, Jilong Li and Wenbo Yang
Impact of major climatic factors on biomass of the main commercial fishes in east China seas

Reiji Masuda (Invited)
Underwater visual census as a tool to monitor coastal ecosystems: Seasonal and interannual fluctuations, effect of thermal discharge from power stations, and recovery from the tsunami disaster

Xuelei Zhang, S.L. Fan, Y. Li, S. Fang, M.Z. Fu, W. Zheng, R.X. Li, Z.L. Wang and M.Y. Zhu (Invited)
The onset and development of green algal tide in the Yellow Sea

Hiroaki Saito, Takaomi Kaneko and Mitsutaku Makino (Invited)
Marine ecosystem responses to sporadic perturbation: Their processes, social impact and possible solutions

Staci Massey Simonich
Is trans-Pacific atmospheric transport and deposition of persistent organic pollutants (POPs) to the North Pacific Ocean significant?

Catharina J.M. Philippart, Martin J. Baptist, Taco de Bruin, Bruno J. Ens, Lucien Hanssen, Folkert de Jong and Frans J. Sijtsma
Sensing marine life and livelihoods at the seashore – An integrated monitoring network and data portal for the Wadden Sea, a coastal UNESCO World Heritage site

Takeo Kurihara, Kengo Suzuki, Gyo Itani, Masatsugu Iseda, Tomoyuki Nakano, Satomi Kamimura Koji Seike, Takenori Sasaki, Hideki Takami and Susumu Chiba
Comparison of the mollusk assemblage in Japan before *vs.* after the Great Tohoku Earthquake

Poster presentations

Victor F. Bugaev
Effects of pink salmon (*Oncorhynchus gorbuscha)* stock abundance on the growth of sockeye salmon (*Oncorynchus nerka)* from Kamchatka River in the ocean

Sangjin Lee
NOWPAP Medium-term strategy to address marine and coastal environment issues in the Northwest Pacific Ocean

Yulia S. Chernyshova and Tatyana Shpakova
Size-age structure of Japanese scallop (*Mizuhopecten yessoensis*) from Alexandrovsky Bay, Japan Sea in 2009–2011

Anna S. Vazhova, Denis P. Kiku, Andrey P. Chernyaev and Lidiya T. Kovekovdova
Assessment of petroleum hydrocarbons and heavy metals in estuarine areas of the rivers of Peter the Great Bay (Japan/East Sea)

Lidiya T. Kovekovdova and Denis P. Kiku
Metals in bottom sediments of Peter the Great Bay (Japan/Est Sea)

Anatoliy L. Drozdov, Galina V. Moyseychenko, Konstantin A. Drozdov and Tatyana S. Vshivkova
Bioassessment of ecological conditions of rivers, estuaries and marine areas around Vladivostok-city: Amurskiy and Ussuriiskiy Gulfs of the Sea of Japan

Vladimir M. Shulkin, Tatyana Yu. Orlova, O.G. Shevchenko and Inna V. Stonik
River runoff as a reason for the seasonal and interannual variability of coastal phytoplankton blooms and hydrochemical characteristics in the northwestern part of the East/Japan Sea

Kuninao Tada, Miho Kayama, Naoto Hirade, Hitomi Yamaguchi, Supaporn Yamaguchi, Kazuhiro Harada, Minoru Tanda, Munehiro Fujiwara, Kazuhiko Ichimi and Tsuneo Honjo
Decrease of surface water nutrient concentration and nutrient flux from the sediment in Harima-Nada, Eastern Seto Inland Sea, Japan

Alla A. Ogorodnikova
A system of biotic indices and impact – Response indicators of hydraulic activity on marine bioresources

Dmitry Galanin, Sergey Dubrovsky, Viktor Sergeenko, Tatyana Shpakova and Yulia S. Chernyshova
Current state of the scallop *Mizuhopecten yessoensis* (Jay, 1856) resources of the Sakhalin-Kuril region (Okhotsk Sea)

Hyeong Kyu Kwon, Han-Soeb Yang, Seok Jin Oh, Ju Chan Kang and Chang Geun Choi
Phytoremediation: Novel approach to remediate eutrophic coastal sediment using light-emitting diodes (LEDs) and benthic microalgae (BMA)

Machiko Yamada, Mayuko Otsubo, Yuki Tsutsumi, Chiaki Mizota, Kuninao Tada and Paul J. Harrison
Effect of fresh water on species diversity of the genus *Skeletonema* (Bacillariophyceae) in coastal and brackish waters

Marisol Garcia-Reyes and William J. Sydeman
Wavelet decomposition of upwelling: Forcing and ecosystem response

Larissa A. Gayko
Influence of climate change on the development of mollusks on marine farms (Possyet Bay, Japan/East Sea)

Anna S. Vazhova and Andrey P. Chernyaev
Content of polycyclic aromatic hydrocarbons (PAHs) in sediments of Amur Bay (Peter the Great Bay, Japan/East Sea)

Talgat R. Kilmatov
Changes in natural environment capacities due to climatic trends and possible migration of manpower on the western shore of the North Pacific

Tamara G. Ponomareva and Polina A. Sokolova
The Amur River estuary system

Min-bo Luo and Yun-long Wang
Community macrobenthos response to engineering in Hangzhou Bay, China

MEQ Topic Session (S2)
Range extension, toxicity and phylogeny of epiphytic dinoflagellates

Co-convenors: *William Cochlan (USA) and Satoshi Nagai (Japan)*

Background

Ciguatera fish poisoning is a growing food-borne illness that is common in tropical waters, where poisoning numbers are poorly known but estimated to range from 50,000 to 500,000 cases per year. The incidence of ciguatera is on the rise, and appears to correspond to disturbances in the environment such as nutrients released into coastal waters, land-use changes, or warmer coastal waters. Indeed, the flagellates, *Gambierdiscus* and *Ostreopsis*, that can produce ciguatoxin- or palytoxin-like compounds, appear to be spreading to more temperate latitudes, including the waters of PICES member countries. To gain better insight to this new issue, papers addressing benthic dinoflagellate taxonomy, evidence for range extension, descriptions of standardized sampling programs; assays for assessing toxicity, and sentinel products to alert public health officials to ciguatera risk were invited. The goal of the session was to formulate a better understanding of environmental conditions fostering the prevalence of ciguatoxin-producing organisms in new geographical regions.

Summary of presentations

The primary goal of the session was to provide PICES scientists with a better understanding of Ciguatera Fish Poisoning (CFP), specifically the taxonomy, distribution, range extension, toxicity and phylogeny of the epiphytic dinoflagellates (*i.e.*, *Gambierdiscus* and *Ostreopsis*) responsible for CFP as well as the methodologies and developments in the detection of their potent biotoxins (*i.e.*, ciguatoxin and palytoxin analogues). As part of the session's overall goal, it was crucial to evaluate the environmental conditions associated with the prevalence and enhancement of ciguatoxin-producing organisms in new geographical regions, and to understand the procedures and approaches to evaluate both the health risks and the mechanisms to alert public health officials (and the public itself) of these harmful algal bloom events in past and newly impacted regions of the Pacific Ocean.

The scheduled session consisted of seven oral presentations and one poster, representing authorship from five PICES member countries: Canada, Japan, Korea, Russia, and the United States, and one non-PICES country: The Cook Islands. There was one last minute cancellation (Dr. Patricia Tester, USA – originally an invited speaker) and one replacement (Dr. Toshiyuki Suzuki, Japan) who graciously agreed to present his group's research results despite only a short time to prepare. Attendance at the session was good, there were many questions and discussions; the audience consistently exceeded 25–30 people throughout the half-day session.

After brief introductory remarks by one of the convenors, Dr. Satoshi Nagai, the first invited (replacement) speaker, Dr. Toshiyuki Suzuki, discussed his research group's successful attempts to detect and characterize palytoxin-like compounds in *Ostreopsis* strains isolated from Japan, and confirmed their production of an analogue of palytoxin (novel ovatoxin isomers). He demonstrated that the toxin content of some strains collected in Japan were comparable to those obtained from the Italian coast, and also noted that *Ostreopsis* isolates collected from the same area at the same time off Japan (and cultured under identical conditions) may or may not be toxic to humans.

The second invited speaker, Dr. Masao Adachi (Japan), demonstrated that non-toxic *Gambierdiscus* species were generally restricted to temperate regions (adapting to temperate conditions) whereas toxic species were mainly distributed in sub-tropical regions (adapting tropical conditions). He examined the growth response of these two typical isolates on different WT-SAL conditions, and speculated that the dominant species in Japanese waters may change from non-toxic to toxic species due to increased sea temperature as a consequence of global climatic warming. A third Japanese speaker, Dr. Takuo Omura, summarized the occurrences of CFP in Japan, and showed that there are several ecotypes evidenced by the different temperature and salinity tolerances exhibited in *Gambierdiscus toxicus*. The fourth speaker, Professor Charles

Trick (Canada), reviewed CFP from the point of view of a scientist's role in public health and safety, and described emerging methodological perspectives using examples from both HAB and other ecosystem health monitoring programs. He stressed the importance of reducing the frequency of toxic impacts to the public by the implementation of toxin surveillance – algal-based, coastal forensics programs (*i.e.*, "plankton watch followed by toxin watch"), and urged PICES scientists to ensure that community goals and scientific goals match, and to remember that a healthy environment leads to healthy people. Our third invited (and fifth speaker overall), Dr. Teina Rongo (Cook Islands and a recent graduate of the Florida Institute of Technology, USA), reported on the frequency and magnitude of CFP in the Cook Islands where currently approximately 10% of the population is impacted each year by CFP, and discussed the linkages between CFP and climate, and the resultant impacts on the population migration patterns of Pacific Islanders in the past. He demonstrated a clear scenario that led to a high risk of CFP due to the positive Pacific decadal oscillations by El Niño whereby the high frequency of physical disturbance events provide increased benthic space on reefs for macro-algal growth which are the preferred habitat for these benthic dinoflagellates, resulting in frequent occurrences of CFP in the Cook Islands. Based on his personal experiences, Dr. Rongo, who has been the victim of CFP on several occasions, reported that other substances (*e.g.*, peanuts) appear to elicit the same clinical responses as CFP.

The sixth speaker, Dr. Tatyana Yu. Orlova (Russia), outlined the abundance, distribution and fluctuation of benthic dinoflagellates of *Ostreopsis* spp. in the Russian coastal waters of the Sea of Japan during the period 2008 to 2011. She showed that thirteen species of *Ostreopsis* are permanent and predominant components of epiphytic assemblages in "slightly shaken" sites in Peter the Great Bay, and emphasized the importance of hydodynamic conditions in controlling the distribution of *Ostreopsis* spp. in her study area. The seventh and final speaker was Dr. Changkyu Lee (Korea) who outlined the geographic distribution of benthic dinoflagellates of *Gambierdiscus* spp., *Ostreopsis* spp., *Coolia monotis* and *Prorocentrum lima* along the southern coast of Korea including Jeju island during June to September of 2011 and 2012, and noted that *Ostreopsis* sp. was the most dominant benthic dinoflagellate. Following the final presentation and a lively period of discussion among speakers and attendees, Dr. William Cochlan (USA) provided closing remarks for the session.

In summary, scientists have made considerable progress from PICES member countries, describing the geographical distribution and spread of the organisms responsible for CFP, but there are still very limited data on the toxicity of most of these epiphytic dinoflagellates. The toxin chemistry is still under investigation, resulting in the difficulty of the risk evaluation of fish poisoning in PICES and non-PICES countries. Although successful culturing attempts have been conducted elsewhere, it is clear that controlled culturing studies of toxic isolates of *Gambierdiscus* are needed to better evaluate not only the toxicology of ciguatoxin, but also for the characterization of related toxins. With such efforts, the scientific community can then establish a supply of standard products and operating procedures for the study of these toxic dinoflagellates, and elucidate the environmental conditions for their growth and determine the environmental and/or physiological triggers for their production of these potent biotoxins.

List of papers

Oral presentations

Toshiyuki Suzuki, Ryuichi Watanabe, Hajime Uchida, Ryoji Matsushima, Hiroshi Nagai, Takeshi Yasumoto, Takamichi Yoshimatsu, Shinya Sato and Masao Adachi (Invited - replacement)
Discovery of novel ovatoxin isomers in several *Ostreopsis* strains in Japan

Masao Adachi, Takamichi Yoshimatsu, Haruka Iwamoto, Tomohiro Nishimura and Haruo Yamaguchi (Invited)
Effect of temperature change on the dominant species of *Gambierdiscus* in Japan - From a non-toxic species to a toxic species?

Takuo Omura and Yasuwo Fukuyo
Gambierdiscus in the mainland of Japan

Charles G. Trick and Danielle Beausoleil
HABs and Ciguatera Fish Poisoning: Emerging methodological perspectives

Teina Rongo and Robert van Woesik (Invited)
Ciguatera poisoning and climate oscillations in Rarotonga, southern Cook Islands

Marina S. Selina, Tatiana V. Morozova, Nellya G. Litvinova and Tatyana Yu. Orlova
Toxic epiphytic dinoflagellates in Peter the Great Bay, Sea of Japan, Russia

Changkyu Lee, Taegyu Park and Youngtae Park
Geographic distribution of benthic dinoflagellates along Korean coasts

Poster presentations

Seung Ho Baek
Occurrence of epiphytic dinoflagellate *Gambierdiscus* spp. in the uninhabited Baekdo Islands and Seopsom Island in the vicinity of Seogwipo, Jeju Province, Korea

POC Topic Session (S3)
Challenges in understanding Northern Hemisphere ocean climate variability and change

Co-sponsored by: *CLIVAR and ICES*

Co-convenors: *Jürgen Alheit (ICES/Germany), Emanuele Di Lorenzo (PICES/USA), Michael Foreman (PICES/Canada), Shoshiro Minobe (PICES/Japan), Hiroaki Saito (PICES/Japan) and Toshio Suga (CLIVAR/Japan)*

Background

Physical climate variability and change exert substantial impacts on marine ecosystems, particularly on longer timescales because of the longer ocean memory compared with the atmosphere, and the cumulative effects on marine ecosystems. On a centennial scale, climate changes due to anthropogenic forcings may dominate over natural variability, but variations on decadal or shorter timescales may be mainly due to natural climate variability. Furthermore, natural climate variability can be modified via climate changes. Therefore, a correct understanding of the mechanisms underlying climate variability and change should be the basis for understanding and predicting future conditions of the North Pacific and North Atlantic. For the North Pacific there is no widely accepted consensus on the mechanisms governing decadal-to-multidecadal climate variability, and this mainly reflects the uncertainty of how, or even whether, the mid-latitude ocean influences the atmosphere. Some linkages between processes, such as oceanic memory due to Rossby wave propagation, are generally accepted, and predictability associated with these processes may also be important for understanding marine ecosystem impacts. It is also unclear if teleconnection dynamics between the North Pacific, North Atlantic and the Arctic exert an important control on the ocean's decadal climate state. This session brings together researchers of marine ecosystems, physical oceanography and climate to share ideas about what physical parameters and processes are important in understanding and predicting the response of specific marine ecosystems to climate forcing. Through collaboration among PICES, CLIVAR and ICES, this session invited contributions exploring important developments in the research field of the North Pacific climate variability and change, including physical environmental variations and their predictability, teleconnection dynamics between oceanic basins, such as the Pacific and Atlantic Oceans, and linkages between physical conditions and marine ecosystems.

Summary of presentations

This session was extremely well attended (>150 scientists) and brought together a rich diversity of scientists ranging from physical oceanographers and climate dynamicists to marine ecosystem scientists. The main goal of this session was to identify the challenges in understanding the physical parameters and processes that are important in diagnosing and predicting the response of specific marine ecosystems to climate forcing. The session was characterized by a set of high profile talks (both invited and regular) that provided a well balanced view of (a) new advances in understanding the climate dynamics of the North Pacific and Atlantic oceans, (b) the observed links between climate and ecosystem variability, and (c) mechanisms that may be important to include when developing climate-driven process models to hindcast and forecast changes in the marine ecosystem.

The session opened with an introductory invited talk by Dr. Kenneth Drinkwater who provided examples of how the changes we observe in the marine ecology are not simply a response to climate but also are influenced by human-induced factors, such as fishing, pollution, ocean acidification, land development, as well as non-climate forced species interactions and diseases. Responses of the marine environment result from a combination of all of these factors, which often interact non-linearly. Nevertheless, the links between long-term changes in marine ecosystems and modes of climate variability are strong and clear. Dr. Jürgen Alheit and Dr. Nathan Mantua (invited) reinforced this point by providing a comprehensive and updated overview of documented long-term changes in a variety of fish stocks in relation to different climate modes over the North Atlantic and North Pacific sectors. These strong links between the climate modes and the ecosystem data archives raised questions about whether it is possible to develop low-order ecosystem process-based models to diagnose and forecast the ecosystem response to climate forcing. Dr. Patrick Cummins and later, Dr. Curtis Deutsch (in session S14), showed how climate-driven process models are indeed capable of explaining important biogeochemical quantities such as dissolved oxygen in the tropical and northeast Pacific. Dr. William Peterson's and Dr. Jennifer Fisher's talks went further and provided specific guidelines and examples for developing simple ecosystem process models for zooplankton variability in the Oregon Shelf in relation to changes in ocean advection, upwelling and temperature forced by the Pacific Decadal Oscillation (PDO). On the other hand, while the prospect of developing these simple process models is exciting, Dr. Akinori Takasuka (invited) introduced caution in using this approach, especially when moving further up the trophic levels to small pelagic fish. Even if the links between fish stock variability and the climate modes are often statistically strong, he presented evidence of how the interaction of climate with small pelagics is not always direct but mediated through changes in a large range of vital parameters to which the small pelagics are sensitive. He also showed that this sensitivity is species dependent and therefore, isolating the species-specific responses to environmental factors is a critical step towards understanding and modeling the dominant biological processes and the consequences of climate variability and change.

Another important consideration on developing models to forecast ecosystem changes was pointed out by Dr. Mantua and is related to how predictable are the oceanic responses (*e.g.,* the climate modes) to atmospheric forcing. Process models often used for explaining large-scale climate modes like the PDO and the North Pacific Gyre Oscillation (NPGO) is an auto-regressive model of order 1 (AR1, red noise process) forced by random white noise atmospheric variability. The AR1 model dynamics implies that there is little predictability beyond the monthly to seasonal timescale because the future state only depends on the preceding state with some auto-decorrelation timescale. Although some other hypotheses were proposed including climate oscillations arising from delay negative feedback from the ocean to the atmosphere and periodic oscillations of extraterrestrial origins, there is no enough evidence that these mechanisms play essential roles in shaping North Pacific climate to an extent that one can expect practical predictability. On the other hand, delayed ocean responses that follow the excitation of these climate modes or follow from other direct atmospheric forcing are predictable and may be used as forcing functions to forecast ecosystem responses. This is the case especially in the western boundary systems.

The talks on western boundary dynamics took place in the afternoon session and presented very exciting new advances in the physical mechanism that control the ocean low-frequency response to external atmospheric forcing. Dr. Young-Oh Kwon (invited) opened the session with a comprehensive review of the conceptual models of decadal climate and ecosystem variability in the Kuroshio-Oyashio Extensions and Gulf Stream. He showed that there are important similarities in the delayed (and predictable) oceanic response of the Pacific and Atlantic western boundary currents to the climate modes (up to 6-year lag), and also provided evidence that these physical changes lead to predictable responses in selected marine ecosystem populations. For example, two populations of silver hake (*Merluccius bilnearis*) in the Northeast U.S. Shelf show significant changes in their spatial distribution that are correlated with the north–south shift in the Gulf Stream ($r = 0.71$). These changes in hake lag the changes in the Gulf Stream suggesting that it is possible to develop multi-year ecosystem forecasts. Following the opening talks were two hard-core physical oceanography talks that explained in more depth the mechanisms controlling the delayed oceanic responses of the western boundary current systems. Dr. Yoshi Sasaki (invited talk who received a Best Presentation PICES award for a POC-sponsored session; see Best Presentations list at the end of Session Summaries) presented a new theory (thin-

jet theory) that explains how ocean decadal anomalies of the PDO and NPGO forced in the central and eastern North Pacific propagate as Rossby waves into the western boundary and transfer their energy into the eddy-scale circulations of the Kuroshio jet. This theory not only explains previous observations showing how the Kuroshio decadal variability has a lagged response to the climate modes but also begins to address the issue of how eddy-scale circulation, which is presumably important to ecosystem processes, responds to climate forcing. This issue was later addressed by Dr. Andrew Davis who showed that atmospheric climate variability could lead to deterministic responses in the eddy-scale circulations also in the North Pacific eastern boundary (*e.g.*, the California Current). To complement Dr. Sasaki's results, Dr. Bunmei Taguchi presented modeling evidence suggesting that the decadal modulations of the Kuroshio (*e.g.*, the delayed response to PDO and NPGO) can have an additional delayed feedback on the central and eastern North Pacific via a subsurface oceanic pathway that involves the advection of thermocline heat anomalies by the North Pacific gyre from the western boundary to the central and then eastern North Pacific. This sequence of cause and effect that originates from the atmospheric forcing can lead to predictable oceanic responses on timescales of decades and, in turn, provide the basis for forecasting ecosystem changes. Although the idea of exploiting the delayed oceanic responses for predictability purposes has been around for a while, especially in the western boundary, the additional understanding of how these delayed effects impact eddy-scale circulations and transport dynamics may link the climate forcing to ecosystem processes and their prediction. In fact this issue was the main focus of the last talk of the session by Dr. Toshio Suga, who introduced Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX). Dr. Suga reinforced the premise that eddy-scale dynamics (*e.g.*, mesoscale and submesoscale processes) play a critical role in linking physical conditions to marine ecosystem dynamics through intense convergence/divergence, upwelling/downwelling and mixing. In fact, this was the motivation behind the launch of INBOX in 2010 by JAMSTEC. The goal of INBOX is to acquire physical-biogeochemical observational data necessary to resolve mesoscale and submesoscale physical-biological phenomena.

List of papers

Oral presentations

Kenneth F. Drinkwater (Invited)
Challenges in understanding ocean climate variability and change and its impacts: Temporal and spatial scales and multi-forcings

Jürgen Alheit
Impact of multi-decadal climate forcing on northern hemisphere small pelagic fish populations

Andrey S. Krovnin, Boris N. Kotenev and George Moury
Interaction of major teleconnection patterns as a mechanism linking the North Pacific and North Atlantic climate

Nathan Mantua and Megan Stachura (Invited)
Empirical evidence for North Pacific ecosystem regime shifts revisited

William T. Peterson, Jay Peterson, Cheryl A. Morgan and Jennifer L. Fisher
Tracking ecosystem change in the northern California Current

Akinori Takasuka, Ichiro Aoki and Yoshioki Oozeki (Invited)
Environmental windows for small pelagic fish in the western North Pacific: How do their vital parameters respond to climate variability and change?

Albert J. Hermann, Nicholas A. Bond, Georgina A. Gibson, Enrique N. Curchitser, Kate Hedstrom and Phyllis J. Stabeno
Biophysical frequency response of the Bering Sea to large-scale forcing

Hyung Jeek Kim, Kiseong Hyeong, Chan Min Yoo, Dongseon Kim and Boo-Keun Khim
Impact of strong El Niño events on sinking particle fluxes in the 10ºN thermocline ridge area of the northeastern equatorial Pacific

Elena I. Ustinova and Yury D. Sorokin
Regional features of the climate variability and change in the Far-Eastern Seas

Young-Oh Kwon (Invited)
Role of the Kuroshio-Oyashio Extensions and Gulf Stream in the decadal climate and eco-system variability

Bunmei Taguchi and Niklas Schneider
Dynamics of North Pacific oceanic heat content variability on decadal time-scale

Yoshi N. Sasaki, Shoshiro Minobe and Niklas Schneider (Invited)
Interannual to decadal variability of the Gulf Stream and Kuroshio Extension jets

Jennifer L. Fisher, William T. Peterson, Cheryl A. Morgan and Jay Peterson
Basin-scale *versus* local-scale drivers of copepod community dynamics in the northeast Pacific (Newport, Oregon, USA)

Andrew Davis and Emanuele Di Lorenzo
Forcing dynamics of mesoscale eddies in the California Current

Vadim Navrotsky
Effects of solar activity on climate-ocean ecosystems interactions

Howard J. Freeland
Temperature, salinity and density trends along Line-P and the implications for mixed layer formation

Patrick Cummins and Diane Masson
Wind-driven variability of dissolved oxygen below the mixed layer at Station P

Haruka Nishikawa, Yoichi Ishikawa, Masafumi Kamachi, Hiromichi Igarashi, Shuhei Masuda, Toshimasa Doi, Shiro Nishikawa, Yoshihisa Hiyoshi, Yuji Sasaki, Takashi Mochizuki, Hiroshi Ishizaki, Tsuyoshi Wakamatsu and Toshiyuki Awaji
Estimation of nutrient supply process in the spring Kuroshio-Oyashio transition region

Toshio Suga, Shigeki Hosoda, Ryuichiro Inoue, Kanako Sato, Koketsu Shinya, Taiyo Kobayashi, Fumiaki Kobashi, Katsuya Toyama, Toshiyuki Kita, Makio C. Honda, Kazuhiko Matsumoto, Kosei Sasaoka, Tetsuichi Fujiki, Hajime Kawakami, Masahide Wakita, Yoshikazu Sasai, Akihiko Murata, Kazuhiko Hayashi, Yoshimi Kawai, Vincent Faure, Akira Nagano, Takeshi Kawano and Toshiro Saino
Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX)

Poster presentations

Svetlana Yu. Glebova
Winter cyclonic activities over the ocean as a factor in the subsequent changes in the atmospheric and thermal regime of the Far Eastern Seas and north-west Pacific (with a shift in one year)

Qinghua Qi, Rong-shuo Cai and Qilong Zhang
The variability of sea temperature in South China Sea (SCS) and its relationship with the early or later of SCS summer monsoon outbreaks

Howard J. Freeland
The current status of the international Argo project

Hong-jian Tan and Rong-shuo Cai
Possible impact of El Niño Modoki on marine environment in China offshore and its adjacent seas

Taewook Park, Chan Joo Jang, Minho Kwon, Hanna Na and Kwang-Yul Kim
ENSO effect on surface salinity variability in the Yellow and East China Seas in summer

Dmitry V. Stepanov, Victoriia I. Stepanova and Nikolay A. Diansky
Interannual to interdecadal variability of circulation in the Japan/East Sea based on numerical simulations

Larissa A. Gayko
Air-sea interaction along the coast of north-western East/Japan Sea within 75 years

Yang Liu, Sei-Ichi Saitoh, I. Nyoman Radiarta, Tomonori Isada, Toru Hirawake, Hiroyuki Mizuta and Hajime Yasui
Impact of climate variability on marine aquaculture: A case study on the Japanese kelp in southern Hokkaido, Japan, using satellite remote sensing and GIS-based models

Yuri Oh, Chan Joo Jang and Jihyun Lee
Enhanced stratification in the southwestern East Sea (Japan Sea)

Yoshikazu Fukuda, Wataru Ito, Toshiya Nakano, Shiro Ishizaki and Tsurane Kuragano
Decadal variability of subsurface temperature in the North Pacific and recent modulation of the leading EOF modes

Larisa Chernysheva and Viktoria Platonova
Seasonal climate variability on the coastal zone of the western part of North Pacific

Kosei Komatsu
3D structure and decadal change of the nutrient in the Kuroshio region detected from historical data

Naoki Furuichi, Toshiyuki Hibiya and Yoshihiro Niwa
Assessment of turbulence closure models for resonant inertial response in the oceanic mixed layer using a large eddy simulation model

Olga Skaberda, Lubov' Vasilevskaya and Julia Stochkute
The relationship between the air temperature of East Kamchatka and the water temperature of western part of the Bering Sea

Yulong Liu, Qi Wang and Jinkun Yang
The features of bifurcate line about the North Equatorial Current in the Pacific

Chan Joo Jang, Jihyeon So, Taewook Park and Sinjae Yoo
Mixed layer variability and its associated chlorophyll *a* changes in the East Sea (Japan Sea)

FIS/MONITOR/POC Topic Session (S4)
Monitoring on a small budget: Cooperative research and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring

Co-convenors: *Steven Barbeaux (USA), Jennifer Boldt (Canada), Martin Dorn (USA) and Jae Bong Lee (Korea)*

Background

Long-term monitoring is a key component of an ecosystem-based approach to fisheries management. Time series data enable the examination of changes in oceanographic and community metrics. Government funding sources for long-term monitoring of biological and oceanographic processes has dwindled in recent years, while the mandate for this type of information has increased. If data driven ecosystem-based management continues to be goal then methods for reducing the costs of data collection must be found while data quality is maintained. An example of this type of innovative approach can be found in Alaska walleye pollock (*Theragra chalcogramma*) fishery where researchers have teamed with commercial fishers to deploy inexpensive temperature and depth data storage tags on trawl nets. At the same time, data on fish density and distribution are being collected using the fishing vessels' own acoustic systems. These data are being used to validate oceanographic models, to assess the effects of oceanographic conditions on bycatch in the walleye pollock fishery, and to evaluate the effects of oceanographic conditions on walleye pollock density and distribution. This session was intended to explore the ways in which cooperative research with other seagoing stakeholders and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring can be integrated into ocean monitoring systems.

