

## Summary of Scientific Sessions and Workshops and List of Best Presentations at PICES-2013

### Science Board Symposium (S1)

#### *Mechanisms of Marine Ecosystem Reorganization in the North Pacific Ocean*

Co-Convenors: *Sinjaee Yoo (SB)*, *Atsushi Tsuda (BIO)*, *Elizabeth Logerwell (FIS)\**, *Chuanlin Huo (MEQ)*, *Hiroya Sugisaki (MONITOR)*, *Kyung-Il Chang (POC)*, *Toru Suzuki (TCODE)*, *Thomas Therriault (AICE)*, *Hiroaki Saito (COVE)*, *Phillip Mundy (SOFE)* and *Igor Shevchenko (Russia)*

\* Elizabeth Logerwell was unable to attend PICES-2013 due to the U.S. government partial shutdown.

#### Invited Speakers:

*Richard Beamish (Fisheries and Oceans Canada, retired)*

*Alida Bundy (Bedford Institute of Oceanography, DFO, Canada)*

*Brian Helmuth (Northeastern University, USA)*

*Mitsutaku Makino (Fisheries Research Agency, Japan)*

*Muyin Wang (University of Washington, Seattle, WA, USA)*

#### Background

The PICES FUTURE program aims to improve our capability to convey how North Pacific marine ecosystems may change due to natural and anthropogenic stressors, including climate change, and ultimately how societies will be affected by these changes. This will require advances in scientific communication which is a relatively new area for PICES and so to facilitate advancement of this topic this Symposium will focus on four focal areas of communication: Products, Communicating Uncertainty, Decision Support Tools, and Human Dimensions. In addition, this Symposium discussed the scientific basis of FUTURE products.

#### Summary of presentations

The Science Board Symposium was held on Monday, October 14, 2013 and was launched with a keynote address by Ian Perry and included five invited presentations: Richard Beamish (Fisheries and Oceans Canada, retired), Alida Bundy (Fisheries and Oceans Canada, Canada), Brian Helmuth (Northeastern University, USA), Mitsutaku Makino (Fisheries Research Agency, Japan), and Muyin Wang (University of Washington, USA). In addition, there were nine contributed oral presentations and two poster presentations.

The keynote address was given by Ian Perry (Fisheries and Oceans Canada, Pacific Biological Station, Canada) who used a local example of ecosystem change to highlight a central question of FUTURE: “What is the future of the North Pacific given current and expected pressures?”. Dr. Perry highlighted the linkages between Products, Tools, Uncertainty, and Human Dimensions as he illustrated how Canadian marine ecosystems have changed in response to potential drivers, including climate change and human influences. Specifically, within the Strait of Georgia, he showed how environmental indicators like temperature have increased and salinity decreased while biological indicators such as seals have increased while Fraser River sockeye have decreased. These products have been communicated to managers via various reports and publications. Linking drivers to change can be difficult but Dr. Perry showed how different modeling approaches, ecological risk assessment frameworks, and simulation models like Ecopath can be useful. However, he also highlighted how any forecast of the “future” has elements of uncertainty that also must be communicated when providing scientific advice to decision makers. Ultimately, the goal of communicating these findings and uncertainty is to allow decision makers to evaluate the trade-offs that will be required to attain a desirable state, likely one that will impact human societies as little as possible. Dr. Perry was clear that when communicating it is essential to “know your message” and be clear on what, why, how, and to whom scientific information is being communicated. This will be essential as the PICES FUTURE program moves forward.

How does marine science become sustainable? Dr. Richard Beamish suggested this could be accomplished by having an informed public by being clear on what scientists know, what they don't know, and what they need to know using the coho salmon fishery in the Strait of Georgia as a case study. In the late 1980s the sport and commercial fisheries were booming but had collapsed by the mid-1990s due to changes in survival and migration patterns. With recreational fishermen, hatchery managers, and scientists all ready and willing to figure out what is happening, a community science team, the Strait of Georgia Coho Study Team, was created to conduct regional science and publicize the results. Dr. Beamish suggested PICES could consider a similar mechanism and the potential creation of a PICES Public Press to reach more general audiences.

