

## Summary of Scientific Sessions and Workshops and List of Best Presentations at PICES-2015

### Science Board Symposium (S1)

#### *Change and Sustainability of the North Pacific*

Co-Convenors: *Thomas Therriault (Science Board), Angelica Peña (BIO), Elizabeth Logerwell (FIS), Chuanlin Huo (MEQ), Jennifer Boldt (MONITOR), Kyung-Il Chang (POC), Toru Suzuki (TCODE), Steven Bograd (FUTURE), Hiroaki Saito (FUTURE), Igor Shevchenko (Russia)*

#### InvitedSpeakers:

*Emanuele Di Lorenzo (Earth and Atmospheric Sciences, Georgia Institute of Technology, USA)*

*Mike Foreman (Fisheries and Oceans Canada, Canada)*

*Mitsutaku Makino (Fisheries Research Agency, Japan)*

*Leonie Robinson (University of Liverpool, UK)*

*George Waldbusser (Oregon State University, USA)*

#### Background

Since its establishment, PICES has provided leadership in developing a better understanding of the structure, function and changes of North Pacific marine ecosystems. The integrative scientific programs of PICES, and other special activities such as periodic Ecosystem Status Reports, have advanced our knowledge of coupled physical-biogeochemical-ecological processes of the North Pacific. The Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems (FUTURE) program is focusing on acquiring better insight into the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services and marine dependent social systems. Climate change research remains important to ocean scientists and governments within PICES. However, the direct and indirect interactions of human activities on coastal and open ocean ecosystems and the services they provide to society are also of great concern in the North Pacific area. A sustainable North Pacific ecosystem is desired by both the public and governments. This vision seeks a balance between resource protection and resource utilization, and a balance between pressing needs at local and regional scales and climate-driven issues at basin and global ocean scales. The nature of the Science Board symposium theme allows for scientific sessions to include topics on climate change, ocean acidification, coastal eutrophication, aquaculture, fishing, pollution, coastal development and planning, sustainability, resilience, vulnerability, cumulative impacts of multiple stressors, and the tradeoffs/conflicts inherent in multiple-use ocean activities, and mechanisms to resolve these. Presentations on some of the above topics and the relationship and compatibility of marine resource development, eco-environment sustainability, protection and restoration were presented in the following.

#### Summary of presentations

The keynote speaker of S1, Dr. Lixin Wu, presented a talk entitled “*Multiscale processes of Pacific western boundary currents and their roles in climate*”. Dr. Wu first stated some key processes that western boundary currents (WBC) impact climate, such as its association with seasonal and interannual storm track variations through sea surface temperature variations, fast warming in the boundary regions affecting marine ecosystems, and path and transport variability of WBC. He also examined changes in atmospheric forcing in a warming climate that could influence the WBC, poleward expansion of the Hadley cell, intensification of both subtropical highs and Aleutian Low, and impacts of ENSO. He concluded his talk by asking several key questions yet to be addressed to understand the structure and variability of WBCs, their connections with global warming, and predictability of WBCs in climate models.

Considering impacts of human-induced alteration and natural variability of climate system on the coastal ocean, Dr. Emanuele Di Lorenzo, the first invited speaker, stressed the importance of establishing networks of

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social and natural scientists in order to explore current dynamics and future changes of complex coastal systems in his talk “Towards a social-ecological-environmental system approach for the coastal ocean”. He introduced the associated PICES Study Group on *Socio-Ecological-Environmental Systems* (SG-SEES) and how we can benefit from the activities by presenting an example of coastal hypoxia.

Following a brief introduction of PICES Working Group 29 on *Regional Climate Modeling* (RCM), Dr. Enrique Curchitser (presenting for Dr. Michael Foreman, the second invited speaker), gave a talk entitled “*Regional climate modeling and FUTURE – An overview and possible future directions*”. He reviewed the state-of-art of RCM by taking examples of British Columbia RCM, California Current RCM, northwestern Pacific RCM works which include physical and biogeochemical downscaling, and 2-way coupled modeling. Dr. Curchitser also suggested possible future directions in RCM activities and how they help PICES FUTURE by addressing important societal questions and assisting decision-makers.

For effective and realistic approach for sustainable fisheries, Dr. Mitsutaku Makino, the third invited speaker, stressed the importance of fisheries co-management in which local fishers, government, and fisheries scientists introduce cooperatively various types of management measures in his presentation “*Toward the integrated research in fisheries science*”. Introducing the “Fisheries System” concept which links various disciplines, Dr. Makino showed examples according to different fisheries and accommodated those examples into a powerful and visually-aided FUTURE diagram which SG-SEES has developed and implemented.

The fourth invited speaker, Dr. George Waldbusser, reported on the “*Impact of ocean acidification on bivalve production in the Pacific Northwest*” where he described the impacts of ocean acidification on the Pacific Northwest oyster seed crisis in the late 2000s and mitigation strategies that have been used effectively in restoring oyster seed output within oyster hatcheries. He further talked about research activities to support bivalve populations for economic and ecological benefit.

As an initial attempt to project climate change impacts to the North Pacific subtropical ecosystem over the 21<sup>st</sup> century, Dr. Jeffrey Polovina presented results from 13 CMIP5 earth system models in his talk “*Using earth system model output to project climate change impacts to the North Pacific Subtropical Ecosystem over the 21<sup>st</sup> century*” to explore spatio-temporal trends in key physical and biological variables, to compute ecological biomes and habitats, and to drive ecosystem models using the earth system models to project changes in ecosystem structure and fisheries yields. Projected changes showed both similarities and differences, and suggestions were made about the improvement of the ecosystem models and different modeling approaches.

Dr. Lingbo Li, an early career scientist, showed results from a study on the effect of environmental changes on a deep fjord in Washington State in her talk “*Fighting a hard battle: Effects of hypoxia and temperature on euphausiids in the North Pacific*”. She found that furcilia I-III is the only stage that demonstrated clear avoidance of low oxygen (<3.6mg/l) and that their distribution is mostly related to temperature and oxygen. To determine the thermal limit of *E. pacifica* more high temperature observations are needed.

The foraging range of seals and seabirds was examined by Dr. Andrew Trites in his talk “*Top predators partition the Bering Sea and are unlikely to respond favourably to climate change*”. His data suggest a common set of selective mechanisms related to compass orientation of breeding colonies, competition within and between species, predation risk, and energetic constraints and that immediate environmental condition may have less effect on broad-scale habitat selection. He concluded that existing breeding colonies in the Bering Sea may be poorly adapted and unable to respond favourably to global warming and environmental change.

The last invited speaker, Dr. Leonie Robinson, presented a talk “*A European perspective on integrated ecosystem assessment*” where she discussed the importance of understanding how humans and natural ecosystems interact to enable sustainable use and how changes in ecosystems affect human wellbeing. She looked at a holistic assessment approach that focuses on achievement of policy objectives. The approach assesses the state of relevant policy objectives, then provides a methodology for identifying threats to these, and from this provides management options, where full consideration of trade-offs across ecological, economic and social issues, and evaluation of the governance complexity surrounding this, are all considered.

In his talk “*Jellyfish blooms as a threat to the sustainability of the East Asian Marginal Seas: An overview of recent jellyfish studies in China, Japan and Korea*”, Dr. Shin-ichi Uye introduced cooperative activities conducted by scientists in China, Japan, and Korea to identify causes of jellyfish (*Nemopilema nomurai*) blooms, to develop adaptive and management strategies for jellyfish predators, to monitor and forecast jellyfish outbreaks, and to develop countermeasures to alleviate the damage of jellyfish blooms. He also reported on the use of fishing gears to exclude and separate jellyfish in fishing nets.

In his presentation entitled “*Multiple scale climate variability in the North Pacific and features of recent climate regime*” Dr. Vladimir Ponomarev analyzed long-term (from 1900 or 1948 to 2014) sea surface temperature, sea level pressure, air temperature, and surface net flux in order to understand multiple scale climate anomalies in the Indo-Pacific Ocean focusing on Mongolia and Lake Baikal. Two climate regimes were identified in the late 1970s and late 90s, which accompanied winter warming in Lake Baikal, and summertime warming and decreased precipitation in Europe and most of the East Asia including Mongolia and Lake Baikal, respectively.

Oxygen concentrations in oxygen minimum zones of the North Pacific have significantly declined in the last several decades. Dr. Shin-ichi Ito’s talk “*Anthropogenic aerosols and climate variability control decadal variability of dissolved oxygen in the North Pacific*” presented results from computational simulations to test the hypothesis that atmospheric pollution over the Pacific Ocean and regional climate variability can change the pattern of biological productivity and the distribution of oxygen in deeper waters. He found the combined effect is the increased O<sub>2</sub> consumption in the oxygen minimum zone of the tropical Pacific, causing the prominent trends observed over recent decades.

Using projected changes in oceanographic climate, Dr. Jameal Samhuri assessed the vulnerability of marine forage species and dependent fishing vessels in the California Current in his talk “*Social-ecological vulnerability of forage fish and fishermen to climate change*”. Based on expected changes in the mean and variability of temperature and chlorophyll concentrations, and species-specific sensitivity to these changes, he ranked the vulnerability of 15 forage species, all of which are fisheries targets. By coupling ecological vulnerability measure to estimates of social vulnerability he provided an integrated assessment of how climate change may differentially affect fishing vessels that target forage species.

## List of papers

### *Oral presentations*

#### **Towards a social-ecological-environmental system approach for the coastal ocean (Invited)**

Emanuele Di Lorenzo, Keith Criddle and Alida Bundy

#### **Regional climate modeling and FUTURE - An overview and possible future directions (Invited)**

Michael Foreman, Chan Joo Chan, Enrique Curchitser and Angelica Peña

*Presented by Enrique Curchitser on behalf of Michael Foreman*

#### **Toward the integrated research in fisheries science (Invited)**

Mitsutaku Makino

#### **Impacts of ocean acidification on bivalve production in the Pacific Northwest (Invited)**

George G. Waldbusser

#### **Using earth systems model output to project climate change impacts to the North Pacific Subtropical Ecosystem over the 21<sup>st</sup> Century**

Jeffrey Polovina and Phoebe Woodworth-Jefcoats

#### **Fighting a hard battle: Effects of hypoxia and temperature on euphausiids in the North Pacific**

Lingbo Li, Julie E. Keister and Mei Sato

#### **Top predators partition the Bering Sea and are unlikely to respond favourably to climate change**

Andrew W. Trites, B. Battaile, K.J. Benoit-Bird, A. Harding, S. Heppell, B. Hoover, D. Irons, N. Jones, K. Kuletz, C. Nordstrom, R. Paredes and D. Roby

#### **A European perspective on Integrated Ecosystem Assessment (Invited)**

Leonie A. Robinson

**Jellyfish blooms as a threat to the sustainability of the East Asian Marginal Seas: An overview of recent jellyfish studies in China, Japan and Korea**

Shin-ichi Uye, Hideki Ikdea, Sun Song, Fang Zhang, Chang-Hoon Han and Won-Duk Yoon

**Multiple scale climate variability in the North Pacific and features of recent climatic regime**

Vladimir I. Ponomarev, Elena V. Dmitrieva and Svetlana P. Shkorba

**Anthropogenic aerosols and climate variability control decadal variability of dissolved oxygen in the North Pacific**

Takamitsu Ito, Athanasios Nenes, Matthew S. Johnson, Nicholas Meskhidze and Curtis Deutsch

**Social-ecological vulnerability of forage fish and fishermen to climate change**

Jameal F. Samhuri, Lucas Earl, Caren Barcelo, Steven Bograd, Ric Brodeur, Lorenzo Cianelli, Emma Fuller, Elliott Hazen, Michael Jacox, Isaac Kaplan, Ryan Rykaczewski, Maria Dickinson Sheridan and Gregory D. Williams

*Poster presentations*

**Socio-ecological linkages enhancing the resilience of Japan's Urato Islands**

Akane Minohara and Robert Blasiak

**Change of the dense bottom water production on the northern Okhotsk Sea shelf and its transport to the intermediate layer of the North Pacific**

Yury Zuenko, Alexander Figurkin, Vladimir Matveev and Elena Ustinova

**Climatic changes of temperature, salinity and nutrients in the Amur Bay of the Japan Sea**

Yury Zuenko and Vladimir Rachkov

**Geographic variation in Pacific herring growth in response to regime shifts in the North Pacific Ocean**

Shin-ichi Ito, Kenneth A. Rose, Bernard A. Megrey, Jake Schweigert, Douglas Hay, Francisco E. Werner and Maki Noguchi

**A multivariate assessment of eutrophication in three typical bays of the northern Zhejiang, East China Sea**

Ran Ye, Xiansen Ye, Lian Liu, Min Ren, Qiong Wang, Kai Wang, Wei Cao, Qinyan He and Yanhong Cai

**Change dynamics analysis of the shoreline using optical sensors in coastal stretch of Bay of Bengal, India**

Swati Katiyar and Pavan Kumar

**Seasonal variability of phytoplankton in the North Pacific and North Atlantic Ocean from space**

Min Zhang, Yuanling Zhang, Fangli Qiao, Jia Deng and Gang Wang

**A quantitative definition of global warming hiatus and 50-year prediction of global mean surface temperature**

Meng Weij, Fangli Qiao and Jia Deng

**Plankton distribution characteristics and its interactive relationship in southern waters of Miaodao Archipelago**

Yuan-yuan Wang, Jie Liand Hong-hua Shi

**Ichthyoplankton assemblage structure of spring in the Yangtze estuary revealed by biological and environmental visions**

Hui Zhang, Weiwei Xian and Shude Liu

**The impact of winter East Asia Monsoon and ice coverage variation on Japanese scallop aquaculture in Saroma Lake, Japan**

Yang Liu, Sei-Ichi Saitoh, Kimihiko Maekawa, Shouyi Yuan and Toru Hirawake

**Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current large marine ecosystem**

Aimee A. Keller, Lorenzo Ciannelli, W. Waldo Wakefield, Victor H. Simon, John A. Barth, and Stephen D. Pierce

**Evaluating management strategies of limited data species based on hierarchical demographic approaches: An example using yellow croaker (*Larimichthys polyactis*) along north Pacific coast of China**

Yiping Ren, Yan Jiao, Ying Xue, Rong Wan and Qiuyun Ma

**Climate change and the fishery in Russia-2030**

Oleg Bulatov

**The International Group for Marine Ecological Time Series (IGMETS): Assessing global oceanic changes through joint time series analysis**

Andrew R.S. Ross, Nicholas Bates, Antonio Bode, James Cloern, Kirsten Isensee, Mike Lomas, Laura Lorenzoni, Anish Lotliker, Frank Muller-Karger, Todd O'Brien, Anthony Richardson, Luis Valdés and Peter Wiebe

**Island economic vulnerability to natural disasters — The case of Changdao**

Zhiwei Zhang and Aiping Feng

**BIO/MONITOR/TCODE Topic Session (S2)*****The 2014/15 El Niño and anomalous warming of the North Pacific: What happened?***

Co-Convenors: *William Peterson (USA), Lisa Eisner (USA), Tony Koslow (USA)*

Invited Speakers:

*Nicholas Bond (University of Washington, USA)*

*Emanuele Di Lorenzo (Earth and Atmospheric Sciences, Georgia Institute of Technology, USA)*

Background

Major El Niño events in 1982/83 and 1997/98 had massive impacts on the ecosystems of the North Pacific Ocean. In spring 2014, computer models were predicting another major El Niño for 2014/15. However, it now appears that the event is weakening (but who knows what the future holds). Despite this, it is perhaps more noteworthy that the entire Pacific north of ~35°N is anomalously warm with SSTs in the Gulf of Alaska that are  $>4\sigma$  above the long-term mean. This warming event appears to be unprecedented, with strong signals in the Gulf of Alaska and Bering Sea, and across the Pacific to Japan, as well as in the Oyashio, the Sea of Okhotsk and coastal waters surrounding Russia, Japan and Korea. Anomalous warming is also seen in the Arctic Ocean, Baffin Bay, the Labrador Sea and much of the far north Atlantic. Key questions addressed in this session included what are the atmospheric conditions leading to wide-spread warming, what are the consequences for local weather, and, what are the consequences to ecosystem structure and fisheries? The session's purpose was to encourage researchers to present evidence of anomalous behaviour in the ecosystems of the North Pacific, including descriptions of anomalous behaviour in the physical environment, the chemistry of the oceans and the biological impacts of the physical anomalies.

Summary of presentations

An interdisciplinary group of scientists representing predominantly the eastern Pacific countries convened for a full-day session to examine the anomalous warming of the Pacific since 2013 followed by a developing El Niño in 2014/2015. The session was well attended and there was a strong sense of discovery as the talks dealt with ongoing phenomena that were still poorly understood. There were 2 invited talks followed by 11 oral presentations. The invited speakers were allotted 35 minutes, with 30 minutes for the other presentations. This allowed time for adequate discussion, which was vigorous and exciting. The initial talks focused on the meteorology and physical oceanography, with subsequent talks examining the apparent ecological responses to the warming, often from a regional or national perspective.

The first invited talk by Nicholas Bond focused on the meteorological conditions that set up the so-called warm “blob”, a term coined by the speaker. He covered the evolution of conditions from the blob, induced by reduced winter cooling, to the developing El Niño.

The second invited talk was by Dr. Emanuele Di Lorenzo, which developed a framework for interpreting the anomalous conditions related to atmospheric teleconnections between the tropics and extra-tropics. He linked the atmospheric ridge that led to development of the “blob” to the activity of the North Pacific Oscillation (NPO), which activates El Niño conditions in the tropics.

Dr. Jack Barth provided a detailed picture of the evolution of physical oceanographic conditions off Oregon in relation to the “blob” and developing El Niño. The most dramatic event was a spike in SST of 6°C in 6 hours on September 14, 2014. This talk concluded a set of three talks that focused on the physical conditions.

Dr. Angelica Peña delivered a talk on the phytoplankton response off Canada to the anomalous warming. Enhanced winter stratification due to the persistent warm “blob” limited nutrient regeneration, leading to a more diverse phytoplankton assemblage in the winter of 2013/2014. However, coastal waters remained cool and thus far phytoplankton conditions in 2015 do not appear anomalous.

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Dr. Eliana Gómez-Ocampo from Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Mexico, presented a picture of the physical and biological oceanographic conditions off Baja California. Around August 2014, a strong warm water anomaly (6°C) developed in that region, leading to an approximately 50-m deepening of the thermocline which, in turn, influenced the availability of nutrients and light for phytoplankton growth. She presented interesting results of a Generalized Additive model (GAM) that related Absolute Dynamic Topography (ADT) to primary production based on satellite data from 1998–2012.

Dr. Sonia Batten discussed results from the Continuous Plankton Recorder (CPR) surveys of the Northeast Pacific, which began in 2000, to examine ocean influences on the abundance of large phytoplankton and zooplankton. Interestingly, warm water copepods were more abundant in 2014 but not dramatically so.

Dr. Tony Koslow presented a paper by William Peterson, who was unable to attend, on the evolution of physical and biological conditions off Oregon. The “blob” produced the most positive (warm) winter PDO conditions ever recorded since the inception of his survey. Eight copepod species were recorded off Oregon that had never been recorded from that region, along with several that were only rarely recorded. A further 9 copepod species remain to be identified. Most of these new or rare species were of offshore rather than southern origin. Anchovy and sardine eggs were also sampled, another first for his time series; both species normally spawn off southern to central California. Several other fish species with tropical/sub-tropical affinities have also been observed recently off Oregon.

Dr. Akash Sastri described observations off the west coast of Vancouver Island of zooplankton abundance and productivity, based on a chitobiase assay. Crustacean zooplankton abundance was the lowest ever observed in 2015, with the zooplankton community dominated by gelatinous zooplankton. This led to anomalously low estimates of crustacean zooplankton production.

Dr. Sam McClatchie showed results of analyses of ichthyoplankton diversity from CalCOFI sampling off southern California, related to the relative influence of northerly and equatorial water. He pointed to the inter-correlations between low oxygen and low pH water in confounding interpretations of factors responsible for changes in the ichthyoplankton community.

Dr. John Field presented observations from central California on anomalies in the pelagic micronekton over the past year, which saw high abundances of pelagic red crabs and gelatinous zooplankton.

Dr. Anne Hollowed gave a talk based on the apparent impact of the “blob” on the abundance and distribution of fishes in the Gulf of Alaska. One key finding was that fish were located deeper in the water column in 2015 than in colder years. This was followed by a talk by Ian Perry on how anomalous conditions have affected the marine system in Canadian waters.

Dr. Fei Chai concluded the scheduled talks by comparing observations with results of ROMS modeling for the west coast of North America. As he showed, the “blob” influenced nutrient availability and consequently both the phytoplankton and zooplankton. The extent of this phenomenon appeared unique in the observational record.

Lively discussions followed the talks that extended past the session itself. Given the magnitude of the El Niño that is now predicted, there was considerable support to follow up this session with one on the continued evolution of ocean conditions, to be held at PICES-2016 in the USA.