Summary of presentations

Although cooperative monitoring has long been part of our scientific tool box, Topic Session 4 at the 2013 PICES annual meeting is the first time ICES or PICES has offered a session aimed specifically at highlighting cooperative monitoring projects. Shrinking governmental budgets are making it difficult to develop or expand ocean monitoring systems. Cooperative monitoring provides a means to leverage scarce government funding and has the added benefit of involving other stakeholders in the scientific process. Working together with fishers and other stakeholders in cooperative projects allows scientists not only to collect data cost effectively, but also to collect data over temporal and spatial ranges and at times of the year that would not be feasible using research vessels or fixed moorings. In this session there were ten papers presented and two posters displayed covering a diverse array of cooperative projects from around the Pacific. The projects ranged from opportunistic data collections where data are collected while vessels and crew go about their everyday activities, to directed cooperative survey efforts where vessels and crew are contracted or volunteer to collect data in systematic manner.

The session began with invited speaker, Dr. Rudy Kloser, the team leader of the Marine Environmental Prediction Program at CSIRO Marine Research Center in Hobart, Tasmania, Australia. His research includes projects that are a part of an integrated marine observing system. Dr. Kloser presented his research that uses cost-effective acoustic technology on commercial vessels to monitor deep-water and remote fisheries and basin-scale ecosystems off Australia using fishing vessels. This has been facilitated in Australia with the overall governance of the fisheries where there are clear incentives for engaging in monitoring. More broadly, this incentive is also driven by societal drivers for sustainable fisheries. To meet these challenges new

technologies and methods have been developed in Australia to ensure data quality is maintained. At the larger ocean basin scale, he showed how fishing vessels provided data useful for developing valuable insights into the structure and function of pelagic ecosystems. This bio-acoustic sampling method has been integrated into an ocean observing system looking at decadal trends in environmental variability. He further demonstrated how complementary depth stratified net tows and fine-scale acoustic and optical sampling were helping to provide some of the necessary biological interpretations. Future research for CSIRO is focused on how best to use the data for ecological indicators or input into ecological models.

The next presenter was Dr. Sonia Batten from the Sir Alister Harder Foundation for Ocean Science. She presented information on ships-of-opportunity sampling of lower trophic levels. In her presentation she stated that Continuous Plankton Recorders (CPRs) have been towed behind commercial ships and other vessels of opportunity generating spatially and temporally referenced quantitative data on the abundance and distribution of many zooplankton and larger phytoplankton taxa. Benefits (*e.g.*, highly cost-effective sampling of large remote oceanic regions), were discussed as well as limitations of this approach (*e.g.*, lack of control over exactly when and where sampling occurs). In more recent years, she stated that the CPR has itself become a sampling platform with instrumentation added to the towed body which autonomously collects physical data (T, S, D) and chlorophyll fluorescence, or microplankton via a self-contained water sampler. She believed that there is the potential to develop large-scale, multi-trophic level monitoring programs with some supplemental physical data.

Dr. Elizabeth Logerwell from the Alaska Fisheries Science Center, Seattle, Washington, presented a study that used walleye pollock acoustic survey data and Steller sea lion abundance and foraging information to manage fisheries interactions with Steller sea lions in the Aleutian Islands, Alaska. The study employed aerial surveys for sea lion abundance, scat sampling from a contracted survey vessel, and acoustic surveys of prey fields from both a commercial fishing vessel and a research vessel. In this study the biomass of pollock potentially available for sea lions and the fishery was quantified, areas of high pollock biomass were identified, and areas where pollock were likely to be important to sea lions were identified. The diet composition of sea lions was related to pollock abundance, but the distribution of sea lions among haul-out sites was not. Instead, the distribution of sea lions appeared to be driven by the distribution of Atka mackerel (*Pleurogrammus monopterygius)*, their most common prey year round. Dr. Logerwell suggested that in the Aleutian Islands, sea lion diets respond to small-scale, short-term distribution of prey (pollock) whereas their spatial distribution during the non-breeding season among haul-out sites may primarily reflect the larger annual-scale distribution of Atka mackerel.

Dr. Elena Ustinova from the Pacific Fisheries Research Centre (TINRO-Centre) in Vladivostok, Russia, presented her research on monitoring oceanographic and biological conditions during the saury fishery (from August to December) in the Northwestern Pacific. Monitoring oceanographic and biological conditions was accomplished using sensors on commercial fishing vessels in combination with other oceanographic and climatological data. She indicated that saury fishing activities were related to oceanic fronts of different scales and the effectiveness of the fishery depends on the ability of forecasting of hydrometeorological conditions. In recent years TINRO has been creating and using new information technologies to providing real-time operational scientific support to the saury fishery, and using collected data to visualize and forecast saury distribution in relation to climate, weather, and oceanographic factors. Sea surface temperature data obtained *in situ* allowed them to improve satellite derived SST estimates for the fishing area and to determine local ocean conditions (areas of the fronts, the individual eddies, *etc.*). The presence of a scientist on board the commercial fishing or processing vessel provided for the collection of biological data (*e.g.*, size-age structure of sampled fish). These data have been added to the long time-series on the biological characteristics of saury. She believed that “saury-related” monitoring could contribute to a larger ocean monitoring system.

Ata Suanda from the College of Earth, Ocean, and Atmosphere at Oregon State University in Corvallis, Oregon, presented long-term observations of internal waves with shore-based video cameras. Internal waves are implicated in the mixing and transport of pollutants and planktonic organisms including juvenile fish; however, the arrival timing and frequency of wave occurrence is poorly understood. In this work, a low-cost

observation technique using shorebased video cameras was presented to provide long-term measurement of internal waves. Using ADCP and thermistor chains with video observations on the central Oregon inner shelf, the surface expression of internal waves, visible as streaks of increased pixel intensity in video imagery, were tracked through time and space and compared to wave propagation speed and direction from *in-situ* measurements. Archived video observations from this location were also analyzed and consideration was given towards extending the technique to the use of non-research, freely available beach webcams.

Oksana G. Mikhailova, Laboratory of the Commercial Invertebrate, Kamchatka Research Institute of Fisheries and Oceanography, presented her study on coastal monitoring of the state of the pink shrimp *Pandalus borealis* population on West Kamchatka using at-sea observers on board commercial fishing vessels. In recent decades, due to budget constraints, pink shrimp population levels on the West Kamchatka coast and the health of the fishery have been monitored by on-board observers. The data they have obtained in the commercial district near the south-west coast of Kamchatka for 2004–2012 became the basis for the stock assessment and abundance forecasts. The total allowable catch for the district was estimated using the on-board observer data during 2005–2011. A stable growth of pink shrimp abundance was shown. Since sampling was carried out using a specialized shrimp trawl, also utilized in commercial fishing, analyses can include a number of commercial parameters, unavailable in scientific survey sampling. A huge biostatistical data pool on distribution, size-weight characteristics and dynamics of egg development of pink shrimp has recently been formed due to the inclusion of these data. Temperature data in the area inhabited by pink shrimp were also collected. The commercial fleet normally operates in spring or autumn, and is helping to track population migrations. Thus, current monitoring of pink shrimp from commercial vessels plays a very important role and can be used in the case of limited finances in the future.

Christopher Siddon, Alaska Department of Fish and Game in Juneau, Alaska, presented an intensive, cost-effective method to improve red king crab stock assessments in southeastern Alaska through collaboration with the commercial fishing industry. A collaborative effort between the Alaska Department of Fish and Game (ADFG) and the commercial fishing industry provides a novel, cost-effective method to improve stock assessment methods and facilitate positive working relationships. Utilizing the strengths of the fishing industry and the ADFG, they designed a joint project to improve the understanding of red king crab distributions and ground-truth current stock assessment methods. Specifically, they compared a Catch Survey Analysis (CSA) model with depletion and mark-recapture estimates for six areas. The depletion model estimate of crab abundance for St. James Bay was 30% lower than the estimate from the CSA model. The mark-recapture estimates of crab abundance averaged 3.6 (±1.6 SE) times higher than the CSA model estimates. In addition, results from the mark-recapture data suggest large changes in crab behavior (movement and catchability) over relatively short time scales (months).

Dr. John A. Barth, College of Earth, Ocean, and Atmosphere at Oregon State University in Corvallis, Oregon, presented information on environmental sampling, hypoxia and the Northwest Fisheries Science Center's Cooperative U.S. West Coast Groundfish Bottom Trawl Survey. The NOAA NMFS Northwest Fisheries Science Center (NWFSC) currently conducts a number of groundfish research and monitoring projects that are cooperative and collaborative with the fishing industry. These include a West Coast Groundfish Bottom Trawl Survey (WCGBTS), a hook and line survey of shelf rockfishes in the Southern California Bight, pelagic trawl surveys of juvenile groundfishes, and acoustical optical pilot surveys of pelagic rockfishes in untrawlable habitats. In the context of such cooperative research programs, advancements in sampling technologies have allowed new types of data to be collected during traditional NMFS surveys. For example, environmental sensing packages were attached to trawls and recorded a full array of environmental parameters (*e.g.*, depth, temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity, and light). These improved environmental sensing capabilities have led to collaborations with academic partners and with the developers and manufacturers of sensing packages. In 2007, the NWFSC added an environmental sampling program to the WCGBTS that included collaboration with physical oceanographers at Oregon State University. This program was initiated, in part, in response to hypoxia that was observed on the continental shelf of the Pacific Northwest, in a region not previously characterized by hypoxic conditions. Fishery and environmental sampling is conducted from chartered commercial trawlers from 55 to 1280 m and from the U.S.–Canada

border to the U.S.–Mexico border. A nested sampling design encompasses the oxygen minimum zone of the California Current as well as a known hypoxic area on the continental shelf off the Oregon coast. Dr. Barth showed some impressive figures on the data collected through these programs and demonstrated the usefulness of this approach. The bottom line is that cooperative monitoring in this case may not be cheap, but was cost-effective.

Dr. Kazuaki Tadokoro, Tohoku National Fisheries Research Institute, Miyagi, Japan, discussed the archive of historical meso-zooplankton samples collected around Japan. Knowledge about the meso-zooplankton community would improve our understanding of the effects of large-scale climate change on marine ecosystems. Meso-zooplankton samples can be preserved in buffered formaldehyde for a long time with low cost. The Fisheries Research Agency of Japan and multiple prefectural fisheries stations/institutes have systematically collected fish eggs and larvae by plankton nets to investigate the spawning of commercially important pelagic fish such as Japanese sardine from the 1970s. More than 6,000 samples were collected in the last fiscal year. A portion of those samples contributed to the Odate Collection, which is a world-famous meso-zooplankton archive. Also, another portion of the samples has been used for studies on the long-term variation of the marine ecosystems analyzed by the bench top Video Plankton Recorder (B-VPR) in the Kuroshio waters. However, the samples have not yet been systematically archived in the center institute. Currently, it is difficult to use the samples for the large-scale studies efficiently. Therefore, archiving the historical collection of samples systematically in the Tohoku National Fisheries Institute has started this year. Moreover, the database of the archival samples is being constructed to utilize them more efficiently.

Because he was unable to attend the conference, Dr. Steven Barbeaux, Alaska Fisheries Science Center, Seattle, Washington, pre-recorded a presentation on cooperative monitoring in the Alaska walleye pollock (*Theragra chalcogramma*) fishery. Researchers in Alaska are implementing cooperative monitoring programs to address the issue of long-term monitoring to help achieve the objective of an ecosystem-based approach to fisheries management. Dr. Barbeaux started with his vision of possible models for ocean monitoring systems and continued with lessons learned in working on cooperative projects in Alaska. He then presented on two projects implemented in Alaska: an opportunistic acoustic data collection project and a project to collect temperature at depth data from commercial trawls. Both projects were very low cost, but resulted in a large amount of high quality data. The opportunistic data were being used to investigate fishery impacts on pollock aggregations across a range of spatial scales in relation to Steller sea lion critical habitat and showed higher exploitation rates inside critical habitat. The temperature at depth data were used to investigate possibilities between temperature and depth and salmon bycatch in the pollock fishery and resulted in concrete advice for fishers to reduce king salmon bycatch. Both projects were successful implementations of cooperative monitoring and are expected to become long-term projects. These projects demonstrated cooperative monitoring programs in which researchers worked with other seagoing stakeholders to inexpensively collect biological and oceanographic data that could be integrated into a long-term ocean observing system.

Dr. Igor Shevchenko, Pacific Fisheries Research Centre (TINRO-Centre) and Far Eastern Federal University in Vladivostok, presented a poster on sharing marine “small science” data. His poster highlighted the fact the major science programs usually specify data format, quality assessment procedures and even ensure open access to collected data through established data centers. Smaller science programs, however, generally do not have these components and the data are unavailable to other scientists. The PICES community has already provided several information services to members and expert groups at the TCODE geospatial portal (http://67.212.128.197/geonetwork). Among them is an electronic catalog for publishing metadata. This service is an outcome of the PICES metadata federation project. It allows scientists to prepare, post, edit, and make metadata spatially searchable by particular groups of end users on the Internet. This tool is not currently widely employed and the number of submissions has not grown. PICES urgently needs to implement a data policy and promote a data sharing etiquette. For example, all PICESians should claim their data “officially” by submitting metadata to a searchable catalog, and the metadata and data set references should be cited when a scientific report or a paper is published.

Dr. Orio Yamamura, Hokkaido National Fisheries Research Institute, Kushiro, Hokkaido, presented a poster on walleye pollock. The Doto area is a nursery ground of the Japan Pacific population (JPP) of walleye pollock, one of the most important fishing targets in the Japanese waters. Juvenile pollock settle from late summer through winter into the area, where the predation mortality by demersal fishes is significant. Dr. Yamamura has continued a monthly monitoring of the demersal fish community during the settlement season (April–December) in this area for 10 years, using a small fishing boat (7.3 ton) equipped with a Danish seine. On a typical survey day trip, this boat departs 5:00 in the morning, samples 4 stations by Danish seine, and returns to port by 14:00. It is chartered at <100,000 yen (ca. 1,250 USD) a day.

The fishing gear used had a limitation in catchability of large-sized and benthopelagic gadids (*i.e.*, pollock and Pacific cod) due to the low height of the sampling gear. But it has been useful in monitoring non-commercial predators including Kamchatka flounder (*Atheresthes evermanni*) and plain sculpin (*Myoxocephalus jaok*). The data are used to quantify the predation impact on newly settled age-0 pollock. In this paper, the temporal and bathymetric change in demersal fish community structure was also presented.

List of papers

Oral presentations

Steven J. Barbeaux
Cooperative monitoring in the Alaska walleye pollock (*Theragra chalcogramma*) fishery

Rudy J. Kloser, Tim E. Ryan, Ryan Downie, Mark Lewis and Gordon Keith (Invited)
Using commercial vessels to monitor deep-water fisheries and basin scale ecosystems

Sonia Batten and Anthony Walne
Ship of Opportunity sampling of lower trophic levels

Elizabeth A. Logerwell, Steven J. Barbeaux and Lowell W. Fritz
Using walleye pollock acoustic survey data and Steller sea lion foraging information to manage fisheries – sea lion interactions in the Aleutian Islands

Viktor N. Filatov, Yury.V. Eremin, Elena I. Ustinova and Aleksey V. Ballo
Monitoring of oceanographic and biological conditions in the Pacific saury fisheries expedition

Ata Suanda and John A. Barth
Long-term observations of internal waves with shore-based video cameras

Oksana G. Mikhailova
Coastal monitoring the state of pink shrimp *Pandalus borealis* population on West Kamchatka

Christopher Siddon
Collaborating with the commercial fishing industry: An intensive, cost-effective method to improve red king crab stock assessments in southeastern Alaska, U.S.A.

Aimee A. Keller, W. Waldo Wakefield, Victor H. Simon, John A. Barth and Stephen D. Pierce
Environmental sampling, hypoxia and the Northwest Fisheries Science Center's Cooperative U.S. West Coast Groundfish Bottom Trawl Survey

Kazuaki Tadokoro, Yuji Okazaki, Akinori Takasuka, Tadafumi Ichikawa and Hiroya Sugisaki
Archiving historical meso-zooplankton samples collected around Japan

Poster Presentations

Igor Burago, Georgy Moiseenko, Olga Vasik and Igor Shevchenko
Sharing marine "small science" data

Orio Yamamura, Kouji Kooka and Takeomi Isono
Monitoring demersal fish community containing predators of walleye pollock using a small fishing boat

MEQ/FUTURE Topic Session (S5)
Social-ecological systems on walleye pollock and other commercial gadids under changing environment: Inter-disciplinary approach

Co-convenors: *Keith Criddle (USA), Suam Kim (Korea), Mitsutaku Makino (Japan), Ian Perry (Canada), Yasunori Sakurai (Japan) and Anatoliy Velikanov (Russia)*

Background

In order to build bridges between scientists, decision-makers, stakeholders, and across sectors, there is a need for more in-depth and concrete inter-disciplinary research framework in the context of the PICES integrative science program FUTURE. One of the typical groundfish resources in the North Pacific, pollock is highlighted to facilitate such academic discussions under the PICES framework. Research on walleye pollock from the perspectives of ecology, biology, stock dynamics, harvesting, fisheries management, history, marketing, processing, international trade, consumption, and culture will be presented. Inter-relationships among these varied perspectives, information needs, potential values for other disciplines, *etc*., were discussed during this session. An expected outcome of this session was a holistic framework for inter-disciplinary research, which could be applied to other species.

Summary of presentations

In order to build bridges between scientists, decision-makers, stakeholders, and across sectors, there is a need for more in-depth and concrete inter-disciplinary research in the context of the PICES integrative science program FUTURE. To facilitate such academic discussions under the PICES framework, this Topic Session highlighted one of the most prominent groundfish resources in the North Pacific: walleye pollock (*Theragra chalcogramma*). As briefly summarized below, studies on pollock and other commercial gadids from the perspectives of ecology, biology, stock dynamics, harvesting, fisheries management, history, marketing, processing, international trade, consumption, and culture were presented. The session drew about 60 participants—so that, at times, there were not enough chairs to go around. Very intensive and constructive discussions were held.

As the first presentation, Dr. Oleg A. Bulatov of VNIRO (Russia), one of two invited speakers in this Topic Session, gave a talk titled "*Walleye pollock: Global view*". Based on decadal-scale temperature forecasts, Dr. Bulatov speculated that the world climate might cool over the coming decades (2015–2030). He anticipates that this cooling will lead to a significant reduction of stocks of northern populations of walleye pollock in the Gulf of Alaska and Bering Sea and that stocks in the Sea of Okhotsk will remain at low levels. In contrast, he anticipates that southern populations of pollock, such as those in the Sea of Japan and the Pacific coast of Japan, will increase significantly during 2020–2040. He suggested that such changes in temperature could have significant effects on the global supply of pollock to the world market.

Dr. Tetsuichiro Funamoto of Fisheries Research Agency (Japan) gave a talk on their study about comparisons of recruitment fluctuation mechanisms of walleye pollock in the Sea of Japan and the Pacific Ocean off northern Japan. He identified important factors for recruitment, such as transport, water temperature, and spawning biomass, and constructed a model to explain the recruitment mechanisms. Dr. Anatoliy Ya. Velikanov of SakhNIRO (Russia) then gave us his study titled "*Long-term changes in abundance and annual catches of walleye pollock off Sakhalin Island in the Japan/East Sea and the Okhotsk Sea: From collapse to renewal*". He reported that a stock near western Sakhalin is deeply depressed whereas a stock near north-eastern Sakhalin has experienced abundant growth. He explained the differences in the renewal process between the two stocks. Mr. Benjamin Williams, a student at the University of Alaska Fairbanks, talked about the variations in walleye pollock maturation rates in the Gulf of Alaska, with his special interest on spatial considerations to improve estimates of spawing stock biomass.

A study by Dr. Anatoly V. Smirnov (TINRO, Russia) entitled "*Ecosystem approaches to pollock fishery management in Russia*" was presented by Dr. Mikhail Stepanenko. It dealt with the relationship between pollock and sea lions, and on other management measures that support ecosystem-based management. Dr. Hiroshi Kuroda of Fisheries Research Agency (Japan) followed with a discussion of their study using a high-resolution coastal model around the southern coast of Hokkaido on passive transport of eggs, larvae and juveniles of walleye pollock. Dr. Igor K. Trofimov (Kamchatka Research Institute of Fisheries and Oceanogaphy, Russia) described a study on the distribution of young-of-the-year saffron cod in Karaginsky and Olutorsky Gulfs, with special emphasis on the effect of temperature. The last presentation of the morning was by Dr. Masayuki Chimura (FRA, Japan) who talked about a newly developed rearing system of larval and juvenile walleye pollock.

The afternoon session mostly dealt with various social aspects related to the pollock fisheries. Dr. Alan Haynie (NOAA Fisheries Alaska, USA), the second invited speaker, led off. His presentation "*FishSET – the spatial economics toolbox for fisheries*" was an introduction of a new modeling tool to incorporate fisher behavior into fisheries management models. FishSET can be used to organize and integrate data for spatial bioeconomic models, provide best management practices for data management, modeling, and model comparison. Also, it can be used for policy analysis.

Dr. Osamu Shida of Hokkaido Research Organization (Japan) presented research on the timing of walleye pollock spawning migration and their impacts on gill-net fishery at the coastal area. Mr. Yohei Kawauch, a student in Hokkaido University (Japan) explained the effect of environmental factors on the distributions of walleye pollock juveniles in Funka Bay and vicinity, Hokkaido, Japan. Dr. Stepanenko of TINRO-Centre (Russia) gave an informative presentation on Bering Sea pollock recruitment, abundance, and distributions, as well as the framework for fishery management measures there. Dr. Keith Criddle from the University of Alaska Fairbanks (USA) introduced the importance of game-theory analysis for analyzing cooperative and non-cooperative strategies for management of transboundary stocks of Bering Sea pollock. Mr. Masamichi Kawano (Maruha-Nichiro Ltd.) and Masahito Hirota of (FRA, Japan), described current market conditions and product distribution pathways for pollock fillet, surimi, mince, and roe. Finally, Dr. Suam Kim of Pukyong National University (Korea) talked about the pollock fisheries in Korea and the role of pollock as a food for Korean culture, domestic market conditions, *etc*.

At the presentations, there was a free-flowing discussion about inter-relationships among the topics and perspectives represented in the talks and the advancement of multidisciplinary research on fisheries. First, Dr. Yasunori Sakurai pointed out the importance of gadid biological and ecological characteristics between Pacific and Atlantic, including the possibility of conducting analyses using a "meta-population" framework for comparison. Also, taking the climate changes and stock dynamics into account, we recognized the importance of the central Bering Sea area (high sea area) in terms of international joint research and management. From the viewpoint of pollock consumption as food, maintaining stable sustainably managed supplies is paramount. In addition, the data sharing amongst PICES/ICES countries, early warning indicators for pollock recruitment regime shifts (based on the analysis like Dr. Funamoto's presentation), *etc.*, were identified as important research issues. It was suggested that PICES-ICES cooperation might be a next step forward. In order to facilitate the academic interactions between disciplines, we discussed the potential synergies between social and natural sciences. We agreed that well-managed fisheries are well-managed biologically and well-managed from social and economic perspectives. Social and economic models need to be scalable to better match temporal and spatial scales of natural science analyses needed for management decision-making. Similarly, natural science models need to be scalable so that they can be used to support models of fishers' behavior and the social and economic dimensions of harvest strategies and other fisheries management measures.

List of papers

Oral presentations

Oleg A. Bulatov (Invited)
Walleye pollock: Global view

Tetsuichiro Funamoto, Osamu Shida, Kazuhiko Itaya, Orio Yamamura, Ken Mori, Yoshiaki Hiyama and Yasunori Sakurai
Comparisons of recruitment fluctuation mechanisms of walleye pollock in the Sea of Japan and the Pacific Ocean off northern Japan

Anatoliy Ya. Velikanov
Long-term changes in abundance and annual catches of walleye pollock off Sakhalin Island in the Japan/East Sea and the Okhotsk Sea: From collapse to renewal

Benjamin C. Williams, Gordon H. Kruse and Martin W. Dorn
Variations in walleye pollock (*Theragra chalcogramma*) maturation rates in the Gulf of Alaska

Anatoly V. Smirnov
Ecosystem approaches to pollock fishery management in Russia

Hiroshi Kuroda, Daisuke Takahashi, Tomonori Azumaya and Humio Mitsudera
Development of a high-resolution coastal model around Hokkaido for fisheries science-A study on passive transport of eggs, larvae and juveniles of walleye pollock

Igor K. Trofimov
About distribution of under-yearling saffron cod in Karaginsky and Olutorsky Gulfs, Bering Sea

Toru Nakagawa, Masayuki Chimura, Naoto Murakami, Takashi Ichikawa, Norio Shirafuji, Jun Yamamoto, Tetsuichiro Funamoto, Ken Mori, Yoshiaki Hiyama and Toyomitsu Horii
Establishment of a rearing system of larval and juvenile walleye pollock for elucidating their biological properties and responses to environmental changes

Alan C. Haynie (Invited)
FishSET: A new tool to better incorporate fisher behavior into fisheries management

Osamu Shida, Yukio Mihara and Kazushi Miyashita
Interannual changes in the timing of walleye pollock spawning migration and their impacts on gill-net fisheries in the southwestern Pacific coast of Hokkaido, Japan

Yohei Kawauchi, Masayuki Chimura, Takashi Muto, Masamichi Watanobe and Kazushi Miyashita
The effect of environmental factors on the distributions of walleye pollock (*Theragra chalcogramma*) juveniles in Funka Bay and vicinity, Hokkaido, Japan

Mikhail A. Stepanenko
Bering Sea pollock recruitment, abundance, distribution and approach to fishery management under changing environment

Keith R. Criddle and James Strong
Straddling the line: Cooperative and non-cooperative strategies for management of Bering Sea pollock

Masamichi Kawano and Masahito Hirota
Market and distribution of walleye pollock

Suam Kim, Sukyung Kang and Dohoon Kim
The ecology of walleye pollock and its market importance in Korea

Poster presentations

Andrei N. Stroganov and Alexei M. Orlov
On the population structure of Pacific cod

Sergey S. Ponomarev
Inter-annual variability of Pollock 0–year–class abundance in the northern sea of Okhotsk

Andrey Smirnov
Correlation of pollock and herring yield broods inhabiting the northern part of the Sea of Okhotsk

Nadezhda L. Aseeva, Marina B. Shedko, Andrey Smirnov and Alexander S. Sergeev
New data on ectoparasites of walleye pollock in the Okhotsk Sea

Tadayasu Uchiyama, Gordon H. Kruse and Franz J. Mueter
Effects of water temperature increases on eastern Bering Sea juvenile pollock predation

BIO/MEQ Topic Session (S6)
Environmental contaminants in marine ecosystems: Seabirds and marine mammals as sentinels of ecosystem health

Co-sponsored by: *JSPS*

Co-convenors: *Peter Ross (Canada), Hideshige Takada (Japan) and Yutaka Watanuki (Japan)*

Background

Urban and industrial developments in the world's coastal regions have led to the release of a large number of pollutants (heavy metals, POPs, plastics, oils, radioactive substances) into the marine environment. In some cases, these have detrimental effects on variety of marine resources in coastal and offshore areas. It is increasingly important to identify sources, subsequent transport through marine physical systems and resulting spatial patterns of these anthropogenic stressors. Compared to river-lake systems, knowledge of anthropogenic stressors in marine systems is less understood due to difficulties with detection over wide areas and in offshore regions. As top predators, such as many marine mammals and seabirds, bio-magnify some of these pollutants, these organisms can be used as bio-indicators of coastal, marine and/or food web contamination. The utility of these 'sentinels' was discussed at the PICES-2011 MEQ Workshop. This session: 1) identified spatial patterns and geographic areas of concern (high concentrations) of pollutants or other stressors in the PICES region using bio-indicator species, 2) examined mechanisms of transport, and ultimate disposition, of contaminants in marine ecosystems, and 3) discussed health risks for certain predators and human consumers. Review papers, case studies, and innovative methods papers on anthropogenic stressors in marine predators were invited, as well as papers that distinguished between the effects of natural and anthropogenic stressors. In particular, studies linking predator habitat use with spatial aspects of stressors in the environment and in predators were encouraged.