Brian Helmuth touched on a different issue when communicating uncertainty and that is: When is it important to provide details? In many cases generalizations of species distributional responses to climate change have been useful but there is growing evidence that these simplifications might not be enough and a more detailed understanding of how organisms respond to their environment might be required to actually forecast change. Approaches like coupled biophysical-energetic models that build on a mechanistic understanding of how coastal organisms interact with their environment have the potential to provide spatially explicit estimates of where, when, and with what magnitude climate-induced impacts might occur. This will allow consideration of cumulative stress impacts, including sublethal effects, as shown here for *Mytilus*. Dr. Helmuth indicated it will be important to embrace variability early in an attempt to avoid potential "surprises" down the road as scientists continue to struggle to predict exact detailed impacts of climate change with a high degree of certainty.

Mitsutaku Makino highlighted why Human Dimensions are needed, especially for the FUTURE program. Dr. Makino showed how good science is sometimes not implemented by managers because of the perceived socio-economic or cultural costs and how inclusion of social science can be useful for setting objectives for social-ecological systems (SES). Further, he introduced the PICES community to the human well-being cube. This is one method that can be used to link ecosystems and human well-being through ecological services. Dr. Makino also showcased how the PICES Section on *Human Dimensions* is addressing key elements of the FUTURE science program and how human dimension indicators are being developed for use by the PICES community.

Science products can be directed at international experts, resource managers, and the general public. Alida Bundy provided an overview of the Indicators for the Seas (IndiSeas) program and showed how an empirical suite of indicators can be used to provide an interdisciplinary assessment or compare changes across ecosystems. In the first cycle, IndiSeas focused on developing ecological indicators that could be communicated to the public in an easy to understand way. Issues of climate change and human dimensions were identified as gaps and the second iteration of IndiSeas has now expanded to include these metrics. Dr. Bundy also introduced the IMBER-ADApT (Assessment based on Description, Responses and Appraisal for a Typology) decision support tool as humans are both drivers and recipients of ecosystem change. This tool allows users to build on knowledge gained from past experiences to inform future decision making, and is a tool that could be useful for implementing parts of the FUTURE program.

Muyin Wang presented results from the Coupled Model Intercomparison Project, phase 5 (CMIP5), especially how these models perform with respect to sea ice. Using observational constraints it was possible to eliminate some outlier models but many still performed relatively poorly with respect to simulated sea ice extent, significantly underestimating it. Despite some uncertainty, models predicted the Arctic will have a 2- to 3-month ice free period by the middle of the 21<sup>st</sup> century and a 5-month ice free period by the end of the 21<sup>st</sup> century. Clearly this will impact not only future climate but will have significant social, ecological, and economic consequences.

The remainder of the symposium included a variety of presentations related to the symposium theme. For example, Harold (Hal) Batchelder introduced the Future Ocean Alliance (FOA) and showed how coupling of natural and human systems will be essential to transfer knowledge to those that need it for sustainable ocean development. Ed Gregor showed how model complexity does not necessarily equate to uptake by managers

using a case study of otters, urchins, and kelp. Further, by not being explicit with respect to uncertainty there can be an overconfidence in models and with no clear endpoint, it can be difficult to determine when models are sufficient (generally when decisions would be unchanged). Carrie Holt showed how limit reference points or benchmarks can be applied to data-limited salmon stocks and highlighted how declines in productivity can be a concern for these data-limited stocks and that this uncertainty needs to be communicated to resource managers. Bill Sydeman presented a meta-analysis as a method to simplify and integrate information that can provide a synthetic view of an ecosystem that could be very useful in FUTURE. Hans Pörtner discussed multiple stressors such as increased sea surface temperature, ocean acidification, eutrophication, *etc.* and how they can impact different life history stages differently. For example, seasonal shifts in thermal windows can have significant large-scale impacts. Using chinook salmon in the Yukon River as an example, Ellen Tyler showed how outlooks and forecasts using real time data can be used for management purposes. Similarly, Sue Grant highlighted how making future predictions based on the past can be problematic when in the realm of “never seen before”. Here, Bayesian methods were used to include uncertainty in forecasts. Shin-ichi Ito spoke about extreme hot events that resulted in very high scallop mortality, even in deep water of Mutsu Bay. Models using the salinity budget were used to identify conditions that resulted in anti-estuarine circulation responsible for this high mortality and this information was used to inform management when this situation arose again. Marc Trudel discussed lessons learned from a juvenile salmon program, including the predictive power of forecasting models, the reality of shifting baselines, and the role of regime shifts: all of which contribute to uncertainty.