### List of papers

#### *Oral presentations*

#### **Causes and effects of the recent warming in the Northeast Pacific Ocean (Invited)**

Nicholas A. Bond and Meghan Cronin

**Persistent record-high temperatures in the North Pacific in 2014/2015: A climate hypothesis (Invited)**

Emanuele Di Lorenzo and Nathan Mantua

**Arrival of 2014-2015 Warm Anomaly waters off Oregon**

P. Michael Kosro, Craig Risien, John A. Barth, Alexander Kurapov, R. Kipp Shearman and P. Ted Strub

**Phytoplankton responses to the anomalous warming in the NE Pacific**

Angelica Peña, Nina Nemcek and Marie Robert

**Warm Blob effects on subtropical NE Pacific Ocean phytoplankton**

Eliana Gómez-Ocampo and Gilberto Gaxiola-Castro

**The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling**

Sonia Batten

**The effects of The Blob on the zooplankton and upper trophic levels of the Northern California Current off Oregon**

William T. Peterson, Jennifer Fisher, Jay Peterson and Tracy Shaw

*Presented by Anthony Koslow on behalf of William T. Peterson*

**Observations of anomalously low crustacean zooplankton production rates along the west coast of Vancouver Island in the spring of 2015**

Akash R. Sastri, John F. Dower, Aidan Neill, R., Karyn D. Suchy, Moira Galbraith, Kelly V. Young and R. Ian Perry

**Ichthyoplankton and corrosive waters off southern California**

Sam McClatchie, Andrew R. Thompson and William Watson

**Anomalous patterns in California Current pelagic micronekton distribution and abundance in 2015**

John C. Field, Keith M. Sakuma, Baldo B. Marinovic, Cynthia N. Carrion and Nathan J. Mantua

**Preliminary observations of the impact of the BLOB on the summer distribution of marine fish in the Gulf of Alaska**

Anne B. Hollowed, Chris Wilson and Wayne Palsson

**Anomalous warming and its impacts in the NE Pacific from a Canadian perspective**

R. Ian Perry, Moira Galbraith, Peter Chandler, Howard Freeland, John Dower, Akash Sastri, Mark Hipfner, Jennifer Boldt and Marc Trudel

**Anomalously warm conditions during 2013-2015 off the California Coast**

Yi Chao, John Farrara and Fei Chai

*Presented by Fei Chai on behalf of Yi Chao*

**FIS Topic Session (S3)**

***Eastern-western approaches to fisheries: resource utilization and ecosystem impacts***

Co-sponsor: International Council for the Exploration of the Sea (ICES)

Co-Convenors: *Gordon H. Kruse (USA), Shijie Zhou (Australia), Xianshi Jin (China), Jacquelynne King (Canada), Mitsutaku Makino (Japan), Marie-Joëlle Rochet (France)*

Invited Speakers:

*Xianshi Jin (China)*

*Marie-Joëlle Rochet (France/ICES)*

*Shijie Zhou (Australia)*

**Background**

FUTURE endeavors to develop a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services and marine-dependent social systems. Although climate change has garnered much deserved attention so far, the direct and indirect interactions of human society on marine ecosystems and the services they provide are also of great concern. Fisheries are major contributors to global food security, while also posing threats to some ecosystem services. Rising demand for seafood and increasing concerns about the ecosystem effects of fishing create a fisheries management dilemma. Improved understanding about how human activities alter marine ecosystem structure

and function is central to exploring options to procure food security in the future. In North America and Europe, emphasis is placed on conservative catch limits for fisheries that are highly selective for large-sizes of certain species. In Asia, a wide spectrum of fish species and sizes enter seafood markets, and less emphasis is placed on constraining catches. Both approaches affect ecosystem structure and functioning. By comparing approaches, can East and West learn from each other? Although questions about how to increase fisheries production while reducing environment impacts are not new, new ideas have entered the debate. For example, “balanced exploitation” advocates sustainable removal levels that strive to maintain natural balance among species, stocks, sexes, and sizes, thus preserving biodiversity. Yet, fisheries are commercial enterprises that must supply consumers with seafood at a profit. Also, fishing represents a diversity of lifestyles that span small-scale, artisanal fishers to large multinational corporations. This topic session provided a forum to compare and contrast alternative fishing strategies for sustainable global food security.

### Summary of presentations

This was a very successful and well-attended topic session that addressed differences among Eastern and Western styles of fishing. The comparisons among PICES member countries in the Northwest and Northeast Pacific were greatly enriched by three presentations from ICES countries. The session was highlighted by three invited speakers.

Invited speaker, Xianshi Jin, gave an overview of the history of fishery resource utilization in China since the 1950s. Chinese fishery production increased slightly during the 1950s to the early 1980s, and then experienced a rapid increase over the ensuing three decades. In 2014, a total of 64.6 million t were landed, with 14.8 million t from marine capture fisheries, 18.1 million t from mariculture, 29.4 million t from freshwater culture and 2.3 million t from freshwater capture fisheries. Since the 1980s, the landings from mariculture greatly increased, as well as its proportion of the total landings; however, there was a significant increase in landings from marine capture fisheries until the end of 1990s, which then kept relatively stable; meanwhile, there was a continuous decrease in the proportion of marine fisheries landings in the total landings since the 1980s. Unlike many other countries with significant fishery discards, there are essentially no discards in Chinese marine capture fisheries; algae, jellyfish, small-sized fish, and other taxa are landed for sale. Chinese marine capture fisheries have suffered from overfishing, pollution, coastal development, climate change, and various ecological disasters (algal blooms, jellyfish outbursts, *etc.*). Significant changes in fish community composition in coastal waters have resulted, with a relative increase in low-valued species. Meanwhile, populations of some valuable species showed a recovery in recent years, *e.g.*, small yellow croaker, though its population experienced age/size truncation, faster growth rates, decline in maximum size, increase in mortality, and the catch demonstrated stable fluctuations. Dr. Jin identified a pressing need to conserve coastal resources including the need for an ecosystem-based fishery management approach. To date, management response has been widely conducted in China coastal fisheries, such as seasonal closures, fishing licenses, a vessel scrapping program, and some other measures. In addition, a lot of mitigation measures also have been involved, for example, restocking programs, sea ranching, and IMTA (Integrated multi-trophic aquaculture).

Invited speaker, Dr. Shijie Zhou, explained that fishing intensity and selectivity affect not only yield, but also the ecosystem. The implications depend on the model being used to explore the effects. For instance, size-spectrum model simulations suggest that selective harvests have more negative effects on community structure and produce lower yields than a more balanced approach to fishing. Ecosystem models indicate that balanced harvest results in higher yield and lower stock depletion than selective harvests. Interestingly, highly selective fishing on the lowest and most productive trophic level results in the least impact on community structure. Holling-Tanner models involving three trophic levels show that balanced harvest in which fishing mortality is proportional to the intrinsic population growth rate produces the highest catch. On the contrary, a balanced harvest in which catch is proportional to current growth, as well as a strategy that fishes only on the primary consumer, results in the least adverse effects on trophic structure. Interestingly, a non-selective fishing policy in which catch is proportional to biomass produces modest yields, but the most adverse effects on trophic structure. Effects of alternative approaches on single-species were also considered. Considering the effects within one species, a minimum size limit leads to high yields, but truncated size structure. Catch in proportion



to abundance results in low yield and truncated age structure. A balanced harvest (catch in proportion to growth) provided low yield, but maintained size structure. And, finally, slot selection (catch of a narrow size/age range) produced the highest yields and extended age structure.

Invited speaker, Dr. Marie-Joëlle Rochet, talked about the landing obligation in the new European Union (EU) Common Fishery Policy, which was launched in January 2014. Among the changes, landing quotas were replaced with catch quotas and minimum landing sizes were replaced with minimum conservation reference sizes (MCRS). Fish of the quota species smaller than MCRS must be landed and used for purposes other than non-human consumption. Discards have been a problem in the EU for the long term, as they account for a large proportion of the catch of some stocks. However, discard rates vary among vessels, seasons, species, fisheries, countries, and areas. For a variety of reasons, full implementation of the new landing obligation has been delayed until 2017. For pelagic fisheries, which have generated low levels of discards, the limits are in force and fishing is proceeding as usual. For demersal fisheries, definition of target species and fisheries, setting of catch quotas, and MCRS are still being worked out. Pilot trips have been conducted, and preliminary results indicate that fishing selectivity might be difficult to improve in many instances and some skippers and crew may be reluctant to comply with the new regulations. Ultimately, the outcome of the new Common Fishery Policy will depend upon the ability of member states to enforce regulations.

Contributed talks provided additional interesting contrasts in eastern and western approaches. For example, Dr. Zuozhi Chen talked about the marine fish stocks in the northern South China Sea (NSCS). More than 1,500 fish species occur in the NSCS of which about 100 are commercially exploited by about 600,000 fishermen, with total landings of 3.6 million t. Trends over the past 50 years include a large increase in fishing power, declining catches, and major changes in catch composition toward smaller fish. The current fishery is plagued by overcapacity, overfishing, harvests of juvenile fish, illegal fishing, and habitat destruction.

In contrast, Dr. Gordon Kruse talked about highly selective commercial groundfish fisheries in the eastern Bering Sea (EBS). In 2013 total marine fishery landings off Alaska equaled 2.6 million t, accounting for 59% of all U.S. landings. Catches from the EBS are dominated by walleye pollock, followed by Pacific cod, several flatfish fisheries, and smaller fisheries for rockfishes and other species. Although fisheries are highly selective, they are managed using an ecosystem-based fishery management approach, which includes license limitations, individual fishery quota programs, scientifically based catch limits, prohibition of discards for fisheries for pollock and cod, ban on forage fish fisheries in federal waters to preserve their ecosystem benefits, strict controls on bycatch and prohibited species, and area closures to protect sensitive habitats and areas required by feeding Steller sea lions. Many ecosystem indicators are monitored to evaluate performance relative to fishery and ecosystem objectives.

Dr. Richard Law considered the theoretical basis for exploiting the natural productivity of aquatic systems, noting that more biomass is available by exploiting small fish than large fish. He contrasted major commercial fisheries, which are driven by economic markets for large fish, with small, artisanal fisheries. He found that selectivity for large fish leads to lower yields in biomass, as well as more size truncation, lower stock resilience, and more fisheries-induced evolution. However, if fishing mortality is constrained to match productivity, then it partially substitutes for natural predation, and results in higher yields and fewer adverse fishery impacts. Interestingly, this is predicted to emerge naturally in a small-scale fishery, when fishers are able to change gear to increase their biomass yield and are not constrained by minimum-size regulations.

Ms. Shengle Yin discussed a case study for selection of coastal aquaculture sites based on environmental, conservation and socio-economic considerations in the U.K. The approach involved both a hydrodynamic model of currents and tides, as well as a questionnaire approach. Optimal sites were identified that avoided special conservation areas, as well as shipping channels required for navigation.

Prof. Xinyu Guo examined annual variability in Japanese common squid off Japan using a physical oceanographic model. A number of factors were considered, including changes in the parent stock, water temperature, and different assumptions about advection. The parent stock turned out to be the most influential factor.

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Ms. Hyun Kim developed a length-based production value-per-recruit analysis for the small yellow croaker fishery in Korean waters. It was argued that this length-based model is better than age-based models in data-limited situations because aging is expensive and fish prices are based on length, not age.

Ms. Minkyong Bang examined changes in the characteristics of walleye pollock among high and low biomass periods. Among other changes, during high biomass periods, fish were smaller, length at 50% maturity was larger, and condition factor was lower.

Mr. Hee Joong Kang developed an ecosystem-based acceptable biological catch (ABC) for consideration in Korea. In addition to traditional population-level factors used to set single-species ABC that provide for sustainability, the proposed approach applies a species risk index developed from considerations of biodiversity, habitat quality and socio-economic benefits.

Remaining talks considered a diversity of approaches. Dr. Vladimir Kulik examined the effects of fishing on ecosystem structure of the northeastern part of the Okhotsk Sea using an ecosystem inverse linear model. Dr. Binduo Xu talked about optimal sampling designs for an assessment survey with multiple objectives, and Ms. Juri Hori considered the effect of changes in marine ecosystems on human well-being using an online questionnaire conducted in China, Indonesia, Korea, Japan, and the U.S.

In addition to the 14 oral presentations, presenters of the 4 posters gave 2-minute overviews of their research during the topic session. The presentations elicited excellent question and answer dialogues, and the session also included three lively discussion sessions.

### List of papers

#### *Oral presentations*

**The marine fisheries resource utilization, ecosystem impacts and fisheries management in China (Invited)**

Xianshi [Jin](#) and Xiujuan Shan

**Exploitation and management of fisheries resources in northern South China Sea**

Zuozhi [Chen](#) and Yongsong Qiu

**An ecosystem-based fishery management approach toward sustainable groundfish resource utilization in the eastern Bering Sea**

Gordon H. [Kruse](#)

**Optimization of sampling design for a fishery-independent survey with multiple objectives**

Binduo [Xu](#), Yiping Ren, Yong Chen, Chongliang Zhang, Ying Xue and Rong Wan

**Selection of suitable coastal aquaculture sites with environmental and socio-economic consideration: A case study in the Menai Strait, UK**

Shengle [Yin](#), Aigo Takeshige, Yoichi Miyake and Shingo Kimura

**Effects of changes in marine ecosystem services on human well-being: International comparison of human well-being structure**

Juri [Hori](#) and Mitsutaku Makino

**Alternative fishing strategies and their consequences (Invited)**

Shijie [Zhou](#)

**Exploiting the natural productivity of aquatic ecosystems**

Richard [Law](#), Gustav W. Delius, Jeppe Kolding and Michael J. Plank

**The effects of fishing on ecosystem structure of the Northeastern part of the Okhotsk Sea**

Konstantin M. Gorbatenko, Vladimir V. [Kulik](#) and Artem E. Lazshentsev

**Modeling interannual variations of Japanese common squid (*Todarodes pacificus*) resources around Japan**

Xinyu [Guo](#), Yucheng Wang, Taishi Kubota and Naoki Yoshie

**Management of small yellow croaker, *Larimichthys polyactis* stock in Korean waters using a length-based production value-per-recruit analysis**

Hyun A [Kim](#), Young Il Seo and Chang Ik Zhang

**Changes in ecological characteristics of walleye pollock *Gadus chalcogrammus* in accordance with the biomass fluctuation**  
Minkyung [Bang](#), Sukyung Kang, Suam Kim and Myong Ho Shon

**The Landing Obligation in the European Union Common Fisheries Policy: Can a regulation focused on resource utilization address broader management objectives such as limited environmental impacts, economic development, and food supply? (Invited)**

Marie-Joëlle [Rochet](#), Verena Trenkel and Laurence Fauconnet

**Acceptable Biological Catch in the ecosystem-based TAC management**

Hee Joong [Kang](#), Young Il Seo and Chang Ik Zhang

### *Poster presentations*

**Assessment of Korean pollock population under data-limited situation**

Saang-Yoon [Hyun](#) and Kyuhan Kim

**Fishery stock assessment and management system in Japan**

Tetsuichiro [Funamoto](#)

**Redistribution of anchovy (*Engraulis japonicus*) wintering stock under climate change scenarios in the Yellow Sea**

Yunlong [Chen](#), Xiujuan Shan, Fangqun Dai and Xianshi Jin

**Efficacy of fishery closure in rebuilding depleted stocks: Accounting for trophic interactions**

Chongliang [Zhang](#), Yong Chen and Yiping Ren College of Fisheries, Ocean University of China, Qingdao, PR China

## **MEQ Topic Session (S4)**

### ***Indicators of emerging pollution issues in the North Pacific Ocean***

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors: *Peter S. Ross (Canada) and Olga Lukyanova (Russia)*

Invited Speakers:

*Tomohiko Isobe (National Institute for Environmental Studies, Japan)*

*Hyo-Bang Moon (NOWPAP, Korea)*

*Vladimir Shulkin (NOWPAP, Russia)*

*Hideshige Takada (NOWPAP, Japan)*

### Background

This session, led by the Working Group on *Emerging Topics in Marine Pollution* (WG-ETMP), provided a forum for wide-ranging interests from a number of disciplines. The purpose of the session was to attract presentations on the use of sediments, shellfish, fish, seabirds, and marine mammals as indicators of marine pollution, and to discuss novel approaches and study designs, with the aim of providing managers, regulators and scientists with timely feedback on emerging pollution threats. The session was open to discussion of a wide range of pollutants including hydrocarbons, organochlorine pesticides, flame retardant chemicals, metals, pharmaceuticals, microplastics and other contaminants. Presentations that provided insight into the identification of contaminants of emerging concern, the ranking of priority pollutants from multiple sources, and the assessment of the relative importance of pollutants among other natural and anthropogenic stressors were encouraged, and presenters were invited to contribute to a special issue of a scientific journal.

### List of papers

#### *Oral presentations*

**Microplastic: An emerging threat to marine environment and a new tool for POP monitoring (Invited)**

Hideshige [Takada](#), Rei Yamashita, Yohei Okazaki, Bee Geok Yeo, Ryu Yoshida, Atsuko Kondo and Yu Saito

## Session Summaries-2015

### **Spatial variability of trace metal concentrations in different mussels from coastal areas of the northwestern Pacific Ocean (Invited)**

Vladimir M. [Shulkin](#) and Victor Ya. Kavun

### **Levels and temporal trends of legacy and emerging POPs in small cetacean species from Japan (Invited)**

Tomohiko [Isobe](#), Yuko Tajima, Tadasu K. Yamada, Masao Amano, Takashi Matsuishi, Tatsuya Kunisue and Shinsuke Tanabe

### **Monitoring of legacy and emerging contaminants in wildlife from Korea (Invited)**

Yunsun Jeong, Hyun-Kyung Lee, Xiangzi Jin, Sunggyu Lee and Hyo-Bang [Moon](#)

### **Microplastic is the macroproblem of the world's oceans, including the Russian Far East**

Iana [Blinovskaia](#)

### **At-sea distributions reveal where Cassin's Auklets are exposed to microplastics in the fall in British Columbia 2014**

Patrick D. [O'Hara](#), Jocelyn Wood, Stephanie Avery-Gomm, Laurie Wilson, Ken H. Morgan and Peter S. Ross

### **Spatial and temporal mercury trends in seabird eggs from Pacific Canada 1968-2012 are due to diet: Evidence from sulfur isotopes**

Kyle H. Elliott and John E. [Elliott](#)

### **Mercury speciation and major factors controlling the cycling of methylmercury in the Yellow Sea and Bohai Sea, China**

Yanbin [Li](#), Lufeng Chen and Yongguang Yin

### **Persistent organic pollutants in the food chain: Salmon, seabirds and marine mammals from the North-West Pacific (Russian Far East)**

Vasilij Yu. [Tsygankov](#), Margarita D. Boyarova, Peter A. Tyupelev, Ilya A. Shcherbakov, Olga N. Lukyanova and Nadezhda K. Khristoforova

### **Emerging ocean pollution issues in the NE Pacific Ocean vary by matrix: Lessons from sediments, shellfish and marine mammals**

Peter S. [Ross](#), Carmen Morales-Caselles and Marie Noel

### **Bioindicators of marine pollution in impacted areas of the Sea of Okhotsk**

Olga N. [Lukyanova](#), Elena V. Zhuravel, Denis N. Chulchekov, Olga V. Podgurskaya and Andrey A. Mazur

### *Poster presentations*

#### **Acute effects of emamectin benzoate on the calanoid copepod *Pseudodiaptomus poplesia***

Xiaoyan [Yi](#), Yunyun Zhuang, Hongju Chen, Yousong Huang, Feifei Yang, Huan Zhang and Guangxing Liu

#### **Phototransformation of oxytetracycline in saline waters under simulated sunlight irradiation: Kinetics, mechanism and products**

Cui [Zhang](#), Xuefeng Hu and Yongming Luo

*Presented by Qian Zhou on behalf of Cui Zhang*

#### **Assessment of marine environment quality of the coastal zone of Peter the Great Bay (the Sea of Japan/East Sea)**

Tatyana A. [Belan](#), Tatyana S. Lishavskaya, Alexander V. Sevastianov, Tatyana V. Chatkina and Boris M. Borisov

*Presented by Olga Likyanova on behalf of Tatyana Belan*

#### **Metal concentrations in pink and chum salmon (Kuril Islands, the North Western Pacific)**

Vasilij Yu. [Tsygankov](#), Nadezhda K. Khristoforova, Margarita D. Boyarova and Olga N. Lukyanova

#### **Estimation of seawater pollution in Uglovoy Bay (Peter the Great Bay, Japan/East Sea)**

Valery I. Petukhov, Oleg V. [Losev](#) and Evgeniya A. Tikhomirova

*Presented by I. Blinovskaya on behalf of O. Losev*

**Topic Session (S5)*****Ocean circulation of the Western Pacific and its response to climate change***

Co-sponsor: Climate and Ocean – Variability, Predictability, and Change (CLIVAR)

Co-Convenors: *Zexun Wei (China), Wang Dongxiao (China), Dezheng Sun (USA), R. Dwi Susanto (USA)*

Invited Speakers:

*Jianping Gan (Hong Kong University of Science and Technology, Hong Kong, SAR China)*

*Xiaopei Lin (China)*

*Tangdong Qu (University of Hawaii, USA)*

Background

The ocean circulation system of the Western Pacific is complex. The Mindanao Current and the Kuroshio originate from the North Equatorial Current, and the Indonesia Throughflow connects the Pacific and Indian Ocean. The region is characterized by the strongest atmospheric convection and greatest frequency of typhoons anywhere in the world. The ocean circulation of the Western Pacific carries heat from low latitude to high latitude areas where it is released to the atmosphere, adjusting the global air temperature. Meanwhile, processes in this region play a key role in the formation and evolution of the Western Pacific Warm Pool, and have an important effect on the global climate system. The ocean circulation and Warm Pool in the Western Pacific play an important role in regulating the ENSO cycle, the East Asian Monsoon and Subtropical High, and have a significant effect on the marine environment and regional climate in East Asian marginal seas. This session was directed on the North Equatorial Current bifurcation, Mindanao Current, the Indonesian Throughflow, and the Kuroshio and its interaction with the coastal circulation, and focused on their response to climate change, feedback process and its mechanism.