Summary of presentations

Ten talks (5 from Japan, 2 from Canada, 1 from Korea, 1 from Russia, and 1 from UK,) and 4 posters (all from Russia) were given. Spatial patterns and interannual changes in POPs (Persistent Organic Pollutants), including PCBs, DDTs, HCHs, and PBDs in marine birds and some terrestrial birds were presented, and their usefulness as bio-indicators were discussed. A common theme among many of the presentations was the need to consider age and the trophic level as important factors when evaluating and comparing contaminants levels among species or populations. Case studies of monitoring marine debris ashore and POPs in plastic pellets were also presented. Forty to 50 people, including bird and mammal researchers, geochemists, and biochemists attended the session and gave useful discussion. The co-convenors discussed the potential for a review paper on the usefulness and limitation of marine birds and mammals as indicators of marine pollutants, and the spatial patterns of POPs shown by them in the PICES region.

List of papers

Oral presentations

Andy Sweetman, John Crosse, Richard Shore, Gloria Pereira and Kevin Jones (Invited)
Long term trends in PBDE concentrations in gannet (*Morus bassanus*) eggs from two UK colonies

Rei Yamashita, Hideshige Takada, Mai Miyazaki, Takashi Yamamoto, Akinori Takahashi, Maki Yamamoto, Philip N. Trathan and Yutaka Watanuki (Invited)
Persistent organic pollutants (POPs) in preen gland oils from streaked shearwaters reflect exposure in overwintering areas

Sang Hee Hong, Gi Myung Han, Won Joon Shim, Sung Yong Ha and Nak Won Heo
Concentrations and profiles of persistent organic pollutants (POPs) in birds collected from an urbanized coastal region of South Korea

Annamalai Subramanian and Shinsuke Tanabe
Developing Asian countries as sources of pollutants to the Asia-Pacific region

John E. Elliott, Kyle H. Elliott, Melanie F. Guigueno, Laurie K. Wilson, Sandi Lee and Abde Idrissi (Invited)
Seabirds are indicators of persistent contaminants in the marine environment: Examples from the Pacific Coast of Canada

Peter S. Ross
Persistent Organic Pollutants (POPs) in marine mammals: Harmless chemicals or lingering poisons?

Vasiliy Yu. Tsygankov, Margarita D. Boyarova, Anna A. Lukashkina, Peter A. Tyupeleev, Ilya A. Shcherbakov, Yuri V. Prikhodko and Olga N. Lukyanova
Marine mammals as bioindicators of persistent toxic substance (PTS) contamination in Russian Subarctic marine ecosystems

Atsuo Ito, Rei Yamashita, Hideshige Takada, Takashi Yamamoto, Kozue Shiomi, Carlos Zavalaga, Takuya Abe, Shinichi Watanabe, Maki Yamamoto, Katsufumi Sato, Hiromi Kohno, Ken Yoda, Tomohiko Iida and Yutaka Watanuki
POPs in the preen gland oil of streaked shearwaters breeding on the islands in Japan reflect marine pollution in western North Pacific

Atsuhiko Isobe, Shin'ichiro Kako and Etsuko Nakashima (Invited)
Marine/beach plastic litter as a transport vector of pollutants

Kosuke Tanaka, Hideshige Takada, Rei Yamashita and Yutaka Watanuki (Invited)
Marine plastics: Monitoring matrix for persistent organic pollutants (POPs) and carrier of POPs to seabirds

Poster presentations

Andrey S. Neroda, Vasily F. Mishukov, Vladimir A. Goryachev, Denis V. Simonenkov and Anna A. Goncharova
Radioactive isotopes in atmospheric aerosols over Russia and the Sea of Japan following the nuclear accident at Fukushima nr. 1 Daiichi nuclear power station in March 2011

Tatiana Chizhova, Pavel Tishchenko, Liubov Kondratieva and Takuya Kawanishi
Polycyclic aromatic hydrocarbon (PAH) distribution in the Amur River estuary

Yulia Koudryashova, Natalia Prokuda, Natalia Khodorenko, Tatiana Chizhova and Pavel Tishchenko
PAHs in sediments of rivers of the Primorsky Region, Far East of Russia

Mikhail V. Simokon
Ecological risk evaluation of metals in the coastal areas of Peter the Great Bay, Japan/East Sea

BIO/FIS Topic Session (S7)
Jellyfish in marine ecosystems and their interactions with fish and fisheries

Co-sponsored by: *ICES*

Co-convenors: *Richard Brodeur (PICES/USA), Cornelia Jaspers (ICES/Denmark), Christopher Lynam (ICES/UK), Song Sun (PICES/China), Shin-Ichi Uye (PICES/Japan) and Won-Duk Yoon (PICES/Korea)*

Background

Evidence is accumulating that gelatinous zooplankton populations have increased substantially in many regions of the world, most likely through anthropogenic stresses, but we have insufficient understanding of how these blooms affect fish and, more broadly, marine ecosystems. Some benefits of jellyfish to marine fish include provisioning of food for some species and shelter for juvenile stages of several others. There is also a relatively minor human benefit in that some jellyfish are both commercially fished and cultured for human consumption in several countries. However, the negative effects of jellyfish population outbursts are thought to greatly exceed any positive ones and their effects on ecosystems and the economies that depend on them can be profound. These effects have been examined through field studies, controlled laboratory experiments, and estimated using quantitative ecosystem models. Jellyfish are generally detrimental to fish because they feed on zooplankton and ichthyoplankton, and so are both predators and potential competitors of fish. Relatively little of the energy consumed by gelatinous zooplankton ends up at higher trophic levels of interest to humans compared to krill and forage fishes. Jellyfish blooms also directly impact commercial fisheries through filling or clogging trawls and fouling fixed gear and aquaculture net pens, resulting in enormous economic losses worldwide. This session focused on empirical field, laboratory, or modeling studies that examine the effects jellyfish have on marine ecosystems, fish species and fisheries, and relevant ecosystem-based management issues important to the needs of society over wide-ranging space and time-scales up to and including climate variations.

Summary of presentations

Studies presented at this meeting indicate that ecosystem degradation in diverse systems such as the Irish Sea, Sea of Japan, and Gulf of Mexico, coupled with climatic changes can be linked to elevated jellyfish abundances. Some synchrony in jellyfish time-series was evident across the world's oceans, in particular between such seemingly unrelated systems as the Adriatic Sea and Inland Sea of Japan. More co-ordinated research effort is necessary to substantiate these general observations and future collaborations between Pacific and Atlantic scientists were discussed, including the possibility of a joint ICES/PICES Working Group.

While climate trends were clear in many of the data sets presented, it is still highly debated which factors and mechanistic processes drive the observed variability in gelatinous zooplankton biomass between the years and decades. Several examples highlighted the relationship between fish landings, their historic reduction due to overfishing and subsequent trends of increasing jellyfish populations. This indicates an indirect interaction between fishing impacts and jellyfish biomass and potentially of importance is the trophic level that the fisheries target. However, it was highlighted that for many years the willingness by fisheries management to consider indirect linkages of fisheries to gelatinous zooplankton has been limited.

Many risks (from reduced tourism to disruption to power plant coolant systems) associated with the threat of rising jellyfish populations were identified during the meeting and these risks should be communicated to managers and policy makers directly. If jellyfish population sizes are to be managed and outbreaks prevented, then the threat posed by jellyfish to fish, fisheries and other activities must be considered within the ecosystem approach to fisheries management.

An interesting approach to manage the consequences of giant *Nemopilema nomurai* blooms was presented where the implementation of diel vertical migration and temperature into a drift model study helped to accurately predict the dispersal of *N. nomurai* in the Sea of Japan, which is crucial information for the fishermen in the respective regions to prevent damage to their equipment.

The interaction between jellyfish and fish can be complex and include bottom-up and top-down pathways. Regarding bottom-up processes, several talks and posters addressed the reproduction potential in relation to hydrographical and environmental features. The polyp stage and/or egg production rates are critical factors determining the next generations' population size. In this context, the continued creation of artificial hard substrates is of paramount importance. Even a relatively small floating pontoon (6×48 m) recently installed in Japanese waters had been found to generate many million young medusoids within a year of installation. It was reported that a treatment to stop such biofouling was in development and shows some promise.

A notable example of the problem of biofouling by polyps on salmon aquaculture facilities, especially in northern Europe, was described. Polyp colonies grow on the cages and this commonly leads to salmon gill disorders and reduced aquaculture revenues. More dramatically, mass mortalities of salmon have occurred owing to jellyfish outbreaks drifting into salmon pens and technological developments (bubble nets, early warning systems) have been used to combat this problem. It was further shown that polyp settling is highly dependent on salinity and has been restricted to high saline areas in Chinese river runoff-influenced lagoons, thereby limiting their settling opportunities and reproductive potential. Similarly, salinity effects on reproduction rates have been documented to restrict the range expansion of the invasive ctenophore *Mnemiopsis leidyi*. This information could be used for determining site locations of large projects introducing artificial hard substrates (*e.g.*, windfarms) which might be better located in low salinity areas where polyp settling is restricted. However, in general bottom-up processes need to be further investigated and the monitoring of ephyra in addition to medusae should be conducted since they are commonly ignored in zooplankton investigations.

From a top-down aspect, it was addressed and experimentally confirmed that many species of fish prey on jellyfish. For several fish species in Japanese waters, it has been shown that gelatinous food sources promote growth and in some cases, are even essential in the fish diet to sustain high growth rates. Similarly, certain

commercially important salmon species (*e.g.*, chum salmon, *Oncorhynchus keta*) depend on a ctenophore diet during their development in the North Pacific. However, the responses are species-specific and much more research is required in this area. Gelatinous species are typically digested so rapidly that they can appear absent from the gut contents of fish even if the fish have fed on them within an hour. To avoid this problem, molecular and genetic tools for gut content analyses, especially for commercially important fish species, should be employed more often to confirm the extent of jellyfish and ctenophores in their diets. Diets of potential jellyfish predators should be examined on fresh material at sea whenever possible.

In conclusion, jellyfish threats to aquaculture, fisheries, tourism, and power generation are well known and the risks should be quantified. The trade-off between potential losses and the cost of mitigation should be considered and the acceptable risk levels evaluated. Ecosystem degradation and climatic changes alongside increased usage of the marine environment by man are likely to stimulate further outbreaks of gelatinous zooplankton populations and detrimental impacts by jellyfish may become more common. The development of the ecosystem approach to fisheries management provides a framework in which to address and tackle these issues.

List of papers

Oral presentations

William M. Graham, Stefan Gelcich, Carlos M. Duarte, Shin-ichi Uye, Richard Brodeur, Robert H. Condon and NCEAS Jellyfish Working Group (Invited)
Jellyfish and fisheries: Risks, trade-offs and adaptations

Thomas K. Doyle, Emily J. Baxter, Graeme C. Hays, Hamish D. Rodger and Neil M. Ruane (Invited)
Detrimental impacts of jellyfish on finfish aquaculture: insights from the North East Atlantic

Reiji Masuda, Yuko Miyajima, Ryosuke Ohata and Yoh Yamashita (Invited)
Jellyfish as a predator and prey of fishes: Underwater observations and rearing experiments

Jennifer E. Purcell, Ana Sabatés, Verónica Fuentes, Francesc Pagès, Uxue Tilves, Alejandro Olariaga and Josep-María Gili
Predation potential of blooming jellyfish, *Pelagia noctiluca*, on fish larvae in the NW Mediterranean Sea

Cornelia Jaspers
The invasive ctenophore *Mnemiopsis leidyi* in northern European waters and its potential impact on fisheries

Shin-ichi Uye, Alenka Malej and Tjasa Kogovsek
Comparative analysis of the Inland Sea of Japan and the northern Adriatic: Can changes in anthropogenic pressures disclose jellyfish outbreaks?

Martin K.S. Lilley, Steven E. Beggs, Thomas K. Doyle, V.J. Hobson, K.H.P. Stromberg and Graeme C. Hays
Direct and indirect evidence for massive differences in jellyfish biomass between the Pacific and Atlantic: Implications for fisheries bycatch?

Lucas Brotz, William W.L. Cheung, Reg Watson, Kristin Kleisner, Evgeny Pakhomov, Philippe Cury, Roxane Maranger, Brooke Campbell and Daniel Pauly
Anthropogenic impacts related to observed increases of jellyfish populations

Christopher P. Lynam, Martin K.S. Lilley, Thomas Bastian, Thomas K. Doyle, Steven E. Beggs and Graeme C. Hay
Have jellyfish in the Irish Sea benefited from climate change and overfishing?

Alexander V. Zavolokin
Jellyfish of the Far Eastern Seas of Russia: Composition, spatio-temporal variations and significance for ecosystems

Song Sun, Chaolun Li, Guangtao Zhang, Shiwei Wang and Xiao Xia Sun
Giant jellyfish blooms in the Yellow Sea and East China Sea

Akira Okuno, Tatsuro Watanabe, Satoshi Kitajima, Naoto Honda and Katsumi Takayama
Numerically simulated migration/distribution of *Nemopilema nomurai* in the Japan Sea using temperature-based controls

Masaya Toyokawa, Akira Yasuda, Yusuke Murata, Kazuhiro Aoki, Manabu Shimizu and Minoru Hamada
Aurelia swarms originate from polyps near the mouth of a bay: evidence from Mikawa Bay and Ise Bay

Mary Needler Arai
Predation on gelatinous cnidaria and ctenophores

Brian E. Smith and Jason S. Link
The presence of gelatinous zooplankton in the diets of fishes of the Northeast U.S. continental shelf: Trends in shelf-wide feeding and consumptive removals

James J. Ruzicka, Elizabeth A. Daly and Richard D. Brodeur
Salmon and jellyfish: Bumping elbows in the Northern California Current

John C. Field Jarrod A. Santora Keith Sakuma Amber Payne and Baldo Marinovic
Spatial and temporal patterns of variability in Scyphomedusae in the central California coastal marine ecosystem

Richard D. Brodeur, Mary Beth Decker, Elizabeth A. Daly, Caren Barcelo, James J. Ruzicka and Kristin Cieciel
A tale of two *Chrysaora*: Pivotal roles in contrasting marine ecosystems

Poster presentations

Sim Yee Kwang, Chuah Chern Chung, Anita Talib and Khairun Yahya
Exogenous impacts on the massive occurrence of jellyfish in the northern part of Malacca Straits, Malaysia

Wen-Tseng Lo, Hung-Yen Hsieh and Shwu-Feng Yu
Comparison of siphonophore assemblages during northeasterly and southwesterly monsoon seasons in the Taiwan Strait, western North Pacific Ocean

Ryosuke Makabe, Ryuji Furukawa, Mariko Takao and Shin-ichi Uye
Marine construction as a factor boosting *Aurelia aurita* s.l blooms: A case study of a new floating pier deployment in Hiroshima Bay, Japan

Takashi Kamiyama
Planktonic ciliates as a prey source for moon Jellyfish *Aurelia aurita*: Feeding activities and growth effects of ephyra and metephyra stages

Satoshi Kitajima, Akira Okuno, Naoki Iguchi, Naoto Honda, Tatsuro Watanabe and Osamu Katoh
Low temperature excludes medusae of *Nemopilema nomurai* in the Japan Sea in winter

Thomas Bastian, Damien Haberlin, Mary Catherine Gallagher, Sean Rooney, Graeme C. Hays and Thomas K. Doyle
Tracking the lion's mane jellyfish: Horizontal and vertical movements of *C. capillata* (Scyphozoa) in a shallow coastal environment

Steven E. Beggs, Thomas Bastian, Martin K.S. Lilley and Thomas K. Doyle
Annual and regional variations in associations between Scyphomedusae and juvenile gadoids in the Irish Sea

Martin K.S. Lilley and F. Lombard
Developing a technique for *in-situ* monitoring of fragile planktonic organisms

Kristin Cieciel, Jeanette Gann and Bruce Wing
Methods for conducting individual measurements on trawled jellyfish

Naoki Fujii, Shinya Magome, Atsushi Kaneda and Hidetaka Takeoka
Relationship between jellyfish abundance and environmental fluctuations in Uwa Sea

Jun Nishikawa, Fatimah Md. Yusoff, Nguyen Thi Thu, Khwanruan Srinui, Mulyadi and Shuhei Nishida
Jellyfish fisheries in Southeast Asia

POC/FIS Topic Session (S8)
Linking migratory fish behavior to End-to-End models II

Co-convenors: *Enrique Curchitser (USA), Shin-ichi Ito (Japan) and Michio Kishi (Japan)*

Background

In order to understand ecosystem response to climate impacts, End-to-End modeling (E2E) approaches are essential. One of the most difficult parts for E2E is the modeling of fish migration. Fish behavior can be very complex; it is a consequence of genetics, physical, chemical and biological environments and their interaction. Learned behavior may also be a factor. To model fish behavior, integrated studies are needed including laboratory experiments, tagging and acoustic observations, and modeling. The purpose of this session was to review the current state of development in laboratory experiments, field observations and modeling to understand fish behavior and to discuss future potential collaborations to improve fish migration models.

Summary of presentations

Co-convenor, Dr. Shin-ichi Ito, introduced the session to the audience highlighting that this is a follow-on to two previous PICES sessions on the topic and is considered an important component of future efforts in modeling the upper trophic levels. The half-day session attracted over 50 attendants.

Invited speaker, Dr. Robert Humston, presented an overview of different methods for modeling fish movement. He started with a statement on the importance of understanding fish movement if we are to be able to predict ecological changes. He stated that behavioral mechanisms determine pathways, which are critical to scaling up to population-level impacts. However, he noted that exact mechanisms are unknown and must be approximated. Dr. Humston explained the difference between four different movement methods: Random walk, Kinesis, Taxis and Area Search. He stated that Kinesis may be inefficient relative to gradient-based methods but he prefered it due to its superior results. He spent described the results with the Kinesis algorithm as well as some discussion explaining why fish move and how we may be able to program that behavior.

Dr. Albert Hermann, on behalf of Dr. Ivonne Ortiz, described work being done with the model FEAST, where movement is based on gradients of "happiness" based mostly on the availability of prey. Dr. Seokjin Yoon described an individual-based modeling approach for Pacific saury migrations, which links environmental data to a bioenergetics model to a migration module and finally to an IBM. Other speakers presented results of implementing different types of behavior to a variety of species, from larvae to adult fish in different environments.

List of papers

Oral presentations

Robert Humston (Invited)
Selecting appropriate models of fish movement for End-to-End models of marine ecosystems

Ivonne Ortiz, Kerim Aydin and Albert J. Hermann
20 species, 15 lengths: How fish move driven by happiness as defined by growth and predation

Seokjin Yoon, Terui Takeshi, Michio J. Kishi and Shin-ichi Ito
An individual-based modeling approach for Pacific saury migrations

Yoshioki Oozeki, Takeshi Okunishi, Akinori Takasuka and Daisuke Ambe
Annual change in migration pattern of Pacific saury larvae from spawning to nursery grounds

Masanori Takahashi, Atsushi Kawabata, Chikako Watanabe, Michio Yoneda, Daisuke Ambe and Takeshi Okunishi
Migratory behavior and recruitment process of the Pacific stock of chub mackerel *Scomber japonicus*

Tohya Yasuda, Ryuji Yukami and Seiji Ohshimo
Changes in spatial distribution of chub mackerel under climate change: The case study using Japanese purse seine fisheries data in the East China Sea

Jung Jin Kim, William T. Stockhousen, Yang-Ki Cho, Gwang Ho Seo and Suam Kim
Transport processes of eggs and paralarvae of Japanese common squid, *Todarodes pacificus* in the Northwest Pacific

Akira Okuno, Tatsuro Watanabe, Naoto Honda, Katsumi Takayama, Naoki Iguchi and Satoshi Kitajima
Importance of swimming-depth model of jellyfishes *Nemopilema nomurai* in simulation of their migration in the Japan Sea

Satoshi Nakada, Takashi Uenaka, Ken-ichi Kitao, Kenta Matsui, Yoichi Ishikawa, Naohisa Sakamoto, Koji Koyamada, Toshiyuki Awaji and Sei-Ichi Saitoh
Estimated migration of scallop larvae in Funka Bay by using streamline visualization

Poster presentation

Michio J. Kishi
Discussions on random walk and behavioral movement models coupled with NEMURO. FISH: Case study on chum salmon and saury

FIS/MEQ Topic Session (S9)
Ecological functions and services associated with marine macrophyte communities as indicators of natural and anthropogenic stressors in nearshore zones of the North Pacific

Co-convenors: Ik-Kyo Chung (Korea) and Jun Shoji (Japan)

Background

Diverse communities of marine and estuarine macrophyte vegetation including kelp beds, seaweeds, macrobenthic algae, seagrasses, and salt marshes occur along the coastlines of the PICES member countries. In addition to the direct primary production of organic material into marine ecosystems, these macrophytic communities are also considered as ecological engineers that can have important indirect supporting roles in the lives of heterotrophic organisms such as fishes, shellfish, seabirds, and other marine organisms. Seasonal growth and breakdown of macrophytic vegetation has important implications for the biochemistry of essential nutrients in the nearshore zones, and for the interactions among vertebrate and invertebrate members of marine and estuarine communities. Fluctuations in physical and chemical parameters such as sea water temperature, salinity, nutrient availability, incident light levels, water flow, and sediment conditions contribute as complex regulating factors toward the establishment and persistence of macrophyte communities. In contrast, the physical structure of the macrophytes themselves can modify the local environment, affect the composition and abundance of their associated organisms, and provide essential ecological roles as recruitment sites, nursery areas, foraging habitats, and sinks for marine carbon. These interactions among ambient environmental parameters, macrophytes, and their associated organisms are collectively known as ecosystem functions and services, which are influenced not only by natural forces but also by anthropogenic stressors. This topic session focused on the ecological functions and services provided by diverse communities of macrophytes throughout the North Pacific coastal zone.

Summary of presentations

Topic session 9 had a total of 8 talks with over 30 attendees in the audience. Talks on very diverse topics concerning the ecological aspects of coastal seascape such as rocky shores, seagrass beds, salt marshes as well as economic value were presented. Invited speaker, Dr. Masakazu Hori, focused on the landscape/seascape structure. He demonstrated the enhancement of secondary production by temporal niches complementary with seascape diversity using mesocosm experiments with fish, seagrass, kelp and bivalves. Dr. Nam-Il Won showed strong benthic pelagic coupling with *Sargassum* associated benthic diatoms, *Carprella* spp. and fish feeding linkage based on field and isotope analyses. Mr. Tsutomu Noda presented a 3-year study of the before and after tsunami event in 2011 and recommended continuous monitoring and research. Ms. Shiori Sonoki discussed a new method to determine the biomass of a seagrass bed using a small quantitative echosounder, KCE-300 (Kaijo Sonic Corporation, 120kHz) and an ROV (Pro3, VideoRay) for identifying species and growth conditions with an Arc GIS (ESRI Corporation, ver. 10) technique. She applied this tool to measure oxygen production. Dr. Katsumasa Yamata elaborated on a valuable concept of functional diversity and functional redundancy of the faunal community in a seagrass ecosystem. Functional strength of a community and ecosystem functioning (Ecosystem service) could be evaluated by these concepts. Emergent functions of the macrofaunal community seem attributable to flexible functional changes among species, and even among individuals. He concluded that Forming Meta-communities of macrofaunal species with Functional Redundancy (FR) among patches could provide resilience. Dr. Sang Rul Park showed the role of the salt marsh, Blue Carbon, as a net sink of CO_2 except in the winter season based on the carbon budget in the southwestern Gulf of Mexico. Dr. Ekaterina Golovashchenko introduced the economic value of ecological functions and services associated with marine macrophyte communities and other natural resources and its practical use in Kievka Bay. Dr. Seokjin Yoon talked about the incorporation of a kelp factor into the NEMURO model for the Kelp-controlled environment. In the poster session, Dr Chunjiang Guan showed a high rate of nutrient removal by salt-resistant plants on the Bohai Sea coast. Dr. Park showed that the effects of intensity and season of disturbance on the benthic community were dependent of the timing of the event. Dr. Chang Geun Choi discussed a restoration method with seaweeds on the artificial reef.