### List of papers

#### *Oral presentations*

**Ian Perry** (Keynote)

Canada’s changing Pacific marine ecosystems: Forecasts, uncertainties, potential consequences, and communication

**Richard J. Beamish** (Invited)

Sustaining Marine Science

**Brian Helmuth** (Invited)

Communicating uncertainty in the era of climate change: When do ‘the details’ matter?

**Harold (Hal) P. Batchelder, Isabel Torres de Noronha, Oran Young, Suzanne Lawrence, Peter Fox, J. Luis Valdes, David Vousden, Ruben Zondervan, Robin Mahon, Leopoldo C. Gerhardinger, Heidi Schuttenberg and Marion Glaser**

Future Ocean Alliance (FOA): Enhancing ocean sustainability challenges through knowledge-based governance and decision-making

**Mitsutaku Makino and Keith R. Criddle** (Invited)

Why do we need Human Dimensions for the FUTURE Program?

**Alida Bundy** (Invited)

Communication is a two-way process: Bringing science to the people and people to the science

**Edward J. Gregr, Kai M.A. Chan and Villy Christensen**

When are models good enough? Assumptions and uncertainty in forecasts of ecosystem state and service supply

**Carrie A. Holt**

Evaluating benchmarks of biological status for data-limited populations of Pacific salmon: Impacts of climate-driven changes in productivity

**William J. Sydeman, Marisol Garcia-Reyes, David S. Schoeman, Ryan R. Rykaczewski, Bryan A. Black, Sarah Ann Thompson and Steven J. Bograd**

Meta-analysis: A tool for communicating complexity to informed general audiences

**Muyin Wang and James E. Overland** (Invited)

Arctic sea ice projections and uncertainties – An update from CMIP5 models

**Hans-O. Pörtner**

An integrated view of climate sensitivity in marine organisms: The need for proxies indicating molecular to ecosystem-level changes

**Phillip R. Mundy, Will Koeppen, Stephanie N. Schmidt, Ellen Tyler, Eric J. Newland, Bryce Mecum, Kathrine Howard, Darcy Dugan and Brian Stone**

Operational outlook and forecast in support of the management of a climate-driven fishery

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**Sue C.H. Grant and Bronwyn L. MacDonald**

Fraser River Sockeye pre-season run size forecasts: Methods, indicators, and uncertainty

**Shin-ichi Ito, Masaki Seito, Tooru Yoshida, Kazuhiro Takeuchi, Shigeo Kakehi, Taku Wagawa, Yutaka Isoda and Hiroshi Kawamura**

Water temperature forecasts to decrease megadeath of aquacultured scallops in Mutsu Bay, Japan

**Marc Trudel**

Using ocean conditions to forecast salmon runs: Lessons learned from a decade of sampling juvenile salmon at sea

### *Poster presentations*

**Gakushi Ishimura, Keita Abe, Kento Ito, Hiroki Nakano and Bolorchimeg Byamba**

Post-Tsunami Recovery Strategies: Issues and challenges for group operations by Kesenuma off-shore longline fisheries in Kesenuma, Japan

**Tuula E. Hollmén and Suresh A. Sethi**

Development of conceptual ecological models to support the Gulf Watch Alaska long-term monitoring program