Summary of presentations

This popular topic session attracted more than 100 attendees. The session highlighted key overview presentations of observations and contemporary insights on novel methods to better explore the circulation in the West Pacific and its response to climate change.

Three invited speakers presented their reports. Dr. Tangdong Qu showed sea surface salinity (SSS) variability in the equatorial Pacific, and highlighted the possibility of SSS as a novel index for ENSO. Dr. Jianping Gan presented excellent results of a numerical model and pointed out several key points in researching the Western Pacific and its adjacent area. Dr. Xiaopei Lin indicated that the decadal variability of the Kuroshio is very sensitive to global warming.

Other talks included those of Dr. R. Dwi Susanto and Dr. Zexun Wei who highlighted the importance of Indonesian Through Flow (ITF) to thermohaline circulation and climate change. Twelve talks (four talks in the published schedule were cancelled) and six posters were presented. Substantial time was allotted to discussion during the session.

The conclusions of this session were fruitful and improved our understanding of ocean circulation in the Western Pacific and its response to climate change.

List of papers*Oral presentations***Sea surface salinity variability in the equatorial Pacific and ENSO (Invited)**

Tangdong Qu

**Extrinsic control on the China Seas circulation from the western Pacific Ocean (Invited)**

Jianping Gan

## Session Summaries-2015

### **The Kuroshio decadal variability and its climate impact (Invited)**

Xiaopei Lin, Jiayan Yang, Ping Chang and Lixin Wu

### **Indonesian throughflow and its proxy from satellite altimeters and gravimeters**

Raden Dwi Susanto, Y. Tony Song

### **Pacific to Indian Ocean throughflow and its South China Sea branch**

Zexun Wei, Guohong Fang, R. Dwi Susanto, Agus Setiawan, Shujiang Li and Tengfei Xu

### **The responses of the Indian Ocean Dipole and South China Sea to El Niño Modoki**

Xin Wang, Chunzai Wang and WeiTan

### **A triggering mechanism for the Indian Ocean Dipoles independent of ENSO**

Shuangwen Sun, Jian Lan and Yue Fang

### **Impact of the chlorophyll bias on tropical mean states with bio-geophysical feedback**

Hyung-Gyu Lim, Jong-Seong Kug and Jong-Yeon Park

### **The development of a new eddy-resolving global ocean forecasting system in NMEFC**

Yu Zhang, Huier Mo and Yinghao Qin

### **The annual velocity along the Slope of Northern South China Sea (SNSCS) from mooring observation**

Dongfeng Xu, Chenghao Yang, Jun Wang, Mingquan Xu, Hong Chen and Yaochu Yuan

### **Comparison between surface cyclonic and anticyclonic eddies along the Kuroshio in the northwestern Pacific Ocean**

Dandi Qin, Jianhong Wang, Changming Dong and Yu Liu

### **The structure analysis of typical western Pacific Ocean eddies forced by strong typhoons**

Jianhong Wang, Chunsheng Miao, Yuyang Deng, Meiqi Li and Liu Gang

### *Poster presentations*

#### **Influences of Indian Ocean and Atlantic Ocean SST on the intensity of interannual variability in summer rainfall over southern China**

Jiepeng Chen, Zhiping Wen, Renguang Wu, Xin Wang, Chao He and Zesheng Chen

#### **The vertical distributions of the volume transport through major exit passages of the Pacific to Indian Ocean Throughflow**

Yonggang Wang, Zexun Wei, Tengfei Xu and Liwei Wang

#### **A comparison of wind stress datasets for the South China Sea**

Zhan Lian, Guohong Fang, Zexun Wei, Gang Wang, Baonan Sun and Yaohua Zhu

#### **Numerical study on the bottom branch of the Yellow Sea Warm Current**

Junchuan Sun, Zexun Wei, Dezhou Yang and Baoshu Yin

#### **A statistical analysis of mesoscale eddies in the northwest Pacific Ocean from 22 years of altimetry data**

Wei Cui, Jie Zhang and Jungang Yang

## **POC/BIO/MONITOR/TCODE Topic Session (S6)**

### ***Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean***

Co-Convenors: *Li-Qi Chen (China), Fei Chai (USA), Kitack Lee (Korea), Toru Suzuki (Japan)*

#### Invited Speakers:

*Richard Bellerby (SKLEC-NIVA Centre for Marine and Coastal Climate Research, East China Normal University, China)*

*Richard Feely (NOAA Pacific Marine Environmental Laboratory, USA)*

*Kunshan Gao (Xiamen University, China)*

*Ja-Myung Kim (Pohang University of Science and Technology, Korea)*

#### Background

Ocean acidification (OA) in the 21<sup>st</sup> century has reached levels not seen for 55 million years. The average surface pH of the world ocean has decreased by 0.1 since the industrial revolution and is projected to decrease

0.3 to 0.4 pH by the end of this century, an up to 2.5 times increase in ocean acidity. Due to its cold water temperature, low alkalinity and rapid loss of sea-ice, the subarctic Pacific Ocean and adjacent Arctic Ocean have absorbed large amounts of atmospheric CO<sub>2</sub> and have changed the CaCO<sub>3</sub> system so that aragonite unsaturated states have appeared or will appear soon on a large scale. OA in the subarctic Pacific Ocean will greatly change the marine chemical environment with far-reaching effect on marine ecosystems. This session included a review of observations and research on OA and looked at the potential for development of an OA observation network. Main discussion issues were 1) advances in investigations and research in OA in the North Pacific and adjacent areas of the Arctic Ocean, 2) the role of the North Pacific and the Pacific Arctic regions in GOA-ON (Global Ocean Acidification Observation Networks) and AMAP-AOA (Arctic Monitoring and Assessment Program-Arctic Ocean Acidification) and 3) the exchange of data and involvement of early career scientists interested in OA.

### Summary of presentations

This popular 1-day session presented 20 talks, including 4 from invited speakers and 7 from early career scientists and students. In addition, 10 posters were given.

Invited speaker, Dr. Richard Feely (USA), introduced the status and initial results of Global Ocean Acidification Observing Network (GOA-ON). Second invited speaker, Professor Richard Bellerby (Norway; presently at East China Normal University, Shanghai), presented key findings in ocean chemistry, biological responses, and socio-economic implications due to ocean acidification conditions in the Arctic Ocean. He described policy-relevant recommendations and research strategy in the future, and encouraged participants to follow up on information provided by the Arctic Monitoring and Assessment Programme (AMAP).

Invited speaker, Professor Kunshan Gao (China), showed his group's latest results on the effects of ocean acidification on marine primary producers. His group's research showed that the positive or negative effects of OA depends on light or solar radiation levels. Ocean acidification increases levels of phenolic compounds in phytoplankton and zooplankton, implying a food chain impact. In the meantime, UV radiation and OA interact synergistically to reduce algal calcification and photosynthetic C fixation. Viruses infecting primary producers would be worse under OA.

In an invited talk by an early career scientist, Dr. Ja-Myung Kim (Korea) showed the results of POC and DOC production shifts under high carbon dioxide and warm ocean conditions, and indicated that an increase in the DOC:POC production ratio implies a shift in the organic carbon flow from particulate to dissolved forms under future ocean conditions. Excess DOC production may act as a positive feedback to increase atmospheric CO<sub>2</sub> (if the produced DOC is labile and rapidly transformed into inorganic carbon by microbial degradation).

Professor Liqi Chen (China) introduced the Chinese work on the Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans, and showed briefly published results on the carbon cycle and on unpublished ocean acidification research. Di Qi, a doctoral student from same laboratory, showed the latest results of ocean acidification in the western Arctic Ocean (WAO) at large, and gave an interesting conclusion that the WAO's OA was partly caused and accelerated by intrusion of Pacific aragonite corrosive "acidified" water into the Arctic Ocean.

Professor Wei-jun Cai (China) detailed DIC changes in the WAO and gave an interesting account of the carbon cycle and ocean acidification with sea-ice retreating over the past two decades.

Dr. Zhongyong Gao used the Chinese national Arctic research expedition and historic Arctic data to compare the carbon fluxes and ocean acidification between two gateways in the Arctic Ocean, *i.e.*, Chukchi Sea and the Nordic Sea, and provided valuable conclusions. The carbon pump is very high effective in the Chukchi Sea, but OA is also happening; Bering Sea inflow water not only maintained the high primary production and high CO<sub>2</sub> flux there, but also caused serious OA.

## Session Summaries-2015

Professor Fei Chai (USA), presenting for Dr. Peng Xiu, discussed their improved high resolution ecosystem model in the Pacific Ocean, up to  $1/8^\circ$  (about 7 to 12 km), and produced an image of anthropogenic  $\text{CO}_2$  accumulation along  $30^\circ\text{N}$  in the Pacific from 1994 to 2004, showing the variability of oceanic carbon cycling and its relation to the ocean acidification in the North Pacific Ocean.

Dr. Bofeng Li (Japan) gave his talk on the spatio-temporal distributions of carbon species in the North Pacific subpolar region by using the parameterization technique.

Dr. Feng Zhou (China) discussed hypoxia off the Yangtze River estuary, reporting on results from observations and simulations. A coupled 3D ROMS-CoSiNE model was successfully used to explain the hypoxia process off the estuary in 2006. The model results showed that both vertical profile and extent of hypoxia had large intra-seasonal variability. During stratified seasons, hypoxia off the estuary was relieved by episodic wind events (tropical storms or northerly winds, which probably account for large intra-seasonal and inter-annual variability of hypoxia). Hypoxia was sensitive to the change in nutrient concentration from both river and ocean. Significant sediment oxygen consumption in the bottom boundary layer was expected.

Dr. Naohiro Kosugi (Japan) reported on  $p\text{CO}_2$  in the Japan Sea in autumn, and found the contribution of Changjiang diluted water depressed  $p\text{CO}_2$ .

Professor Juying Wang (China) showed the two kinds observation of Variation of sea surface  $p\text{CO}_2$  in the northern Yellow Sea, China, one is  $p\text{CO}_2$  observation, and the other was from long-term station. Those two kinds of methods were compared each other and showed they are agree with each other in general but there were two months totally different from each other. controlling processes in cold seasons were specially discussed.

Dr. Shintaro Takao (Japan) showed the diurnal variation of pH in Oshoro Bay, Hokkaido, Japan, assessing the impacts of ocean acidification on the coastal ecosystem in a monitoring study. Also from Japan, Dr. Michiyo Yamamoto-Kawai analyzed the saturation of calcium carbonate and ocean acidification in Tokyo Bay and Dr. Tsuneo Ono reported on spatio-temporal variation of  $p\text{CO}_2$  in shore-reef waters off Arasaki district, Sagami Bay, Japan.

Dr. Julie Keister (USA) discussed the differential sensitivities of crustacean zooplankton to ocean acidification.

Dr. Liang Xue (China) presented results of his analysis on the question of climate affecting ocean acidification. Gunasekaran clarified the impact of ocean acidification on morphological variation in captive condition of the benthic foraminifera *Ammonia beccarii*.

Professor Ian Jones (Australia) described the expected impact of ocean nourishment on ocean acidity. He believed nourishment can pump hydrogen ions into the deep ocean where acidity can be diluted well. It would be expensive; however, the benefit would be considerable and more importantly, it would cost less than the using wind power to replace the coal.

The session discussed all aspects of ocean acidification, and the talks drew a huge enthusiastic crowd. Our session was enhanced by four invited presentations, which surpassed most of the other sessions in terms of number at the Annual Meeting and showed substantially the importance of ocean acidification nowadays. We suggest setting up a workshop on ocean acidification at next year's Annual Meeting as the next step, to improve this work step by step, and to push forward ocean acidification research and focus on each country's efforts. We feel this topic will make a significant contribution to the whole PICES meeting.



List of papers

*Oral presentations*

**The Global Ocean Acidification Observing Network (GOA-ON): Status and initial results (Invited)**

Richard A. Feely and Elizabeth Jewett

**Arctic Ocean acidification: Present understanding, management requirements and future research strategies (Invited)**

Richard Bellerby, Jeremy Mathis, Wenting Chen, Kumiko Azetsu-Scott, Lisa Miller, Sam Dupont and Howard Browman

**Effects of ocean acidification on marine primary producers (Invited)**

Kunshan Gao

**Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions (Invited)**

Ja-Myung Kim, Kitack Lee, Kyungsoon Shin, Eun Jin Yang, Anja Engel, David M. Karl and Hyun-Cheol Kim

**Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans**

Liqi Chen

**Recent accelerated intrusion of Pacific aragonite corrosive “acidified” water into the Arctic Ocean**

Di Qi

**Carbon cycle and ocean acidification strongly modulated by sea-ice retreat in the Pacific sector of the Arctic Ocean over the past two decades**

Wei-Jun Cai, Baoshan Chen, Liqi Chen, Zhongyong Gao, Heng Sun, Di Qi, and Jianfang Chen

**Comparison of carbon fluxes and ocean acidification between two gateways in the Arctic Ocean: The Chukchi Sea and the Nordic Sea**

Zhongyong Gao, Liqi Chen, Heng Sun, Zhenglin Xiao and Di Qi

**Spatiotemporal distributions of carbon species in the North Pacific subpolar region by using the parameterization technique**

Bofeng Li and Yutaka W. Watanabe

**Variability of oceanic carbon cycling and its relation to the ocean acidification in the North Pacific Ocean**

Peng Xiu and Fei Chai

*Presented by Fei Chai on behalf of Peng Xiu*

**Hypoxia off the Yangtze River estuary: Observations and simulations**

Feng Zhou, Fei Chai, Daji Huang, Huijie Xue, Jianfang Chen, Peng Xiu, Jiliang Xuan, Jia Li, Dingyong Zeng, Xiaobo Ni and Kui Wang

**Autumn depression in  $p\text{CO}_2$  in the Japan Sea and contribution of Changjiang diluted water**

Naohiro Kosugi, Daisuke Sasano, Masao Ishii, Kazutaka Enyo and Shu Saito

**Variation of sea surface  $p\text{CO}_2$  and controlling processes in cold seasons in the northern Yellow Sea, China**

Juying Wang, Huade Zhao, Xuemei Xu, Kunpeng Zang and Nan Zheng

**Diurnal variation of pH in Oshoro Bay, Hokkaido, Japan – A monitoring study assessing and projecting impacts of ocean acidification on a coastal ecosystem**

Shintaro Takao and Masahiko Fujii

**Calcium carbonate saturation and ocean acidification in Tokyo Bay, Japan**

Michiyo Yamamoto-Kawai, Natsuko Kawamura, Tsuneo Ono, Naohiro Kosugi, Atsushi Kubo, Masao Ishii and Jota Kanda

**Spatio-temporal variation of  $p\text{CO}_2$  in shore-reef waters off Arasaki district, Sagami Bay, Japan**

Tsuneo Ono, Ryo Kimura, Toshihiro Onitsuka, Hideki Takami and Daisuke Muraoka

**Differential sensitivities of crustacean zooplankton to ocean acidification**

Julie E. Keister, Anna K. McLaskey, Paul McElhany and M. Brady Olson

**Is ocean acidification disturbed by climate?**

Liang Xue, Meng Wei, Libao Gao, Yongliang Duan and Weidong Yu

**The expected impact of ocean nourishment on ocean acidity**

Ian S.F. Jones

*Poster presentations*

**The surface seawater DMS distributions, sea-air fluxes and its influence to sulfur aerosols in the North Pacific Ocean**

Miming Zhang and Liqi Chen

**Ocean acidification observation system at Bohai Gulf based on ocean acidification characteristic parameters**

Yumei Zhao, Qiufeng Zhang and Bing Han

## Session Summaries-2015

### **Advances in ocean acidification of a vulnerable carbon pool in the Southern Ocean**

Yanmin Wang and Liqi Chen

### **Surface undersaturation and subsurface maxima of nitrous oxide in the Chukchi Sea Shelf and Chukchi Abyssal Plain**

Jiexia Zhang, Liyang Zhan, Liqi Chen, Yuhong Li and Jianfang Chen

### **Trend of ocean acidification in the tropical and subtropical zones of the western North Pacific along 137°E**

Masao Ishii, Naohiro Kosugi, Daisuke Sasano, Takashi Midorikawa, Kazutaka Enyo, Toshiya Nakano and Hisayuki Y. Inoue  
*Presented by Naohiro Kosugi on behalf of Masao Ishii*

### **Effects of CO<sub>2</sub>-driven ocean acidification on the early development of scallop *Argopecten irradians* (Lamarck, 1819)**

Weimin Wang, Guangxing Liu, Tianwen Zhang, Hongju Chen, Liao Tang and Xuewei Mao

### **CDIAC data management and archival support for a high-frequency atmospheric and seawater pCO<sub>2</sub> data set from 14 open ocean moorings**

Adrienne J. Sutton, Christopher L. Sabine and Alex Kozyr

## **POC/BIO/TCODE Topic Session (S7)**

### ***Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5***

Co-Convenors: *Chan Joo Jang (Korea), Ho-Jeong Shin (Korea), Zhenya Song (China), Sukgeun Jung (Korea), Anne Hollowed (USA), Kyung-Il Chang (Korea), Angelica Peña (Canada), Shin-ichi Ito (Japan)*

#### Invited Speakers:

*Jacquelynne R. King (Pacific Biological Station, Fisheries and Oceans Canada, Canada)*

*Shoshiro Minobe (Hokkaido University, Japan)*

*Yongqiang Yu (State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, China)*

#### Background

Climate has been changing and is highly likely to have been influenced by human activities. These changes, which have greatly affected the Earth's environment, have been manifested in oceanic ecosystems. Social demands for information on future projections are increasing the need to adapt to and mitigate climate change. The objective of this session is to update our understanding since IPCC AR5 on the past, present and future climate for the North Pacific Ocean and its marine ecosystems, focusing particularly on climatic change in ecosystem-relevant upper ocean and atmospheric variables. Climate change and its impact have been widely investigated using global climate models, while adaptation and mitigation issues have been studied using mostly regional climate models. While this session invited papers on various topics related to both climate simulations and observations, presentations were encouraged on the development and results of regional climate models (RCMs) and Earth System Models (ESMs), and assessment of hindcast simulations and their application to the projection of future climate or marine ecosystems using coupled general circulation models (CGCMs) in the North Pacific Ocean. Future projections of the North Pacific Ocean and its ecosystems, as obtained from global climate models (including CMIP5 standard experiment data for comparison with RCM results), were also important contributions to this session.

#### Summary of presentations

Dr. Chan Joo Jang (co-convenor, Korea) introduced the goals and objectives of the topic session. He noted that this session included oral presentations from 3 invited speakers, 12 contributed talk, and 11 posters. The talks were organized into three overarching sub-themes: climate change from a global perspective (4 talks); Marine ecosystem and biogeochemistry (6 talks); and ocean dynamics (5 talks). Dr. Jacquelynne King (Canada, invited) introduced climate change from a global perspective sub-theme with an overview of the key findings from the 3<sup>rd</sup> PICES/ICES/IOC Symposium on “*Effects of climate change on the world's oceans*” which was held in Santos, Brazil, in March 2015. The following 3 talks emphasized the importance of maintaining and improving the ocean observation system, the role of heat storage in the global heat budget;

and the performance of CMIP5 models in reconstructing air–sea fluxes in the equatorial Pacific. Dr. Shoshiro Minobe (Japan, invited) introduced the marine ecosystem and biogeochemistry sub-theme by demonstrating how output from CMIP5 models can be used to project range shifts of Pacific salmon. His work suggested that sockeye salmon will be vulnerable to climate change. Dr. Anne Hollowed reported on an international coordinated research program by S-CCME (PICES/ICES Section on *Climate Change Effects on Marine Ecosystems*). The following 5 talks addressed a framework for projecting the implications of climate change on marine ecosystems through innovative modeling approaches. Dr. Yongqiang Yu (China, invited) introduced the ocean dynamics sub-theme with a review of the impacts of external forcing on decadal variability in CMIP5 simulations. The following 4 talks focused on the mechanisms underlying specific ocean features including the genesis of tropical cyclones, seasonal differences in long-term trends in sea surface temperature, and observed patterns of circulation variability. Dr. Shin-Ichi Ito (co-convenor, Japan) closed the session by thanking the speakers. He acknowledged the value of interdisciplinary topic sessions and encouraged continued collaborations within the PICES research community.