List of papers

Oral presentations

Masakazu Hori (Invited)
Effect of coastal seascape diversity on associated fish production

Nam-Il Won, Hideki Takami, Yutaka Kurita, Daisuke Muraoka and Tomohiko Kawamura
Trophic structure of the rocky shore ecosystem in Otsuchi Bay, Japan: Implications for benthic–pelagic coupling

Tsutomu Noda, Yoshitomo Nagakura, Daisuke Shimizu, Hideaki Aono, Hiroyuki Okouchi, Masami Hamaguchi, Atsushi Fukuta, Yasuhiro Kamimura and Jun Shoji
Impact of the tsunami from the Great East Japan Earthquake on seagrass beds and fish assemblages in Miyako Bay

Shiori Sonoki, Yuka Morita, Jun Syoji and Kazushi Miyashita
Monitoring seasonal variations in a seagrass bed by an acoustics method

Katsumasa Yamada (Invited)
Functional diversity and functional redundancy of a faunal community in a seagrass ecosystem of northern Japan

Sang Rul Park, Joseph Stachelek and Kenneth H. Dunton
The role of salt marsh plants as a net sink or source for carbon dioxide in the southwestern Gulf of Mexico

Ekaterina V. Golovashchenko
The economic value of ecosystem services in Kievka Bay (Japan Sea)

Seokjin Yoon, Michio J. Kishi, Satoshi Nakada, Yoichi Ishikawa, Tomonori Isada and Sei-Ichi Saitoh
Ecological functions of a kelp community as an indicator of anthropogenic nutrient stressors

Poster presentations

Chunjiang Guan, Jie Na, Meng Xu and Xiutang Yuan
Studies on carbon, nitrogen, and phosphorus uptake fluxes by *Suaeda salsa* around the Bohai Sea District

Ivan I. Cherbadgy and Ludmila I. Sabitova
Influence of environmental factors on ammonium and phosphate uptake rates by a red alga (*Ahnfeltia tobuchiensis*) population in Izmena Bay (Kunashir Island)

Yun Hee Kang, Chang Jae Choi and Sang Rul Park
Effects of intensity and season of disturbance on the marine benthic community of a rocky intertidal shore with a periodic green tide occurrence in Korea

Chang Geun Choi and Seok Jin Oh
Development of artificial seaweed bed for ecological restoration

BIO/MEQ/FUTURE Topic Session (S10)
Ecosystem responses to multiple stressors in the North Pacific

Co-sponsored by: *SOLAS*

Co-convenors: *Vladimir Kulik (Russia), Ian Perry (Canada) and Motomitsu Takahashi (Japan)*

Background

Marine ecosystems of the North Pacific, both coastal and offshore, are influenced by multiple stressors, such as increased temperature, change in iron supply, harmful algal blooms, invasive species, hypoxia/eutrophication, ocean acidification, and intensive fishing. These multiple stressors can (but do not always) act synergistically to change ecosystem structure, function, and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region and over time. This session seeks to understand the responses of various marine ecosystems to multiple stressors and to identify appropriate indicators of these effects. Contributions were invited which reviewed and defined categories of indicators to document the status and trends of ecosystem change at a variety of spatial scales (*e.g.*, coastal, regional, basin) in response to multiple stressors. Emphasis was placed on empirical and theoretical approaches that forge links between ecosystem change and the intensities of multiple stressors. This session was a contribution to the work of PICES WG 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*.

Summary of presentations

Session S10 was held on Friday, October 19, 2012 (half day). It was launched with an invited speaker, Natalie Ban (Australian Research Council Centre of Excellence for Coral Reef Studies, Australia) and included 5 other oral presentations, 8 poster presentations, and time for discussion.

Dr. Ban discussed issues related to mapping cumulative impacts, including advances, relevance and limitations to marine management. She began by noting there is global concern about multiple stressors and currently a lot of interest in mapping where multiple stressors might be interacting. She identified the purpose of her presentation as providing examples of methods and data for mapping multiple stressors in a given region. She concluded that such approaches do provide informative uses of existing data and information, baselines for future mapping, new opportunities to improve mapping approaches, but cautioned that there is a need to ground-truth these mapping efforts. She also recommended caution when scores for the vulnerabilities of different habitats to different stressors developed in one region (*e.g.*, the California Current system) are applied to a different region (*e.g.*, the coast of British Columbia) without critical consideration of their "transferability". An important next step in these types of habitat vulnerability analyses is the use of Bayesian methods to assess multiple stressors, which are now being investigated in some coral reef regions. Discussion following her presentation included how to move from GIS analyses of multiple stressors to impacts; it was noted that some of this needs to come from directed studies of impacts. However, such studies currently often examine only one stressor at a time.

Dr. Ian Perry, with co-author Dr. Jennifer Boldt, provided an example of a study to identify multiple stressors on multiple habitats in a specific region, the Strait of Georgia, British Columbia, featuring the early work of Working Group 28. The objectives of his study were to develop a structured process to identifying multiple stressors in the Strait of Georgia, and the responses of selected (key) habitats to these stressors, to identify which habitats might be more vulnerable to which stressors, and to provide base information that is needed to develop indicators of ecosystem responses to multiple stressors in this area. He described a GIS-based approach to identify which stressors occur in the Strait of Georgia and how they might impinge upon various habitats, and then described an expert-based project to identify the potential vulnerabilities of these habitats to which stressors. He concluded that considerable (but not complete) information is available for the Strait of Georgia on spatial patterns of important marine habitat features and human stressors, that we are beginning to understand the knowledge gaps concerning measures of habitat vulnerability and resilience, and that expert surveys are one method to obtain information but they need to be cross-linked with empirical data. Ecosystem models may provide useful "platforms" to understand ecosystem responses to multiple stressors, but they also need to be supported and cross-checked with empirical data and expert surveys. This type of analysis does not permit inclusion of temporal trends in stressors, which can be important in assessing current conditions when the information base is from past conditions.

Mr. Vladimir Kulik provided a detailed and thorough statistical analysis of mapping cumulative human and natural impacts in the Sea of Okhotsk, based on the monitoring of energy emissions from fishing activities. He derived time series of this information and applied statistical analyses to extract the dominant underlying features and trends. Planned activities include additional stressors such as SST and sea ice, adding nearshore human activities (specifically small-scale fishing), involving experts in a survey to get weights for ecosystem vulnerability, clustering the bottom area by ground type and depth, and summarizing impact scores by clusters.

Dr. Motomitsu Takahashi and co-authors provided an initial comparative study of ecosystem responses to anthropogenic activities and natural stressors among inland, shelf and oceanic waters around Japan. They used the expert-based screening method developed by Working Group 28 to identify the impacts of human activities and natural stressors in each of these regions. They then compared the outcomes from the expert-based approach with observed data. They concluded that increasing sea temperatures affect all three ecosystems, that coastal development and engineering have strong impacts on the East China Sea and the Seto Inland Sea, that demersal and pelagic fishing impacts the East China Sea and the Kuroshio/Oyashio region, respectively, and that nutrient inputs have synergistic impacts to Harmful Algal Blooms and hypoxia. They also identified

problems with the expert-based scoring method, including that the certainty of the experts on the impacts differ among ecosystems because of the quality and quantity of information available, that the evaluation of impacts can differ among experts with different experience and expertise, that more information in the intertidal and coastal waters along China are needed for the East China Sea region, and that for oceanic waters, a lack of information may preclude appropriate evaluation of ecosystem responses.

Dr. Mingyuan Zhu and co-authors examined ecosystem changes under multiple stressors in the Yellow Sea, including the natural environment of Yellow Sea and East China Sea, their multiple stressors, the resulting changes in pelagic and benthic communities, and the consequent response of the ecosystems. They concluded that multiple stressors on the ecosystems of these Chinese seas occur from both climate change and anthropogenic activities and that they are increasingly severe, that there are clear ecosystem changes as evidenced by loss of biodiversity, declines in living marine resources, increasing HABS, "green tides", jellyfish blooms, *etc.*, and that further studies and management actions to reduce environmental stresses are urgently needed.

The presentation by Mr. Kyung-Su Kim and co-authors received the Best Paper award from the MEQ Committee (see the end of Session Summaries for the list of recipients). They examined the combined effects of elevated carbon dioxide concentrations and temperature on the development of olive flounder, the most important aquaculture species in Korea. It provided an example of the type of directed study that is needed to begin to understand the joint effects of more than one stressor. They concluded that larval growth was similar at the two lower CO_2 concentrations examined and within the range of seawater temperature range of 18~22°C, but that growth was enhanced at the highest CO_2 concentration at both temperatures. They also noted that the calcium component in larval bone was significantly increased at the highest CO_2 concentration. This study provided a nice example of the (often) non-linear relationships that can occur with multiple stressors interact.

General discussion considered whether these expert-based survey approaches should be done with a regional or global focus, *i.e.*, whether the respondents should be asked to consider just the range of values and experiences in a particular geographic region or on a global comparison. No consensus was reach other than to note this question can be important and should be considered in such surveys and their questions. In addition, how can the impacts of multiple stressors on habitats be examined when more than two stressors are occurring? For example, Perry and Boldt found that the mode number of stressors on any 4 km^2 region in the Strait of Georgia was between 20 and 25. When developing indices for multiple stressors, they need to be "simple" but at the same time allow for users to "drill down" to obtain more details about how particular sets of stressors might be driving particular responses in habitats. An important shortcoming in these approaches was noted regarding temporal changes, and how to update the analyses. A stepwise process was recommended, involving identification of habitats, stressors, and their vulnerabilities, noting that these vulnerabilities of specific habitats to different stressors likely do not need to be updated on a regular basis. Updates for new time periods would then use the established vulnerabilities and simply update the stressor information.

List of papers

Oral presentations

Natalie C. Ban, Stephen S. Ban and Hussein M. Alidina (Invited)
Mapping cumulative impact: Advances, relevance and limitations to marine management and conservation in Pacific Canada, and emerging Bayesian approaches

R. Ian Perry and Jennifer Boldt
Identifying multiple stressors and potential habitat responses in marine ecosystems of Pacific Canada

Vladimir V. Kulik
Mapping cumulative human and natural impacts in the Sea of Okhotsk

Motomitsu Takahashi, Sachihiko Itoh, Naoki Yoshie, Kazuhiko Mochida, Masakazu Hori and Shigeru Itakura
Comparative study on ecosystem responses to anthropogenic activities and natural stressors among inland, shelf and oceanic waters around Japan

Mingyuan Zhu, Ruixiang Li and Zongling Wang
Ecosystem Changes under multi-stressors in the Yellow Sea

Kyung-Su Kim, JeongHee Shim and Suam Kim
The combined effects of elevated carbon dioxide concentration and temperature on the early development stage of olive flounder *Paralichthys olivaceus*

Poster presentations

Evgeniya Tikhomirova
Typical distributions of primary production at the surfaces of Peter the Great Bay (Japan Sea)

Kanako Naito, Setsuko Sakamoto, Mineo Yamaguchi, Ichiro Imai and Ken-ichi Nakamura
Iron as a triggering factor for harmful dinoflagellate blooms

Aya Morinaga and Kazumi Matsuoka
Eutrophication suggested by the heterotrophic signal of dinoflagellate cyst assemblages; Case of Omura Bay, West Japan

Yuta Inagaki, Tetsuya Takatsu, Masafumi Kimura, Yota Kano, Toyomi Takahashi, Yoshihiko Kamei, Naoto Kobayashi and Tatsuaki Maeda
Effects of hypoxia on annual changes in growth and somatic condition of flathead flounder *Hippoglossoides dubius* in Funka Bay, Japan

Tetsuya Takatsu, Koji Shinoda, Shoichi Inoue, Tomofumi Seta and Yuta Inagaki
Drastic reduction of demersal fish abundance by hypoxia in Mutsu Bay Japan in the fall of 2011

Stephani Zador and Kirstin Holsman
Identifying and comparing ecosystem stressors in the eastern Bering Sea and Gulf of Alaska

Yumiko Yara, Meike Vogt, Masahiko Fujii, Hiroya Yamano, Claudine Hauri, Marco Steinacher, Nicolas Gruber and Yasuhiro Yamanaka
Ocean acidification limits temperature-induced poleward expansion of coral habitats

Anastasiia Strobykina
Spatial and temporal variability of nutrients in the Okhotsk Sea shelf zone

MONITOR/POC Topic Session (S11)
Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation

Co-sponsored by: *JSFO and FRA*

Co-convenors: *Michael Foreman (Canada), Toyomitsu Horii (Japan), Vladimir Kulik (Russia), Phillip Mundy (USA), Sei-ichi Saitoh (Japan), Hiroya Sugisaki (Japan) and Tokio Wada (Japan)*

Background

From ancient times, we have been discussing and taking countermeasures on revival of fisheries and social infrastructures of waterside from natural disasters such as tsunamis and floods. The earthquake (Magnitude 9.0) that occurred in northeastern Japan on the 11th of March, 2011, was beyond our imagination. The earthquake and the subsequent gigantic tsunami destroyed the regional fisheries and surrounding society, and impacted marine ecosystems in eastern Japan. The tsunami also damaged the nuclear power plant of Fukushima, posing a serious threat to the North Pacific ecosystems due to the radioactive contamination of the ocean. Other recent examples of disasters which caused serious problems of environmental pollution for the marine ecosystems are hurricane Katrina in 2005, and the oil spill of the Gulf of Mexico in 2010. The magnitude of climatic disasters such as storms and floods may have been enhanced due to global warming. Since oil refineries, factories, power plants and other industrial infrastructures are often built in the coastal areas of the world, coastal ecosystems are vulnerable to natural and artificial disasters. For the wise use of ecosystem services, it is urgent and important to reveal the effects of natural and artificial disasters on marine ecosystems, to document their restoration processes, and to promote effective measures for restoration and mitigation of disaster impacts. The purposes of this session were to discuss: (1) the effect on the marine ecosystem by disasters, (2) the effect on the marine industries and societies by disasters, (3) schemes for the

mitigations and recoveries from the disasters, (4) field monitoring on the effect and the process of recoveries, (5) domestic and international cooperation, and (6) policy and its effect.

Summary of presentations

This session was held to exchange information on current research on natural and artificial ecosystem disturbances, which was a particularly timely topic for a meeting in Japan so soon after the Great East Japan Earthquake of 2011. An audience of about 100 people heard 14 oral presentations, 5 of which were invited, while 7 posters were presented in the PICES poster session.

After the opening address by Dr. Tokio Wada (S11 Co-convenor; Vice-president of the Japanese Society of Fisheries Oceanography, and the Executive Director of the Fisheries Research Agency), Dr. Hiroya Sugisaki introduced the purpose of the session. The opening paper, "*Exxon Valdez: Long term environmental consequences of oil persistence and toxicity*" by Dr. Stanley Rice, an invited speaker, was made by Dr. Rice's colleague, Dr. Phillip Mundy, as Dr. Rice was unable to travel to the meeting. As the only presentation on artificial ecosystem disturbances, the talk addressed the history of more than two decades of efforts to identify and address oil induced disturbances. The importance of long-term monitoring for understanding disturbances in marine environments was a major conclusion of the talk. In the next talk, Dr. Hiroya Sugisaki (on behalf of the Japanese Society of Fisheries Oceanography) introduced the projects implemented to identify disturbances arising from the Great East Japan Earthquake that were enabled by the PICES/ICES/JSFO fund for fisheries and oceanographic research in the area.

In the second part of the morning session, Dr. Shin-ichi Ito, an invited speaker, represented 18 co-authors in providing an overview of the damages to the fishing industries and living marine resources of the nearshore areas that were caused by the earthquake and the resulting tsunami and massive debris input to the marine environments. Two subsequent talks described surveys of disturbances to important nearshore marine habitats, the eel grass (*Zostera*) meadows (Dr. Daisuke Muraoka) and the rocky shore and near subtidal areas (Dr. Hideki Takami). In the final talk of the morning, Dr. Atsushi Tsuda (on behalf of Mr. Hiroshi Isami) introduced their research activities on the effect of the earthquake and tsunami on the zooplankton communities in the nearshore ecosystems in Tohoku region. The need for long-term monitoring in the marine environment was frequently mentioned in these talks.

In the afternoon session, Dr. Masahiro Yamao, an invited speaker, shared lessons learned from research on the effect of the tsunami of Sumatra, as a potential model for the roles of sustainable livelihood recovery and social resilience in areas affected by the Japanese earthquake. Dr. Yamao introduced the concept of "social capital" as a means to strengthen the resilience of coastal communities in the face of disasters. In the following talk, Dr. Natsuki Hasegawa provided the example of an impact to a coastal community in Japan by describing tsunami damages to the Asari clam fishery of Hokkaido, and the possibilities of its recovery. In the next two presentations, the effects of the accident at the nuclear power plant following the tsunami were discussed. Dr. Richard Brodeur introduced the concept of possible radio-biologic stress in food webs on the scale of the North Pacific. Dr. Toshihiro Wada described losses of fishery facilities and interruption of availability of marine products that were experienced closer to the site of the plant in Fukushima Prefecture. In both cases monitoring of radionuclides and the environment were advanced as important considerations for understanding the disturbances studied.

The main subjects of talks in fourth part of the session were physical oceanographic monitoring and predicting the effects of the earthquake and tsunami using models. Dr. Nikolai Maximenko, an invited speaker, introduced his models for tracking marine debris across the North Pacific Ocean while Dr. John Barth described observing systems off the California, Oregon and Washington coasts and the emergency preparedness measures that have been taken in anticipation of the tsunami arising from a major Cascadia Subduction earthquake. Dr. Josef Cherniawsky, an invited speaker, described the tsunami inundation modeling that he has carried out for parts of the west coast of Vancouver Island, assuming a Cascadia event, while Dr. Xiaorong Li described his model simulations to study the impact of a possible tidal power station on the

surrounding marine environment. After the all papers had been presented, Dr. Toyomitsu Horii, one of the Co-convenors, reviewed the session briefly, and introduced related sessions on the research of the earthquake.

The subject of every poster of this session was related to the research on the effects of the Great East Japan Earthquake. During the poster session on Thursday, the presenters had enthusiastic discussions with many interested parties till the session end.

The Co-convenors and a member of the Technical Committee on Monitoring (MONITOR) judged that the best oral presentation for a MONOTOR-sponsored Topic Session by an early scientist was by Dr. Toshihiro Wada (Japan) who spoke about "*Tsunami disaster and nuclear power plant accident effects on fishery facilities and marine products in Fukushima Prefecture: present conditions and prospects*". The best poster presentation was by Dr. Hideki Kaeriyama (Japan) on "*Oceanic dispersion of radioactive cesium around Japan and western North Pacific after the Fukushima Dai-ichi Nuclear Power Plant Accident*" . These two papers were quick reports on the effects of the nuclear power plant accident through direct research at the site of the accident with a view to international concerns.

List of papers

Oral presentations

Stanley D. Rice (Invited)
Exxon Valdez: Long term environmental consequences of oil persistence and toxicity

Hiroya Sugisaki
On behalf of *Japanese Society of Fisheries Oceanography*
General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake

Shin-ichi Ito, Shigeho Kakehi, Taku Wagawa, Yoji Narimatsu, Yutaka Kurita, Tomoko Sakami, Hideki Takami, Hideki Kaeriyama, Ken Fujimoto, Tsuneo Ono, Hiroyuki Tanaka, Takashi Kamiyama, Shigeru Itakura, Yuji Okazaki, Kazuaki Tadokoro, Akira Kuwata, Hiroaki Saito, Masaki Ito and Tsutomu Hattori (Invited)
The application of marine research to the study the marine ecosystem on the Pacific coast of northeastern Japan after the Great East Japan Earthquake disaster

Daisuke Muraoka, Tomoko Sakami, Goro Yoshida, Masakazu Hori, Hiromori Shimabukuro, Takehisa Yamakita and Hitoshi Tamaki
Impact of the Great East Japan Earthquake on *Zostera* meadows in the coastal area close to the epicenter

Hideki Takami, Tomohiko Kawamura, Daisuke Muraoka, Nam-Il Won and Hiroshi Nakaie
Effects of the mega-earthquake and tsunami on rocky shore ecosystems on Sanriku Coast, Japan

Hiroshi Isami and Atsushi Tsuda
Effects of the tsunami on zooplankton communities in Otsuchi Bay, northern Japan

Masahiro Yamao Zulhamsyah Imran, Achmad Zamroni, Kazuko Tatsumi and Michiko Amamo (Invited)
Strengthening social resilience in earthquake and tsunami affected coastal Asia through improvement of livelihood and social capital

Natsuki Hasegawa and Toshihiro Onitsuka
Damage from the tsunami on the Asari clam fishery in east Hokkaido, Japan and the problems in its recovery

Delvan Neville, Richard D. Brodeur, A. Jason Phillips and Kathryn Higley
Assessment and characterization of radionuclide concentrations from the Fukushima Reactor release in the plankton and nekton communities of the Northern California Current

Toshihiro Wada, Yoshiharu Nemoto, Shinya Shimamura and Satoshi Igarashi
Tsunami disaster and nuclear power plant accident effects on fishery facilities and marine products in Fukushima Prefecture: Present conditions and prospects

Nikolai Maximenko and Jan Hafner (Invited)
Tracking marine debris generated by the March 11, 2011 tsunami using numerical models and observational reports

John A. Barth, Jonathan Allan, Craig Risien, Jan A. Newton and NANOOS Colleagues
The Northwest Association of Networked Ocean Observing Systems (NANOOS) interactive tsunami evacuation maps

Josef Cherniawsky and Roy Walters (Invited)
Predicting future tsunami waves and currents on the West Coast of Canada

Xiaorong Li, Huaming Yu and Songyang Song
A new method based on FVCOM to simulate the impacts of a tidal power station on the surrounding marine environment

Poster presentations

Yuichiro Yamada, Shinnosuke Kaga and Takehiko Ogata
Influence of a huge tsunami on the coastal plankton community structure, especially on the abundance of the toxic dinoflagellate (*Alexandrium tamarense*) in Ofunato Bay, Sanriku, Japan

Yuji Okazaki, Yutaka Kurita and Shinji Uehara
Changes in the demersal fish communities of the sandy beach in Sendai Bay after the disturbance by the tsunami

Hiroyuki Tanaka, Shigeho Kakehi and Shin-ichi Ito
Temporal variation of polycyclic aromatic hydrocarbons in surface seawater from Sendai Bay, Japan, between June 2011 and March 2012

Daisuke Ambe, Hideki Kaeriyama, Yuya Shigenobu, Ken Fujimoto, Hajime Saito, Hideki Sawada, Tsuneo Ono, Takashi Setou and Tomowo Watanabe
Distribution of radioactive cesium in sea sediment and bottom boundary layer after the Fukushima Daiichi Nuclear Power Plant accident

Galina S. Borisenko, Yuriy G. Blinov and Igor I. Glebov
Investigation of radioactive pollution of biological resources in the northwest part of the Pacific Ocean after leakage at the nuclear power station "Fukushima-1" in Japan

Hideki Kaeriyama, Daisuke Ambe, Masachika Masujima, Kou Nishiuchi, Ken Fujimoto, Tsuneo Ono and Tomowo Watanabe
Oceanic dispersion of radioactive cesium around Japan and western North Pacific after the Fukushima Dai-ichi Nuclear Power Plant accident

Hiroya Sugisaki
On behalf of *Japanese Society of Fisheries Oceanography*
General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake

BIO/FIS/POC Topic Session (S12)
Advances in understanding the North Pacific Subtropical Frontal Zone Ecosystem

Co-convenors: *Michael Seki (USA), Skip McKinnell (PICES) and Taro Ichii (Japan)*

Background

The goal of this session was to compile a comprehensive collection of papers for the first time in two decades that can serve to synthesize knowledge of the roles of climate, physics, chemistry, biology, and humans in the Subtropical Frontal Zone (STFZ). The STFZ is a large, seasonally variable, dynamic, and complex oceanic region spanning the breadth of the North Pacific Ocean from Asia to North America. Its large-scale fronts and mesoscale processes give rise to localized "hot spots" of enhanced biological aggregation. The productivity of the region provides the ecological underpinnings for multi-national commercial fisheries. The STFZ provides important habitat for many species of fish and squid, seabirds, and marine mammals that undergo extensive seasonal migrations between the STZF and summer feeding grounds in the Subarctic. Concern for interactions between protected species, such as loggerhead turtles, and fisheries are focus areas of interest today, as is the health and productivity of the fisheries resources. Finally, interest in the effect of marine debris that is accumulating in oceanic "garbage patches" is increasing, perhaps exacerbated by growing interest in the fate of the debris field in the aftermath of the 2011 tsunami near Japan. This session sought to provide valuable information on potential impacts of climate and humans on marine ecosystem in the STFZ.

Summary of presentations

Topic Session S12 brought together a collection of speakers and presentations that advanced our understanding of the North Pacific Subtropical Frontal Zone (STFZ) ecosystem. The half-day session of 8 speakers and 2 posters brought new insights into the relationship between the physics of oceanography, atmospheric forcing, and climate and the biological and chemical patterns observed in the region. Several speakers highlighted differences observed between the higher productive pre-1998 regime and the lower productive post-1999

period and importance of the Transition Zone Chlorophyll Front (TZCF) to reproductive and foraging success. Through the presentations, we heard on research regarding aspects of ecological (*e.g.*, food web) function and relationships among phyto- and zoo-plankton in the Kuroshio Extension and aspects of the spatial ecology and biology of key transition zone ecosystem nekton, such as neon flying squid, Pacific saury, Pacific pomfret, seabirds (albatrosses), and predatory fishes. Anthropogenic concerns (impacts of fishing, fate and distribution of marine debris) were also discussed in the context of the STFZ oceanography and regional resources. Papers contributed to this session and a number of focused invited contributions are planned to be published in a special dedicated issue of Progress in Oceanography.

List of papers

Oral presentations

Hiromichi Igarashi, Toshiyuki Awaji, Taro Ichii, Mitsuo Sakai, Yoichi Ishikawa, Shuhei Masuda, Haruka Nishikawa, Yoshihisa Hiyoshi, Yuji Sasaki and Sei-Ichi Saitoh (Invited)
Diagnosis of the possible link between interannual variation of neon flying squid abundance in the North Pacific and the recent climate regime shift in 1998/99 by using 4DVAR ocean data assimilation product

Evan A. Howell, Aimee L. Hoover, Jeffrey J. Polovina and Michael P. Seki
Spatial and temporal variability in the biophysical properties of the North Pacific Subtropical Frontal Zone during 1997-2011

Carey Morishige and Evan A. Howell
Marine debris movement and concentration within the North Pacific Ocean

Hiroaki Saito, Kazutaka Takahashi, Yuichiro Nishibe, Ken Furuya, Koji Hamasaki, Kiyotaka Hidaka, Tadafumi Ichikawa, Mutsuo Ichinomiya, Shigeho Kakehi, Miwa Nakamachi, Yuta Nishibe, Yuji Okazaki and Yuya Tada
Food-web structure and dynamics in the frontal zone of Kuroshio Extension

Mitsuo Sakai, Toshie Wakabayashi, Haruka Urabe, Makoto Okazaki, Yoshiki Kato, Masachika Masujima, Denzo Inagake and Yasuhiro Senga
Distribution and growth of young neon flying squid, *Ommastrephes bartramii*, in the central North Pacific Subtropical and Transition Zones during winter

Taro Ichii, Haruka Nishikawa, Hiromichi Igarashi, Hiroshi Okamura, Kedarnath Mahapatra, Mitsuo Sakai, Toshie Wakabayashi, Denzo Inagake and Yoshihiro Okada
Impacts of extensive squid driftnet fishery and climate variability on epipelagic nekton in the Transition Region of the central North Pacific

David G. Foley, Elliott L. Hazen, Steven J. Bograd, Scott A. Shaffer, Scott Benson, Barbara A. Block and Daniel P. Costa
Convergence from bottom to top: An oceanographic perspective on the movements of apex predators near the North Pacific transition zone chlorophyll front

Lesley H. Thorne, Scott A. Shaffer, Elliott L. Hazen, Steven J. Bograd, David G. Foley, Melinda G. Connors, Michelle A. Kappes and Daniel P. Costa
Effects of inter-annual variability of the transition zone chlorophyll front on the habitat use and reproductive success of Laysan and Black-footed albatrosses

Poster presentations

Atsushi Yamaguchi, Kohei Matsuno, Yoshiyuki Abe and Ichiro Imai
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

Dharmamony Vijai, John R. Bower, Yoshihiko Kamei and Yasunori Sakurai
Distribution and characteristics of neon flying squid (*Ommastrephes bartramii*) near a spawning area off Hawaii

MEQ/FUTURE Topic Session (S13)
Risk management in coastal zone ecosystems around the North Pacific

Co-convenors: *Masahide Kaeriyama (Japan) and Thomas Therriault (Canada)*

Background

Currently, approximately 60% of the world's population lives within 60 km of the coast and this number is expected to reach 75% within the next two decades due to increased population growth. The coastal zone is an extremely complex environment that includes both coastal, nearshore marine and estuarine ecosystems and the adjacent terrestrial area. Human populations around the North Pacific rely heavily on this zone for their livelihood but growing pressures from increasingly diverse human activities coupled with climate change and natural catastrophes (*e.g.*, earthquake and tsunami) threaten the sustainability and productivity of coastal ecosystems. Risk management based on adaptive management and precautionary principles, is one way to prioritize, identify, and potentially mitigate impacts resulting from diverse human activities in coastal zones. This session focused on the following issues: (1) Preparation and countermeasures to respond to natural catastrophes; (2) Protection of coastal zone ecosystems from human-mediated impacts (e.g., habitat loss, pollution, harmful algal events, invasive species); (3) Planning and use of marine protected areas (MPAs).