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

### ***Are marine ecosystems of the North Pacific becoming more variable?***

Co-Convenors: *Steven Bograd (USA), Elizabeth Logerwell (USA), William Sydeman (USA) and Yutaka Watanuki (Japan)*

Invited Speakers:

*Emanuele Di Lorenzo (Georgia Institute of Technology, USA)*

*Michael Litzow (University of Tasmania, Australia)*

### Background

It is well-known from fundamentals of population biology that demographic variability (*i.e.*, variability/variance in offspring production, survival, and recruitment) is a key attribute of population stability and sustainability (Caswell, 2001). This concept has important implications for fish and fisheries management, marine wildlife (seabirds and marine mammals), and marine ecosystem ecology and conservation, especially in light of ongoing and future climate change. Indeed, based on projections from recently updated Global Climate Models (GCMs; Solomon *et al.*, 2007, IPCC, 2013) as well as observations (*e.g.*, Hansen *et al.*, 2012, but see Huntingford *et al.*, 2013), a likely outcome of global warming is increasing variance in physical environmental characteristics. If marine environments generally become more variable, with more extremes in currents, temperatures, winds, or precipitation, there could be substantial impacts to populations and ecosystems with potentially severe socio-economic consequences. Increasing spatial and temporal variance in populations has also been hypothesized to be a precursor to low-frequency marine ecosystem “regime shifts” (Scheffer *et al.*, 2009) and fisheries collapses (Litzow *et al.*, 2013).

### Summary of presentations

With this background, the convenors (Steven Bograd, Elizabeth Logerwell, William Sydeman, and Yutaka Watanuki) convened a topic session for the 20<sup>th</sup> PICES Annual Meeting asking what we considered, at the time, to be a basic and simple question: Are marine ecosystems of the North Pacific becoming more variable? Papers were invited that tested hypotheses of increasing marine ecosystem variability relative to global climate change. The topic session was held in Nanaimo, British Columbia, Canada, on 18 October 2013. Due to the U.S. government shutdown, as well as other personal circumstances, only four presentations were made. The talks included a) invited speaker, Emanuele Di Lorenzo, who spoke on changes in characteristics of North Pacific climate variability and ecosystem responses, b) Michael Litzow *et al.*, who discussed non-linear change in the variability of North Pacific climate – and the response of biological systems, c) Marisol García-Reyes *et*

*al.*, who investigated the hypothesis of increasing variance in the California Current upwelling ecosystem using IPCC-class AR5 GCM, and d) Jay Peterson *et al.*, who addressed the hypothesis of increasing ecosystem variability based on an array of ecological indicators from the northern California Current. Two other presentations, Seokjin Yoon *et al.*, who discussed chum salmon (*Oncorhynchus keta*) habitat in the Western Arctic using coupled models, and Sen Tok Kim, who presented on demersal fish biomass within the East Sakhalin Current area of the Sea of Okhotsk, were made but these talks did not directly address the primary question of the topic session.