### List of papers

#### *Oral presentations*

**Report from Brazil: Effects of climate change on the world's oceans (Invited)**

Jacquelynne King

**The latest progress on global Argo observations**

Jianping Xu and Zenghong Liu

**The CMIP5 ocean heat storage and temperature**

Ho-Jeong Shin and Chan Joo Jang

**Evaluation on air-sea CO<sub>2</sub> fluxes in the equatorial Pacific simulated by CMIP5 models**

Lei Wang, Yong Luo and Jianbin Huang

**SST habitat and food change projections for Pacific salmon (*Oncorhynchus spp.*) in the North Pacific and adjacent seas based on CMIP5 climate models (Invited)**

Shoshiro Minobe, Hiromichi Ueno, James R. Irvine, Alexander V. Zavolokin, Katherine W. Myers, Mio Terada, Mitsuho Oe and Skip McKinnell

**S-CCME's international coordinated research program to project climate change impacts on fish and fisheries by 2019**

Anne B. Hollowed, Kristin Holsman, Shin-ichi Ito, Myron Peck, John Pinnegar and Cisco Werner

**Climate-change driven range shifts of chub mackerel (*Scomber japonicus*) projected by bio-physical coupling individual based model in the western North Pacific**

Sukgeun Jung, Ig-Chan Pang, Joon-ho Lee, Lee Kyunghwan, Tae Hoon Kim, Hwa Hyun Lee, Kyung-Su Kim and Suam Kim

**Potential effect of climate change for copepods distribution in western North Pacific Ocean**

Hiroomi Miyamoto, Kazuaki Tadokoro, Takeshi Okunishi, Hiroya Sugisaki, Kiyotaka Hidaka, Yuichi Hirota, Tsuneo Ono, Kou Nishiuchi, Satoshi Kitajima, Takahiko Kameda, Haruyuki Morimoto and Tadafumi Ichikawa

**Near future lower-trophic ecosystem projection in the seas around Korea**

Hyoun-Woo Kang, Hanna Kim, Jae Kwi So, Momme Buttenschon, Icarus Allen and Ok Hee Seo

**Future changes of nutrient dynamics and biological productivity in California Current System**

Fei Chai, Peng Xiu and Enrique N. Curchitser

**Impacts of external forcing on the decadal climate variability in CMIP5 simulations (Invited)**

Yongqiang Yu and Yi Song

**A genesis potential index for tropical cyclone using oceanic parameters**

Min Zhang, Lei Zhou and Dake Chen

**Seasonal characteristics of the long-term sea surface temperature variability in the Yellow and East China Seas**

Yong Sun Kim, Chan Joo, Jang Jin, Yong Jeong and Yongchim Min

**Effects of atmospheric forcing on circulation variability in the northern Japan/East Sea in 1948 to 2010**

Dmitry V. Stepanov, Victoria I. Stepanova and Anatoly V. Gusev

**Anomalous tropical cyclone activity in the northwestern Pacific in 2014**

Lei Yang, Dongxiao Wang, Xin Wang and Ke Huang

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### *Poster presentations*

#### **Effects of CO<sub>2</sub>-driven ocean acidification (OA) on early life stages of marine medaka (*Oryzias melastigma*)**

Jingli Mu, FeiJin, JuyingWang, Nan Zheng and Yi Cong

#### **Features of the circulation structure in the Okhotsk Sea based on high-resolution numerical simulation in 1979 to 2000**

Dmitry V. Stepanov, Vladimir V. Fomin and Nikolay A. Diansky

#### **Development of a regional climate coupled model for the seas around Korea**

Hee Seok Jung, Chan Joo Jang and Ho-Jeong Shin

#### **The effects of runoff forcing on the summer monsoon onset in a climate model**

Yajuan Song, Fangli Qiao and Zhenya Song

#### **Change of beginning and duration of the first stage of Far-Eastern summer monsoon on the southern coast of Primorye**

Lyubov' N. Vasilevskaya, Tatiana A. Shatilina and D.N. Vasilevskiy

## **FIS Topic Session (S8)**

### ***Marine ecosystem services and economics of marine living resources***

Co-sponsor: International Council for the Exploration of the Sea (ICES)

Co-Convenors: *Shang Chen (China), Sebastian Villasante (Spain/ICES), Minling Pan (USA), Ian Perry (Canada), Keith Criddle (USA), Mitsutaku Makino (Japan)*

Invited Speakers:

*Daniel K. Lew (NOAA Fisheries, Alaska Fisheries Science Center, USA)*

### Background

Marine ecosystem services (MES) are benefits people obtain from the seas and oceans. Marine ecosystems provide ecological products and services, such as seafood, regulation of climate, reduction of storm disasters, waste purification, recreation and leisure, and biodiversity maintenance. Assessing the value of MES has become an emerging and somewhat challenging subject in the scientific world and is receiving increasing attention from politicians. The United Nations' Millennium Ecosystem Assessment reports published in 2005 focused on discovering changes in global ecosystem status and services. The ongoing World Ocean Assessment program has an urgent need for knowledge on MES. The United Nations Environmental Program formed the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. The aim of the IPBES was to develop and use knowledge on ecosystem services and biodiversity to improve national, regional, and global ecosystem management. The goals of this session were: (1) to provide marine scientists, economists, and ecologists with a venue to exchange results from research on MES, on the economics of marine ecological resources, and on the contribution of the marine environment to the marine and coastal economy, and (2) to provide scientists around the North Pacific a chance to discuss collaboration on scientific projects.

### Summary of presentations

This session was developed and led by members of PICES' Section on *Human Dimensions of Marine Systems*. Drs. Shang Chen, Minling Pan and Keith Criddle moderated the session. It was well attended, with more than 50 people, and generated good questions and discussion. One invited, 7 contributed oral, and 3 poster presentations were given in the session, even though 3 oral presentations were canceled just prior the Annual Meeting. The oral presentations focused on: Willingness to pay (WTP) for marine protected areas (MPAs), the intrinsic value of ecosystems, methods for assessment of ecosystem services and ecological losses, case studies of assessment of ecosystem services and ecological losses, and social behaviour and job satisfaction of fisheries communities and villages. Study sites included Shandong and Fujiang provinces of China, Okinawa and Hokkaido in Japan, Alaska, *etc.*

Dr. Daniel Lew was the invited speaker. He spoke on estimation of the economic value of protected marine species in the U.S. His research applied the contingent value method (CVM) to the valuation of marine endangered species as well as MPAs. The U.S. WTP for improving the population of:

- Steller sea lion was estimated to be \$34–\$112 per person per year;
- Hawksbill sea turtle and Leatherback sea turtle was estimated to be \$51.17 and \$36.04 per person per year, respectively;
- Southern resident killer whale, North Pacific right whale and North Atlantic right whale, was estimated to be \$48.30, \$39.61 and \$36.83 per person per year, respectively;
- Hawaiian monk seal was estimated to be \$34.43 per person per year;
- Southern California steelhead was estimated to be \$45.71 per person per year;
- Smalltooth sawfish was estimated to be \$30.81 per person per year;
- Black abalone was estimated to be \$39.56 per person per year;
- Elkhorn coral was estimated to be \$38.00 per person per year.

Dr. Shang Chen's talk was on valuation of ecosystem diversity maintenance service of Shandong MPAs based on contingent valuation method. Eighty-eight MPAs have been set up in Shandong coastal waters of the west Yellow Sea. The WTP per inland resident was estimated to be 56.08CNY, 19.11CNY higher than the WTP per coastal resident in Shandong (36.97CNY). In 2014, the value of ecosystem diversity maintenance service of 88 Shandong MPAs was estimated to be 1.924 billion CNY; the average is 21.9 million CNY per MPA. Among them, the value of ecosystem diversity maintenance service of 12 natural reserves was estimated to be 0.714 billion CNY; the average was estimated to be 59.51million CNY per MPA. The value of ecosystem diversity maintenance service of 30 special protected areas was estimated to be 0.650 billion CNY and the average was estimated to be 21.51 million CNY per MPA. The value of ecosystem diversity maintenance service of 46 aquatic germplasm resources protection areas was estimated to be 0.57 billion CNY; the average was estimated to be 12.88 million CNY per MPA. The value of natural reserves approved by the environmental protection department is higher than special protected areas approved by the marine management department; the value of aquatic germplasm resources protection areas approved by the fisheries management department is the lowest. The results show the management measures of these three kinds of MPAs should be assessed and different measures should be adopted for each.

Prof. Luo-ping Zhang spoke about marine ecosystem intrinsic valuation. He defined the ecosystem intrinsic value (EIV) as an objective value that emerges from the existence, structures, functions and processes of the ecosystem expressed by its substance, energy and information, but independent with man, man's will and preferences. The valuation approach and methods for EIV were developed by using an energy approach and Emergy and Eco-emergy analysis. The EIV calculated by emergy from the substance, energy and information of ecosystem and by eco-emergy from the structure and function of ecosystem represent the existent value and the externally working capacity of the ecosystem, respectively. The approach and methods of EIV were applied to Xiamen Bay, China. The results showed that the marine EIV in Xiamen Bay was RMB 222 billion including RMB 130 billion of emergy and RMB 92.4 billion of eco-emergy in 2010. The EIV in unit area of Xiamen Bay is nearly 10 times higher than the average ESV in the World estuaries calculated by Costanza *et al.* (1997). This implies a potential undervaluation to ecosystem value by ESV calculation, and thus may mislead the decision-making process.

Dr. Linhua Hao introduced the guidelines on the assessment of compensation for ecological damage caused by marine engineering construction projects. The key points of this guidelines include: (1) a table for baseline value of ecological capital in Shandong coastal waters, (2) a table for damage coefficients of different sea-occupied manners, and (3) a table for compensation coefficients of different marine industries. The baseline value times damage coefficient, damaged area and damaged period equals to ecological loss, then times compensation coefficient equals to compensation money. The 119 cases studies evaluated according to these guidelines show that construction in 1 ha. of sea area results in 8 ha. of ecological loss in affected nearby waters. This entails a loss of  $114.4 \times 10^4$  CNY of marine eco-loss and an eco-loss of  $12.8 \times 10^4$  CNY per ha. for the damaged area. The study suggests that  $28.1 \times 10^4$  CNY of marine eco-compensation should be paid for constructing 1 ha. of sea area. The total eco-compensation money is about 25% of the total eco-loss. The

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guideline is effective and practical as a mechanism for rapid assessment of eco-loss and eco-compensation for marine construction projects in Shandong province.

Ms. Chengcheng Shen talked about assessment and regulation of ocean health based on ecosystem services. A quantitative approach was developed to assess present and near-term ocean health based on ecosystem services. The case study of Laizhou Bay, China, showed that the index score of ocean health was 0.7856 out of 1.0 at present and ranged from 0.5551 to 0.8041 in the near future due to different artificial regulating activities. The analysis process provides flexible tools to guide regulations in the next step so as to facilitate ecosystem-based management in the coastal zone.

Dr. Stephen Kasperski described research that used socio-economic and fisheries involvement indices to understand well-being and resilience in Alaska fishing communities. There is an increasing need to better understand the impacts of fisheries management decisions on the social well-being and sustainability of fishing communities. He developed the socio-economic and fisheries-dependence indices to measure fishing community well-being in Alaska based on data from more than 300 communities. Several applications of the indices were discussed including ground-truthing the indices, assessing their predictive accuracy, and predicting vulnerability to fishery management changes. He found that creating performance measures, such as the indices presented here, provides a useful way to track the status of important fisheries and social variables over time.

Ms. Aoi Sugimoto presented a study of the connections between migrant fishermen and local communities in Japan. She considered how migrant fishermen and local residents can build social relationships, and how sustainable coastal resource management could be achieved by communities that include migrant fishermen. She aimed at clarifying the dynamic process of building relationships between migrant fishermen and the host community through the connection with coastal resources by using case of Shiraho village, Okinawa, Japan. Her study showed that migrant fishermen and the host community share a good relationship through their shared connection with coastal resources. She proposed a new socio-cultural value of marine fisheries that connects migrant fishermen and local community.

Dr. Emmanuel A. Sweke discussed job satisfaction from perspectives of fishers in northeastern Hokkaido, Japan. He examined factors associated with satisfaction of fishers in two traditional fishing communities: Akkeshi and Erimo in Japan. Fisheries in these two communities are integrated (capture fisheries and aquaculture) and specialized-capture, respectively. Satisfaction was significantly correlated to household size and target species. Poor fisheries harvest among fishers may have contributed to a difference in satisfaction of respondents between areas. Specialized-capture fisheries with few but economically important species, exemplified by kelp and salmon in Erimo, are more likely to maximize satisfaction of fishers than mixed fisheries with many species that are less economically important. Although about 60% of the respondents were proud of their occupation, over 90% of them were not willing to quit fishing due to limited alternatives, and fishing being connected to community traditions. His study will assist stakeholders, including fishers, policy makers, and scientists in managing fisheries resources, and maximize fishing satisfaction by addressing challenges facing local fisheries communities.

### List of papers

#### *Oral presentations*

#### **Economic values of protected marine species in the U.S.: Empirical studies and conceptual challenges for ecosystem-based management (Invited)**

Daniel K. Lew

#### **Evaluation of marine ecosystem intrinsic value**

Luo-ping Zhang, Hong-ni Xu, Hua-xia Sheng and Wei-qi Chen

#### **Using socio-economic and fisheries involvement indices to understand Alaska Fishing Community well-being**

Stephen Kasperski and Amber Himes-Cornell

**Valuing ecosystem diversity maintenance services of the Shandong marine protected areas: An application of the contingent valuation method**

Yi Xiao, Shang Chen, Zhiquan Cao, Tao Xia and Linhua Hao

**Fish as “Bridge” that connects migrant fishermen and local community: Proposing a new value of marine resources from socio-cultural aspects**

Aoi Sugimoto, Nobuyuki Yagi, and Hisashi Kurokura

**Assessment and regulation of ocean health based on ecosystem services: Case study in the Laizhou Bay, China**

Chengcheng Shen, Wei Zheng, Honghua Shi and Dewen Ding

**Job satisfaction: Perspectives from fishers in northeastern Hokkaido, Japan**

Emmanuel A. Sweke, Yumi Kobayashi, Mitsutaku Makino and Yasunori Sakurai

**Assessment of ecological damage and compensation from marine engineering construction projects in Shandong**

Linhua Hao, Shang Chen, Tao Xia and Zhiquan Cao

*Poster presentations*

**Evaluation of the Marine Ecosystem services of the Liaodong Gulf, Bohai Gulf and Laizhou Gulf, China**

Liang Liu, Shan-shan Wu and Shuang Wang

**Sea use intensity assessment and practice in China – A new methodology for ocean management**

Wei Xu, Han Wang, JingYi Zhang and Qi Yue

**FIS Topic Session (S9)**

***Experiences and lessons learned in managing shared/transboundary stock fisheries***

Co-Convenors:

*Minling Pan (USA), Shang Chen (China), Keith Criddle (USA), Mitsutaku Makino (Japan)*

Invited Speakers:

*Robert Blasiak (University of Tokyo, Japan)*

*Kanae Tokunaga (Ocean Alliance, University of Tokyo, Japan)*

Background

The fisheries management for a shared/transboundary stock—a stock that straddles jurisdictional boundaries—is a complex balancing act that will become even more challenging as the distribution of stocks shift in response to climate change. Some of these stocks may only involve users with different interests within a single jurisdiction. Other stocks may involve users from different jurisdictions within a nation, or users from many nations. Achieving conservation objectives for shared/transboundary stocks will require adoption of management regimes that consider biological, economic, and social criteria and elicit effective cooperation among groups. The objective of this session was to gather empirical studies involved with shared/transboundary stock management and to discuss the experiences, challenges, lessons learned, and decision-making processes that will lead to successful management.

Summary of presentations

This ½-day session attracted high quality papers. Feedback from one ex-chairperson of FIS was that three out of his five favorite presentations at PICES-2015 were given during the S9 topic session. Despite being scheduled on the last day of the meeting, this session attracted a good audience and generated in-depth discussion. A total of seven papers were presented with presenters from China, Japan, Russia, and USA.

Invited speaker, Dr. Robert Blasiak, reported on a collaborative study with Dr. Nobuyuki Yagi about “balloon effects” in global fisheries. He indicated that the sustainable management of straddling, transboundary, and highly migratory fish stocks is a considerable challenge in a globalized and interconnected world. He

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introduced evidence for an emerging paradigm of balloon effects caused by the virtual absence of untapped new frontiers for fisheries resources and the uneven regulatory landscape. Within this context, there is risk that new control measures or intensified enforcement activities will simply cause fishing activities to shift into the areas of least statehood. Highly migratory and straddling fish stocks, which extend into weakly regulated areas beyond national jurisdiction (ABNJ), are particularly prone to such effects. Drawing on balloon effects research in other disciplines, recommendations were provided for a holistic framework of management interventions to reduce the risk of the potentially destabilizing balloon effects and the resulting unintended consequences.

Invited speaker, Dr. Kanae Tokunaga, introduced an alternative model for the management of straddling and highly migratory fish stocks. Her study focused on non-seasonal movements of fish, while previous studies on trans-boundary fish stock management have focused on seasonal migrations of fish stocks. In addition, the model considers stock leakages from exclusive economic zones to international waters. The study confirms that cooperation is beneficial when fish migrate, and also found that leakage of stocks to international waters reduces the surplus gained from cooperative management. These two model features are applicable to the tuna fisheries of the Pacific Islands region, where national exclusive economic zones are surrounded by international waters.

Ms. Ekaterina Kurilova presented a paper co-authored with Ms. Tatiana Semenova on walleye pollock fisheries, a species distributed across waters of Russia, Japan, and North America. The character of the transboundary relationship of these pollock stocks is that spawning takes place in the waters of the EEZ of one country but juveniles and adults may migrate into the EEZ of a neighboring country for feeding. Ms. Kurilova presented the regulatory measures for walleye pollock fisheries management in Russia, including a strict system for determining total allowable catches (TACs); bans on fishing by area, season, and gear; restrictions on the length or tonnage of fishing vessels; and limits on the allowable catch of juveniles and the minimum fish length. She indicated that the distribution of quotas by fishing area, and the determination of fishing grounds, are the key aspects of fishery regulations.

Dr. Catarina Wor and her collaborators presented a Lagrangian movement model and the implications of this model to assess management performance for transboundary stocks. She indicated that systematic changes in the distribution of transboundary stocks, given the expected effects of climate change on ocean temperature, circulation, and pH could cause one or both signatories to become dissatisfied with such agreements; this is because management of transboundary stocks commonly relies on international treaty agreements that assume that the transboundary distribution of the exploited resource will remain stable. Thus, in their study, a Lagrangian movement model was used to characterize biological and environmental processes that drive fish movements and changes in the distribution of transboundary stocks. The model was applied to assess the performance of several management strategies for Pacific hake (*Merluccius productus*), a transboundary resource shared between the USA and Canada. She suggested that this new approach might be valuable for the evaluation of management strategies applied to transboundary stocks around the world.

Dr. Minling Pan presented work co-authored with Dr. HingLing Chan on an empirical analysis of “spillover effects” where conservation-minded reductions in fishing effort and harvesting by one RFMO (Regional Fisheries Management Organization) member may lead to increases in effort and harvests by other RFMO members; this can be detrimental to the very species intended for protection, and *vice versa*. The study examined the spillover effects in both fishery production and bycatch, resulting from U.S. fishing regulations instituted to protect endangered sea turtles. An empirical model was used to estimate the increase in sea turtle bycatch that would occur if unilateral reductions in swordfish catches by the Hawaii shallow-set longline fleet were offset by increased catches of swordfish by the non-U.S. fleet that operates in the same ocean area. The model can be used to demonstrate changes in the magnitude of stock-wide sea turtle interactions as Hawaii swordfish production increases or decreases.

Dr. Mikhail Stepanenko presented a study co-authored with Dr. Elena V. Gritsay on interannual variability of Bering Sea pollock seasonal migrations and the impact of ecosystem changes. The spatial distribution of



eastern Bering Sea pollock during the summer–autumn feeding period varies annually depending on short-term and long-term variability of the environment. This could depend on zooplankton (primarily euphausiid and copepod) abundance and distribution. The study found that unusual, early, large-scale pollock migrations from the northwestern Bering Sea onto the eastern Bering Sea shelf were the result of low zooplankton abundance and a deficit of food, which has been a common occurrence in recent years. Dr. Stepanenko suggested that additional studies of zooplankton communities may be needed to determine annual and seasonal zooplankton fluctuations in the Bering Sea, and the relationship between eastern and northwestern Bering Sea zooplankton communities.

Dr. Yu Heng Lu presented a case study (co-authored with Dr. Nobuyuki Yagi) on Sakuraebi shrimp (*Sergia lucens*) in Taiwan and Japan. This study aimed to understand the role of fishery cooperative associations on fishery management and the conservation of fishery resources. The study reported that the price of Taiwanese Sakuraebi in the Japanese market was primarily based on Taiwanese domestic supply and Japan market demand conditions, without being influenced by international prices; this could create incentives for Taiwanese fishermen to accept reduced days of operation as a management measure because the resulting loss of production might be offset by an increase in per-unit price, with no net loss of revenue to the fishermen. Within this context, the study identified a positive role played by fishery cooperative associations in Taiwan for the recent successful management of the Sakuraebi (shrimp) fishery.

#### List of papers

##### *Oral presentations*

**Balloon effects in global fisheries: Shifting paradigms (Invited)**

Robert Blasiak and Nobuyuki Yagi

**Cooperative management of trans-boundary fish stocks (Invited)**

Kanae Tokunaga

**Management of transboundary stocks of walleye pollock in the Russian Federation**

Ekaterina Kurilova and Tatiana Semenova

**The use of a Lagrangian movement model and management strategy evaluation to assess management performance for transboundary stocks**

Catarina Wor, Carl Walters, Steve Martell and Murdoch McAllister

**Spillover effects of marine environmental regulation for sea turtle protection**

HingLing Chan and Minling Pan

**Interannual variability of Bering Sea pollock seasonal migrations and the impact of ecosystem changes**

Mikhail A. Stepanenko and Elena V. Gritsay

**The role of fishery cooperative associations on fishery management and the conservation of fishery resources: A case study of Sakuraebi (*Sergia lucens*) in Taiwan and Japan**

Yu Heng Lu and Nobuyuki Yagi

#### **SB/MEQ Topic Session (S10)**

##### ***The human dimensions of harmful algal blooms***

Co-Convenors: *Mark Wells (USA), Mitsutaku Makino (Japan)*

Invited Speakers:

*Lorraine C. Backer (Center for Disease Control, USA)*

*Takashi Kamiyama (Tohoku National Fisheries Research Institute, FRA, Japan)*

#### Background

Harmful algal blooms (HABs) comprise a spectrum of ecological, economic, and human health impacts. High

biomass phytoplankton blooms in coastal and shelf waters, most often stemming from anthropogenic inputs of macronutrients, can massively shift ecosystem structure away from the support of higher trophic levels, lead to hypoxia and associated ecological impacts in deep waters, and thereby dramatically affect the human dimension. Smaller biomass blooms of toxic cells can selectively impair ecosystem components, decimate aquaculture industry success, or substantially impact human health. In some instances there are clear effects from direct human activity on HAB development; in others the oceanographic conditions regulate the success of harmful species. Despite the obvious relationship between HABs and human wellness, there has been little formalized linkage between ecological and human wellness research. This topic session's aim was to initiate this linkage by stimulating the cross-thinking needed to better assess human–HAB interactions. Presentations were invited on the distributions and character of HAB events, particularly for PICES member countries and their national interests, and the potential social–economic consequences of these societally-defined (harmful) algal bloom events. The overall goal of this session was to provide the foundation for more coordinated efforts between the HAB and Human Dimension Sections to generate inputs useful to Ecosystem Based Management activities, and to guide goals for the FUTURE program.