Summary of presentations

Session S13 was convened for a ½ day on Wednesday, October 17, 2012, and was launched with Dr. Erlend Moksness (Institute of Marine Research, Norway) providing the introductory keynote address followed by eight contributed papers on the topic, including one by an early career scientist. Late cancellations resulted in three new presentations added to this session after the program was printed, including some originally identified as posters (see changes below).

Given the complexity of coastal ecosystems and the degree to which humans depend on them for their variety of ecosystem services, a good governance structure that links science and management is imperative to ensure long term sustainability. As an example, Dr. Moksness showed how the increasing human population and shift away from poverty in some regions is driving up demand for food resources, including fisheries ones that, in turn, results in additional pressures on coastal ecosystems. To reduce conflicts and increase sustainability there is a need for integrated coastal zone management (ICZM), a process that is complementary to ecosystem-based management (EBM), and allows for spatially-based decision making with input from stakeholders/clients. Using a Norwegian example, Dr. Moksness showed how competing demands for marine coastal waters has increased from shipping and fishing being the original conflicts but over time additional demands such as oil and gas and salmon farming became major coastal activities. By developing explicit spatial maps of these activities, Norway is implementing a research initiative on area-based management that will identify no-catch zones, sensitive habitat zones, aquaculture zones, and zones with no management restrictions. The intent of this initiative is that results will be scalable to larger spatial units. This integrated approach provides a way to identify risks and develop mitigation measures.

The Seto Inland Sea of Japan is an example of a coastal ecosystem that has seen significant changes over the last half century. Dr. Ichiro Imai (Hokkaido University, Japan) showed how land reclamation activities led to eutrophication and harmful algal bloom (HAB) events in the 1960s and 70s. In addition, he showed how algicidal bacteria living on seagrass can mitigate the impacts of HAB events. In a risk context, restoration of seagrass beds could lead to increases in these bacteria that would ultimately reduce the impacts (frequency or severity) of HAB events in coastal waters.

Dr. Ellik Adler (United Nations) introduced a COBSEA project entitled Spatial Planning in the Coastal Zone – Climate Change and Disaster Risk Reduction in the East Asian Seas Region. This project was implemented in three phases. The first phase produced guidance documents for authorities to incorporate risk reduction strategies into existing policies and procedures. The goal was not to tell authorities how to change legislation

but rather to identify ways to work within existing legislation to achieve project goals. The second phase used consultations to identify capacity building and adaptation needs such that training could be tailored to meet demands. The last phase is a train-the-trainer approach to develop longer-term capacity with respect to marine spatial planning in developing countries. For this project stakeholder involvement was high, in part due to a focus on local issues and priorities with products translated and adapted for specific audiences.

High school student Ji-Yeon Shin presented a paper that analyzed awareness of ocean environment issues among two different groups in Korea: high school students and SCUBA divers. While awareness on some "popular" topics was high among students it was low on others. However, this group was very willing to engage on the topic, and increased awareness of marine environmental issues might increase activity. Although SCUBA divers tended to be more aware of environmental issues, even they lacked awareness on emerging topics such as barren grounds. Like high school students, this active group was willing to engage on marine environmental issues once they were identified. Ms. Shin suggested that awareness for both groups could be raised simply by employing social media networks.

Dr. Tomohiko Kawamura (University of Tokyo, Japan) introduced a new long-term project to monitor recovery of coastal environments following the Great East Japan Earthquake and Tsunami for sustainable future fisheries. Although kelp beds and algae appeared undamaged following the tsunami, urchins were removed from these habitats which could suggest longer-term impacts. Further, increased sedimentation following land subsidence is an emerging issue. With a reduction in the number of grazers in the system, an increase in macroalgae was observed which had positive impacts on adult urchin and abalone populations but negatively impacted juvenile populations due to a loss of corral crystalline algae habitat needed for larval settlement and early life history development. Increased monitoring of coastal environments will provide data necessary to manage fisheries in this area in a sustainable way and thereby mitigate the risk of longer-term impacts.

Mr. Tomoya Kataoka (National Institute for Land and Infrastructure Management, Japan) provided an overview of a project to identify transport processes of marine debris, especially plastics, using a webcam monitoring program. Color references were developed to separate plastics from natural debris (*e.g.*, wood) and by using the field of view of the webcam it was possible to calculate the coverage of plastic debris on each of the monitored beaches. To show this approach is responsive to actual changes, he showed that following planned beach cleanup events, the amount of plastics confirmed by webcam decreased. Although wind and other factors can affect the actual distribution of marine debris on beaches, this webcam approach is a cost effective method to monitor a number of beaches without having to constantly sample them.

Dr. Sei-Ichi Saito (Hokkaido University, Japan) introduced the development and application of Tohoku Coastal Web-GIS for supporting recoveries of the Tohoku Earthquake. The Tohoku Coastal Web-GIS, containing satellite information with high resolution GeoEye images, is applied for services and contributions to support activities of recoveries from the Tohoku Earthquake and Tsunami. This system will be useful for on-going Web-GIS in support of risk management and recoveries.

Dr. Paul Harrison (University of British Columbia, Canada) discussed the relationship between N:P ratios and the occurrence of red tide events and highlighted how these ratios can be misleading from a risk management perspective. If the actual concentration of either N or P (or Si) is not limiting for diatom/dinoflagellate growth, then regardless of the ratio, red tide events should be expected. Conversely, even if the N:P ratio suggests red tides might be expected, if the actual concentrations are limiting, then red tide organisms will not have the resources required to bloom. He used a sewage treatment diversion in Hong Kong as an example of how these N:P ratios can be misleading and showed how other variables such as hydrodynamics, wind, typhoon events, *etc*. can affect the stratification of coastal waters making them more (or less) susceptible to red tide events.

The last contributed oral presentation was given by Dr. Masahide Kaeriyama (Hokkaido University, Japan) who talked about the need for an adaptive management strategy to create sustainable chum salmon fisheries in Japan. Climate change is affecting the carrying capacity of the North Pacific and is resulting in distributional

changes in many species, including salmon. By considering factors such as regime shifts, climate change impacts, distribution and carry capacity changes, managers potentially can mitigate longer-term sustainability impacts by pro-actively reducing harvest in expected poor return years and increasing it when conditions are favorable. A similar adaptive management strategy would apply to fisheries impacted by the Great East Japan Earthquake and Tsunami.

Overall, this session on risk management provided an overview of how integrated/adaptive management can be used to identify and mitigate impacts in coastal zones. Given the wide variety of human activities in coastal zones and the growing list of potential threats/impacts, having a management strategy that is risk-based, transparent, and understood by managers, clients, and stakeholders alike is essential to ensuring sustainable coastal systems. In addition to specific frameworks and examples, this session also identified potential tools that could be used for adaptive management, including webcams and GIS-based applications. Japan is using adaptive management to mitigate impacts from the Great East Japan Earthquake and Tsunami as highlighted in some oral presentations in this session; reconfirming risk-based management approaches are broadly applicable for ensuring long term sustainability in coastal zones.

List of papers

Oral presentations

Erlend Moksness (Invited)
Coastal marine ecosystems and Integrated Coastal Zone Management (ICZM): A way forward

Ichiro Imai, Asami Kuroda, Yuka Onishi, Atsushi Yamaguchi and Mineo Yamaguchi
History of eutrophication and harmful algal bloom (HAB) events in the Seto Inland Sea of Japan and a proposal for prevention strategies for HABs using seaweed- and seagrass-beds

Ellik Adler, Lawrence Hildebrand and Reynaldo Molina
Coastal Spatial Planning in the East Asian Seas Region – Climate Change and Disaster Risk Reduction

Ji-Yeon Shin
Analysis of urban high school students' and scuba divers' awareness on the ocean environment and plans to enhance public awareness

Tomohiko Kawamura
Secondary succession in coastal ecosystems after the enormous disturbance by the Great East Japan Earthquake on the Sanriku Coast: Importance of scientific guidelines for future sustainable fisheries and ecosystem management

Tomoya Kataoka, Hirofumi Hinata and Shin'ichiro Kako
Simultaneous monitoring at multiple sites of beached plastic litter quantity using webcam

Sei-Ichi Saitoh, Katsuyoshi Tanaka and Fumihiro Takahashi
Development and application of Tohoku Coastal Web-GIS for supporting recoveries of the Tohoku Earthquake

Paul J. Harrison, Jie Xu and Kedong Yin
Do changes in N:P ratios influence the occurrence of HABs?

Masahide Kaeriyama, Yu-xue Qin, Yosuke Koshino, Daisuke Uryu and Hideaki Kudo
Sustainability and risk management of Pacific salmon under changing climate and catastrophic earthquake and tsunami in coastal ecosystems around Japan

Poster presentations

Galina S. Gavrilova
Some risks of on-bottom shellfish aquaculture in Peter the Great Bay (Japan Sea)

POC/TCODE Topic Session (S14)
Changing ocean biogeochemistry and its ecosystem impacts

Co-sponsored by: *ICES, IMBER and SOLAS*

Co-convenors: Silvana Birchenough (ICES/UK), Steven Bograd (PICES/USA), Arthur Chen (IGBP), Masao Ishii (PICES/Japan) and Tony Koslow (PICES/USA)

Background

Ocean biogeochemistry is undergoing rapid and growing anthropogenic change. A significant fraction of anthropogenic CO_2 is taken up by the ocean, which drives down pH and reduces the saturation state of carbonate minerals like calcite and aragonite, a process known as "ocean acidification". Global climate models also predict that dissolved oxygen concentrations in the deep ocean will decline by 20–40% over the coming century or so as global warming enhances stratification of the upper mixed layer and reduces ventilation of the deep ocean. Declining oxygen levels have now been reported from mid-ocean depths in the tropical oceans and across the North Pacific. Both processes are of particular concern in the North Pacific, where the water is naturally "old" and has shallow carbonate saturation horizons, relatively low buffering capacity, and extensive oxygen minimum zones. It is anticipated that these anthropogenic influences on the global ocean will increase in coming decades as atmospheric CO_2 levels and global temperatures continue to rise. Papers were invited on the changing biogeochemistry of the global ocean, its impacts on organisms and ecosystem function, and emergent impacts on biogochemical cycles related to the interaction of ocean acidification and declining oxygen with climate change and other anthropogenic impacts.

Summary of presentations

Session S14 was held on Tuesday, October 16, 2012 (full day), and was launched with an invited talk by Dr. Akihiko Murata (JAMSTEC, Japan) and included two other invited presentations: Brad Seibel (URI, USA) and Curtis Deutsch (UCLA, USA). In addition, there were 14 contributed oral presentations and five posters.

The lead invited address was given by Dr. Murata who reviewed decadal changes in dissolved inorganic carbon (DIC), reflecting uptake of anthropogenic CO_2 across the North and South Pacific based on repeat hydrographic sections. The pattern was surprisingly variable, with low inventory in the Equatorial Pacific and high in the subtropical gyres. In deeper waters, high CO_2 was found in mode waters but deeper, only in Antarctic Intermediate Water; not so much in North Pacific Intermediate Water. Overall ~40% of the oceanic uptake of CO_2 is found in the Pacific Ocean from 50°S–65°N. Distribution processes have not changed significantly over the past decade.

Dr. Liqi Chen from the Key Lab of Global Change and Marine-Atmospheeric Chemistry (China) followed on by examining changes in surface pCO_s in the western Arctic Ocean, in particular the implications of shrinking sea-ice extent. The paper was based on five Chinese Arctic cruises from 1999–2010. Over this period, the expeditions progressively reached further north due to the shrinking sea ice. Very low pCO_2 is found under the sea ice but high values, almost as high as in the air, are found in exposed surface waters due to uptake from the atmosphere. This could accelerate the negative impact of ocean acidification in Arctic ecosystems. A mixing model was developed for CO_2 in the western Arctic based on exchanges with the Bering Sea. Surface acidification was caused by both biological recycling and uptake of atmospheric CO_2. The increased uptake by the Arctic may provide a negative feedback to the buildup of CO_2 in the atmosphere.

The next paper by Drs. Takamitsu Ito (Georgia Institute of Technology) and Curtis Deutsch (University of California, LA) was delivered by Deutsch due to the early departure of Ito. The paper examined decadal-scale trends in the expansion and contraction of the oxygen minimum zone (OMZ) in relation to changing respiration. Using time series from the Eastern Tropical Pacific (ETP) from 1960–2000, recent work by Stramma *et al.* showed expansion of the OMZ in the last 20 years. Ito and Deutsch used CalCOFI data to

develop a global ocean biogeochemical model, which focused on the ETP. The model showed contraction of the OMZ in the 1970s but expansion in the recent past. The volume of suboxic water varied considerably with multidecadal variability and the influence of major El Niños. The apparent oxygen utilization (AOU) is the major contributor to the pattern. Transport was dominated by the Equatorial Undercurrent. Respiration shows a positive trend highly correlated with warming and dominates. The model indicates there are two competing effects. El Niño leads to not only weaker transport of low O_2 water, but also less upwelling and hence less productivity. But the overall effect is increased O_2 due to decreased upwelling. La Niña, however, leads to OMZ expansion. The thermocline water has a kind of memory that integrates the ENSO signals to a PDO, or multidecadal signal.

The next paper presented by Dr. Shuchai Gan (East China Normal University, China) examined patterns of bio-available dissolved organic carbon (BDOC) of different water masses in the East China Sea. DOC comprises the largest carbon pool in the ocean: 1% is equivalent to 1 year's fossil fuel combustion. Micro-organisms are major consumers of DOC. But much is refractory and this portion of the carbon cycle is poorly understood. There are several water masses in the East China Sea, including coastal and oceanic water and water with Yangtze River influence. As Dr. Gan and co-author, Dr. Ying Wu, showed, each water mass may have a distinct chemistry with different labile and non-labile components with different bioavailability.

Dr. Kosei Komatsu (University of Tokyo) and colleagues used historical observations and survey data to investigate nutrient transport within the Kuroshio Current and its impacts on regional productivity. They found maximum nutrient concentrations within the Kuroshio jet at levels between 24.5–26.0s_q with a structure similar to that seen in the Gulf Stream. Evidence of high epipycnal and diapycnal fluxes were observed, the latter contributing significantly to spring new production in adjacent regions.

Dr. Jim Christian (Fisheries and Oceans Canada) and colleagues compared patterns and trends in ocean calcite and aragonite saturation states from a suite of CMIP5 Earth System Models. Each of the 7 models compared demonstrated strengths and weaknesses when compared to observations, emphasizing the need to use multiple models. They found an order of magnitude increase by 2100 in total area of shallow aragonite saturation in all models under the "no mitigation" scenario, although this depended strongly on the rate of CO_2 increase. All models underestimated the North Pacific contribution to the growth of the area of shallow undersaturation.

Dr. Silvana Birchenough (Lowestoft, UK) and colleagues showed how a sediment profile imagery camera could be used to characterize benthic communities and their sedimentary characteristics in areas adjoining cold-water coral reefs, which are subject to potential stress due to ocean acidification. They demonstrated the use of the camera system based on a cruise to the Outer Hebrides and Banana reef complex and the Logachev Mounds in the northeast Atlantic. Distinct benthic communities and sediments were found at each site, and the work showed the potential of the camera system to explore these habitats and develop time series to assess the potential impacts of acidification on a diverse deepwater habitat.

Dr. Jack Barth (Oregon State University, USA) and colleagues described patterns of hypoxia on the Oregon continental shelf from a suite of instruments including buoys, moorings, gliders, and ship-based surveys, as well as historical hydrographic observations. They described significant interannual variability in the timing, intensity and spatial distribution of hypoxia on the inner shelf, including the appearance of anoxia in summer 2006. A simple model driven by local wind forcing and source water dissolved oxygen levels explains 80% of the variability in near-bottom, inner shelf dissolved oxygen. Based on projected changes in source water dissolved oxygen, they estimated that the frequency of inner shelf hypoxia during the summer upwelling season could increase to 90%, comparable to the persistent hypoxic conditions found in the Humboldt Current.

Dr. Yvette Spitz (Oregon State University, USA) presented a paper by herself and Dr. Harold Batchelder based on a coupled ecosytem-ROMS modeling approach to investigating dissolved oxygen dynamics on the Oregon continenal shelf and cross-shelf exchanges. They presented a model hindcast for three years (2002, 2006, and 2008) that had different forcing and displayed different patterns of hypoxia. The model reproduced

the observed interannual variability quite well, but they found that their results were highly sensitive to initial and boundary conditions.

Dr. Curtis Deutsch (University of California, LA) presented an invited talk, co-authored with Dr. Aaron Ferrel, on organisms' metabolic constraints related to oxygen requirements and the potential impacts of climate change. They presented a metabolic index based on the ratio of O_2 supply and demand. They compiled laboratory studies for a range of organisms to show that despite a wide range of thermal and hypoxic tolerances, the contemporary range of the investigated species was bounded by a similar metabolic index. Changing climate will thus impose a fundamental metabolic constraint on their habitat. Marine organisms (unlike terrestrial organisms) are generally metabolically constrained at the equatorial edge of their range. Habitats will generally shrink in the future with warmer and deoxygenated water.

Dr. Brad Seibel (University of Rhode Island, USA) changed the title of his invited talk to "*Existing oxygen levels are the critical oxygen levels*". He presented a range of field and laboratory studies identifying the critical oxygen levels for marine animals that depend on temperature and other environmental factors. He showed the adaptations of mesopelagic organisms to low oxygen concentrations but showed that many of those organisms were already living at the limits of their oxygen and temperature tolerances. Thus future potential changes due to warming, acidification, and deoxygenation could have dramatic impacts on midwater communities.

Drs. Angelica Peña and William Crawford (Fisheries and Oceans Canada) showed the long-term trend of dissolved oxygen in the ocean interior off the west coast of Canada. Dr. Peña examined oxygen time series on the shelf as well as at OS Papa. She demonstrated that the decadal pattern on the shelf matched that observed in the southern California Current with dissolved oxygen level low around 1960, increasing in the mid-1980s, and decreasing significantly in the last decade. The pattern in the open waters of the Gulf of Alaska shows a different pattern, exhibiting a monotonic decline.

Dr. Yukihiro Nojiri (National Institute for Environmental Studies, Japan) and colleagues presented a paper on the variability of the carbon cycle and biological production in the North Pacific estimated from mapping pCO_2, alkalinity, and dissolved inorganic carbon. Observations of ocean surface pCO_2 were collected as part of the NIES programme. The presentation showed a climatology map including DIC values, demonstrating a decrease in concentration during the summer season, mainly related to the community productivity at the ocean surface. DIC changes were observed in some areas. The main conclusions were that: i) DIC distribution has higher spatial variation and can be analyzed with neural networks, including pCO_2 mapping and ii) the maps could be compared against the oceanic variability such as ENSO and/or PDO to estimate the influence of these oceanic patterns on biological production to understand the impact of PDO on the changing DIC distribution.

Dr. Keith Rodgers (Princeton University, USA) and colleagues discussed the re-emergence of anthropogenic carbon and Pacific pool acidification. They presented a model to test the hypothesis that meridian overturning of the Pacific subtropical cell controls the supply of anthropogenic DIC to the Pacific warm pool. The model results agreed well with the results presented by Ishii (2009). The upwelling of thermocline waters rich in anthropogenic carbon in the cold tongue regions serves as a "re-emergence" of anthropogenic carbon. Some of this work suggests that re-emergence is a first order, if not dominant, driver of the acidification of equatorial Pacific warm pool waters.

Dr. Finlay Scott (Lowestoft, UK) and colleagues prepared a paper on predicting the regional impacts of ocean acidification based on integrating sediment biodiversity and ecosystem function. The effects of ocean acidification for benthic species were developed in a model to examine faunal responses. A Biological Traits approach (BTA) was used to code the species based on their sensitivity. The North Sea benthos 1986 survey was used since biomass and abundance were available and the data were used to calculate a Bioturbation Potential index. The use of Chl and organic carbon to characterize the areas was also examined in relation to

the index values. A series of histograms were used to examine changes by area and to explore the importance of sensitive species in those areas. The work is still under development.

Dr. Tony Koslow (Scripps Institution of Oceanography, USA) and colleagues presented a talk on **t**he influence of declining oxygen concentration on mesopelagic fish biomass in the California Current and the potential impacts on ecosystems structure. CalCOFI ichthyoplankton and environmental data were used to show a close relationship between decadal changes in midwater oxygen concentration and the abundance of a wide range of mesopelagic fishes in the California current. Changes in the mesopelagic fishes were correlated as well with large-scale environmental indices, such as the ENSO and PDO on the one hand and with fluctuations of dominant epipelagic planktivores (anchovy, hake, and mackerel) on the other. The abundance of both mesopelagic migrators and total meso- and epipelagic planktivores were negatively correlated with the abundance of key plankton groups. However, the correlation seemed to be mediated by common correlations with environmental forcing, such as the strength of the California Current.

Dr.Julie Keister (University of Washington, USA) and colleagues talked about the oxygen and pH conditions experienced by zooplankton in Puget Sound. Field and laboratory results were combined to study the relationship between ocean chemistry and zooplankton distribution, focusing primarily on areas with particularly extreme oxygen and acidification conditions. Experiments examined the influence of hypoxia on developmental rate, hatching success and mortality. This information has the potential to be used to model the future for coastal ocean ecosystems under conditions of increasing oxygen and acidification stress.

List of papers

Oral presentations

Akihiko Murata, Shinya Kouketsu, Toshimasa Doi, Kazuhiko Hayashi and Yuichiro Kumamoto (Invited)
Decadal changes of dissolved inorganic carbon in the Pacific

Liqi Chen, Zhongyong Gao, Wweijun Cai, Heng Sun and Suqing Xu
Surface Carbon Changes in the western Arctic Ocean under seaice rapid shrinking and its implication of Arctic Ocean acidification

Takamitsu Ito and Curtis Deutsch
Understanding low-frequency variability of subsurface oxygen using a hierarchy of models

Shuchai Gan and Ying Wu
Quantification of BDOC (bio-available dissolved organic carbon) of different water masses in East China Sea

Kosei Komatsu, Ichiro Yasuda, Sachihiko Itoh, Toru Ikeya, Hitoshi Kaneko, Kiyotaka Hidaka and Satoshi Osafune
Impacts of epipycnal and diapycnal nutrient-transport by the Kuroshio on the productivity in the adjacent epipelagic waters

James Christian, Laurent Bopp, John Dunne, Michael Eby, Paul Halloran, Tatiana Ilyina, Ian Totterdell and Akitomo Yamamoto
Trends in ocean $CaCO_3$ undersaturation in the CMIP5 suite of Earth System Models

Silvana N.R. Birchenough, Nigel Lyman, David A. Roberts, Juan Moreno-Navas and J. Murray Roberts
In-situ characterisation of habitats adjoining cold-water coral reefs using a Sediment Profile Imagery (SPI) camera

John A. Barth, Francis Chan and Stephen D. Pierce
Understanding and predicting hypoxia over the Pacific Northwest continental shelf

Yvette H. Spitz and Harold P. Batchelder
Oregon shelf oxygen dynamics and exchange with the deep ocean: A modeling approach

Curtis Deutsch and Aaron Ferrel (Invited)
Metabolic constraints on marine habitat and its climatic change

Brad A. Seibel (Invited)
Existing oxygen levels are the critical oxygen levels

Angelica Peña and William Crawford
Trends in oxygen concentrations in the Gulf of Alaska and British Columbia waters

Yukihiro Nojiri, Sayaka Yasunaka, Shinichiro Nakaoka, Tsuneo Ono, Hitoshi Mukai and Norihisa Usui
Variability of carbon cycle and biological production in the North Pacific estimated from mapping of pCO_2, alkalinity, and dissolved inorganic carbon

Keith B. Rodgers, Masao Ishii, Daniele Iudicone, and Olivier Aumont, Matthew C. Long and Joan A. Kleypas
Re-emergence of anthropogenic carbon and pacific warm pool acidification

Finlay Scott, Ruth Parker and Silvana N.R. Birchenough
Predicting the regional impacts of ocean acidification: Integrating sediment biodiversity and ecosystem function

J. Anthony Koslow, Peter Davison and Ana Lara-Lopez
The influence of declining oxygen concentrations and mesopelagic fish biomass on ecosystem structure in the California Current

Julie E. Keister, Anna McLaskey, Lisa Raatikainen, Shallin Busch, Amanda Winans and Paul McElhany
Oxygen and pH conditions experienced by zooplankton in a North Pacific fjord: Impacts on taxonomic composition, distributions, and growth

Poster presentations

Toshiya Nakano, Takashi Midorikawa, Tomoyuki Kitamura, Yusuke Takatani, Kazutaka Enyo, Masao Ishii and Hisayuki Y. Inoue
Recent slowdown of wintertime oceanic pCO_2 increase in the western North Pacific: Relationship to variation in the subtropical gyre

Yusuke Takatani, Daisuke Sasano, Toshiya Nakano, Takashi Midorikawa and Masao Ishii
Decrease of dissolved oxygen due to warming and other factors in the western North Pacific subtropical gyre

Naohiro Kosugi, Daisuke Sasano, Masao Ishii, Kazutaka Enyo, Toshiya Nakano and Takashi Midorikawa
Acidification in the North Pacific subtropical mode water and its relation with climate variability

Sébastien Putzeys, Carlos Almeida, Pierrick Bécognée, Lidia Yebra, Ángeles Marrero Diaz and Santiago Hernández-León
Active carbon flux by diel migrant zooplankton in the eutrophic and oligotrophic waters of the Canary Current

Toru Suzuki, Masao Ishii, Tsuneo Ono, Takeshi Kawano, Masahide Wakita, Lisa A. Miller, Akihiko Murata, Ken-ichi Sasaki, James Christian and Robert M. Key
PACIFICA: Pacific Ocean Interior Carbon Data Synthesis

BIO Paper Session

Co-Conveners: *Michael Dagg (USA), Hiroaki Saito (Japan) and Atsushi Tsuda (Japan)*

Background

The Biological Oceanography Committee (BIO) has a wide range of interests spanning from molecular to global scales. BIO targets all organisms living in the marine environment including bacteria, phytoplankton, zooplankton, micronekton, benthos and marine birds and mammals. In this session, we welcomed all papers on biological aspects of marine science in the PICES region. Contributions from the early career scientists were especially encouraged.

Summary of presentations

The BIO Paper Session at PICES-2012 had high participation, with a total of 18 oral presentations and 31 poster presentations. Oral sessions were divided over two days and were well attended. This session was very popular this year. Oral presentations spanned a wide range of biological issues focusing around microbes (1), phytoplankton (1), zooplankton (7), jellyfish (2), micronekton (1), benthos (1), marine birds and mammals (3), and other issues (2). Similarly, poster presentations covered a broad spectrum of biological topics. The convenors recognized that this regular session provides important opportunities for PICES scientists to present their results and for early career scientists to participate in PICES activities.