Di Lorenzo examined the drivers of coupled climate–ocean variability in the North Pacific and considered whether variance in time series for the Aleutian Low (AL) and North Pacific Oscillation (NPO), as primary drivers of the PDO and NPGO, respectively, have changed over the past six decades. Updating the work of Sydeaman *et al.* (2013), Di Lorenzo demonstrated significant changes in the driver (NPO) of the NPGO, but no change in the variance structure of the AL and corresponding PDO. Di Lorenzo then considered whether changes in variance in the NPO could be attributed to climate change, finding that no definitive answer could yet be provided. Thereafter, Litzow *et al.* examined long-term observations of SST using the Had1SST data set (20°N to 60°N) and biological populations (copepods in the western Pacific off Japan, ichthyoplankton and euphausiids off southern California, and fish [salmon, flatfish] and mammal [fur seal] production time series from Alaska), and conducted a statistical assessment of trends in variance using 11-year running standard deviations as the response variable. At the basin scale, Litzow *et al.* showed an 18% increase in SST variability from the mid 1950s to the late 1980s, but overall an 18% decrease in SST variance, contra Hansen *et al.* (2012), from the mid 1950s to 2010. However, Litzow and colleagues also showed substantial spatial variability in SST variance trends in Large Marine Ecosystems (LME) of the North Pacific. While SST increased across all LME (with varying slopes), variance in SST only increased substantially for two LME and it decreased in one. SST variability appeared to increase in the Aleutian Islands–Bering Sea and in central Pacific oligotrophic waters. In accordance with SST variance, change in population variance was found for the Bering Sea/Gulf of Alaska ( $p < 0.01$ ), but no associations were illuminated in the western Pacific or California Current. Litzow *et al.* concluded that while the question of increasing variability is exceedingly important and warrants additional attention, it would be most fruitful if investigated at the regional or LME scale of observation. Next, García-Reyes *et al.* investigated changes in the variance structure upwelling-favorable winds of the California Current. Based on her previous work on upwelling and ecosystems responses in this system (García-Reyes *et al.*, 2013), winter was selected as the season of interest. García-Reyes *et al.* tested the hypothesis that variance in winter upwelling would increase using IPCC GCM output (38 outputs from 21 models) made available recently on the CMIP5 website. As upwelling is a local process, the low resolution of most GCMs prevented direct analysis of coastal winds. Instead, they tested this hypothesis by examining the distribution and amplitude of the North Pacific High (NPH) as a proxy for winter upwelling in this system (Schroeder *et al.*, 2013). Using this approach, they found no systematic change in amplitude of positioning of the NPH, and that an equal number of models showed no change, increasing variance, and decreasing variance. García-Reyes *et al.* concluded that variability among the GCMs is too high to be able to assess changes in the variance of upwelling-favorable winds in the California Current. Last, Peterson *et al.* investigated changes in ecosystem variance using 18 years of observations of mesozooplankton abundance off central Oregon. Peterson and colleagues showed substantial seasonal and interannual variability in the zooplankton (copepod) community structure and how variability in both “southern” and “northern” copepod communities related well to variability in the PDO, on seasonal and annual temporal scales. While time series from this region are relatively short, if anything it appears that variance in the abundance of copepods has decreased, not increased, in recent years.

Overall, the topic session produced a number of interesting and surprising results. First, contrary to expectations, based on both observations and numerical experiments, it is unclear whether variance in the physical attributes of North Pacific marine ecosystems has or will increase or decrease. Observations and models support both interpretations. Second, while some population data appear to be tracking changes in environmental variance (in SST in this case), most population/ecosystem data sets are too short to provide strong inference regarding trends in variance and relationships to environmental variance. It seems probable

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though that some populations of the North Pacific are experiencing increasing variability in demographic attributes that could lead to reduced population viability with impacts on sustainability

The fact that findings were few, and contradictory to expectations, indicates that this fascinating question should be reconsidered at a future date by the PICES community, with greater attention paid to regional variation and novel methods and ideas to circumvent the limitations of data and models.

### Literature cited

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### List of papers

#### *Oral presentations*

**Emanuele Di Lorenzo** (Invited)

Changes in character of North Pacific variability and ecosystem implications

**Michael Litzow, William J. Sydeman, David S. Schoeman, Sanae Chiba, Marisol García-Reyes, Michael Malick, Hiroya Sugisaki and Sarah Ann Thompson** (Invited)

Nonlinear change in the variability of North Pacific climate – Are biological systems responding?

**Marisol García-Reyes, William J. Sydeman, Ryan R. Rykaczewski, Allison R. Wiener, Isaac D. Schroeder and Steven J. Bograd**

What do Global Climate Models say about increasing variance in the California Current upwelling ecosystem?