### Summary of Presentations

Dr. Lorraine Backer (Invited Speaker, USA) talked about harmful cyanobacteria. HABs damage ecology, limit access to recreation, seafood, drinking water, and cause illness in people and animals. She posed the question on how we should best address pressures from HABs – through research, risk communication, education or outreach? The One Health Approach identifies human, animal, and ecological health effects together. Physician and veterinary reference cards are provided by the Center for Disease Control. CASPER (Community Assessment for Public Health Emergency Response) uses robust statistical methods to gather information about health and basic needs. It can be used to assess preparedness and recovery. A challenge is that there is no comprehensive assessment of environmental, sociocultural, or economic effects of HABs.

The One Health HAB reporting system is a web-based reporting system that focuses on Great Lakes HABs. It is used for case-based outbreak reporting and includes event and environmental reporting, human case reporting, and animal case reporting. In August 2014, there was a huge *Microcystis* bloom in Lake Erie resulting in microcystins in the drinking water which increased visits to hospital emergency rooms for gastrointestinal distress. An epidemiological study was done that detected microcystins on nasal swabs but not in blood. There was no difference in symptoms pre- and post-exposure.

Another challenge is the lack of clinical understanding of HAB-related diseases. More affordable tools for diagnosis of clinical disease is needed, and there is the issue of defining the cost of HABs including:

- Monitoring and testing,
- Treatment,
- Prevention.

A multi-disciplinary approach is needed to mitigate the harm of “blooms”, and the question was–What can be done to mitigate the pressures of the human system on ecosystem processes (shown in FUTURE)?

Dr. Takasi Kamiyama (Invited Speaker, Japan) reported on the occurrence of paralytic shellfish poisoning (PSP) and its effects on bivalve aquaculture after the Great East Japan Earthquake. Both scallop and oyster culture is found in Tohoku coastal region of Japan, and the earthquake on March 11, 2011, had a huge impact on cultures in the area. Cyst populations after the earthquake increased dramatically. Over 8000 cysts per cubic cm were measured – about 10 times higher than prior to the earthquake. The huge tsunami resuspended diverse sediment particles into seawater so that high specific gravity particles (minerals) settled first and cysts, with low specific gravity, settled last. The increased occurrence of cysts subsequently led to a dramatic increase in PSP in shellfish in many areas after the tsunami. The number of scallop farmers decreased after the tsunami showing that the increased PSP had an impact on jobs. Some scallop farmers shifted to oyster culture.

Dr. Aoi Sugimoto made a presentation on reducing environmental, social and economic impacts by mariculture on coastal communities in the northwestern Philippines. Milkfish production has been impacted by

massive fish kills due to HABs in Bolinao area of the Philippines. Dr. Sugimoto's study took three approaches: community, institutional and economic analysis. Community surveys showed that the mariculture industry does not benefit the local fisherfolk; some fisherfolk are severely marginalized. The feeding process for milkfish is very inefficient in that there are poor food conversion ratios. Weak enforcement and co-management in Anda compared to Bolinao impacted the environmental degradation, causing social and economic problems.

Dr. Zheng Xi Zhou discussed the relationship of HABs and environmental factors near Changjiang River estuary. Since the year 2000, there has been a shift from diatoms to a dominance of dinoflagellates. An intensive intrusion of offshore water occurs during the dinoflagellate bloom. Principal components analysis showed this as well.

Dr. Vera Trainer reported on the large-scale, long-lasting *Pseudo-nitzschia* bloom off the U.S. West Coast, beginning in spring 2015, resulting in closures of the razor clam and Dungeness crab fisheries. Some of the highest toxin levels ever were measured in anchovies and seawater, and were the cause of marine mammal mortalities. The bloom impacted many sites along the West Coast, including the U.S. and western Vancouver Island, Canada, in early May 2015. Cruises of opportunity made it possible to sample along the continental shelf from California to Alaska during summer. These samples will be analyzed for particulate and dissolved domoic acid to determine the spatial distribution of the large HAB event. NOAA declared an Unusual Mortality Event (UME) in Alaska due to the deaths of fin whales, humpback whales and a gray whale that may be associated with this HAB.

Dr. Polina Kameneva presented on diarrhetic shellfish poisoning (DSP) from a socio-economic perspective in the Prymorsky region, Russia. This region is declared as a territory of advanced economic growth, and there is an interest in attracting investment to the area, including the DSP region. Maximum DSP toxins in shellfish shift somewhat with the seasons. In the waters adjacent to the Primorsky aquarium research and education center, several potential HAB species are found. High-level government efforts in creating sustainable aquaculture operations are being attempted but government seems somewhat resistant to change. Dr. Kameneva stressed that government, business and scientists need to work together to develop an effective system for prevention of food poisoning and ensuring sustainable development of aquaculture.

Dr. Jinhui Wang's talk focused on aquaculture and ballast discharge influencing the scope of HABs and on why the occurrence of red tide is rarer in the Yellow Sea compared to other sea areas of China. Shellfish aquaculture accounts for the highest percentage of aquaculture in China. However, HABs can cause high economic losses to fish and aquaculture. In a study of the seasonal prevalence of *Ulva*, biomass decreased in net screens compared to rope and bamboo. Mitigation methods were presented including taking net screens onshore to allow them to dry in the sun, and discouraging aquaculturists from cleaning screens offshore. Increased nutrients have been found in the coastal areas near the regions where *Ulva* appears. May is important as the month for early development of *Ulva*. *Ulva* is transported north via the Yellow Sea current. Ballast water discharge in the port of Shanghai may be a source of new HABs to this coastal region. Regions of high ballast water exchange include the Changjiang estuary and Bohai Sea. Ballast water comes from Korea, Japan, Singapore, America, and Europe and there is evidence of non-native species occurring in China. In 1980 *Karenia mikimotoi* was found in a Hong Kong port, and in 2004, *Heterocapsa circularisquama* was also found there, for the first time.

Dr. Baodong Wang looked at how reduced sediment load may contribute to increased outbreaks of HABs off the Changjiang Estuary. Before 2000 there was no positive correlation between frequency of HABs and nutrient inputs, but there was after 2000 (looking at both DIN and P). However, the variation in frequency of HABs is not well explained by nutrient inputs off the Changjiang Estuary, and the sediment supply appears to be inversely correlated with the numbers of HABs in this estuary. Both river inputs and reduction of sediment load appear to contribute to the increase in HAB frequency in the Changjiang area.

Ms. Svetlana Esenkulova highlighted how data collected by "citizen scientists" is used in the Salish Sea Marine Survival Project to address the decrease in chinook and coho salmon in the region. Properties/samples

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are measured/collected by citizen volunteers at specific stations in 9 areas in Strait of Georgia and the collected data are posted on the Ocean Networks Canada and Strait of Georgia websites. For example, phytoplankton are sampled at the surface but at one station 0, 5, 10, 20 m samples are collected and preserved with Lugols iodine. In 2015, unusually warm sea surface temperatures and an early spring bloom were confirmed by sample analysis and remote sensing. This spring bloom was unusually long and was dominated by *Chaetoceros* sp.

In summary, various types of human activities were covered in the session, including climate change, dam construction, sediment loading – resulting in impacts on humans, marine wildlife and terrestrial animals. Of the nine presentations, four were given by early career students. This session was a first step in moving forward in establishing a stronger link to associate HABs with human dimensions. The interaction of social systems and how they operate well in some HAB situations and less well in others will be critical to study.

### List of papers

#### *Oral presentations*

**Human dimensions of harmful algal blooms (HABs): Contributing to ecosystem-based management (Invited)**

Lorraine C. Backer

**Changes in occurrence of paralytic shellfish poisoning and the effects on bivalve aquaculture in Tohoku region of Japan after the Great East Japan Earthquake (Invited)**

Takashi Kamivama

**Suggestions for reducing environmental, social and economic impacts by mariculture on coastal communities based on a case study in Anda-Bolinao, northwestern Philippines**

Aoi Sugimoto, Maria Lourdes San Diego-McGlone, Francisco Paciencia, Shielameh P. Milan, Elizabeth T. Tomas, Carolina C. Ramirez, Annabelle Echavez, Jessem Gabatin, Miguel D. Fortes and Kazuo Nadaoka

**Untangling the relationship between harmful algal blooms and environmental factors in the coastal waters adjacent to the Changjiang River estuary**

ZhengXi Zhou, RenCheng Yu, YunFeng Wang, FanZhou Kong, QingChun Zhang, Tian Yan and Mingjiang Zhou

**The impacts of a massive harmful algal bloom along the US west coast in 2015**

Vera L. Trainer, Ryan McCabe, Barbara Hickey and Raphael Kudela

**Diarrhetic shellfish poisoning in socio-economic perspective in Prymorsky region, Russia**

Polina A. Kameneva and Tatiana Yu. Orlova

**Do the aquaculture and ballast discharge influence the scope of Harmful Algal Bloom?**

Jinhui Wang, Zhuyou Ma, Yun Li and Hongying Qian

**Does reduced sediment load contribute to increased outbreaks of harmful algal blooms off the Changjiang Estuary?**

Baodong Wang and Ming Xin

**Monitoring of harmful algal blooms in the Strait of Georgia by a Citizen Science program, Canada 2015**

Svetlana Esenkulova and Isobel Pearsall

#### *Poster presentations*

**Application of qPCR methods in detection of PST-producing *Alexandrium* species in the Yellow Sea and East China Sea**

Ren-Cheng Yu, Yan Gao, Qing-Chun Zhang, Fan-Zhou Kong and Ming-Jiang Zhou

**Advances in marine algae hemolysin molecules**

Yang Lin, Liu Lei, Liu Li, Zhao Rui, Wei Ning, Liu Ren-Yan and Liang Yu-bo

**Numerical study on the prediction of the Harmful Algae Blooms in the East China Sea**

Jing Yang, Hai Li and Qinzheng Liu

**Prediction, prevention and mitigation of harmful algal blooms in the China Sea**

Dan Wang

**BIO Contributed Paper Session**

Co-Convenors: *Angelica Peña (Canada), 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, papers on all biological aspects of marine science in the PICES region were welcomed. Contributions from early career scientists were especially encouraged.

List of papers*Oral presentations***Using imaging flow cytometry to examine phytoplankton assemblage structure in the Bering Sea**

Samuel R. Laney and Lisa Eisner

**Distribution of mixotrophic phytoplankton along the latitudinal transect of the central North Pacific**

Mitsuhide Sato, Takuhei Shiozaki and Fuminori Hashihama

**Using 454 pyrosequencing to analyze the *in situ* diet of the marine copepod *Calanus sinicus***

Yunyun Zhuang, Huan Zhang, Yousong Huang, Guangxing Liu and Senjie Lin

**The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA**

C. Tracy Shaw and William T. Peterson

**Interannual variation of summer zooplankton size structure and its relation to physical and biological processes in the Yellow Sea and East China Sea**

Yongjiu Xu, Joji Ishizaka, Meixun Zhao and Jing Zhang

**Buoyancy and vertical distribution of Pacific mackerel eggs and larvae and its climate change implication for the temporal variability of recruitment**

Hwa Hyun Lee, Sukyung Kang, Kyungmi Jung, Suam Kim and Sukgeun Jung

**Archeological data indicate that northern fur seals are likely to once again become a dominate predator in the California Current System**

Andrew W. Trites and Frances C. Robertson

**Decadal scale change in the feeding habits of sei whales in the western North Pacific off Japan**

Kenji Konishi, Tatsuya Isoda and Tsutomu Tamura

**Scales of inference: The influence of spatial and temporal resolution on habitat-based models for marine predators**

Kylie L. Scales, Elliott L. Hazen, Michael G. Jacox, Christopher A. Edwards, Andre M. Boustany, Matthew J. Oliver and Steven J. Bograd

*Poster presentations***Distribution modeling for species and species assemblages, an exploration of spatial patterns with gradient forest**

Andrew McMillan and Anders Knudby

**Spatial distribution of  $\delta^{15}\text{N}$  of chlorophyll-*a* in surface sediment of the northern Benguela Upwelling System**

Yu Xin, Kirstin Dähnke and Kay-Christian Emeis

**Phytoplankton phenology in the Bering Sea: Variability and drivers**

Rubao Ji, Zhixuan Feng, Jinlun Zhang and Carin Ashjian

**Diet of long-beaked common dolphin (*Delphinus capensis*) in the East Sea (Japan Sea), Korea**

Soeon Ahn, Hyun Woo Kim, Suam Kim, Young Ran Lee, Kyum Joon Park, Doo Nam Kim and Doo Hae An

**Paleoceanographic changes since 50 ka B.P. inferred from radiolarian assemblages in Gulf of Alaska, subarctic North Pacific**

Haifeng Zhang, Rujian Wang, Wenshen Xiao and Wenbao Li

**Ecological characteristics of zooplankton in the northern waters of Nan'ao Island**

Lianggen Wang, Feiyan Du and Pimao Chen

**Polyamines response to nutrient limitation stress and their physiological roles in *Skeletonema Costatum***

Yan Liu, Wei-hong Zhao and Hui Miao

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### **Contribution of bacterial communities to total primary production in the Northwestern Pacific Ocean**

Howon Lee, Jae Hoon Noh and Sang Heon Lee

### **Carbon and nitrogen uptake rates of phytoplankton in the East Sea (Japan Sea) in 2012**

HuiTae Joo, Jung-Woo Park, JangHan Lee and Sang Heon Lee

### **Spatial and temporal patterns of primary production in the Japan/East Sea**

Sang Heon Lee, Hui Tae Joo, SeungHyun Son, JungWoo Park, Jung Hyun Kwak, Jae-Hoon Noh, Jin-Yong Jeong and Chang-Keun Kang

### **Relationship between phytoplankton macromolecular compositions and zooplankton proximate compositions in the Southwestern Japan/East Sea**

Na-eun Jo, Jae Joong Kang, Ho Won Lee, So Hyun An and Sang Heon Lee

### **Comparative reproductive biology of three dominant myctophids of the genus *Diaphus* on the slope region of the East China Sea**

Chiyuki Sassa, Hiroshige Tanaka and Seiji Ohshimo

### **Responses of microbial communities to dosing with the algicide thiazolidinedione derivative TD49 in a mesocosm experiment**

Seung Ho Baek, Moonho Son, Kyoungsoon Shin, Hoon Cho, Si Wouk Kim and Young Ok Kim

### **Comparison of macromolecular compositions of different size phytoplankton in Gwangyang Bay, Korea**

Ye Won Kim, So hyun Ahn, Janghan Lee and Sang Heon Lee

### **The use of the LOPC to measure horizontal and vertical zooplankton size and abundance of 35°N section in summer**

Pan Jun, Cheng Fangping and Yu Fei

### **Three-year variability of *Eucalanus californicus* population in Sagami Bay, Japan: Relationships between population density and duration of surface occurrence**

Shinji Shimode, Masumi Inui, Tomohiko Kikuchi and Tatsuki Toda

### **Spatial variations of phytoplankton communities in July of 2011 and 2013 in the East China Sea derived by photosynthetic pigments**

Qian Xu, Chiho Sukigara, Joji Ishizaka, Watanabe Yuji, Takeshi Matsuno and Sinjae Yoo

### **Seasonal changes in prosome length and egg reproduction of planktonic copepod *Calanus sinicus* in Sagami Bay, Japan**

Takafumi Yamaguchi, Tomohiko Kikuchi, Tatsuki Toda and Shinji Shimode

### **Oyashio spring bloom observed by an underwater glider**

Daisuke Hasegawa, Takeshi Okunishi, Yugo Shimizu, Shigeo Kakehi, Taku Wagawa, Sousuke Ohno, Hiroshi Kuroda, Akira Kuwata, Hiromi Kasai, Tsuneo Ono, Yuji Okazaki, Kazuaki Tadokoro and Akira Kusaka

### **Marine microbiological communities in Korean coastal waters examined by NGS analysis**

Nam-Il Won, Ki-Hwan Kim, Youngsung Kim, Ji Eun Jang, Jae Hwan Kim, Sang Rul Park and Hyuk Je Lee

### **Trophic linkages among biological communities in Korean coastal waters examined by stable isotope analyses**

Nam-Il Won, Jun-Sop Kim, Hyeon Seok Kim and Youngsung Kim

### **Phytoplankton change in the Kuroshio region of the East China Sea associated with the Kuroshio frontal eddy**

Naoki Yoshie, Narihiro Sato, Miwa Nakagawa, Eisuke Tsutsumi, Yoshikazu Sasai and Xinyu Guo

### **The influence of decadal typhoon events on chlorophyll and carbon fixation in the East China Sea**

Dongxing Chen, Kedong Yin, Lei He and Jianzhang He

### **Seasonal variation of mesozooplankton community in the Oyashio and Kuroshio-Oyashio Transition waters, western North Pacific**

Kazuaki Tadokoro, Yuji Okazaki and Hiromi Kasai

### **Mixed layer depth and chlorophyll *a*: Profiling float observations in the Kuroshio-Oyashio Extension region**

Sachihiko Itoh, Ichiro Yasuda, Hiroaki Saito, Atsushi Tsuda and Kosei Komatsu

### **Hypoxia tolerance in oxygen minimum zone euphausiids**

Brad A. Seibel, Jillian Schneider, Stein Kaartvedt, Karen Wishner, Kendra Daly and C. Tracy Shaw

### **Hypoxia off the Changjiang River estuary and its relationships with plume front and upwelling in summer**

Qinsheng Wei

### **Ecological responses to the offshore detached Changjiang diluted water in summer**

Qinsheng Wei, Zhigang Yu, Xuelei Zhang, Hui Wu and Baodong Wang

### **Delineating a physical and biological break point in the Gulf of Alaska**

Jason Waite, Franz Mueter and Brendan Coffin

### **Examination of water quality of an oligotrophic salmon lake in British Columbia, Canada using MERIS satellite imagery**

Gary Borstad, Eduardo Loos, Leslie Brown, Kaan Ersahin, Daniel Selbie, James Irvine and Maycira Costa

## FIS Contributed Paper Session

Co-Convenors: *Xianshi Jin (China), Elizabeth Logerwell (USA)*

### 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 FIS-P Session comprised 10 oral presentations (one of which was withdrawn at the Annual Meeting) and 23 posters. Oral presentations were given by scientists from all PICES member countries, with the exception of Korea. The first two talks of the session were on key pelagic species, squid and myctophids. Mr. Hiromichi Igarashi (Japan) made the presentation on squid. The study addressed the relationship between ocean state variables and habitat suitability indices (HSI) of the neon flying squid in the main fishing area for Japanese commercial vessels offshore on the Sanriku coast in northern Japan in winter. The results showed that the HSI of squid can be strongly affected by the sub-surface structure of fronts and eddies. The myctophid presentation given by Mr. Shinya Ohshima (Japan) was on the results of acoustic and trawl surveys off western Kyushu Island, an important fishing ground around Japan. The investigators found that species composition and biomass of myctophid species showed different spatial patterns between two years (2012 and 2013) and that fluctuation in currents, such as the Kuroshio warm current, was a potential factor influencing the fish distributions. Ms. Sandra Neidetcher (USA) gave the third oral presentation on the spatial and temporal variability of fecundity in walleye pollock. Fecundity was estimated from specimen collections from the Gulf of Alaska, Bering Sea and Aleutian Islands from the early 1990s to the present. Fecundity was statistically compared to pollock abundance, body condition, ocean temperature and ocean productivity. The last two talks before the morning coffee break were on issues relating to formulating abundance indices for eastern North Pacific fish, specifically rockfish and herring. Ms. Shannon Obradovich (Canada) gave a presentation of the impact of fine-scale spatial behavior of quillback rockfish on a relative abundance index from longlines. Longline gear was observed with a remotely-operated vehicle during fishing. Quillback were observed around a baited hook but did not move to adjacent hooks with available bait. This behavior made the index (an exponential model) insensitive at low densities of fish. Dr. Jennifer Boldt (Canada) gave a presentation on an index of relative biomass, abundance and condition of juvenile Pacific herring in the Strait of Georgia. To calculate unbiased estimates of the relative biomass (abundance) of young herring, two methods were applied (two-stage and two-stage stratified) to a variety of data types for three scenarios (based on assumptions about nets used). The first talk after the morning coffee break was by one of the session conveners, Dr. Elizabeth Logerwell (USA), about Arctic fish. She presented an analysis of the environmental drivers of Arctic cod distribution in and around Barrow Canyon in the northeastern Chukchi Sea and western Beaufort Sea. Arctic cod density was statistically correlated with cold, high salinity water in the canyon in the Chukchi Sea and downstream in the deep waters off the Beaufort Sea shelf. These waters are likely high in high-energy zooplankton prey and thus provide good foraging habitat for Arctic cod. The next two talks were on the structure and function of communities and ecosystems. Mr. Alexey Khoruzhiy (Russia) gave a presentation of the structure of the nekton community in the northwestern Pacific Ocean. Data from trawl surveys from 2009–2011 showed that mesopelagic fish and salmon dominated the nekton. Diets of the fish consisted of copepods, euphausiids, amphipods and micronekton. However, total consumption of forage did not exceed 4% of the zooplankton and micronekton biomass. The following talk, by Mr. Zhongxin Wu (China), was on trophic flows in the ecosystem of an artificial reef zone in the Lidao coastal ecosystem of northern China. An Ecosim model was developed for a small area in the region and Ecosim was used to explore one scenario for alternative fishing practices. The total fishery yield from all fisheries was dominated by low trophic-level herbivorous and detritivorous species such as the sea cucumber, sea urchin, and abalone. A simulation of closing all fisheries for 20 years resulted in an increase of about 100% in the relative biomass of the main exploited species, sea cucumber and abalone. The final talk of the session was by Dr. Tsuyoshi Wakamatsu (Japan), on the development of a regional marine environment analysis system for fishery applications. Wakamatsu and co-authors developed a

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framework for a marine environment analysis and dissemination system that was tested in a pilot study of the neon flying squid fishery. Key components of the system were a four-dimensional variational data assimilation system, an empirical mapping scheme of a habitat suitability index at an oceanic frontal scale and a web-based visualization system for delivering the analysis products to fishing operators in quasi-operational mode. Posters addressed an even more diverse set of topics covering a broad range of marine fish and invertebrate taxa throughout the PICES region. Based on the number and high quality of oral presentations and posters, diversity of species, mix of topics, and level of attendance, the FIS Contributed Paper Session at PICES 2015 was deemed to be a success.