List of papers

Oral presentations

John R. Bower, Katsunori Seki, Tsunemi Kubodera, Jun Yamamoto and Takahiro Nobetsu
Egg brooding in a gonatid squid off the Shiretoko Peninsula, Hokkaido, Japan

Oh Youn Kwon, Jung-Hoon Kang, Kyun-Woo Lee, Woong-Seo Kim and Jin Hwan Lee
Size-fractionated phytoplankton biomass and species composition in the Yellow Sea: A comparison of different latitudes in spring and summer

Hidefumi Fujioka, Atsushi Tsuda and Ryuji J. Machida
Early life cycle of *Neocalanus plumchrus* and *Neocalanus flemingeri* in the Oyashio region, western north Pacific

Yuichiro Nishibe, Kazutaka Takahashi, Tadafumi Ichikawa, Kiyotaka Hidaka, Hiroaki Kurogi, Kyohei Segawa and Hiroaki Saito
Feeding of oncaeid copepods on discarded appendicularian houses

Minkyung Shin, Wongyu Park and Jungwha Choi
Population dynamics of *Oithona similis* off Busan, South Korea

C. Tracy Shaw, Leah R. Feinberg and William T. Peterson
Effects of environmental changes on the euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA

Rui Saito, Atsushi Yamaguchi, Hiromichi Ueno, Hiroji Onishi and Ichiro Imai
Interannual variations in the zooplankton community in the Alaskan Stream region during the summer of 2004-2010

Akash R. Sastri, John Nelson and Beatrix E. Beisner
Spatial patterns of zooplankton community productivity and functional trait diversity in the Bering and Chukchi Seas

Jarrod A. Santora, John C. Field, Isaac D. Schroeder, Keith Sakuma, Brian K. Wells and William J. Sydeman
Spatial ecology of krill, micronekton and top predators in the central California Current: implications for defining ecologically important areas

Vjacheslav S. Labay
Long-term variability of sublittoral macrobenthos of the Sakhalin's shelf of Tatar Strait (Sea of Japan)

Harold P. Batchelder
Spatial-temporal patterns of residence-time, transport and connectivity among near-shore marine reserves on the Oregon shelf from particle-tracking using inputs from multiple physical models

Yongjiu Xu, Joji Ishizaka and Hisashi Yamaguchi
Interannual variation of jellyfish (*Nemopilema nomurai*) abundance and magnitude, and timing of phytoplankton bloom in the Yellow and East China Seas

Koji Hamasaki, Akiko Tomaru, Akito Taniguchi, Yuya Tada, Yasuyuki Nogata and Haruto Ishii
Microbial control of jellyfish larval settlement

Tabitha C.Y. Hui, Yumi Kobayashi, Yoko Mitani, Kei Fujii, Kei Hayashi and Kazushi Miyashita
Spatial, temporal and dietary overlap between harbour seals and fisheries in Erimo, Japan: Conflict at sea?

George L. Hunt, Jr. , Martin Renner and Kathy Kuletz
The composition and distribution of seabird communities across the southeastern Bering Sea shelf

Robert M. Suryan and Amanda J. Gladics
Effects of environmental variation on diets and stable isotope signatures of a piscivorous seabird in a coastal upwelling system

Andrew W. Trites, Elizabeth Atwood, Christopher Barger, Brian Battaile, Kelly J. Benoit-Bird, Ine Dorresteijn, Scott Heppell, Brian Hoover, David Irons, Nathan Jones, Alexander Kitaysky, Kathy Kuletz, Chad Nordstrom, Rosana Paredes, Heather Renner, Daniel Roby and Rebecca Young
Is it food? A comparative analysis of increasing and decreasing populations of thick-billed murres, black-legged kittiwakes and northern fur seals in the eastern Bering Sea

Peter A. Thompson, Anya Waite and Lynnath Beckley
Investigating the recruitment failure of Australia's western rock lobster (*Panulirus cygnus*)

Poster presentations

Yuji Tomaru and Yoshitake Takao
Diversities of diatom viruses isolated from Japanese coastal waters

Anastasia S. Dolganova
Far eastern seas benthos and its investigation in TINRO-Centre (2002-2012)

Toru Kobari, Minoru Kitamura and Makio C. Honda
Seasonal changes in abundance, stage composition and depth distribution of *Neocalanus* copepods in the Western Subarctic Gyre

Chiyuki Sassa and Yuichi Hirota
Seasonal occurrence of mesopelagic fish larvae in the onshore side of the Kuroshio off southern Japan

Young-Ok Kim, Seung Won Jung and Eun-Sun Lee
Effects of oil pollution on attached microbial communities in short-term indoor microcosms

Seung Won Jung, Young-Ok Kim, Jung-Hoon Kang, Moonkoo Kim and Won Joon Shim
Impact of dispersant plus crude oil on natural plankton assemblages in short-term marine mesocosms

Kyun-Woo Lee, Chang Kyu Joo, Jung-Hoon Kang, Oh-Yoon Kown and Won Joon Shim
Acute and chronic toxicity of the water accommodated fraction (WAF) and chemically enhanced WAF (CEWAF) of crude oil in the rock pool copepod *Tigriopus japonicus*

Elena Dulepova and Vladimir Dulepov
Carrying capacity of the Okhotsk Sea pelagic ecosystem

Ludmila S. Belan, Tatyana Belan, Boris Borisov, Alexander Moshchenko and Tatyana Konovalova
Distribution of macrozoobenthos along the pipeline route at the Lunskoye field (NE Sakhalin Island Shelf)

Seung Ho Baek, Moon Ho Shon and Won Joon Shim
Effects of the chemically-enhanced water-accommodated fraction of Iranian Heavy Crude oil on the periphytic microbial communities in microcosm experiments

Vladimir P. Korchagin, Olga Grunina, Alexander Dubov and Olga N. Vakulenko
Bioconversion of algae biomass into bioethanol using homogenate from marine invertebrate digestive organs

Rie Nakamura, Toru Kobari, Kazuyuki Tanabe, Minoru Kitamura and Makio C. Honda
Comparison of seasonal changes in the mesozooplankton community between the subtropical and subarctic North Pacific Ocean

Liudmila Dolmatova and Olga Zaika
Temporal variations in activities of antioxidant enzymes in coelomic fluid of the holothurian *Eupentacta fraudatrix* in Alexeev Bay (Peter the Great Bay), Sea of Japan

Kiyotaka Hidaka, Takumi Nonomura, Kosei Komatsu, Sachihiko Itoh, Ichiro Yasuda, Toru Ikeya and Shingo Kimura
Distribution of calanoid copepods of the genus *Paracalanus* around the Izu Ridge, south of Japan, and extent of the 'island mass effect' in the region

Hirotada Moki, Akira Okuno and Tatsuro Watanabe
Development of a new ocean carbon cycle model for the Japan Sea

Corinne Pomerleau, Francis Juanes, Rodney Rountree and Kate Moran
A comparative study of sound production in two marine environments monitored by the NEPTUNE Canada undersea observatory network

Kate Moran, S. Kim Juniper and Corinne Pomerleau
The Two Ocean Networks Canada (ONC) undersea observatory networks: NEPTUNE Canada and VENUS

William J. Sydeman, Jarrod A. Santora, Jason Hassrick, Marcel Losekoot, Sean Hayes and William T. Peterson
Canyonlands: Krill "hotspots" of the northern California Current

Naoya Kanna, Koji Suzuki, Aiko Murayama and Jun Nishioka
Bioavailability of sea ice-derived iron for phytoplankton growth

Natsuko Nakayama, Shinichi Kondo, Reiko Nakao, Yasuhiro Shima, Naotsugu Hata, Yuji Tomaru, Masami Hamaguchi, Keizo Nagasaki and Shigeru Itakura
Contribution of HcRNAV viruses against *Heterocapsa circularisquama* bloom by inoculating frozen sediment

Sayaka Sogawa (nee Matsumura), Hiroya Sugisaki and Tomohiko Kikuchi
Carbon and nitrogen isotope ratios of euphausiids in the northwestern Pacific

Yoshiyuki Abe, Masafumi Natsuike, Kohei Matsuno, Atsushi Yamaguchi and Ichiro Imai
Variability in assimilation efficiency of the copepod *Neocalanus cristatus*: Effect of food

John R. Bower, Yusuke Okude, Tetsuya Nishikawa and Kazutaka Miyahara
Movement of diamond squid in the Sea of Japan revealed using pop-up satellite tags

Shinji Shimode Kazutaka Takahashi and Atsushi Tsuda
Ontogenetic vertical migration of two tropical-subtropical copepods, *Rhincalanus nasutus* and *Rhincalanus rostrifrons*, in the northwestern Pacific Ocean: Implication for a variety of life history strategies of *Rhincalanus*

Toru Kobari, Keisuke Unno, Haruka Nagafuku, Hajime Kawakami, Minoru Kitamura and Makio C. Honda
Comparisons of fecal pellet characteristics in the surface layers between the subarctic and subtropical North Pacific Ocean

Hironori Higashi, Hiroshi Koshikawa, Wang Qinxue, Motoyuki Mizuochi, Toru Hasegawa, Yoko Kiyomoto, Kou Nishiuchi, Kazumaro Okamura, Hiroaki Sasaki, Yasushi Gomi, Hideki Akiyama, Kunio Kohata and Shogo Murakami
A numerical study on predominance of dinoflagellates on the central continental shelf of the East China Sea

Yuri V. Prikhodko, Vasiliy Yu. Tsygankov and Margarita D. Boyarova
Pesticides and seafood safety in the Russian fish market

Wang Lijun
Introduced marine species and their impacts in China seas

Konstantin A. Karyakin, Alexander A. Nikitin and Oleg N. Katugin
Distribution Patterns of the Common Squid (*Todarodes pacificus*) in the Russian EEZ in 2009-2011

Shinichi Watanabe, Satoshi Morinobu and Norimichi Souji
Daily and seasonal activity patterns of horseshoe crabs in the Kasaoka Bay estuary, Seto-Inland Sea, Japan

FIS Paper Session

Co-convenors: *Elizabeth Logerwell (USA) and Xianshi Jin (China)*

Background

This session invited papers addressing general topics in fishery science and fisheries oceanography in the North Pacific and its marginal seas, except those covered by Topic Sessions sponsored by the Fishery Science Committee (FIS).

Summary of presentations

The session consisted of 13 oral presentations and 15 posters that covered a wide variety of species and topics from all six PICES member countries. Oral presentations were given during the morning and afternoon of October 18. In the morning were two talks on the Japanese squid fishery, one on fishery income fluctuation due to changing vessel speed and one on spatial modeling of potential fishing zones. There was also a talk on comparison of fish community and trophic structure from three Japanese marine ecosystems, the Tsushima, Kuroshio and Oyashio. A talk on the role of oceanographic features (Lagrangian coherent structures) for detecting Pacific saury fishing grounds was also presented in the morning. After the morning coffee break there were two talks on cartilaginous fishes of the North Pacific, the spotted ratfish and the spiny dogfish. The spiny dogfish talk was on demographic and risk analysis and the spotted ratfish presentation was on age, growth and maturity estimates. Following these two talks were two presentations on Bering Sea fisheries. The first was on using acoustic data collected opportunistically from fishing vessels to estimate location and scale-specific fishing exploitation rates of walleye pollock. The second was on climate change and fisher behavior in the walleye pollock trawl and Pacific cod longline fisheries. The last talk of the morning was a broad-scale presentation on understanding pelagic ecosystem dynamics in the central North Pacific from a size-based perspective. In the afternoon a talk on the growth and survival of juvenile Japanese anchovy in the Kuroshio-Oyashio transitional regions was given. There was also a presentation on interannual variability in large-scale hydrometeorological processes and the potential impact on the migration routes of herring and blue whiting in the Atlantic Ocean and walleye pollock in the Pacific Ocean. Another talk was given on the relationship between habitat conditions and distribution, growth and mortality of jack mackerel in the southern East China Sea. The session concluded with a presentation on a simulation modeling study of the changes in fish phenotypic traits induced by trawl selectivity. The poster session covered a broad range of fishery science topics including population structure, reproductive biology, life history dynamics, juvenile dispersal, spatio-temporal distribution patterns, stable isotopes, oceanographic characteristics of fishing grounds, community structure, ecosystem-based assessment, impacts of underwater vessel noise, and fishery conservation status.

List of papers

Oral presentations

Yongjun Tian, Kazuhisa Uchikawa and Yuji Ueda
A comparison of fish community and trophic structure from three marine ecosystems around Japan: Synchronies, differences and environmental forcing

Osamu Tamaru, Kazushi Miyashita, Nobuo Kimura, Yasuzumi Fujimori, Toshihiro Watanabe, Hideo Takahara and Teisuke Miura
Fishery income fluctuation due to changing vessel speed from harbor to the fishing ground in the Japanese coastal squid jigging fishery

Xun Zhang, Sei-Ichi Saitoh and Toru Hirawake
Spatial modeling of the potential fishing zone of Japanese common squid in coastal waters of southwestern Hokkaido, Japan

Sergey V. Prants, M.V. Budyansky and M.Yu. Uleysky
Lagrangian coherent structures in the ocean favourable for fishing grounds

Cindy A. Tribuzio and Gordon H. Kruse
Demographic and risk analyses of spiny dogfish in the Gulf of Alaska

Jacquelynne R. King and Romney P. McPhie
Age, growth and maturity estimates of spotted ratfish (*Hydrolagus colliei*) in British Columbia

Alan C. Haynie and Lisa Pfeiffer
Climate change and fisher behavior in the Bering Sea pollock trawl and Pacific cod longline fisheries

Jeffrey Polovina and Phoebe Woodworth-Jefcoats
Understanding ecosystem dynamics in the central North Pacific pelagic ecosystem from a size-based perspective

Steven J. Barbeaux, John Horne and Jim Ianelli
A novel approach for estimating location and scale-specific fishing exploitation rates of eastern Bering Sea walleye pollock (*Theragra chalcogramma*)

Kai Zhang, Yoshiro Watanabe, Hiroshi Kubota, Atsushi Kawabata and Tomohiko Kawamura
Growth and survival of juvenile Japanese anchovy *Engraulis japonicus* in the Kuroshio-Oyashio transitional regions in 2010

Pavel Chernyshkov
Interannual variability of large-scale hydrometeorological processes in the northern parts of the Pacific and Atlantic Oceans and their probable impact on commercial fish migrations

Chiyuki Sassa, Motomitsu Takahashi, Kou Nishiuchi and Youichi Tsukamoto
Distribution, growth, and mortality of larval jack mackerel *Trachurus japonicus* in the southern East China Sea in response to habitat conditions

Peng Sun, Zhenlin Liang, Liuyi Huang and Xin He
Changes in fish phenotypic traits induced by trawl selectivity

Poster presentations

Pavel Mikheev
Relationships between Pacific salmon and residential fish in the Amur River basin

Svetlana Yu. Kordicheva, Alexei M. Orlov, Alexander A. Volkov, Pavel K. Afanasiev and Eugeny G. Shaikhaev
Preliminary results of the study of sablefish population structure within the Russian waters using DNA-markers

Wen-Bin Huang, Chih-Shin Chen and Wei-Ting Hsu
The spatio-temporal pattern of Pacific saury *Cololabis saira* abundance in the Northwestern Pacific

Yu-xue Qin, Ryo Koyama, Yosuke Koshino, Hideaki Kudo, Shigehiko Urawa and Masahide Kaeriyama
Spatiotemporal change in carbon and nitrogen stable isotopes of chum salmon during developmental

Eugene V. Samko and Nafanail V. Bulatov
The role of a warm anticyclonic eddy at Hokkaido (North-West Pacific) in the formation of saury fishing grounds

Indah Puspitasari and Chulwoong Oh
Population structure and reproductive biology of the lake prawn *Palaemon paucidens* (Caridea, Palaemonidae) from Goesan Lake, Korea

Oleg Ivanov
Nekton species structure in the Far East Seas and adjacent waters of the Pacific Ocean in 1980-2009

Ming-Ming Zhang, Chulwoong Oh, Wan-Ok Lee and Kyung-Jun Song
Reproductive biology of the largemouth bass, *Micropterus salmoides* from Goe-san Lake, Korea

Ming-Ming Zhang, Chulwoong Oh, Wan-Ok Lee and Kyung-Jun Song
Age and growth of the catfish *Pelteobagrus fulvidraco* in Goe-san Lake, Korea

Youjung Kwon and Chang Ik Zhang
An ecosystem-based assessment and management system in Korean waters

Hiroshi Kuroda, Takashi Setou, Kazuhiro Aoki, Yoshitsugu Hagiwara and Hiroko Akabane
A numerical study of "shirasu" fishing ground formation based on the Kuroshio submesoscale model, south of Japan

Atsushi Tawa, Taku Yoshimura and Noritaka Mochioka
High dispersal of moray eel larvae to the open ocean: Early life history estimated from ocean-wide distribution patterns

Michail Kuznetsov
The influence of underwater vessel noise on fish behaviour and methods of its reduction

Graham E. Gillespie, Tammy Norgard, Sean MacConnachie, Lily Stanton and Jessica Finney
Program to assess the conservation status of the Olympia oyster, *Ostrea lurida*, in Canada

Hideki Nakano
International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

POC Paper Session

Co-convenors: *Kyung-Il Chang (Korea) and Michael Foreman (Canada)*

Background

Papers were invited on all aspects of physical oceanography and climate in the North Pacific and its marginal seas, except those covered by POC-sponsored Topic Sessions.

List of papers

Oral presentations

Makoto Kashiwai
TσV analysis on watermass processes in the Sea of Okhotsk

Yohei Takano, Taka Ito and Curtis Deutsch
High-frequency variability of dissolved oxygen in the subpolar North Pacific

Michael Foreman, Wendy Callendar, Diane Masson, John Morrison and Isaak Fain
An update on the IOS regional climate model for the British Columbia continental shelf

Evgeny Vyazilov, Evgeny Uraevsky, Igor Rostov, Natalia Rudykh, Vladimir Rostov, Elena Dmitrieva and Andrey Golik
Far Eastern segment of the Unified State System of Information on the World Ocean (ESIMO)

Jae-Hun Park, Hanna Na, D. Randolph Watts, Kathleen A. Donohue and Ho Jin Lee
Near 13-day barotropic ocean response to atmospheric forcing in the North Pacific

Hiroyuki Tsujino, Shiro Nishikawa, Kei Sakamoto, Norihisa Usui, Hideyuki Nakano and Goro Yamanaka
Effects of large-scale wind variation on the Kuroshio path south of Japan in a 60-year historical GCM simulation

Olga Trusenkova
Intraseasonal SST oscillations in the Japan/East Sea

Jun-pen Zhang and Rong-shuo Cai
Modeling the East China Sea Cold Eddy responses to the inter-decadal climatic jump of the East Asian monsoon around 1976/77

Viktor Kuzin, Gennady Platov and Elena Golubeva
Influence of interannual variations of Siberian river discharge on the redistribution of freshwater in the Arctic Ocean

Vadim Navrotsky and Elena Pavlova
Biological effects of internal waves in coastal waters

Keiichi Yamazaki, Yujiro Kitade, Yosuke Igeta and Tatsuro Watanabe
Time variations of large amplitude near-inertial internal waves induced by typhoon observed around the Tango Peninsula, Japan

Takahiro Tanaka, Ichiro Yasuda, Kenshi Kuma and Jun Nishioka
Vertical turbulent iron flux sustains the Green Belt along the shelf break in the southeastern Bering Sea

Fangli Qiao and Chuan Jiang Huang
Comparison between vertical shear mixing and surface wave-induced mixing in the extra-tropical ocean

Young-Gyu Park, Jae-Hun Park, Ho Jin Lee, Hong Sik Min and Seon-Dong Kim
The effects of geothermal heating on the East Sea circulation

Andrey G. Andreev and Igor A. Zhabin
Origin of the mesoscale eddies and year-to-year changes of the chlorophyll *a* concentration in the Kuril Basin of the Okhotsk Sea

Aigo Takeshige, Tetsuya Takahashi, Hideaki Nakata and Shingo Kimura
Long-term trends in seawater temperature in Omura Bay, Japan

Masanori Konda, Tamami Ono, Kazuyuki Uehara, Kunio Kutsuwada, Osamu Tsukamoto, Fumiyoshi Kondo and Naoto Iwasaka
Ocean mixing layer variation as indicated by the measurement of the dissipation rate in the Kuroshio Extension region

Poster presentations

Igor Rostov, Vladimir Rostov, Natalia Rudykh, Elena Dmitrieva and Andrey Golik
Components of oceanographic and marine environment management information support in the Far Eastern region of Russia

Valentina V. Moroz
Thermohaline structure peculiarities formed by tides in the Kuril Straits archipelago and adjacent areas

Valentina V. Moroz
Thermohaline structure peculiarities formed in the Kuril Islands area and climate change

Yosuke Igeta, Tatsuro Watanabe, Akira Okuno and Naoto Honda
Strong coastal currents associated with winter monsoon around the Noto Peninsula, Japan

Sachihiko Itoh, Ichiro Yasuda, Masahiro Yagi, Satoshi Osafune, Hitoshi Kaneko, Jun Nishioka, Takeshi Nakatsuka and Yuri N. Volkov
Strong vertical mixing in the Urup Strait, Kuril Islands

Hiroshi Kuroda, Daisuke Takahashi, Takashi Setou, Tomonori Azumaya and Humio Mitsudera
Hindcast experiment for the Okhotsk Sea using the sea-ice-coupled Regional Ocean Modeling System

Tatsuro Watanabe and Koji Kakinoki
Interannual variation in the volume transport through the Sado Strait in the Japan Sea

BIO Workshop (W1)

Identifying critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts

Co-Convenors: *Jennifer Boldt (Canada), Vladimir Kulik (Russia), Chaolun Li (China), Jameal Samhouri (USA), Motomitsu Takahashi (Japan) and Chang-Ik Zhang (Korea)*

Background

Multiple natural and human stressors on marine ecosystems are common throughout the North Pacific, and may act synergistically to change ecosystem structure, function and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region, and over time. This workshop seeks to understand responses of various marine ecosystems to multiple stressors, and to identify and characterize critical stressors in PICES regional ecosystems including appropriate indicators of their impacts. The goal is to help determine how ecosystems might change in the future and to identify ecosystems that may be vulnerable to the combined impacts of natural and anthropogenic forcing. Contributions are invited which identify and characterize the spatial and temporal extent of critical stressors in marine ecosystems (both coastal and offshore regions) of PICES member countries, and in particular the locations at which multiple stressors interact. Contributions will include a review and identification of broad categories of indicators which document the status and trends of ecosystem change at the most appropriate spatial scale (*e.g.*, coastal, regional, basin) in response to these multiple stressors. This workshop is linked with the Topic Session titled "*Ecosystem responses to multiple stressors in the North Pacific*" but is designed to provide more in-depth examination and discussion of the spatial and temporal extents of critical marine ecosystem stressors and their potential indicators. It will assist with progress towards the goals of PICES WG 28 on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors.

Summary of Workshop

The BIO Workshop (W1) was held on Friday, October 12, 2012 (full day), and was launched with a talk by invited speaker, Dr. Natalie Ban (Australian Research Council Centre of Excellence for Coral Reef Studies, Australia) and included 6 other oral presentations.: Olga Lukyanova (TINRO-Centre, Russia), Stephani Zador (NMFS, USA), Christopher Mulanda Aura (Hokkaido University, Japan), Elliott Hazen (University of Hawaii and NMFS, USA), Jameal Samhouri (NMFS, USA), and Jennifer Boldt (Fisheries and Oceans Canada). In addition, there were general discussions after the morning presentations, and in-depth discussions in the afternoon.

Workshop presentations and discussion focused on three apparent approaches to evaluating stressors: (1) expert-based surveys, (2) model-based analyses, and (3) empirical/data based analyses.

The invited presentation was given by Dr. Ban who provided a view of cumulative human impacts in the marine environment, using an expert-based survey approach as well as combinations of all approaches. Utilizing the empirical analyses approach, Dr. Lukyanova introduced her research showing that eggs, embryos and larvae of marine fish and echinoderms may be used as bioindicators of early disturbances due to multiple stressor interactions in vulnerable ecosystems, in particular from hydrocarbons in water. Dr. Zador (presented by Ms. Patricia Livingston) summarized indicator-based ecosystem assessments in the Bering Sea and Aleutian Islands regions, utilizing a team-based approach, thereby addressing the expert-based survey approach. Three broad conclusions from this study were provided: (1) the physiological and biological nature of the ecosystem, the extent of scientific knowledge about the ecosystem, and the particular expertise of team members will influence the final assessment product; (2) team discussion of assessment structuring themes should occur before indicator selection, and (3) developing assessments should be an iterative process with frequent review by fisheries managers. Dr. Aura's presentation highlighted a model-based approach to evaluating stressors and features suitable for aquaculture sites in northern Japan. Dr. Aura's research included the development of a site suitability model, conducted using geographic information system (GIS)-based, multi-criteria evaluation (MCE) with weighted linear combinations to assess suitable scallop culture sites. For scallop culture, requisite biophysical (sea temperature, chlorophyll-*a*, secchi disk depth and bathymetry) and social infrastructure (distance to pier and town) parameters formed thematic layers that were limited by a constraint layer, and results were consistent with existing scallop culture locations. Dr. Hazen's presentation focused on the data-based analytical approach. He developed a quantitative indicator selection framework by looking for composite indices and links between pressure and state variables for the California Current region. Dr. Samhouri highlighted expert-based survey approaches to evaluating stressors. He compared and contrasted results from multiple efforts to elicit the opinions of regional experts about the vulnerability of coastal habitats along the U.S. west coast. These assessments encompass stressors as varied as pollution, climate change, invasive species, and overharvest in relationship to habitats from rocky shorelines and sandy beaches to the deep sea. Dr. Aseeva's presentation highlighted a data-based analytical approach to evaluating environmental stressors that explain fluctuations in flounder species composition on the shelf of West Kamchatka. Dr. Boldt gave an overview of the Indicators for the Seas 2 (IndiSeas2) research program, which uses all three approaches (data-based, model-based, and expert surveys) to evaluating stressors. The goal of IndiSeas2 is to evaluate the status of marine ecosystems in a changing world using a suite of indicators that reflect effects of multiple drivers on the states and trends of exploited marine ecosystems.

Morning Discussion

During the discussion after the morning presentations, workshop participants discussed the pros and cons of the three alternative approaches for evaluating stressors: (1) expert elicitation, (2) model-based simulation, and (3) empirical analysis (Table 1), as well as a general discussion on indicators.

Main discussion points:

- Some pros and cons derived from the presentations were listed by the group. There was general agreement that, despite pros and cons of each approach (Table 1), there is a need to use multiple approaches due to data availability and, where data are available, constraints and assumptions of analyses, *e.g.*, the constraint that

Principal Components Analyses represent only linear relationships, and that most approaches conducted to date of the impacts of multiple stressors assume their effects to be additive.

- The pros and cons of the three approaches depend on the objectives. For example, is the objective to know the state of ecosystems or to identify management interventions? WG 28 is looking at the state of ecosystems and ecosystem responses; linking that to management actions could be a next step.
- The selection of indicators and stressors will be affected by the behaviour of species and ecosystem properties (surroundings and hydrodynamics).
- The goal of WG 28 is not to forecast future indicator responses, but rather, to choose indicators (or at minimum to develop a process for choosing indicators of ecosystem responses to multiple stressors) that will be of interest in the future. One goal of WG 28 is to understand if ecosystems are responding to human activities (and climate), so that management actions can control human impacts. Separating human and climate effects is very difficult; can we identify indicators of interactions (*e.g.*, fishing and climate) that will help us identify deteriorating ecosystem conditions?