### List of papers

#### *Oral presentations*

**Relationships between ocean conditions and interannual variability of habitat suitability index (HSI) distribution for neon flying squid in central North Pacific examined using new 4D-VAR ocean reanalysis dataset**

Hiromichi Igarashi, Yoichi Ishikawa, Tsuyoshi Wakamatsu, Yusuke Tanaka, Masafumi Kamachi, Norihisa Usui, Mitsuo Sakai, Sei-ichi Saitoh and Yutaka Imamura

**Annual variability in the distribution and biomass of dominant myctophid fishes off western Kyushu, Japan**

Shinya Ohshima, Tohya Yasuda, Masa-aki Fukuwaka, Rintaro Koide, Koki Abe and Hiroki Yasuma

**Image-analysis software applied to assess spatial and temporal variability of fecundity in Walleye pollock, *Gadus chalcogrammus***

Sandra Neidetcher, Benjamin Williams, Elizabeth Logerwell, Martin Dorn, Gordon Kruse, Susanne McDermott, Carol Ladd and Wei Cheng

**The impact of fine-scale spatial behaviour of quillback rockfish (*Sebastes maliger*) on a hook-based relative abundance index from longlines**

Shannon G. Obradovich, K. Lynne Yamanaka and Murdoch K. McAllister

**An index of relative biomass, abundance, and condition of juvenile Pacific Herring (*Clupea pallasii*) in the Strait of Georgia, British Columbia**

Jennifer L. Boldt, Matthew Thompson, Charles Fort, Chris Rooper, Jake Schweigert, Terrance J. Quinn II, Doug Hay and Thomas W. Therriault

**Environmental drivers of benthic fish distribution in and around Barrow canyon in the northeastern Chukchi Sea and western Beaufort Sea**

Elizabeth Logerwell, Kimberly Rand, Seth Danielson and Leandra deSousa

**Structure of the nekton community of the upper epipelagial in the Northwestern Pacific Ocean in February-April**

Alexey A. Khoruzhiy and Svetlana V. Naydenko

**Trophic flows in the marine ecosystem of an artificial reef zone in the Yellow Sea China**

Zhongxin Wu, Xiumei Zhang, Hector M. Lozano-Montes, Neil R. Loneragan

**Development of a regional marine environment analysis system for fishery applications**

Tsuyoshi Wakamatsu, Yusuke Tanaka, Shiro Nishikawa, Haruka Nishikawa, Hiromichi Igarashi and Yoichi Ishikawa

#### *Poster presentations*

**Shifts in hydrological regime and their implication for distribution and abundance of fish in the western Bering Sea in 21 century**

Alexander Zavolokin and Gennady Khen

*Presented by Alexey Khoruzhiy on behalf of Alexander Zavolokin*

**Stock assessment for the *Trichiurus japonicus* fishery in the East China Sea based on Bayesian state-space modelling**

Kui Zhang and Zuo-zhi Chen

**The impact of climate factors on Pacific salmon within Khabarovsk territory**

Albina Kanzeperova, Sergei Zolotukhin and Tatiana Kozlova

*Presented by Ekaterina Kurilova on behalf of Albina Kanzeperova*

***In situ* target strength measurements of skipjack tuna *Katsuwonus pelamis* and yellowfin tuna *Thunnus albacares* in the South China Sea**

Jun Zhang, Guo-bao Chen, Zuo-zhi Chen and Yong-song Qiu

**Modeling the migration and growth of immature Pacific saury (*Cololabis saira*) using an individual-based bioenergetics model**

Hitomi Oyaizu, Satoshi Suyama, Sachihiko Itoh, Shin-ichi Ito, Daisuke Ambe, Takahiko Kameda, Takeshi Terui and Michio J. Kishi



**Proximate composition and stable isotope ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of Japanese jack mackerel (*Trachurus japonicus*) in the Geumo Island nursery ground**

Su Min [Kim](#), Heeyong Kim Sang Heon Lee

**Evaluation of a commercial CPUE standardization model applied to the Pacific saury fishery in the North Pacific**

Wen-Bin [Huang](#) and Wei-Ting Hsu

**Examining two macro invertebrate communities using functional traits and environmental variables in and around Barrow canyon in the Chukchi and Beaufort seas**

Kimberly Rand, Elizabeth [Logerwell](#), Bodil Bluhm, H lo se Chenolot, Seth Danielson, Katrin Iken and Leandra de Sousa

**Restricted separation of the spawning areas of two lineages of sand lance, *Ammodytes personatus*, in the Yellow Sea and East Sea**

Jin-Koo [Kim](#) and Soo Jeong Lee

**Diversity and community structure of marine fish species in Korean waters during 2006-2013**

Jung Hwa [Ryu](#) and Jin-Koo Kim

**The role of Gangjin Bay: Spawning or nursery grounds for fish?**

Se Hun [Myoung](#), Soo Jeong Lee, Jung-Hwa Ryu and Jin-Koo Kim

**Food partitioning among three reef fish in the Lidao coastal waters of northern Yellow Sea, China**

Zhongxin [Wu](#), Xiumei ZhangCharlotte R. Dromard

**Environmental thresholds and species distribution: Implications for interactions and recruitment in multispecies models**

Matthew R. [Baker](#), Anne B. Hollowed, Kirstin Holsman and Albert Hermann

**Using species distribution models to define essential fish habitat in Alaska**

Chris [Rooper](#), Ned Laman, Kali Turner, Sean Rooney and Dan Cooper

**Particle tracking experiments to specify hatching areas of the Pacific stock of chub mackerel off the southeastern coast of Japan**

Hiroshi [Kuroda](#), Yugo Shimizu, Masanori Takahashi, Atsushi Kawabata, Takeshi Okunishi and Takashi Setou

**Interannual variations in growth trajectories of juvenile jack mackerel *Trachurus japonicus* in the Tsushima Warm Current**

Motomitsu [Takahashi](#), Chiyuki Sassa, Satoshi Kitajima and Youichi Tsukamoto

**Behavioral responses of Pacific cod (*Gadus macrocephalus*) juveniles to food deprivation, temperature gradients and light**

Zhe [Li](#), Jun Yamamoto, Mitsuhiro Nakaya and Yasunori Sakurai

**Optimum survival temperature for walleye pollock larvae**

Ryo Nakagawa, Takashi Yokota, Hiroshige Tanaka, Yukimasa Chimura, Yuho Yamashita and Tetsuichiro [Funamoto](#)

**Acoustic survey of dominant mesopelagic fishes off eastern Hokkaido, Japan**

Rintaro [Koide](#), Kazuhiro Sadayasu, Tetsuichiro Funamoto, Hiroshige Tanaka, Shinya Ohshima and Hiroki Yasuma

**The abundance of the chinook salmon *Oncorhynchus tshawytscha* (Walbaum) population in the basin of the Kamchatka River**

Olga [Zikunova](#)

**Genetic variation and population structure of marbled rockfish (*Sebastes marmoratus*) in the Northwestern Pacific inferred from microsatellite analysis**

Lu [Liu](#), Tian-xiang Gao, Takashi Yanagimoto, Na Song and Chun-hou Li

**Evaluating three size removal methods in otolith shape analysis, using the Japanese grenadier anchovy (*Coiliasus*) and Osbeck's grenadier anchovy (*Coiliamystus*) in Chinese coastal waters**

Xin [Yu](#), Liang Cao, Jinhua Liu, Bo Zhao, Xiujian Shan and Shuozeng Dou

**“Jawless Fishes of the World” – A new book dealing with various aspects of lampreys and hagfishes worldwide**

Alexei M. [Orlov](#)

**MEQ Contributed Paper Session**

Co-Convenors: *Chuanlin Huo (China), Darlene Smith (Canada)*

Background

The Marine Environmental Quality Committee (MEQ) has a wide range of interests spanning from regular research area to emerging marine environmental issue. This session invited papers dealing with all aspects of

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marine environmental quality research in the North Pacific and its marginal seas, except those covered by Topic Sessions sponsored by the Marine Environmental Quality Committee (MEQ).

A total 7 papers were approved and scheduled in this session before the Annual Meeting. Three papers were about the assessment of marine radioactivity around the North Pacific, one paper was about microplastics on coastal beaches, one paper was about the hydrocarbon impact on marine ecosystems, and two papers were about the terrigenous organic carbon of Changjiang and Huanghe rivers.

Since MEQ's Working Group on *Assessment of Marine Environmental Quality of Radiation around the North Pacific* (WG 30) and Working Group on *Emerging Topics in Marine Pollution* (WG 31) had their own topic workshop and topic session, respectively, the MEQ-P Session had fewer contributed papers, which were accommodated in a ½-day session.

### Summary of presentations

The MEQ Paper Session was well attended. Oral presentations were given during the morning of October 23. The first three talks were on the radioactivity which covered a wide variety from methodology to the assessment of the radioactivity distribution in seawater, sediment and organisms. The first talk (presented by Dr. Delvan Neville on behalf of Dr. Kathryn Higley (USA) was a summary of Workshop W5 on “*Monitoring and assessment of environmental radioactivity in the North Pacific*”, Both were by early career scientists: Dr. Hongzhi Li (China) discussed radioactivity estimates in the North Pacific Ocean based on radiation dose rate; Dr. Shizuho Miki (Japan) presented on Strontium-90 in marine fishes (and received the Best Presentation award in an MEQ-sponsored session at the Closing Session) Dr. Qian Zhou (China) reported on microplastics on coastal beaches in China. Early career scientist, Dr. Sergey Kulbachnyi (Russia), reported on possible impacts on marine ecosystems in the Sea of Okhotsk due to hydrocarbon exploration on the shelf. The last two talks were from China: Dr. Yu Hao summarized the historical trends of terrigenous organic carbon transported by the Yangtze River (Changjiang), and early career scientist, Ms. Lijun Qi, described geochemical signals in the abandoned Huanghe River Delta surface sediments.

The convenors recognized that this regular session provided important opportunities for PICES scientists to present their studies not only on known areas, but also on emerging marine environmental issues, and for early career scientists to participate in PICES activities. The convenors also recognized that all the participants to the session showed the interest and concern about the marine ecosystem status of the North Pacific.

### List of papers

#### *Oral presentations*

#### **Summary of Workshop 5 on “Monitoring and assessment of environmental quality of radioactivity in the North Pacific”**

Kathryn Higley

*Presented by Delvan Neville on behalf of Kathryn Higley*

#### **Radioactivity estimates at North Pacific Ocean based on radiation dose rate**

Hongzhi Li, He Wu, Jinzhao Zhang, Lei Wang and Chunfang Li

#### **Strontium-90 in marine fishes**

Shizuho Miki, Ken Fujimoto, Takami Morita, Yuya Shigenobu, Kaori Takagi, Tsuneo Ono, Tomowo Watanabe and Hiroya Sugisaki

#### **Accumulation of microplastics on coastal beaches, China: Abundance, composition and sources**

Qian Zhou, Haibo Zhang, Yuan Li and Yongming Luo

#### **Hydrocarbon exploration on the Sea of Okhotsk shelf and its possible impact on marine ecosystems**

Sergey E. Kulbachnyi

#### **Historical trends of terrigenous organic carbon transported by the Yangtze River (Changjiang)**

Yu Hao and Wu Ying

#### **The geochemical signals in the abandoned Huanghe River Delta surface sediments**

Lijun Qi, Ying Wu and Shenliang Chen

*Poster presentations*

**Study of impact of moderate and heavy weathering processes on individual carbon and hydrogen isotope of n-alkanes in oils**

Shijie He and Chuanyuan Wang

**The role of temporary cysts in dense blooms caused by *Cochlodinium polykrikoides* Margalef**

Hyeon Ho Shin, Zhun LI and Eun Song Kim

**The occurrence and Distribution of HBCDs in Laizhou Bay of China**

Ruijing Li, Guangshui Na, Hui Gao, Zihao Lu, Ziwei Yao and Chuanlin Huo

**Responses of mesozooplankton communities to different anthropogenic activities in a subtropical eutrophic bay**

Ping Du, Zhi B. Jiang, Yi B. Liao, Jiang N. Zeng, Xiao Q. Xu, Jing J. Liu, Xin Luo, Lu Shou, Quan Z. Chen and De M. Zhang

**Estimation of carrying capacity by measuring coastal environmental parameters in Geoje-Hansan Bay, Korea**

Dabin Lee, Jae Hyung Lee and Sang Heon Lee

**Radiocesium transfer from contaminated sediment to benthic organisms and demersal fish**

Yuya Shigenobu, Daisuke Ambe, Hideki Kaeriyama, Tsuneo Ono, Takami Morita, Shintaro Yamasaki Kousuke Yoshida and Seiichi Tomihara

**Spatio-temporal variation of radiocesium in sea sediment on benthic marine ecosystem based on five-minute resolution mapping**

Daisuke Ambe, Shigeo Kakehi, Toru Udagawa, Kazuhiro Aoki, Yuya Shigenobu, Tsuneo Ono, Takami Morita, Mikiko Tanaka, Ken Fujimoto, Hideki Kaeriyama and Shizuho Miki

**Distribution of major and trace elements in surface sediments of the Gulf of Thailand**

Pokin Channimitsri, Zhifei Liu and Penjai Sompongchaiyakul

**Clay mineralogical records of sediment provenance change during the sea level rise of last deglaciation in the southern South China Sea**

Thanakorn Jiwarungrueangkul, Zhifei Liu and Yulong Zhao

**Geochemical records of provenance and East Asian monsoon evolution during the Late Quaternary in the western South China Sea**

Sang Pham Nhu, Zhifei Liu and Yulong Zhao

**Radioactive cesium in marine organisms around Japan**

Takami Morita, Ken Fujimoto, Yuya Shigenobu, Daisuke Ambe, Hideki Kaeriyama, Shizuho Miki, Tsuneo Ono, Tomowo Watanabe and Hiroya Sugisaki

**Resting cysts of potentially harmful dinoflagellates in Korean coastal area**

Zhun Li, Eun Song Kim, Joo-Hwan Kim, Myung-Soo Han and Hyeon Ho Shin

**POC Contributed Paper Session**

Convenor: *Kyung-Il Chang (Korea)*

Background

Papers covering all aspects of physical oceanography and climate in the North Pacific and its marginal seas were invited, except those covered by Topic Sessions sponsored by the Physical Oceanography and Climate Committee (POC).

List of papers

*Oral presentations*

**The development of a high resolution global ocean surface wave-tide-circulation coupled model**

Fangli Qiao, Qi Shu and Bin Xiao

**Global distribution of mergers and splits of oceanic mesoscale eddies**

Hiromu Ishiyama, Hiromichi Ueno, Masaru Inatsu and Sachihiko Itoh

**Tomographic mapping of nonlinear tidal and residual currents**

Ze-Nan Zhu, Xiao-Hua Zhu, Xinyu Guo

## Session Summaries-2015

### **ADCP measurements in the Discovery Islands, British Columbia, Canada**

Di Wan and Michael [Foreman](#)

*Presented by Peter Chandler on behalf of Michael Foreman*

### **Structure and formation of the South Yellow Sea water mass in spring**

Xinyuan [Diao](#), Guangcheng Si, Chuanjie Wei and Fei Yu

### **Extracting fronts from chlorophyll and SST satellite data and analysing the relation between them**

Xiu-mei [Fan](#), Yu-mei Wu, Xue-sen Cui, Wei Fan and Cheng-jun Hua

### **Subsurface hydrographic structures and the temporal variation of Aleutian eddies**

Rui [Saito](#), Ichiro Yasuda, Kosei Komatsu, Hiromu Ishiyama, Hiromichi Ueno, Hiroji Onishi, Takeshi Setou and Manabu Shimizu

### **An improved wave-induced mixing parameterization in the Great Lakes**

Wei [Hu](#), Jia Wang, Conghua Cao, Juan Huang, Xueming Zhu and Haoguo Hu

### **The structure of regional climate variability in the Far-Eastern Seas**

Elena I. [Ustinova](#) and Yury D. Sorokin

### **Procedures for correcting *in situ* CTD data and results obtained during the NEAR-GOOS Cross-Basin Climate Monitoring Section project**

Dmitry [Kaplunenko](#), Aleksander Lazaryuk, Vyacheslav Lobanov, Sergey Sagalaev, Sho Hibino and Toshiya Nakano

### **Filtering methods for detecting ocean striations**

Yuping [Guan](#), Yu Zhang, Zhaohui Chen, Hailong Liu and Rui Xin Huang

### **On specifics and effects of processes in stratified bottom layers in the shelf zone of the sea**

Vadim [Navrotsky](#), Valeriy Liapidevskii, Viacheslav Lobanov, Elena Pavlova and Fedor Khrapchenkov

### **Seasonal variation of coastal currents in the East/Japan Sea**

Kyung-Il [Chang](#) and Jae-Hyoung Park

## *Poster presentations*

### **Investigation of shallow and deep water wave dynamics using unstructured SWAN: An application to Lake Michigan**

Miaohua [Mao](#) and Meng Xia

### **Paleoenvironmental reconstruction from deepwater sedimentary records in the central South China Sea since the middle Pleistocene**

Neil K.S. [Cheong](#), Zhifei Liu, Xuan Lv and Yanli Li

### **Study on the hydrodynamic performance of a flap bottom-hinged wave energy converter**

Xiang-nan [Wang](#) and Zhong-hua Zhang

### **Dynamic evaluation of Envisat ASAR derived ocean swell in North Pacific**

He [Wang](#), Alexis Mouche, Romain Husson, Jianhua Zhu and Bertrand Chapron

### **Error variation analysis and global assessment for total water vapor of HY-2 Scanning microwave radiometer**

Xiaoqi [Huang](#), Yili Zhao, Jianhua Zhu, He Wang and Chuntao Chen

### **Seasonal variability of water circulation in the deep Bering Sea**

Svetlana [Marchenko](#), Galina Vlasova and Natalia Rudykh

### **Application of Wave Drifter to marine environment observation**

Mingbing [Li](#), Suoping Zhang, Zhanhui Qi and Chaoqun Dang

### **Study of the turbulent mixing in the northwestern Pacific based on a fine-scale parameterization method**

Ying [Li](#), Zexun Wei and Yongsheng Xu

### **Upper layer phenomena monitoring of the sea using EOF analysis of remote sensing data**

Georgiy S. [Moiseenko](#)

### **Annual variation of Ba/Ca and Mn/Ca ratios in *Porite* coral from eastern Hainan Island and their environmental implication**

Qiaowen Jiang, Zhimin Cao, Daoru Wang, Yuanchao Li, Zhongjie Wu and Jianyu [Ni](#)

### **Winter cyclonic activity in the Asia-Pacific region and its effect on surface temperature in the Sea of Okhotsk in the 2000s**

Svetlana Yu. [Glebova](#)

### **Long term, high-resolution ocean reanalysis of the Northwest Pacific Ocean**

Tsuyoshi [Wakamatsu](#), Norihisa Usui, Yosuke Fujii, Yusuke Tanaka, Hiromichi Igarashi, Masafumi Kamachi and Yoichi Ishikawa

### **Measurements of the turbulent energy dissipation rate in the Changjiang river near-field plume**

Jianfeng [Wang](#), Fei Yu and Chuanjie Wei

### **A preliminary study on the tidal effects on the Yellow Sea Bottom Cold Water and its ecosystem using a physics-ecosystem coupled model**

Jae-Kwi [So](#), Hyoun-Woo Kang and Ok-Hee Seo

**Variation of sea surface Chlorophyll a in the southwestern boundary area of the East Sea**

Hee Dong Jeong, Sang Woo Kim, Yong Kyu Choi, Jeong Min Shim, Kee Young Kwon and Yong Hwa Lee

**Linkages of climatic anomalies in the North Pacific, Asia at temperate latitudes, Indo-Pacific and Arctic oceans**

Svetlana P. Shkorba, Vladimir I. Ponomarev, Elena V. Dmitrieva and Lubov N. Kuimova

**The formation process of Southern Yellow Sea Cold Water Mass in spring**

Fei Yu, Guangcheng Si, Xinyuan Diao, Chuanjie Wei and Qiang Ren

**Simulation of mesoscale and submesoscale circulation in the northwestern Japan Sea**

Vladimir I. Ponomarev, Pavel A. Fayman, Vyacheslav A. Dubina and Irina V. Mashkina

**Decadal variability of upper ocean heat content in the Pacific**

Gang Wang, Shuangxi Yan and Fangli Qiao

**Workshop (W1)**

***Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific – A comparative ecosystem approach***

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors: *Douding Lu (China), Vera Trainer (USA)*

Invited Speaker:

*Charles Trick (University of Western Ontario, Canada)*

Background

There is clear evidence of contrasting occurrence and impacts of fish-killing fish-kill flagellates between the western and eastern Pacific in the comprehensive dataset (2000–2012) assembled during the PICES-2012 workshop on contrasting HABs in PICES member countries. These data provide a unique opportunity for east–west Pacific comparisons to identify and rank those environmental factors that promote HAB success at different times. This workshop focused on the fish killing species—*Heterosigma akashiwo*, *Cochlodinium* and *Chattonella* and ribotypes—organisms that historically have had massive economic impacts in western PICES member countries, as well as increasingly prevalent impacts in eastern Pacific coastal waters. The workshop foundation was an extension of the current dataset to the 1990s and earlier where available, with PICES participants pre-submitting available data on: HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, water clarity, nutrients, wind, river flow (flooding), and upwelling indices. As part of the workshop, participants evaluated the trends and patterns in these data to develop hypotheses for development into outlook products on day 1, and developed a detailed outline for manuscript preparation on day 2, including writing assignments and submission deadlines. The manuscript will be targeted for an appropriate peer-reviewed journal.