Table 1. Some pros and cons of three alternative approaches for evaluating stressors: (1) expert elicitation, (2) model-based simulation, and (3) empirical analysis.

Approach	Pros	Cons
Expert elicitation	Solution to the no data problem	Difficult to validate responses
	Appropriate for global and regional visualization	
Empirical analysis	Track emerging stressors where expert input is untested or models are unavailable	Difficult to find data at appropriate scales
	Appropriate indicators can be tailored to the physical and biological nature of ecosystem	Least common denominator issue (shortest time series, smallest common spatial domain)
	Remotely sensed data available for many physical variables	
Model based analyses	Can generate as much data as you need	Must have a model
	Can create an ensemble of models using different frameworks	Outputs are only as good as the data that go into the model

Afternoon discussion

After presentations in the afternoon, workshop participants discussed and compared indicators that are used in different regions to characterize the spatial and temporal extents of critical stressors and understand responses of ecosystems to multiple stressors.

Main discussion points:

- There was acknowledgement that indicators are collected and used for varying temporal and spatial scales, thereby making it difficult to combine indicators. One solution is to leave indicators disaggregated and ensure discussions around the indicator responses are framed within the varying response-times (and scales). Composite indices need to preserve enough information so that the driving factors of index variability are understood. Another related point raised was that what we see is how ecosystems respond to multiple stressors, and as part of our analyses we attempt to separate these responses into effects of individual stressors. We may not need to disaggregate individual effects of each stressor in order to choose appropriate indicators of ecosystem responses; however, we will need to tease these effects apart if we want to ensure a process-based understanding that can be used for forecasting the future.

- The group then discussed and identified four groups of indicators, stressors, and activities: environmental, biological, human activities and stressors, and sociopolitical-economic. Broad categories of indicators were then listed for each of three of these groups (environmental, human activities and stressors, and sociopolitical-economic); this was *not* meant to represent a complete list, and could be supplemented with existing knowledge in the literature. For each country and each category of indicators (Table 2), member countries established the existence of data, and the temporal and spatial extent of the data (3 responses for each indicator). The tables were not filled out completely (indicators or data availability), but this could be a WG 28 activity. For the biological indicators, some information can be acquired from the work of PICES Working Group 19 on *Ecosystem-based Management Science and its Application to the North Pacific*, in their Ecosystem-Based Fisheries Management 2010 report (PICES Scientific Report 37, Table 3.1.3). Note that this table would not include information about data availability for habitats.

Table 2. Some broad-scale indicators identified in the workshop to address three main categories (environmental, human activities and stressors, and sociopolitical-economic). The tables were not filled out completely, but this could be a WG 28 activity. Biological indicator information can be acquired from the EBFM 2010 PICES Scientific Report 37, Table 3.1.3. Each cell contains three responses for the existance of data, availability of time series data, and spatial extent of data. Y = Yes, N = No, S = Some, N/A = Not applicable

Indicators, Activities, and Stressors	Canada	Japan	Russia	U.S.A.	High Seas
Environmental stressors/indicators					
Temperature					
Sea Ice					
Chla					
Nutrients	Y,Y,N	Y,Y,S	Y,Y,N	Y,Y,N	
River discharge	Y,Y,Y	Y,Y,Y	S,Y,N	Y,Y,Y	N/A
Toxic contaminants	Y,N,N	Y,N,N	Y,N,N	Y,N,N	S,N,N
Large scale climate index (e.g., PDO, ENSO)					
pH	Y,N,N	Y,N,N	Y,N,N	Y,N,N	Y,N,N
Oxygen	Y,Y,N	Y,Y,S	Y,Y,N	Y,Y,N	
Human activities & stressors					
Fishing	Y,Y,Y	Y,Y,Y	Y,Y,Y	Y,Y,Y	S,S,S
Oil and Gas					
Military Activity	N,N,N	N,N,N	N,N,N	N,N,N	N,N,N
Wave/Wind/Tidal					
Shipping					
Coastal engineering	Y,S,S	Y,S,S	Y,N,S	Y,N,S	N/A
Aquaculture					
Ecotourism					
Land-based pollution					
Socio-economic-political					
Seafood demand					
Coastal population trends	Y,Y,Y	Y,Y,Y	?,?,?	Y,Y,Y	N/A
Marine Employment	S,Y,Y	Y,Y,Y	N?,N?,N?	S,Y,Y	S,S,S
Marine Revenue					
Marine exports/domestic consumption					
Participation/stakeholder involvement					
Governance					
Happiness					
Satisfaction with ocean status					
Community vulnerability					
Coastal infrastructure					

Recommendations

- Use multiple approaches (expert elicitation, model-based simulation, and empirical analysis) to identify and evaluate critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts.
- Finish filling out the tables with help from other PICES working groups, sections, and committees. For example, the Section on *Human Dimensions on Marine Ecosystems* could provide expertise on socio-economic indicators. The FIS and BIO committees could provide help on biological indicators and the MONITOR committee could provide expertise environmental indicators and stressors.
- A next step might be to identify the gaps in the tables and those that are important for which to get information.

List of papers

Oral presentations

Natalie C. Ban, Stephen S. Ban and Hussein M. Alidina (Invited)
Combining stressor information – Experiences from Canada's Pacific waters and Australia's Great Barrier Reef

Olga N. Lukyanova, Elena V. Zhuravel, Sergey A. Cherkashin, Denis N. Chulchekov, Viktor A. Nadtochyi and Olga V. Podgurskaya
Bioindicators of multiple stressors interaction in the North-Eastern shelf of Sakhalin Island (Sea of Okhotsk)

Stephani Zador, Kirstin Holsman, Sarah Gaichas and Kerim Aydin
Developing indicator-based ecosystem assessments for diverse marine ecosystems in Alaska

Christopher Mulanda Aura, Sei-Ichi Saitoh, Yang Liu and Toru Hirawake
Spatio-temporal model for mariculture suitability of Japanese scallop (*Mizuhopecten yessoensis*) in Funka and Mutsu Bays, Japan

Elliott L. Hazen, Jameal F. Samhouri, Isaac D. Schroeder, Brian K. Wells, Steven J. Bograd, David G. Foley, Nick Tolmieri, Phillip S. Levin, Greg Williams, Kelly Andrews, Sam McClatchie, William T. Peterson, Jay Peterson, Jessica Redfern, John C. Field, Ric Brodeur and Kurt Fresh
Ecosystem indicators for the California Current: A quantitative approach towards indicator development

Jameal F. Samhouri
Much ado about everything: Comparison of expert-based vulnerability assessments for coastal habitats along the U.S. west coast

Jennifer Boldt, Alida Bundy, Caihong Fu, Lynne Shannon and Yunne Shin
An overview of IndiSeas2: Evaluating the status of marine ecosystems in a changing world

Poster presentation

Nadezhda L. Aseeva
Reconstructions of flounder community on the shelf of West Kamchatka (Okhotsk Sea) under influence of environmental changes and interspecies relationships

BIO Workshop (W2)
Secondary production: Measurement methodology and its application on natural zooplankton community

Co-conveners: *Toru Kobari (Japan) and William Peterson (USA)*

Background

Zooplankton communities play important roles on the transfer of primary production to higher trophic levels of marine ecosystems. In the past two decades, the quantitative evaluation of the energy flow has been emphasized for better understanding how marine ecosystems respond to climate change and global warming. To date, primary production can be globally estimated with remote sensing techniques and validated with *in situ* experiments using radio or stable isotope. Although secondary production has been estimated with various methods (natural cohort, artificial cohort, molting rate, egg production, nucleic acids ratio, enzyme activity and empirical models), there is little information which method is relevant for natural zooplankton population or community. Thereby, we have little knowledge or confidence of secondary production measurements

compared with that of primary production. In this workshop, the intent was to review current methodologies to measure secondary production. Through published reports of secondary production on natural zooplankton population or community, this workshop aimed to clarify the assumptions, advantages and disadvantages for each method. New techniques (nucleic acids ratio, enzyme activity, chitobiase, or other methods) and challenges in the calibration between the estimates using different methods were also discussed.

Summary of Workshop

Throughout the oral presentations, we clarified not only advantages but also disadvantages of the current methodologies used to estimate zooplankton production of natural zooplankton populations or communities. More direct measurements on body mass would be recommended for those who use the traditional methods (such as the "molt rate"), while these methods are laborious and time-consuming and need special care to eliminate artifacts. Biochemical approaches would take advantages to the traditional methods due to the simple protocols and quick measurements, but they need some calibrations of the parameters to the direct measurements.

Before discussion, we confirmed consensus to specify the target group for production estimation because "secondary production" means sum of production for wide taxonomic groups. As a first issue to be discussed, we confirmed the necessity of writing a review paper on current methodologies for estimating zooplankton growth rate because it is very helpful for our prospective activities. Second, we agreed that we should propose a new working group on zooplankton production (including a workshop/symposium at the PICES 2014 annual meeting) to the BIO Committee before PICES-2013. In the working group we will conduct an exchange program to compare methodologies by cross-calibration of biochemical methods (Nucleic acids ratio, AARS, Chitobiase) of growth and validation against traditional methods (Direct growth, Molting rate, Egg production, Physiological rate). The value to PICES and FUTURE is as follows. Researchers involved with modeling and monitoring as well as scientists associated with BIO, FIS and MONITOR consider aspects of zooplankton biomass and species composition in their work, but little attention is given to "rates" of growth and production. Since "rates" are likely to be more sensitive to environmental change than "biomass", "rates" could be more sensitive to, and excellent early indicators of, environmental change than biomass alone. We suggest that both AP-COVE and AP-SOFE would be interested in incorporating a better understanding of zooplankton growth and production rates into (a) understanding of effects of climate variability on ecosystems (COVE) and (b) outlooks and ecosystem status (SOFE). A new PICES Working Group on Zooplankton Production would clarify (1) methods of measurements of rates, and (2) recommend a set of techniques that could be adopted by scientists of not only PICES but also ICES member countries.

Prospective activities

1. Make guidance to review advantages and disadvantages of the current methodologies for zooplankton production
2. Establish a PICES Working Group on Zooplankton Production.
3. Champion an international research program to compare methodologies (including proposal for funding)
4. Establish a cooperative network between PICES Working Group on Zooplankton Production and ICES Working Group on Zooplankton Ecology

Proposed Steering Committee for the proposed new Working Group
T. Kobari (KUFF), B.T. Peterson (NOAA), R. Escribano (IIO), L. Yebra (IEO), A. Sastri (UQAM), Hyung-Ku Kang (KIOST)

PICES-2012 Workshop (W2) (front row, from left) Lidia Yebra, Julie Keister, Rie Nakamura, Bill Peterson, Tracy Shaw, Pamela Hidalgo, Akash Sastri; (back row, from left) Hyung-Ku Kang, Keisuke Unno, Rubén Escribano, Atsuhiro Hirata, Sachi Miyake, Michael Dagg, Toru Kobari, Yasuhide Nakamura, and Jennifer Fisher

List of papers

Oral presentations

Lidia Yebra (Invited)
Biochemical indices of zooplankton production

Akash R. Sastri
Chitobiase-based measurements of crustacean zooplankton community biomass production rates: Method development and application in the NE subarctic Pacific

William T. Peterson, Jay Peterson and Jennifer L. Fisher
Use egg production of adult female copepods as a measure of secondary production

Hyung-Ku Kang
Secondary production of *Acartia steueri* and *A. omorii* (Copepoda: Calanoida) in a small bay, southeastern coast of Korea: The growth rate approach

Rubén Escribano and Pamela Hidalgo
Can temperature-dependent growth be used to measure secondary production of copepods in coastal upwelling systems?

Pamela Hidalgo and Rubén Escribano
The importance of rapid development to produce more biomass on a year cycle: Comparing some copepod species from the Humboldt Current

Yasuhide Nakamura, Atsushi Yamaguchi and Noritoshi Suzuki
Characteristics of zooplankton community in the Japan Sea: Biomass, stable isotope ratio and dominant taxa

Poster presentations

Lidia Yebra, Elisa Berdalet, Rodrigo Almeda, Verónica Pérez, Albert Calbet and Enric Saiz
AARS activity and RNA/DNA ratio as proxies for growth and fitness of *Oithona davisae* early developmental stages

Lidia Yebra, Sébastien Putzeys, Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado and Soluna Salles
Application of biochemical tools to assess zooplankton metabolism in the coastal North Alboran Sea (SW Mediterranean)

Toru Kobari, Shigeki Kori and Haruko Mori
Nucleic acids and protein contents as proxies for protein-specific growth of *Artemia salina*

Sachi Miyake and Toru Kobari
Nucleic acids and protein contents as proxies for starvation of marine copepods

Andrew G. Hirst, Julie E. Keister and numerous contributors
Assessing copepod growth rates using the Modified Moult Rate Method

BIO Workshop (W3)
The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions

Co-Convenors: *George Hunt, Jr. (USA), Hidehiro Kato (Japan) and Michael Seki (USA)*

Background

It has been 12 years since the publication of PICES Scientific Report No. 14 on "Predation by marine birds and mammals in the subarctic North Pacific Ocean" edited by Hunt, G.L. Jr., Kato, H., and McKinnell, S.M. This publication is the sole overview of the trophic requirements and trophic roles of marine birds and mammals for the North Pacific, and has been a much used reference by a wide variety of scientists including those interested in modeling the roles of marine birds and mammals. As of 2012, Google Scholar lists 49 citations of this report. In the 12 years since its publication, it has become rather considerably out of date. Our knowledge of the distribution and abundance of marine birds and mammals has advanced greatly, as has our knowledge of the food habits of a number of species. Additionally, there has been an increase in interest in the roles of large predatory fish in the world's oceans. Thus it would seem timely to provide an update of PICES Scientific Publication 14, and, if there is interest for it, to include information on prey consumption by large predatory fishes.

Workshop 3 tasks:
1. Review what has been learned about the distribution, abundance and prey habits of marine birds and marine mammals, and whether there have been sufficient advances to warrant conducting an update of PICES Scientific Report 14 *Predation by marine birds and mammals in the subarctic North Pacific Ocean*.
2. Explore the possibility of adding to a revision of PICES Scientific Report 14 information on prey consumption by large predatory fish.
3. Discuss and identify the mechanisms and sources of funding for conducting a new Report.
4. By the 2014 PICES Annual Meeting, provide a full report to the AP-MBM on the findings of Workshop 3.

Summary of Workshop

Workshop 3 met from 09:00 to 18:30 on October 12, 2012 in the Hiroshima. Fifteen scientists from three countries attended the workshop, and a few others dropped in for parts of the discussions. There were six presentations in the morning followed by discussions in the afternoon led by experts in the various taxonomic groups and regions. Presentations were accompanied by lively discussions, and all present participated in questioning the Presenters and Discussion Leaders.

From the presentations and discussions, it was clear that a great deal has been learned about the abundance and distribution of marine birds and marine mammals since the assembly of PICES Scientific Report 14. There is now far greater at-sea coverage of the distributions and abundance of marine birds and mammals than was available in the 1990s in both the eastern and western North Pacific Ocean. The breadth of seasonal coverage has also improved, at least in some areas, which will allow for the possibility of examining seasonal changes in prey consumption, and in developing information on the annual days of residency. It was also evident that in a few regions there were sufficient data to allow inter-decadal comparisons of the numbers of marine birds and mammals occupying a region. It was acknowledged that there should be a discussion of what the most

appropriate boundaries may be for calculation of prey consumption, and that that attention should be paid to quality control of the data used. An improvement over PICES Scientific Report 14 would be the inclusion of estimates of confidence intervals.

Overall, there appeared to be less progress in gaining new information on the prey habits of marine birds and mammals. However, particularly in the western North Pacific, there has been a significant improvement in our knowledge of prey use by marine mammals. Not unexpectedly, there was evidence of spatial and temporal variability in diets, which, in at least one case, was linked to inter-decadal changes in the stocks of commercially important fish.

The presentation and discussions of whether to include fish in a future overview of prey consumption by top predators centered on defining the goals of a future report and why the inclusion of fish might be important. It was agreed that understanding the roles and prey requirements of some of the most conspicuous top predatory fish could be useful in assessing their prey needs and the potential for competition among these fish and marine birds and mammals. Species that appeared to be most suitable for inclusion in an initial effort included bluefin tuna, albacore, one or two species of salmonids, blue shark, possibly salmon shark, and one or two gadids, such as walleye pollock and/or Pacific cod. Availability of data would be instrumental in the final determination of species to be included.

Decisions from the Workshop:

1. Workshop 3 participants agreed unanimously that it would be of value to update the information on prey consumption by marine birds and mammals throughout the PICES areas of the North Pacific Ocean where new data were available. This information would permit ecosystem modelers to account for prey consumption by marine birds and mammals more accurately than is presently possible. There was also recognition that an updated version of PICES Scientific Report 14 could facilitate the use of marine birds and mammals as indicators of ecosystem change in those regions in which sufficient data were available.

2. Workshop 3 participants agreed that it would be valuable to include a select group of large predatory fishes in the production of a new report on prey consumption by top predators. It was recognized that this could require a different approach than the regional approach used in PICES Scientific Report 14, as many of the fish species of interest are assessed on a basin-wide scale due to their highly migratory behavior.

3. Workshop 3 participants discussed the relative merits of seeking a formal working group under the auspices of the BIO and FIS committees, or of developing a less formal working group within the AP-MBM. It was agreed that the decision as to the framework for accomplishing a new report on prey consumption by marine birds, mammals and select fish species should be decided by the AP-MBM with due consideration for their ongoing commitments.

4. Workshop 3 participants agreed that suggestions for the leadership and potential membership of a new group assessing prey consumption should be made by the membership of the AP-MBM, once they have the opportunity to assess the ability to take on a new initiative and how it might fit within their plans for examining the spatial ecology of marine birds and mammals in the North Pacific.

5. Workshop participants agreed that there would be a need to devote considerable effort to assemble and integrate the wealth of new knowledge on the distribution and abundance of marine birds and mammals and their diets. These tasks were seen as requiring one or more dedicated scientists for at least two years and possibly three. Additionally resources would be required to assemble the required data on the biomass of the fish species of interest, their prey habits and their rates of prey consumption. The possibility of seeking support from the North Pacific Research Board and the U.S. National Science Foundation was discussed. Should the revision of PICES Scientific Report 14 go forward, the possibility of approaching ESSAS for support was discussed.

Acknowledgments

The Workshop Convenors thank PICES for support of an invited speaker, Gary Drew and Martin Renner for their expeditious work in preparing the North Pacific Pelagic Seabird Database and maps and tabulations of recent survey effort, and travel support for GLH from the IMBER Regional Program, Ecosystem Studies of Sub-Arctic Seas (ESSAS).

List of papers

Oral presentations

Robert J. Olson (Invited)
Data availability for estimating prey consumption by large pelagic fishes, particularly tunas, in the PICES region

Tsutomu Tamura and Kenji Konishi
Prey consumption and feeding habits of three baleen whale species in the western North Pacific

Kaoru Hattori, Yoko Goto, Mari Kobayashi and Orio Yamamura
Food habits of pinnipeds in Japanese waters: A review

Yutaka Watanuki
Diet study of seabirds breeding in Japan

Sayaka Nakatsuka, Daisuke Ochi, Yukiko Inoue, Kotaro Yokawa, Hiroshi Ohizumi, Yasuaki Niizuma and Hiroshi Minami
The food composition of Laysan and Black-footed Albatrosses in the North Pacific from 2010 to 2011

George L. Hunt, Jr. , Martin Renner, Kathy Kuletz, Gary Drew and John Piatt
Seabird numbers, days of occupancy, and prey habits in the Gulf of Alaska and the eastern Bering Sea

Mike Seki Lead
Discussion*:* Should we include fish, and if so, what species?

Yutaka Watanuke Lead
Discussion*:* How much can we add about seabirds in the Western Pacific?

George L. Hunt, Jr. Lead
Discussion: How much can we add about seabirds in the Eastern Pacific?

Hidehiro Kato Lead
Discussion*:* How much do we know about cetaceans in the Western Pacific?

Kaoru Hattori Lead
Discussion*:* How much do we know about pinnipeds in the Western Pacfic?

Rolf Ream Lead
Discussion*:* How much do we know about pinnipeds in the Eastern Pacfic?

Rolf Ream Lead
Discussion*:* How much do we know about cetaceans in the Eastern Pacific?

ESSAS/PICES Workshop Subarctic–Arctic interactions (W4)
Subarctic–Arctic interactions

Co-Convenors: *Kenneth Drinkwater (ESSAS/Norway), Jackie Grebmeier (ESSAS/USA), James Overland (PICES/USA) and Sei-Ichi Saitoh (PICES/Japan)*

Background

Exchanges of water masses and their associated flora and fauna strongly link the marine Arctic and the Subarctic. Both regions have undergone significant warming, and there has been reduced sea-ice in recent years in some regions. Climate change scenarios indicate that these regions are likely to experience even greater warming and transformation in the future. To better understand how climate variability and change will

affect these marine ecosystems from biogeochemical processes, through the food web to the highest tropic levels, it is essential to improve our knowledge of the role of physical and biological fluxes between the Subarctic and Arctic and the fate of the transported organisms. Therefore, this workshop examined the influence of the warm Subarctic inflows on the physical conditions and biology in the Arctic basin and shelves, as well as the role of fluxes of water from the Arctic basin onto the surrounding shallow shelves and into the Subarctic. Papers that cover multiple trophic levels or investigate biophysical coupling were especially sought. Also, presentations on the observed changes that are occurring as well as those on possible scenarios under climate change were encouraged. Emphasis will be on the Arctic-Pacific Ocean linkages but those considering the exchanges in the Atlantic were also welcome.

Summary of Workshop

This 1-day ESSAS (Ecosystem Studies of Sub-Arctic Seas)/PICES sponsored workshop consisted of 9 oral presentations and 2 posters and represented contributions from 4 different countries. Most of the talks and the 2 posters focused upon the Pacific-Arctic sector but there were also 2 talks that made comparisons between regions within the Pacific to the Atlantic sectors.

The workshop was told that the Bering Sea circulation structure is strongly sensitive to the wind direction, which is set by the relative positions of the Aleutian Low, the Siberian High and the Beaufort High. Southeasterly winds, especially in winter, produce a broad flow over the Bering Sea shelf that eventually flows through Bering Strait. In contrast, under northwesterly winds, much of the flow over the Bering Sea shelf is southward, away from the Bering Strait. At such times, the flow through the Bering Strait into the Arctic is derived from an intensification of the Anadyr Current, which delivers nutrient-rich waters into the Chukchi Sea. The ecology of the Chukchi Sea is also strongly influenced by advection from the Bering. Observations reveal abundant resting phytoplankton cells in the sediments in the northern Bering Sea during the winter. The majority rise towards the surface in the spring, initiating a spring bloom. However, some are believed to be advected into the Chukchi Sea, contributing to its spring bloom. Some resting cells of ice algae rise off the sediments in the late fall to be incorporated into the ice that forms. Zooplankton from the Bering Sea are advected through Bering Strait in most years, resulting in Pacific species dominating the region north of Bering Strait. In some years, this community structure stretches north of Lisburne Peninsula.

Another talk showed the importance of meso-scale eddies in the Canada Basin. High chlorophyll-*a* values were observed in these eddies, due to entrainment of high quantities of phytoplankton and nutrients from off the Beaufort Shelf. These eddies are a mechanism that transport primary production from the shelf into the Basin.

Comparisons of the reproductive strategies of walleye pollock and Arctic cod showed that the former spawns in 2–8ºC temperatures in the Bering Sea while the later spawns in 0–2ºC primarily in the Chukchi Sea. The hatching rate of pollock is temperature-dependent but not so for Arctic cod. Another presentation showed a general northward movement of fish species in the southeastern Bering Sea, mostly in response to local warming. Fish have also tended to shoal because of the replacement of cold pool water by warmer waters in the shallow depths. Distributional changes were driven mostly by changes in population density and secondly by temperature and along-shelf winds.

Spatially-explicit Distributed Biological Observatories (DBOs) have been established as a latitudinal “change detection array” that can track advection from the Bering Sea into the Chukchi Sea as well as the biological response to sea ice retreat and environmental change. International cooperation is resulting in multiple occupations in 5 different DBOs. Data indicate seasonal freshening and warming as Pacific seawater transits northward over the spring to fall season, with potential impacts on both plankton and benthos. Observations have also showed changes in benthic dominant macrofauna and biomass at benthic hotspots in the region.

The final two oral presentations dealt with comparative studies. The first compared the Chukchi and Barents seas. The main question being asked was why is fish production in the Barents Sea two orders of magnitude

larger than in the Chukchi Sea in spite of the fact that the estimated primary production is similar. The main conclusion was that the year-round inflow of warm Atlantic waters provide a refuge for boreal fish species even in winter in the Barents Sea, whereas in the Chukchi Sea the waters are too cold in winter to allow many fish to overwinter and do well there. Also, the generally colder waters in the Chukchi Sea limit the growth rates of those fish that inhabit its waters. The second paper compared the role of advection between the Arctic and the subarctic in the Pacific and Atlantic sectors. In the Pacific sector there is mainly a one-way, near surface flow through Bering Strait into the Arctic. In contrast, in the Atlantic sector there is a two-way exchange in Fram Strait with the warm Atlantic inflow being subsurface. Warm Pacific water has contributed to the increasing rate of Arctic ice melt but because of the subsurface inflow through Fram Strait, its effect on ice melt is greatly reduced. Large quantities of ice are exported through Fram Strait with accompanying ice biota but little to no ice from the Arctic leaves through the Bering Strait. Both gateways to the Arctic allow phytoplankton and zooplankton to be advected from the subarctic into the Arctic but few if any survive through the year.

Two poster contributions were also presented at the workshop. One compared the partial pressure of CO_2 in several regions from the Antarctic to the Arctic. Over approximately the last decade, the carbon sink has varied differently by region. There were increases in the Antarctic, a decline in the Taiwan Strait and relative stability in the Bering Basin, although with large variability in the Bering Slope region, on the Bering Shelf, and in the Chukchi Sea. The second poster described the Pacific Arctic Group, which is an international consortium that collaborates on scientific activities in the Arctic.

Discussion at the end of the session highlighted the need to further long-term observations, including flux measurements and the advection of fish larvae. In terms of modeling, increased effort is needed on dealing with sea ice and its variability. Finally, further comparative studies of the role of advection between the Arctic and subarctic was encouraged.