Summary of the workshop

A series of presentations, including an invited talk by Dr. Charles Trick, in the morning and early afternoon of the first day described what is known about raphidophytes in PICES member countries. This was followed by a discussion of data spreadsheets, describing historical abundance and toxicity of raphidophytes together with associated environmental data, prepared by country representatives in advance of the workshop.

The discussion on the second morning resulted in a unanimous decision to focus analysis on *Heterosigma akashiwo* that would result in a publication comparing and contrasting what is known about historical occurrences of this raphidophyte in PICES member countries. A paper outline and components for submission to a peer-reviewed journal were discussed and finalized (see [S-HAB report](#) for outline).

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### List of papers

#### *Oral presentations*

##### **Comparing physiologies and toxicities in *Heterosigma akashiwo*: An east-west perspective (Invited)**

Charles G. Trick

##### ***Heterosigma akashiwo* bloom and associated environmental conditions in Cowichan Bay, Canada in 2014**

Svetlana Esenkulova, Chrys Neville and Isobel Pearsall

##### **Fish-kill flagellates in the Salish Sea –A comparative ecosystem approach**

Vera L. Trainer and Nicola Haigh

##### **Biological characteristics of the red tide causing raphidophytes *Heterosigma akashiwo* and *Chattonella* spp. in the coastal Sea of Japan**

Ichiro Imai, Shigeru Itakura and Mineo Yamaguchi

##### ***Fish-killing Heterosigma akashiwo* blooms in Chinese coastal waters**

Douding Lu, Xinfeng Dai, Chunjiang Guan and Hao Guo

##### **Testing several hypotheses on the outbreak mechanisms of *Cochlodinium polykrikoides* blooms in the southern coastal waters of Korea**

Yeseul Kim, Sinjae Yoo, Young baek Son and Soonmi Lee

### **Workshop (W2)**

#### ***Identifying major threats to marine biodiversity and ecosystems in the North Pacific***

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors: *Takafumi Yoshida (Japan/NOWPAP), Chris Rooper (USA)*

Invited Speakers:

*Malcolm Clark (National Institute of Water and Atmospheric Research, Wellington, New Zealand)*

*Noriaki Sakaguchi (IPBES Asia-Pacific Regional Assessment, IGES Tokyo Office, Japan/NOWPAP)*

### Background

Marine ecosystems in the North Pacific are influenced by multiple emerging threats, such as rising sea temperature, harmful algal blooms, marine invasive species, hypoxia and eutrophication. These multiple threats can act synergistically, but perhaps differently, from region to region to change ecosystem structure, function and dynamics. In order to enhance conservation and sustainable use of marine ecosystems in the North Pacific region, it is essential to identify critical threats to them. This will require consultation across PICES and NOWPAP member countries to collect extensive information covering potential main threats. Recently, PICES' Working Group 21 reported on the status of non-indigenous aquatic species in the North Pacific region. That report is complemented by additional studies to identify and characterize ecosystem responses to multiple stressors through Working Group 28. CEARAC, one of the four Regional Activity Centres of NOWPAP, recently launched a project to assess the impact of major threats to marine biodiversity in the western North Pacific. A goal of this activity is to select appropriate indicators for marine biodiversity conservation and develop marine environment assessment methodology for the future. This workshop discussed common assessment indicators to understand the status of major pressures/stressors/threats to marine biodiversity and to identify future collaborations between PICES and NOWPAP. The workshop is expected to contribute to understanding of marine ecosystems in the North Pacific by selecting candidate indicators for investigating their status in the North Pacific. The output from the workshop will also contribute to FUTURE activities.

### Summary of the workshop

The 1-day workshop was held on October 16 in Qingdao, China, immediately preceding the PICES-2015. It was co-convened by Drs. Takafumi Yoshida (Japan) and Chris Rooper (USA). Throughout the day

approximately 35 participants attended and 9 presentations were made. The session started with a brief introduction of the workshop goals and objectives, as well as comments on future direction.

The morning talks focused on activities and studies related to NOWPAP. An invited talk by Dr. Noriaki Saguchi introduced the IPBES (International Science-Policy Platform on Biodiversity and Ecosystem Services) reporting framework and identified data gaps that could be informed by information from PICES members. Dr. Takafumi Yoshida presented background information on NOWPAP studies related to monitoring biodiversity and the three threats NOWPAP has identified (eutrophication, non-indigenous species and habitat alteration), as well as example data from Japan. Next, Dr. Bei Huang presented data from two sites in China where NOWPAP monitoring was being conducted and described a methodology for deriving a relative indicator score for the two systems based on perceived threats to biodiversity. Dr. Young Nam Kim discussed an interesting case study from Korea where the construction of a long dike to reclaim land had resulted in decreased biodiversity and changes in species composition and water properties for the area that was isolated from the sea by the new dike. Dr. Tatiana Orlova showed results of monitoring biodiversity and threats to biodiversity in Peter the Great Bay, the least populated of the NOWPAP monitoring sites; threats such as warming waters and runoff from river systems were identified in addition to concerns about anthropogenic threats to biodiversity. A short discussion of the NOWPAP presentations concluded the morning section of the workshop.

In the afternoon, the focus of presentations shifted to concerns about biodiversity and vulnerable habitats in the open ocean. Invited speaker, Dr. Malcolm Clark, presented research from the South Pacific that identified and mapped areas of vulnerable marine ecosystems in international waters that are threatened by fishing and mining activities. Dr. Chris Rooper presented a case study of validating species distribution models to make informed fisheries management decisions in Alaska. Dr. Janelle Curtis introduced a study that mapped the distribution of deep-sea corals in reference to observed fishing activity in the area on a vulnerable seamount in the NE Pacific. Dr. Clark returned to present a final study that addressed recommendations for science-based management measures that can be taken to protect biodiversity through spatial closures, and the types of data that are needed to design effective spatial management plans. After the presentations, a group discussion focused on the goals of monitoring biodiversity and threats to biodiversity, the challenges to these efforts and how NOWPAP and PICES could enhance collaboration to address these challenges.

#### Workshop recommendations

One of the primary goals of this workshop was to encourage communication among NOWPAP and PICES researchers regarding issues of biodiversity. The afternoon discussions led to a collection of specific recommendations that could serve as next steps in the NOWPAP-PICES collaborations. These recommendations included:

- Encouraging the sharing of relevant fisheries and environmental data that address trends and threats to biodiversity in order to fill gaps in monitoring activities in nearshore and offshore waters;
- Identifying and communicating with regional entities (such as the NPFC, NPAFC and others) that maintain relevant data on biodiversity and threats to biodiversity in nearshore and offshore waters;
- Maintaining data and/or metadata on threats to biodiversity and indicators of biodiversity (for example, providing more open access to data and metadata available through the NOWPAP website);
- Developing tools and recommendations for use in a NOWPAP-PICES advisory role (such as marine spatial planning tools and tools to measure marine protected area performance linked to the Convention on Biological Diversity);
- Identifying and proposing specific joint topic sessions for future PICES Annual Meetings to address the goals of monitoring biodiversity and threats to biodiversity;
- Identifying and proposing specific workshops for future PICES Annual Meetings that will bring together researchers to address the challenges in meeting the monitoring goals for biodiversity.

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### List of papers

#### *Oral presentations*

**IPBES Asia-Pacific regional/subregional assessment on biodiversity and ecosystem services (Invited)**

Noriaki [Sakaguchi](#)

**Regional report on the impact of major threats to marine biodiversity in the NOWPAP region**

Takafumi [Yoshida](#) and Kazuya Kumagai

**Assessment of the impacts of major threats to marine biodiversity in coastal waters of Yantai and Dalian, China**

Bei [Huang](#)

**Case study of identifying major threats to marine biodiversity in Korean coastal waters**

Jae Hoon Noh and Young Nam [Kim](#)

**Potential threats to marine biodiversity and ecosystems in the Russian area of NOWPAP**

Tatiana [Orlova](#) and Vladimir M. Shulkin

**Threats to marine biodiversity in the Deep Sea: Experience from New Zealand in data-poor situations (Invited)**

Malcolm R. [Clark](#), Ashley A. Rowden

**Distribution of vulnerable marine ecosystem indicator taxa in relation to fishing effort on Cobb Seamount**

Janelle M.R. [Curtis](#) and Cherisse Du Preez

**Sustainable deep-sea fisheries and environmental conservation: How can we balance conflicting objectives?**

Malcolm R. [Clark](#) and Matthew Dunn

#### *Poster presentations*

**Macroalgal-coral phase shifts on subtidal benthic community on the northern coast of Jeju Island, Korea**

Minji Kim, Sang Rul Park, Kwang-Sik [Choi](#) and Shashank Keshavmerthy

### **Workshop (W3)**

***Linking climate change and anthropogenic impacts to higher trophic levels via primary producers***

Co-Convenors: *Joji Ishizaka (Japan), Angelica Peña (Canada), Sinjae Yoo (Korea)*

Invited Speaker:

*Heather Bouman (Oxford University, UK)*

### Background

The North Pacific and its marginal seas encompass diverse environments under different influences of climate change and anthropogenic impacts. As a result, these ecosystems exhibit a wide range of characteristics. For example, the primary productivity of North Pacific ecosystems ranges from an extreme oligotrophic to hyper-eutrophic state. Various nutrient limitation conditions can be found as exemplified by the subarctic region, one of the major HNLC regions in the world ocean. While ecosystem regime shifts were first identified in the North Pacific, the change in the primary producer level has not been thoroughly compared and studied in relation to regime shifts. The intent of the workshop was to review the current understanding of the long-term dynamics and distributional differences of primary producers in the North Pacific; examine the factors that determine the primary productivity in different ecosystems of the North Pacific; discuss differential responses by functional groups; and finally, identify gaps in using primary producers as a linking element in end-to-end modeling, which is an important component of the FUTURE program.

### Summary of the workshop

W3 was held on October 15, 2015, and started with an introduction from the co-conveners. Participants during the 1-day workshop ranged from 25 to 35. The workshop ended around 4:00 pm after a short discussion. Various issues were discussed *via* 10 presentations ranging from nutrient distribution and its effects on



phytoplankton and productivity to albacore distribution and front location. Dr. Heather Bouman (UK) gave an invited talk on phytoplankton functional types (PFTs): definition, metrics, food web implication, and observational methods. She emphasized the importance of satellite observation and the progress made to understand the global distribution of PFTs. In such efforts, the Pacific Ocean is where the least amount of data was collected for PFTs and least is understood. Dr. Kirill Kivva (Russia) looked at the seasonal change in the nutrient ratios in the western Bering Sea, postulating their relationship with phytoplankton. Dr. Young-Baek Son (Korea) examined the 1998–2014 time series of satellite chlorophyll-*a* in the East China Sea and hypothesized a large proportion of its variability might be related to Changjiang River discharge. Dr. Xinming Pu (China) showed cruise data for the Yellow Sea and how the various ecosystem components in the Yellow Sea Cold Water Mass were affected by the intrusion of Changjiang Diluted Water. Dr. Shu Yang (China) discussed long-term changes in diatoms observed from a sediment core covering a 100-year period in the Yellow Sea. He showed that before 1980s the variability of diatom abundance was mostly influenced by climate variability such as the PDO while after 1980s it was more influenced by anthropogenic factors. Ms. Soonmi Lee (Korea) analyzed the phenology of phytoplankton in JES for 1998–2014. She showed that the relationship between phenological metrics change through seasons and suggested possible mechanisms. In the afternoon session, Ms. Yuping Zhou (China) presented the results of mesocosm experiments in the vicinity of Changjiang River mouth and discussed how nitrogen load can impact the successional process of HAB species. Dr. Sinjae Yoo (Korea) examined a modeling study of PFTs in JES. He discussed how the growth and grazing loss of PFTs are differentially affected by winter vertical mixing using ERSEM (European Regional Sea Ecosystem Model). Ms. Svetlana Esenkulova (Russia) introduced an ongoing study on Chinook salmon in the Cowichan River, British Columbia. The fish responded to the three phytoplankton blooms by reduced feeding although the mechanism of avoidance is still being studied. She emphasized the importance of the food web linkage of phytoplankton-zooplankton-fish under changing climate. Dr. Yi Xu's (USA) talk was about the albacore physiology and behavior using tags in its migratory route between the western and eastern North Pacific. The results indicated albacore physiology and behaviour change across the frontal regions.

The original intention of the co-conveners in proposing the workshop was to seek possibilities of establishing a new expert group on primary producers which has not been very active in PICES. As a matter of fact, the Pacific Ocean has not been well investigated in the primary producer level among others. To this end, the workshop reviewed and discussed: 1) The current understanding of the long-term dynamics and distributional differences of primary producers in the North Pacific; 2) The factors that determine the primary productivity in different ecosystems of the North Pacific; 3) Differential responses by functional groups; 4) Gaps in using primary producers as a linking element in end-to-end modelling. All the presentations at the workshop touched upon one or more of the above points. After the presentations, the participants had a brief discussion. We asked ourselves whether we have enough momentum to pursue a new expert group for the FUTURE program. Everyone agreed that predictability of primary producers is an important FUTURE requirement and there are many research questions that need to be dealt with at the primary producer level. At the same time the participants agreed that, at the moment, our research questions are too diverse and diffuse while we have a limited phytoplankton community within PICES. The discussion concluded that it is too early for phytoplankton ecologists to try to establish a new expert group at this time.

### List of papers

#### *Oral presentations*

#### **Detection and distribution of phytoplankton types: A view from space, and implications for higher trophic levels (Invited)**

Heather A. Bouman, Shubha Sathyendranath and Trevor Platt

#### **Seasonal nutrient dynamics in the western Bering Sea**

Kirill Kivva and Vladimir Matveev

#### **Collapse of summer biological activity in the East China Sea during 1998-2014**

Young Baek Son, Taehee Lee, Dong-Lim Choi, Chan Joo Jang and Sinjae Yoo

#### **Effects of Changjiang Diluted Water on the planktonic ecology of the Yellow Sea Cold Water Mass**

Xin-Ming Pu and Zong-Ling Wang

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### **Regional differences in decadal variations of diatom primary productivity in the southern Yellow Sea and adjacent seas over the past 100 years**

Shu Yang, Qian Yang, Keming Qu and Yao Sun

### **Variability of chlorophyll-*a* bloom timing associated with physical forcing in the East Sea/Sea of Japan (1998-2014)**

Soonmi Lee, Sinjae Yoo and Young Baek Son

### **Effects of increasing nutrient loads on the competition and succession between two predominant red tide algae of East China Sea**

Yuping Zhou, Fangfang Li, Rong Pan, Qiuting Pang, Liju Tan and Jiangtao Wang

### **Variability of the phytoplankton functional types under changing winter vertical mixing in the Ulleung Basin, East Sea: A modeling study**

Soonmi Lee and Sinjae Yoo

### **Examining linkages between juvenile salmon growth and phytoplankton, zooplankton dynamics during the early marine period**

Chrys Neville, Svetlana Esenkulova, Mary Thiess, Ian Perry and Marc Trudel

### **Migration behavior changes of juvenile North Pacific albacore linking to environmental variability**

Yi Xu, Steven Teo, Stephanie Snyder and Suzanne Kohin

### *Poster presentations*

#### **How does explicit treatment of spatial variability in environmental conditions affect simulated anchovy recruitment?**

Yi Xu, Kenneth A. Rose, Fei Chai, Francisco P. Chavez and Patricia Ayón

#### **A Modeling study of the hypoxia dynamic off the Changjiang Estuary**

Jingjing Zheng, Guimei Liu and Shan Gao

#### **The merged global ocean chlorophyll content product**

Yanfang Xiao and Tingwei Cui

## **Workshop (W4)**

### ***Marine environment emergencies: Detection, monitoring, response, and impacts***

Co-sponsors:

International Council for the Exploration of the Sea (ICES)

Northwest Pacific Action Plan (NOWPAP)

Co-Convenors: Ziwei Yao (China), Seong-Gil Kang (Korea/NOWPAP), Peter Ross (Canada), Olga Lukyanova (Russia)

Invited Speakers:

*Seong Gil Kang (Korea/NOWPAP)*

*Yongge Sun (Zhejiang University, China)*

### Background

In recent years, the importance of marine environmental emergency issues has been illustrated by oil and chemical spills, as well as by a major nuclear power plant accident. Globalization of markets has led to rapid growth of maritime transport in the North Pacific, which has become more vulnerable to ship-source incidents, including oil and hazardous and noxious substances (HNS) spills. Oil and HNS spills may be hazardous to human health, harm living resources and marine life, and can damage amenities or interfere with other legitimate uses of the sea. In 2003, the NOWPAP Regional Oil and HNS Spill Contingency Plan (RCP) provided technical and operational guidelines for regional cooperation in responding to oil and HNS spills. Marine environmental emergency issues and their strategies become an increasingly important topic for PICES member countries. However, accepted scientific and monitoring methods to document the ecological impacts of such emergencies, and post-accident recovery of the environment, are lacking. In order to better understand the interaction between the marine ecosystem and human pressures, and to formulate sustainable marine

development strategies more effectively, an applied information sharing workshop for PICES is timely. The workshop on marine environmental emergencies had three objectives:

- 1) Summarize important examples of North Pacific marine environmental emergencies from the perspective of different nations, and to discuss the different approaches taken by PICES member countries;
- 2) Develop response strategies and capacities of PICES member countries in light of environmental emergencies;
- 3) Develop joint strategies to improve responsiveness and effectiveness of current national approaches to manage and mitigate such emergencies in the PICES region.

The workshop addressed the following three aspects: (1) oil and chemical spills and their damage on the marine environment, (2) detection methods for oil and chemical spills and (3) spill response, monitoring and mitigation strategies at the interface of science and management. Case studies were used to illustrate this workshop and served to focus efforts to design a response and monitoring framework for implementation in the event of a major environmental emergency.

#### Summary of the workshop

This 1-day workshop was held on October 15, as part of the 2015 PICES Annual Meeting in Qingdao, China. The event was co-sponsored by the International Council for the Exploration of the Sea (ICES) and the Northwest Pacific Action Plan (NOWPAP). The meeting was co-convened by Drs. Ziwei Yao (China), Seong-Gil Kang (Korea/NOWPAP), Peter S. Ross (Canada), and Olga Lukyanova (Russia). Invited speakers were Drs. Seong-Gil Kang (Korea/NOWPAP) and Yongge Sun (Zhejiang University, China).

More than 40 researchers attended W4, with a total of 10 oral presentations (2 invited) given. Topics included presentations on geochemical and microbial community response oil spills, marine pollution preparedness and response to oil and Hazardous and Noxious Substance (HNS) spill incidents, lessons on oil spill response, examples of a number of oil spills in the North Pacific Ocean, determination of oil fingerprints, adverse effects, and prediction models.

The workshop featured presentations from five PICES member countries (USA excepted) as well as from NOWPAP. These included talks from Yongge Sun, Seong Gil Kang, Peter S. Ross, Chuanyuan Wang, Adedayo Adeleye, Zhen Wang, Patrick O'Hara, Un Hyuk Yim, Yongliang Wei, and Yoon Young Back.

Based on the oral presentations and workshop theme, several hot topics and related questions were posed and reviewed. A constructive and forward-looking roundtable discussion followed these presentations, with salient points summarized below.

#### I) Data:

- 1) Data is everything. Participants recognized that high resolution (fingerprinting) data were key to identifying the source, tracking the event, documenting the impact, and monitoring the recovery following a spill.
- 2) Data ownership was recognized as a frequent point of contention. Polluters ('Responsible Parties') are typically responsible for much monitoring, but such results are owned by a private party that may well face litigation or charges. This highlighted the importance of independent, third party data that are open to all parties and comes from scientifically-defensible sampling, analysis and interpretation efforts.
- 3) Pre-spill baselines are important. In a time of diminishing support for environmental monitoring, it was recognized that having baseline signatures for pre-existing levels and profiles of a variety of contaminant classes, including hydrocarbons, is very important. *Post-hoc* evaluation can garner some insight *via* depositional sediment core records.