List of papers

Oral Presentations

Seth L. Danielson, Tom Weingartner, Kate Hedstrom, Knut Aagaard, Enrique N. Curchitser, Jinlun Zhang and Rebecca A. Woodgate (Invited)
The Bering Sea shelf circulation and its role in Pacific-Arctic exchanges

Ichiro Imai, Chiko Tsukazaki, Kohei Matsuno, Ken-Ichiro Ishii and Atsushi Yamaguchi (Invited)
Abundant distribution of diatom resting stage cells in bottom sediments of Bering Sea and Chuckchi Sea: Possible seed populations for blooms

Eiji Watanabe, Michio J. Kishi, Akio Ishida, Maki N. Aita and Takeshi Terui (Invited)
Biological hot spots emerging along the pathway of Pacific summer water in the western Beaufort Sea

Atsushi Yamaguchi, Rie Ohashi, Kohei Matsuno and Ichiro Imai
Interannual changes in the zooplankton community structure on the southeastern Bering Sea shelf and Chukchi Sea during summers of 1991–2009

Yasunori Sakurai, HaeKyun Yoo and Jun Yamamoto
A comparison of reproductive characteristics and strategies between walleye pollock (*Theragra chalcogramma*) and Arctic cod (*Boreogadus saida)*

Franz J. Mueter, Mike A. Litzow, Seth L. Danielson, Paul D. Spencer and Robert R. Lauth
The roles of temperature, abundance and advection in modifying the spatial dynamics of groundfish at the Subarctic-Arctic boundary in the eastern Bering Sea

Jacqueline M. Grebmeier
The Distributed Biological Observatory (DBO): A change detection array in the Pacific Arctic region

George L. Hunt, Jr., Arny Blanchard, Peter Boveng, Padmini Dalpadado, Kenneth F. Drinkwater, Lisa Eisner, Russ Hopcrofb, Kit Kovacs, Brenda Norcross, Paul Renaud, Marit Reigstad, Martin Renner, Hein Rune Skjoldal, Andy Whitehouse and Rebecca A. Woodgate
The Barents and Chukchi Seas: Comparison of two Arctic shelf ecosystems

Kenneth F. Drinkwater
On the role of advection on the interaction between the Arctic and Subarctic seas: Comparing the Atlantic and Pacific sectors

Poster Presentations

Zhongyong Gao, Heng Sun and Liqi Chen
Comparison of decadal changes in the carbon sink and potential responses to climate change in the Taiwan Strait, Bering Sea and bipolar regions

Jacqueline M. Grebmeier and Takashi Kikuchi
The Pacific Arctic Group (PAG): A Pacific perspective on Arctic science

BIO Workshop (W5)
Comparison of multiple ecosystem models in several North Pacific shelf ecosystems (MEMIP-IV)

Co-Convenors: *Harold Batchelder (USA), Shin-ichi Ito (Japan), Angelica Peña (Canada) and Yvette Spitz (USA)*

Background

This will be the first MEMIP (Marine Ecosystem Model Intercomparison Project) workshop where we have completed model comparisons within single shelf systems; *e.g.*, within the Northern California Shelf, Gulf of Alaska shelf and Oyashio shelf and offshore, individually. The workshop tasks will be to undertake quantitative assessment of the successes and shortcomings of individual models within regions and across regions. This formal skill assessment is a key activity to enable MEMIP to identify which, if any, of the various ecosystem models have broad skill spatially and temporally in multiple North Pacific shelf ecosystems. The observations (nutrients, chlorophyll and zooplankton biomass) from the key years of simulation (2000-2003) have been compiled to enable model-data comparisons for each of the three regions. To our knowledge this will be the first multiple model skill assessment that extends to zooplankton, *e.g.*, beyond phytoplankton, and the first that focuses on ecosystem models applied to coastal systems.

Summary of Workshop

The workshop began with a review of the goals for the project from 2011 to 2012. That was followed by a summary of the discussions that were held during 4 days at the MEMIP workshop in Corvallis, USA, in March 2012 attended by Angelica Peña, Jerome Fiechter, Hal Batchelder and Yvette Spitz. A summary of that workshop and the activities planned to occur between March 2012 and October 2012 is described in the BIO Committee report. Workshop W5 had one formal presentation by Dr. Jarrod Santora.

The group was updated on the stumbling blocks encountered in finalizing the physical testbeds that provide the foundation for the coupled modeling. In short, the original premise that a two-dimensional spatial (cross-shelf by depth) domain would serve as the testbed was found to be flawed, and led to spurious and unrealistic physical results, probably caused by instabilities. There were hints of problems as early as March 2012, but we believed they could be solved. It was not to be, so the approach was reformulated to use three-dimensional physical models for each domain. This is reflected in the revised workplan for the MEMIP.

The workshop was initially scheduled for October 12–13, 2012; however, due to delayed progress in having the physical test bed simulations completed by July 2012, most of the coupled biophysical simulations of the three testbeds were not completed. It was unfortunate that two members (Drs. Peña and Shin-ichi Ito) of the core MEMIP team had to attend meetings of other PICES expert groups during these two days. If the four co-convenors of the MEMIP workshop, and Dr. Fiechter, had been available for both days of the workshop, there may have been an opportunity to utilize the second day of the scheduled workshop. In the end, the group met for about 5.5 hours on October 12, only. In the future, it would be preferable if key members, including co-chairs of a workshop in this case, were not scheduled to participate in other simultaneous meetings. Eleven scientists attended the first half day of W5. During those discussions, which had the benefit of email communication with MEMIP member, Jerome Fiechter in the USA, who was unable to attend PICES-2012, a

plan was developed to complete the comparisons of three coastal ecosystem models (see the MEMIP project report in the BIO Committee Annual Report).

List of papers

Oral presentations

Jarrod A. Santora, William J. Sydeman,Monique Messié, Fei Chai, Sarah Ann Thompson, Brian K. Wells and Francisco P. Chavez
Triple check: Spatio-temporal observations of krill and seabirds verifies structural realism of an ocean ecosystem model

Yvette Spitz (Chair)
Work Session 1: Overview of MEMIP Model Status. Update on progress since Oct 2011.

Hal Batchelder (Chair) / Angelica Peña (Chair)
Work Session 2: MEMIP Impressions, Recommendations, Stumbling Blocks

Hal Batchelder (Chair)
Coupled model results/new simulations/*etc.*

Angelica Peña (Chair)
Work Session 4: Coupled model results/new simulations/*etc.* (*continued*)

Workshop Convenors
Day 1 Wrap-up: Open Discussion of Progress and Planning Day 2

Yvette Spitz (Chair) / Hal Batchelder (Chair)
Skill Assessment: Example of SA using Newport Spitz model

Hal Batchelder (Chair) / Angelica Peña (Chair)
Work Session 5: Continue model simulations and/or skill assessments

Yvette Spitz (Chair) / Hal Batchelder (Chair)
Work Session 6: Continue model simulations and/or skill assessments

Yvette Spitz (Chair) / Hal Batchelder (Chair)
Work Session 7: Continue model simulations and/or skill assessments

Yvette Spitz (Chair) / Hal Batchelder (Chair)
Work Session 8: Continue model simulations and/or skill assessments

Workshop Convenors
Workshop Wrap-up: Accomplishments, Progress Report, Future Steps, Requests to BIO (if any)

MEQ Workshop (W6)
The contrasting cases of HABs in the eastern and western Pacific in 2007 and 2011

Co-conveners: *Changkyu Lee (Korea) and Mark Wells (USA)*

Background

Harmful algal blooms reached historic levels along coastlines of the eastern Pacific in 2011, but similar blooms were minimal to non-existent in Japan, Korea and Russia. The situation was largely reversed in 2007, and this disparity between these years offers a unique opportunity to compare and contrast the basic environmental parameters and HAB dynamics during these regimes. Combining these observations with a broader overview of the basin-scale physical dynamics during this time frame would provide new insights to the factors enhancing these blooms. The workshop foundation was the pre-submission of available data from member countries, including but not limited to: HAB species presence and abundance, time of year, temperature range, salinity range, water clarity, wind, river flow (flooding), and upwelling indices. Workshop participants were to review and discuss the trends and patterns in these data over the first day, and integrate them with information on the basin-scale physical dynamics. Participants were to develop a detailed outline for manuscript preparation during the second day, with agreed writing assignments and draft submission deadlines.

Summary of Workshop

The motivation for this workshop stemmed from a trend in observations showing that Harmful Algal Blooms (HABs) achieved historic impact levels in 2011 along eastern Pacific coastal regions, whereas only minimal corresponding outbreaks occurred in many regions of the western subarctic Pacific. Moreover, this situation was largely reversed in 2007, suggesting there is a potential linkage between basin-scale forcing factors and HAB dynamics in coastal waters. The initial phase of the 1.5 day workshop focused on in-depth presentations on intercomparison of toxic blooms, fish killing HAB blooms, and high biomass HAB events in 2007 and 2011, along with an assessment of the potential linkage between the tsunami of the Great East Japan Earthquake and the resultant distribution of toxic dinoflagellates in Tohoku coastal areas of Japan. Dr. William Peterson and Dr. Sanae Chiba, invited speakers at the workshop, put these local or regional HAB observations into a wider basin-scale perspective by presenting their work and insights on the influence of atmospheric forcing factors (PDO, MEI, NPGO) on the physical and ecosystem dynamics in Pacific oceanic and nearshore waters. This information, new to many HAB Section members, provided a more system-wide outlook on factors likely to influence regional scale oceanography and HAB events.

In the second phase of the workshop, participants divided in to small teams to assess and distill the primary implications of these data, observations, and insights. Each team was charged with identifying the most compelling findings, which then were debated in a full workshop discussion. The hypothesis that emerged was "The variability in basin-scale climate forcing (PDO, MEI, NPGO) shapes the intensity and duration of HABs in North Pacific coastal waters in conjunction with local driving factors". More specifically, participants felt that local forcing was particularly evident in semi-enclosed basins while broader-scale forcing was indicated along open coastlines. A plan was developed to begin testing this hypothesis by identifying specific regions and years for more detailed assessment. As first step, each PICES member country will identify two sentinel sites (or regions) where possible, one in a semi-enclosed region or basin and one along an open coastline. The participants will focus on three broad HAB categories; Fish Killing events, Toxic events (bivalves), and High Biomass events. A unified database will be developed to record the occurrence and qualitative intensity in these regions over the last ten years, thus encompassing the North Pacific regime shift in 2005. Each event will be categorized in terms of the toxic level, cell concentration, fisheries damage, or other human impact (*e.g.*, for high biomass events), as well as the duration of event, the spatial extent of the event, and the seasonal timing of event. This unified database will enable assessment of the basin-scale patterns in HAB events from which selected years and sites will be assigned for more in depth intercomparison. Point persons for data collection from each country were identified, and participants agreed upon a timeline for the initial and secondary data collections. The joint findings will be assembled into a draft manuscript for presentation to the HAB Section in Fall, 2013.

These workshop findings result from the unique and productive collaboration among nations that could not come about without the PICES organization. The thrust of the workshop, and the direct findings and insights, directly address two FUTURE research themes:

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?

List of papers

Oral presentations

Takashi Kamiyama, Hiroyuki Yamauchi, Shinnosuke Kaga, Satoshi Nagai and Mineo Yamaguchi
Effects of the tsunami by the Great East Japan Earthquake on distribution of *Alexandrium* cysts and risk of PSP occurrence in Tohoku coastal areas in Japan

Ruixiang Li, Zongling Wang and Mingyuan Zhu
Harmful Algal Blooms in coastal water of China in 2011

William T. Peterson (Invited)
The potential influence of local physical forcing (factors related to coastal upwelling) and basin-scale forcing (factors related to ENSO and the PDO) on harmful algal bloom in the Oregon upwelling zone

Sanae Chiba (Invited)
Contrast of the lower trophic level responses to climatic forcing over the eastern and western North Pacific

Tatyana Yu. Orlova, O.G. Shevchenko, Inna V. Stonik and Vladimir M. Shulkin
Cases of HABs in 2007 and 2011 in Peter the Great Bay (East/Japan Sea), Russia

Svetlana Esenkulova and Nicola Haigh
Bloom dynamics of *Heterosigma akashiwo* in coastal waters of British Columbia (BC), Canada in 2007 and 2011; Data from the Harmful Algae Monitoring Program

Chang-Hoon Kim and Ji Hoe Kim
Monitoring and development of PSP toxins along the south coast of Korea

Changkyu Lee
HAB DATA 2007 and 2011 - Korea

Shigeru Itakura
HAB DATA 2007 and 2011 - Japan

Charles Trick
HAB DATA 2007 and 2011 - Canada

Vera Trainer
HAB DATA 2007 and 2011 – USA

Poster Presentations

Junya Tomita, Tomoki Nishiguchi, Motoaki Yagi, Daekyung Kim and Tatsuya Oda
Evaluation of toxic potential of newly isolated *Chattonella antiqua*, by laboratory exposure experiments and micro-bioassay using cultured cells

Hao Guo, Xu Xiao-man and Li Xia
Red tide survey and information system in Dalian Port

Feng-ao Lin, Hao Guo, Yongjian Liu, Daoyan Xu and Xingwang Lu
High-incidence HAB**s** species in China Coastal Waters and the forewarning method based on the HAB**s** Risk Index

SCOR/PICES Workshop (W7)
Global patterns of phytoplankton dynamics in coastal ecosystems

Co-convenors: *Kedong Yin (China) and Hans Paerl (USA)*

Background

Phytoplankton biomass and community structure have undergone dramatic changes in coastal ecosystems over the past several decades in response to climate variability and human disturbance. These changes have short- and longer-term impacts on global carbon and nutrient cycling, food web structure and productivity, and coastal ecosystem services. There is a need to identify the underlying processes and measure rates at which they alter coastal ecosystems on a global scale. Hence, the Scientific Committee on Ocean Research (SCOR) formed Working Group 137 (WG 137) on Global Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observations (http://wg137.net/). To address fundamental questions that emerged, WG 137 would use data compiled from 84 sampling stations, representing research and monitoring programs spread across five continents, and would seek additional time series of coastal/estuarine/near-shore phytoplankton and relevant hydrographic data. Investigators with decadal observational data were encouraged to contribute to this growing compilation and discuss interests in collaboration. The wealth of information in these data sets provides an unprecedented opportunity to develop a global analysis and investigation of the dynamics and status of ecosystems where land and sea meet. The workshop was intended to cover conceptual models of phytoplankton community variability and quantitative approaches for extracting patterns from time series.

Summary of Workshop

Workshop W7 was a joint SCOR WG 137/PICES workshop. The meeting objectives were for participants to: (1) present progress made on data synthesis and cross-system comparisons of anthropogenic and climatic impacts on coastal phytoplankton community structure and function since the WG 137 1st and 2nd meetings, (2) review and revise research questions, (3) discuss the approaches (what data sets to use, what analysis to perform, *etc*.) needed to address questions and formulate the framework (outline) of papers related to the questions, and (4) determine take-home assignments for preparing publications.

W7 invited Dr. William Li from the Bedford Institute of Oceanography, Halifax, Canada, who gave a presentation on "*An ecological status report for phytoplankton and microbial plankton in the North Atlantic and adjacent seas*" by ICES Working Group on Phytoplankton and Microbial Ecology (WGPME). This excellent, thought-provoking presentation stimulated much cross-discilinary discussion on climatically and anthropogenically altered trends in oceanic and coastal phytoplankton communities, and it stressed the overall importance of the <3 μm diameter picophytoplankton in the world's oceanic and coastal waters.

There were several additional coastal phytoplankton dynamics presentations by PICES participants in the open session component of the WG 137 workshop. These included participants form Canada, Japan, Korea, Russia, and Spain.

Overall, there were were over 30 participants with 11 participants making presentations. In particular, Dr. Todd O'Brien reported data sets available for use by participants**.** He has developed the http://WG137.net web site, which contains links to an interactive map and data and site summary tables that list and link to standard summary pages for each of the existing time series sites.

Two new online time series tools are available to the WG137 community. The COPEPOD Interactive Time-series Explorer (COPEPODITE, http://www.st.nmfs.noaa.gov/copepodite/) is a publicly available, online toolkit that allows any user to upload their own time series data and select from a variety of standard analysis and visualizations to be applied their data. The second tool is the Multi-Site Time-Series Explorer (MSTSE). This tool is not public; access is controlled by email-based login.

W7 participants also discussed questions for future publications as follows.

- Do changes in nutrient supplies, sources (new vs. regenerated), concentrations and ratios cause shifts in phytobiomass and community composition?
  Subquestion 1: nutrients vs species diversity
  Subquestion 2: nutrients vs community status
  Subquestion 3: ammonium/nitrate, Si, vs community structure (diatoms/(diatoms+dinos)), hypothesis HN4, or DON favours dinoflagellates
- Are there temperature thresholds that determine dominance of different phytoplankton groups and do temperature regimes and ranges govern interactions?
- How is phytoplankton cell size a reflection of environmental conditions across systems?
- How does variability of hydrology/salinity, residence time influence phytoplankton
- How to establish the relationship between residence times and phytoplankton community structure
- What are the common seasonal patterns along single species & communities?
- How much local scale variation can be explained by progressively larger scale variation?
- What role does bottom-up vs. top-down processes play in regulating planktonic communities? To what extent does phytoplankton composition affect food quality?

We appreciate the opportunity to have had the WG 137 Workshop in conjunction with the PICES Annual Meeting. The participation of PICES attendees added both new information on potentially useful long-term data sets and dimensionality to the Workshop.

List of papers

Oral presentations

William K.W. Li, Todd D. O'Brien and Xosé Anxelu G. Morán (Invited)
An ecological status report for phytoplankton and microbial plankton in the North Atlantic and adjacent seas

Jacob Carstensen, Hans W. Paerl and James E. Cloern
The phytoplankton composition across the world's coastal ecosystems

Todd D. O'Brien
COPEPODITE: An online toolkit for plankton time series analysis and visualization

N. Ramaiah
Anthropogenic influences on phytoplankton compositional variability in coastal waters

Kedong Yin and Paul J. Harrison
Anthropogenic influence on phytoplankton community structure: Long time series data analysis in Hong Kong coastal waters

Yury I. Zuenko
Conditions of phytoplankton blooms at Primorye coast (Japan/East Sea) and year-to-year change of their timing

Poster Presentations

Hyeon Ho Shin, Jong Sick Park, Young-Ok Kim, Seung Ho Baek, Dhongil Lim and Yang Ho Yoon
Dinoflagellate cyst production and flux in Gamak Bay: A sediment trap study

Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado, Sébastien Putzeys, Iria Sala, Soluna Salles and Lidia Yebra
Time variability of the taxonomical composition and the physiological performance of diatom-dominated assemblages in an area affected by coastal upwelling

Inna V. Stonik and Tatyana Yu. Orlova
Population dynamics and toxicity of the diatom species of the genus *Pseudo-nitzschia* in Peter the Great Bay, the northwestern part of the Sea of Japan

Ah-Ra Ko, Se-Jong Ju, Ho Young Soh and Kyoungsoon Shin
Understanding seasonal variation of the source of particulate organic matter in relationship with plankton community in the estuary of Sumjin River, Korea

FIS Workshop (W8)
Recruitment of juvenile Japanese eel (Anguilla japonica) ineastern Asia

Co-Sponsored by: *FRA*

Co-convenors: *Ruizhang Guan (China), Tatsu Kishida (FRA, Japan), Akihiro Mae (Japan), Tae Won Lee (Korea), Wann-Nian Tzeng (Chinese Taipei) and Kazuo Uchida (FRA, Japan)*

Background

Japanese eel is one of an important fisheries resource in the eastern Asia. In recent three years, however, catch of glass eel in this area has remained in low level. In view of this situation, we recognized the necessity to investigate the reason why recruitment of glass eel decreased and consider the proper management measures on this resource. Because Japanese eel distributes throughout the eastern Asia, we planned the international workshop to discuss these issues. The purpose of this workshop is to discuss on 1) the mechanisms and reasons of the inter-annual variability of the recruitment of glass eel to the coastal area of the eastern Asia,

2) effective measures for sustaining the glass eel recruitment, 3) necessary information exchange and 4) how to enhance the international collaboration in order to sustain the resource of Japanese eel.

Summary of Workshop

Prof. Wann-Nian Tzeng (National Taiwan Ocean University) chaired the first session. Dr. Kazuo Uchida of Fisheries Research Agency of Japan (FRA) reviewed the life history of Japanese eel, including the results of the newest studies using otolith analysis of spawning adults collected in spawning grounds. Dr. Seinen Chow (FRA) lectured on the discovery of mature eels in the spawning area, the first case in the world, and on the oceanic migration. Dr. Tomowo Watanabe (FRA) talked about oceanographic conditions in spawning grounds as well as larvae transportation areas of the Japanese eel.

Prof. Tae Won Lee (Chungnam National University, Korea) chaired the second session constituting lectures from each nation/area. Dr. Hiroaki Kurogi (FRA) discussed ecology and annual recruitment levels of Japanese eel in Japan; Prof. Tae Won Lee lectured on ecology and recruitment of Japanese eel in Korea; Prof. Ruizhang Guan (Jimei University, China) made a presention on ecology and annual recruitment levels of Japanese eel in continent China; and Prof. Tzeng lectured on spatial and temporal variations in the recruitment of Japanese eel in Taiwan. They discussed yearly fluctuations of glass eel catch and possible causes of decrease of catch in their nations. The third session was chaired by Prof. Ruizhang Guan. Dr. Tatsu Kishida (FRA) reviewed the management measures for eel in Europe as a reference for the participants to consider in the management of Japanese eel.

Lastly, Dr. Kazuo Uchida chaired the general discussion. Possible causes of the stock decline pointed out by plural nations are: (1) reduction of habitat in inland freshwater and coastal areas, (2) overfishing and (3) changes in oceanic conditions. In order to recover and sustain the stock of Japanese eel, the workshop concluded that it is necessary to implement (1) international cooperation on collecting fishing data, (2) advancing research and study on the distribution and migration of Japanese eel, (3) strengthening the stock management for both glass eel and adult eel in each nation/area as a first step, (4) conservation of habitat and environment in rivers and coastal areas, and (5) evaluation of the stocking effectiveness of eel. The importance of the continuation of information exchange and building the framework for this purpose were also recognized.

List of papers

Oral Presentations

Kazuo Uchida
Life history of Japanese eel (review)

Seinen Chow, Toshihiro Yamamoto, Hiroaki Kurogi, Makoto Okazaki and Tomoo Watanabe
Discovery of mature freshwater eels in the spawning area and remarks on the oceanic migration

Daisuke Ambe, Makoto Okazaki, Tomowo Watanabe, Hiroaki Kurogi and Seinen Chow
Oceanographic conditions in spawning ground and larvae transportation area of the Japanese eel

Hiroaki Kurogi
Ecology and annual recruitment levels of Japanese eel in Japan

Tae Won Lee
Ecology and recruitment of Japanese eel in Korea

Ruizhang Guan
Ecology and annual recruitment levels of Japanese eel in continent China

Wann-Nian Tzeng and Yu-San Han
Spatial and temporal variations in the recruitment of Japanese eel (*A. japonica*) in Taiwan

Tatsu Kishida and Kazuo Uchida
Management measures for eel in Europe

Best Presentations for Committee/Program-sponsored Topic Sessions or Workshops at PICES-2012

Science Board Best Oral Presentation

Benjamin S. Halpern (National Center for Ecological Analysis and Synthesis, Santa Barbara, USA) on "The Ocean Health Index: Global assessment and future priorities"

Science Board Best Poster

Kuninao Tada (Kagawa University, Japan) on "Decrease of surface water nutrient concentration and nutrient flux from the sediment in Harima-Nada, Eastern Seto Inland Sea, Japan" co-authored with Miho Kayama, Naoto Hirade, Hitomi Yamaguchi, Supaporn Yamaguchi, Kazuhiro Harada, Minoru Tanda, Munehiro Fujiwara, Kazuhiko Ichimi and Tsuneo Honjo

Best Oral Presentation by an early career scientist for the BIO-sponsored Contributed Paper Session

Tabitha C.Y. Hui (Hokkaido University, Japan) on "Spatial, temporal and dietary overlap between harbour seals and fisheries in Erimo, Japan: Conflict at sea?" co-authored with Yumi Kobayashi, Yoko Mitani, Kei Fujii, Kei Hayashi and Kazushi Miyashita

Best Poster for the BIO-sponsored Contributed Paper Session

Chiyuki Sassa (Seikai National Fisheries Research Institute, Fisheries Research Agency, Japan) on **"**Seasonal occurrence of mesopelagic fish larvae in the onshore side of the Kuroshio off southern Japan" co-authored with Yuichi Hirota

Best Oral Presentation by an early career scientist for the FIS-sponsored Contributed Paper Session

Xun Zhang (Hokkaido University, Japan) on "Spatial modeling of the potential fishing zone of Japanese common squid in coastal waters of southwestern Hokkaido, Japan" co-authored with Sei-Ichi Saitoh and Toru Hirawake

Best Poster for the FIS-sponsored Contributed Paper Session

Atsushi Tawa (Kyushu University, Fukuoka, Japan) on "High dispersal of moray eel larvae to the open ocean: Early life history estimated from ocean-wide distribution patterns" co-authored with Taku Yoshimura and Noritaka Mochioka

Best Oral Presentation by an early career scientist for the MEQ-sponsored BIO/MEQ/FUTURE Topic Session on "Ecosystem responses to multiple stressors in the North Pacific" (S10)

Kyung-Su Kim (Pukyong National University, Korea) on "The combined effects of elevated carbon dioxide concentration and temperature on the early development stage of olive flounder *Paralichthys olivaceus*" co-authored with JeongHee Shim and Suam Kim

Best Poster for the MEQ-sponsored BIO/MEQ/FUTURE Topic Session on "Ecosystem responses to multiple stressors in the North Pacific" (S10)

Kanako Naito (Prefectural University of Hiroshima, Japan) on "Iron as a triggering factor for harmful dinoflagellate blooms" co-authored with Setsuko Sakamoto, Mineo Yamaguchi, Ichiro Imai and Ken-ichi Nakamura

Best Oral Presentation by an early career scientist for the POC-sponsored Contributed Paper Session

Yoshi N. Sasaki (Hokkaido University, Sapporo, Japan) on "Interannual to decadal variability of the Gulf Stream and Kuroshio Extension jets" co-authored with Shoshiro Minobe and Niklas Schneider

Best Poster for the POC-sponsored Contributed Paper Session

Sachihiko Itoh (The University of Tokyo, Japan) on "Strong vertical mixing in the Urup Strait, Kuril Islands" co-authored with Ichiro Yasuda, Masahiro Yagi, Satoshi Osafune, Hitoshi Kaneko, Jun Nishioka, Takeshi Nakatsuka and Yuri N. Volkov

Best Oral Presentation by an early career scientist for the MONITOR-sponsored MONITOR/POC Topic Session on "Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation" (S11)

Toshihiro Wada (Fukushima Prefectural Fisheries Experimental Station, Japan) on "Tsunami disaster and nuclear power plant accident effects on fishery facilities and marine products in Fukushima Prefecture: Present conditions and prospects" co-authored with Yoshiharu Nemoto, Shinya Shimamura and Satoshi Igarashi

Best Poster for the MONITOR-sponsored MONITOR/POC Topic Session on "Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation" (S11)

Hideki Kaeriyama (National Research Institute of Fisheries Science, Kanagawa, Japan) on "Oceanic dispersion of radioactive cesium around Japan and western North Pacific after the Fukushima Dai-ichi Nuclear Power Plant accident" co-authored with Daisuke Ambe, Masachika Masujima, Kou Nishiuchi, Ken Fujimoto, Tsuneo Ono and Tomowo Watanabe

Best Oral Presentation by an early career scientist for the TCODE-sponsored POC/TCODE Topic Session on "Changing ocean biogeochemistry and its ecosystem impacts"(S14)

Shuchai Gan (East China Normal University, Shanghai, People's Republic of China) on "Quantification of BDOC (bio-available dissolved organic carbon) of different water masses in East China Sea" co-authored with Ying Wu

Best Poster for the TCODE-sponsored POC/TCODE Topic Session on "Changing ocean biogeochemistry and its ecosystem impacts" (S14)

Lidia Yebra (Centro Oceanográfico de Málaga, Spanish Institute of Oceanography, Spain) on "Active carbon flux by diel migrant zooplankton in the eutrophic and oligotrophic waters of the Canary Current" co-authored with Sébastien Putzeys, Carlos Almeida, Pierrick Bécognée, Ángeles Marrero Diaz and Santiago Hernández-León