#### II) Response:

- 1) The operational spill response is a short-term emergency effort. Who leads this operational spill response? Who leads discussions /evaluation of dispersant decisions? Are samples being collected during an emergency for environmental monitoring? For enforcement?
- 2) Environmental monitoring needs to be in place for the 'long-term'. Who leads this monitoring? How

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many samples of what matrix will be collected over space and time? Who decides on the extent of the monitoring? Are data freely available? Who pays for this monitoring?

- 3) How does one go about establishing recovery goals following a spill? Environmental recovery goals provide guidance for those overseeing the cleanup as well as other stakeholders (users). Which Environmental Quality Guidelines should be used? Are they adequate in protecting all valued species? Should new EQGs be developed?

### III) Research needs / gaps:

- 1) Impacts of dispersants on the environment;
- 2) Fate and weathering of dispersants;
- 3) Environmental Quality Guideline development for hydrocarbons;
- 4) Molecular and isotopic fingerprinting methods (*e.g.*, new techniques to distinguish between crude and fuel oils);
- 5) Toxicology of hydrocarbons and other contaminants (invertebrates, fish, birds, marine mammals);
- 6) Fate of spilled oil and chemicals;
- 7) Remediation techniques;
- 8) Prediction models;
- 9) Ecological effects assessment methods;
- 10) Rapid (onsite, *in situ*) detection methods (*e.g.*, fluorescence-based methods).

Participants agreed to propose a Special Issue for a scientific journal resulting from this workshop, including additional submissions from researchers that were unable to participate in this session. The topic would be “*Environmental emergencies in the North Pacific*”. It was recognized that the 2016 PICES Annual meeting is likely to feature a complementary topic session on “*Source, transport, fate and effects of hydrocarbons in the North Pacific Ocean*”. The distinction between the two is clear: the first relates to immediate and catastrophic spills, while the latter relates to chronic, cumulative releases from multiple non point and point sources. The latter topic session was proposed to also provide for a Special Journal Issue under the Terms of Reference for WG 31.

### List of papers

#### *Oral presentations*

**Geochemical and microbial community response to oil spill: A five year investigation after the Xingang oil pipeline explosion, the Dalian Bay, North China (Invited)**

Yongge Sun, Kai Zhang, Bingfang Shen, Xing Liu, Ziwei Yao and Zhenmei Lu

**Marine pollution preparedness and response to oil and HNS spill incidents in the Northwest Pacific Action Plan (NOWPAP) region (Invited)**

Seong Gil Kang

**The *MV Marathassa*: Lessons learned from the 2015 spill of bunker fuel in Vancouver Harbour**

Peter S. Ross, Carmen Morales and Mark Yunker

**Distribution and sources of hydrocarbons in surface sediments from tail reaches of the Yellow River Estuary**

Chuanyuan Wang and Shijie Ho

**Genotoxic effects of PCBs and heavy metals on marine mussels**

Adeyayo O. Adeleye, Yanan Di, Yi FieZhang, Ying Ye and Jian Fang Chen

**Distinguishing crude oils from heavy fuel oils by polycyclic aromatic hydrocarbon fingerprints**

Xing Liu, Zhen Wang, Xindong Ma, Hengzhen Xu and Ziwei Yao

**Oil dispersants impact feather function in marine birds**

Patrick D. O'Hara, Benjamin G. Fieldhouse and Lora A. Morandin

**Lessons learned from the *Hebei Spirit* oil spill: Environmental perspectives**

Un Hyuk Yim, Won Joon Shim, Jong Seong Khim, Moonkoo Kim and Jee-Hyun Jung

**Oil spill trajectory prediction using the GNOME model and satellite images**

Yongliang Wei, Zeyan Tang, Jianqiang Liu and Xiaofeng Li

**The activities of Marine Environmental Emergency Preparedness and Response Regional Activity (MERRAC) for oil and HNS spills preparedness and response in the Northwest Pacific Action Plan (NOWPAP) region**

Seong Gil Kang, Jeong Hwan Oh, Yoon Young Back, Jung Hyun Lim and Bo Sik Kang

*Poster presentation*

**Exploring the potential of Geospatial Technology for oil spill detection in shallow coastal areas in the Arabian Gulf**

Pavan Kumar, Swati Katiyar and J.S. Rawat

**Complex toxic impacts of heavy metals and PAHs to marine mussels cells**

Yifei Zhang, Adedayo Adeleye and Yanan Di

**Workshop (W5)**

***Monitoring and assessment of environmental radioactivity in the North Pacific***

Co-sponsor: Scientific Committee on Oceanic Research (SCOR)

Co-Convenors: *Yusheng Zhang (China), Kathryn A. Higley (USA)*

Invited Speakers:

*Michio Aoyama (SCOR)*

*Minhan Dai (SCOR)*

*Ronald Szymczak (Nuclear and Oceanographic Consultant, Tradewinds)*

Background

The Marine Environmental Quality Committee's area of responsibility is to promote and coordinate marine environmental quality and interdisciplinary research in the North Pacific. This workshop has three objectives: 1) To coordinate with external expert groups, 2) To review the situation and to discuss the information gaps and deficiencies in monitoring and assessment of the Environmental Quality of Radioactivity and its impact on marine ecosystems in the North Pacific, especially since the "3·11" Fukushima Nuclear Accident, and 3) To exchange information on new techniques and methodologies for monitoring and assessment of the environmental quality of radioactivity in the marine environment, and to discuss development trends and research priorities. The main topics of the workshop include: 1) the current situation of environmental quality of radioactivity and its effect on marine ecosystems in the North Pacific, 2) new techniques for the analysis of radionuclides in the marine environment and 3) assessment of the radiological risk to non-human species. The workshop will invite experts in relevant fields, and welcome reports on research and progress in the above topics with regard to the monitoring and assessment on the marine environmental quality of radioactivity in the North Pacific.

Summary of the workshop

The well attended 1½-day workshop, co-sponsored by SCOR, was held on October 15 and 16, 2015, in Qingdao, China, and was convened by Dr. Kathryn A. Higley (USA) and Dr. Yusheng Zhang (China). Seventeen talks were presented, including invited talks by Drs. Michio Aoyama and Minhan Dai (representing SCOR) and Dr. Ronald Szymczak (Tradewinds/Australia). Participant discussions centered around 1) information gaps in models and model validation with field data; 2) the technical challenges in monitoring/impact assessment, and possible solutions; 3) information gaps in seawater and biota data, and spatial and temporal change of radioactivity in the North Pacific. The outcome of the workshop was that the distribution of radionuclides in the North Pacific was well studied, new techniques were being developed to aid in monitoring, and that little impact on the marine ecosystems is predicted, using simple models.

List of papers

*Oral presentations*

**Asia/Pacific marine ecosystem impacts from the Fukushima Daiichi nuclear power plant accident: A 2011-2015 overview (Invited)**

Ronald Szymczak

## Session Summaries-2015

**$^{134}\text{Cs}$  and  $^{137}\text{Cs}$  in the North Pacific Ocean derived from the TEPCO Fukushima Dai-ichi Nuclear Power Plant accident, Japan in March 2011: Transport processes and estimation of  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  inventories (Invited)**

Michio [Aoyama](#)

**Sources and inventory of Cesium and Plutonium in China seas (Invited)**

Junwen Wu and Minhan [Dai](#)

**Development of a radionuclide transport model applicable to coastal regimes with multi-fractional cohesive and non-cohesive sediments**

Kyung-Tae [Jung](#), Igor Brovchenko, Vladimir Maderich, Kyeong Ok Kim and Fangli Qiao

**Long-term transport and dispersion of  $^{137}\text{Cs}$  released into ocean off Fukushima nuclear accident**

Chang [Zhao](#), Gang Wang, Fangli Qiao, Guansuo Wang, Changshui Xia and KyungTae Jung

**Model developments to estimate movements of radioactive cesium with ocean sediment after the Fukushima Dai-ichi nuclear power plant accident**

Shin-ichi [Ito](#), Kazuhiro Aoki, Hiroshi Kuroda, Takashi Setou, Kazuhiro Takeuchi, Daisuke Hasegawa, Hideki Kaeriyama, Ambe Daisuke, Tsuneo Ono, Shigeo Kakehi, Hiroshi Yagi, Kouichi Sugimatsu and Akiyoshi Nakayama

**Transport of the Fukushima radioactivity plume to the Eastern North Pacific Ocean**

John N. [Smith](#)

**Monitoring activity on radioactive cesium in seawater and sediment in the North Pacific by Fisheries Research Agency after the Fukushima Dai-ichi Nuclear Power Plant Accident**

Hideki [Kaeriyama](#), Daisuke Ambe, Tsuneo Ono, Shigeo Kakehi and Tomowo Watanabe

**Distribution and impact of radiocesium in the seawater of northwest Pacific in 2014**

Wen [Yu](#), Jianhua He, Wu Men, Tao Yu and Yusheng Zhang

**The radioactive level of nekton species in the Northwest Pacific more than one year after Fukushima nuclear accident**

Wu [Men](#), Jianhua He, Fenfen Wang, Wen Yu, Yiliang Li and Yusheng Zhang

**Temporal changes in the distribution of radiocesium contamination among ten dominant coastal fish species in Sendai bay and the coastal area off Fukushima**

Hiroyuki [Togashi](#), Yukinori Nakane, Yuya Shigenobu and Yutaka Kurita

**Radiocesium contamination histories of Japanese flounder *Paralichthys olivaceus* after the 2011 Fukushima Nuclear Power Plant accident**

Yutaka [Kurita](#), Hiroyuki Togashi, Yuya Shigenobu and Shin-ichi Ito

**Challenges in calculating radiation dose to marine organisms**

Kathryn A. [Higley](#), Delvan Neville and Mario Gomez-Fernandez

**Assessment on marine environmental impact from artificial radionuclides in the coastal waters of Liaodong Bay**

Jinqiu [Du](#), Hui Gao, Guangshui Na, Ziwei Yao and Chuanlin Huo

**Use of otoliths to estimate the concentration of radioactive strontium**

Ken [Fujimoto](#), Shizuho Miki, Tomowo Watanabe and Takami Morita

**A new device for precipitation and filtration of radiocesium in seawater**

Jianhua [He](#), Wu Mem, Yiliang Li, Wen Yu, Tao Yu and Yusheng Zhang

**Auto-system development and invention for measurement of  $^{137}\text{Cs}/^{134}\text{Cs}$  in-situ**

Zhenfang [Dong](#), Hongqi Shi and Deyi Ma

### Poster presentation

**Radioactive status of seawater and assessment in the northeast South China Sea, the Luzon Strait and its adjacent area**

Peng [Zhou](#), Dongmei Li, Hongda Fang, Chuguang Huang, Haitao Li, Weixu Cai, Lingling Wu, Li Zhao, Feng Zhao, Yuanlai Zheng and Hongbiao Zhang

**Monitoring of  $^{134}\text{Cs}$  in surface sea water**

Hongqi [Shi](#), Zhenfang Dong, Jianwei Zhu and Yu Zhang

**Temporal variations of  $^7\text{Be}$  and  $^{210}\text{Pb}$  activity in aerosols at Xiamen, China**

Dekun [Huang](#), Jianhua He and Tao Yu

**Temporal variations of  $^7\text{Be}$  and  $^{210}\text{Pb}$  activity in aerosols at Xiamen, China**

Dekun [Huang](#), Jianhua He and Tao Yu

**Effects of external gamma irradiation on growth of *Phaeodactylum tricornutum***

Jianda [Ji](#), Fulong Cai and Tao Yu

**Radionuclide tracers suggest different migratory patterns in two groups of North Pacific albacore (*Thunnus alalunga*)**

Jason Phillips, Owyn Snodgrass, Delvan [Neville](#), Daniel Madigan, Lorenzo Ciannelli, Ric Brodeur, Kathryn Higley and William Pearcey

**Assessment impact of radioactive contamination on the Pacific saury after the Fukushima Dai-ichi Nuclear Power Plant accident**Galina S. [Borisenko](#), Victor N. Filatov, Yuriy G. Blinov, Yuriy V. Novikov and Nikita M. Blishchak**Workshop (W6)*****Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems***Co-Convenors: *Sung Yong Kim (Korea), Jack Barth (USA), Tony Koslow (USA)*

## Invited Speakers:

*David M. Checkley, Jr. (Scripps California Cooperative Oceanic Fisheries Investigations, CalCOFI, USA)**Daji Huang (Second Institute of Oceanography, State Oceanic Administration, China)**Song Sun (Institute of Oceanology, Qingdao, China)*Background

The collection of time series of high-quality physical, chemical and biological data from coastal ocean observatories is critical to the PICES science mission. Coastal ocean observing data are important for documenting changes in coastal ocean ecosystems and for driving numerical circulation and biogeochemical models. There is broad agreement that the ‘operators’ of coastal observing systems around the North Pacific would benefit from developing best practices – basically sharing experiences on what works and what does not work. At the same time, there have been significant advances in scientific understanding using coastal ocean observing systems. In recent years there has been a big increase in the number of permanent coastal ocean observing systems around the North Pacific, which is expected to continue in the near future. These observatories include shore-based instrumentation, very shallow installations near the coast and in semi-enclosed bays, as well as observatories that span from the coast to full ocean depth. The workshop sought contributions that illustrate the growing number of coastal ocean observatories across the PICES member countries, and examples of topics to be considered for ‘best practices’ for coastal ocean observing systems included:

- Observing platforms (cabled nodes, autonomous vehicles, moorings, profilers, shore-based instruments, *etc.*),
- Sensors and sensor calibration, including physical, optical, biogeochemical, bioacoustics sensors,
- Data quality control,
- User interfaces to data and information products, with user interfaces varying, depending on their intended audience, *e.g.*, observatory operators, scientists, ocean users,
- Data delivery to users, in particular, to numerical modelers
- Data archiving.

Summary of the workshop

Nine talks (3 invited) were presented at the W6 session on “*Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems*”. Talks by Drs. Daji Huang, Song Sun (both invited) and Jiajia Liu examined the extensive development of coastal observations in China in recent years. Drs. Jack Barth and David Checkley discussed the U.S. coastal observation systems in the northern and southern California Current, respectively, and Dr. Matthew Baker described the recent development of baseline understanding in the U.S. Arctic. Dr. Tony Koslow described dramatic changes observed among midwater and cool-water affinity fish communities in the southern California Current, obtained through analysis of the CalCOFI ichthyoplankton time series. He also talked about the potential for a network of such observations along the west coast of North America and around the rim of the North Pacific. Dr. Kim Juniper examined best practices implemented for the Ocean Networks Canada ocean observatory system, and Dr. Sung Yong Kim described the potential for an integrated ocean observing system around Korea. Although there were no talks

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from Japan or Russia, the workshop provided a good overview of the development of coastal observing systems around the North Pacific. The emphasis of the presentations, with the exception of those on CalCOFI by Checkley and Koslow, was on the development of physical and chemical oceanographic monitoring. The development of biogeochemical and species-resolved ecological monitoring is still undeveloped in most North Pacific coastal observing systems.

### List of papers

#### *Oral presentations*

**Chinese efforts in coastal ocean observation in 21<sup>st</sup> century (Invited)**

Daji [Huang](#)

**CalCOFI: Best practices under a changing climate (Invited)**

David M. [Checkley, Jr.](#)

**Brief introduction of marine observing system in China (Invited)**

Song [Sun](#)

**Development and implementation of best practices for the Ocean Networks Canada ocean observatories**

S. Kim [Juniper](#), Reyna Jenkyns and Marlene Jeffries

**Research in the Arctic: Coordinated approaches to baseline understanding of the ecosystem and analyses of change in the Northern Bering Sea, Chirikov Basin, and Chukchi Sea**

Matthew R. [Baker](#)

**Coastal ocean observing in the northeast Pacific**

John A. [Barth](#) and many NANOOS and OOI Colleagues

**Fishes as indicators of ecosystem change and how they can be incorporated into coastal ocean observing systems**

J. Anthony [Koslow](#)

**An overview of wireless communication technology in ocean observing system**

Jiajia [Liu](#), Lingfeng Liu and Yuhong Dou

**A vision for the integrated coastal ocean observing system in Korea**

Sung Yong [Kim](#)

#### *Poster presentation*

**Temporal change of plankton and environmental factors during typhoons observed at the Oshima Cabled Observatory**

Ryuta [Murashige](#) and Yoshinari Endo

## Best Presentations for Committee-sponsored Topic Sessions or Workshops at PICES-2015

Science Board Best Oral Presentation (S1) on “*Change and Sustainability of the North Pacific*”

[Mitsutaku Makino](#) (Fisheries Research Agency, Yokohama, Japan, [mmakino@affrc.go.jp](mailto:mmakino@affrc.go.jp)) on “*Toward the integrated research in fisheries science*”

Science Board Best Poster Presentation (S1) on “*Change and Sustainability of the North Pacific*”

[John A. Barth](#) (College of Earth, Ocean, and Atmospheric Sciences (CEOAS), Oregon State University, Corvallis, U.S.A. [barth@coas.oregonstate.edu](mailto:barth@coas.oregonstate.edu)) on “*Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current large marine ecosystem*” co-authored with Aimee A. Keller, Lorenzo Ciannelli, W. Waldo Wakefield, Victor H. Simon, and Stephen D. Pierce

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

[Yunyun Zhuang](#) (College of Environmental Science and Engineering, Ocean University of China, Qingdao, China, [yunyun.zhuang@ouc.edu.cn](mailto:yunyun.zhuang@ouc.edu.cn)) on “*Using 454 pyrosequencing to analyze the in situ diet of the marine copepod Calanus sinicus*” co-authored with Huan Zhang, Yousong Huang, Guangxing Liu and Senjie Lin.



Best Poster for the BIO-sponsored Contributed Paper Session

**Sachihiko Itoh** (Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan, itohsach@ori.u-tokyo.ac.jp) on “*Mixed layer depth and chlorophyll a: Profiling float observations in the Kuroshio-Oyashio Extension region*” co-authored with Ichiro Yasuda, Hiroaki Saito, Atsushi Tsuda and Kosei Komatsu.

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

**Shengle Yin** (Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Japan, yin.shengle@gmail.com) on “*Selection of suitable coastal aquaculture sites with environmental and socio-economic consideration: A case study in the Menai Strait, UK*” co-authored with Aigo Takeshige, Yoichi Miyake and Shingo Kimura.

Best Poster for the FIS-sponsored Contributed Paper Session

**Motomitsu Takahashi** (Fisheries Resources and Oceanography Division, Seikai National Fisheries Research Institute, FRA 1551-8 Taira-machi, Nagasaki, Japan, takahamt@fra.affrc.go.jp) on “*Interannual variations in growth trajectories of juvenile jack mackerel *Trachurus japonicus* in the Tsushima Warm Current*” co-authored with Chiyuki Sassa, Satoshi Kitajima and Youichi Tsukamoto.

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

**Shizuho Miki** (Research Center for Fisheries Oceanography and Marine Ecosystem, National Research Institute of Fisheries Science, FRA, Yokohama, Japan, mikish@affrc.go.jp) on “*Strontium-90 in marine fishes*” co-authored with Ken Fujimoto, Takami Morita, Yuya Shigenobu, Kaori Takagi, Tsuneo Ono, Tomowo Watanabe and Hiroya Sugisaki.

Best Poster for the MEQ-sponsored MEQ sponsored Contributed Paper Session

**Ren-Cheng Yu** (Key Laboratory of Marine Ecology and Environmental Sciences, Institute of Oceanology, CAS, Qingdao, China, rcyu@qdio.ac.cn) on “*Application of qPCR methods in detection of PST-producing *Alexandrium* species in the Yellow Sea and East China Sea*” co-authored with Yan Gao, Qing-Chun Zhang, Fan-Zhou Kong and Ming-Jiang Zhou.

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

**Yong Sun Kim** (Physical Oceanography Division, Korea Institute of Ocean Science and Technology (KIOST), Ansan, Korea, yongsun76@gmail.com) on “*Seasonal characteristics of the long-term sea surface temperature variability in the Yellow and East China Seas*” co-authored with Chan Joo, Jang Jin, Yong Jeong and Yongchim Min.

Best Poster for the POC-sponsored Contributed Paper Session

**Gang Wang** (Key Laboratory of Marine Science and Numerical Modeling, First Institute of Oceanography, SOA, Qingdao, China, wangg@fio.org.cn) on “*Decadal variability of upper ocean heat content in the Pacific*” co-authored with Shuangxi Yan and Fangli Qiao.

Best Oral Presentation by an early career scientist for the MONITOR-sponsored Topic Session

**Ja-Mvung Kim** (Environmental Science & Engineering, Pohang University of Science and Technology (POSTECH), Pohang, Korea, jamyung@postech.ac.kr) on “*Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions*” co-authored with Kitack Lee, Kyungsoon Shin, Eun Jin Yang, Anja Engel, David M. Karl and Hyun-Cheol Kim.

Best Poster for the MONITOR-sponsored Topic Session

**Weimin Wang** (College of Environmental Science and Engineering, Ocean University of China, Qingdao, China, wwmin@126.com) on “*Effects of CO<sub>2</sub>-driven ocean acidification on the early development of scallop *Argopecten irradians* (Lamarck, 1819)*” co-authored with Guangxing Liu, Tianwen Zhang, Hongju Chen, Liao Tang and Xuwei Mao.

Best Oral Presentation by an early career scientist for the TCODE-sponsored Topic Session

None this year.

Best Poster for the TCODE-sponsored Topic Session

None this year.