**Jay O. Peterson, William T. Peterson and Jennifer L. Fisher**

Assessing ecosystem variability from an array of indicators relevant to the northern California Current

**Seokjin Yoon, Eiji Watanabe, Hiromichi Ueno and Michio J. Kishi**

Estimating potential habitat for chum salmon (*Oncorhynchus keta*) in the Western Arctic using a bioenergetics model coupled with a three-dimensional lower trophic ecosystem model

**Sen Tok Kim**

Spatial distribution and long-term dynamics of demersal fish biomass within East Sakhalin Current area, Sea of Okhotsk

**MEQ/FUTURE Topic Session (S3)*****Status, trends and effects of pollutants in coastal ecosystems: Implications for wildlife and humans***

Co-Convenors: *Olga Lukyanova (Russia) and Won Joon Shim (Korea)*

## Invited Speakers:

*Sandra O'Neill (NWFSC, NOAA, USA)*

*Lorrie Rea (University of Alaska Fairbanks, USA)*

Background

Marine pollutants can impact the quality and/or abundance of invertebrates, fish, and wildlife. In addition, the contamination of seafood can diminish the viability of commercial species and/or deliver potentially harmful contaminants to human consumers. While pollutant topics vary geographically, a number of priority pollutants are common throughout the northern hemisphere. This session highlighted a number of practical approaches to assessing the status, trends and effects of emerging and/or priority pollutants in the PICES region, as well as examples from other parts of the world. Some of these approaches are presently being used as indicators of marine environmental quality in some jurisdictions. Examples include the 'Mussel Watch' program for monitoring metals and persistent organic pollutants (POPs), spatial and temporal trends in POPs in seabird eggs, and effects of POPs and hydrocarbons on the health of marine biota. Some of these efforts have proven very useful in revealing improvements to marine ecosystem health subsequent to the implementation of regulations, including the dramatic declines in PCB, DDT, dioxin and organotin levels and associated effects. Nevertheless, a number of pollutant concerns are emerging, such as replacement flame retardants, pharmaceuticals, and current use pesticides. Characterizing the status, trends and effects of marine pollutants in coastal ecosystem components can provide cost-effective means to guide regulations, source control and/or remediation strategies that will ultimately protect ecosystem health and services.

Summary of presentations

Session S3 was held on Wednesday, October 16, 2013 (half day). It was launched with two invited speakers, Sandra O'Neill (Washington Department of Fish and Wildlife, USA) and Lorrie Rea (University of Alaska Fairbanks, USA) and included other 6 oral presentations, 14 posters, and time for discussion. Approximately 30 to 40 people, including marine and geochemists, marine biologists, and bird and mammal researchers attended the session and provided useful comments.

The session covered a wide spectrum of pollutants (persistent organic pollutants, polycyclic aromatic hydrocarbons, tributyltin, mercury, arsenic, microplastics and infective human enteric virus) in the Pacific region from all six PICES member countries. There are on-going marine chemical pollution issues which affect salmon and stellar sea lion populations. O'Neill *et al.* found that the tissue residue levels and composition of persistent organic pollutants were distinctly different among five Pacific salmon species, depending their dwelling region, migratory route and diet. Rea *et al.* showed that Steller sea lions in the western Aleutian Islands had an apparent elevation in mercury and discussed its possible relationship with population decline in specific region. Simokon *et al.* reported on arsenic pollution originating from land-based activity in the coastal ecosystems of Far Eastern Seas. Polycyclic aromatic hydrocarbons contamination and their possible source and input pathways after the great tsunami in Japan were presented by Maki *et al.* Effective reduction of tributyltin levels in water and biota as well as its effects on marine organism was evaluated by Shim *et al.* after the implementation of total ban on tributyltin based antifouling paints in Korea. It could be a good example of proper management of marine chemical pollutants. A new emerging pollutant, microplastics in the marine environment in coastal British Columbia, was revealed by Desforges *et al.* An abundance of floating microplastics showed an obvious gradient from the coast to the open ocean. Watanuki *et al.* presented on a monitoring technique using feathers of tracked seabirds for investigating the spatial pattern of marine pollution was presented. Fan (Fan and Ming) discussed infective human enteric virus contamination and its risk assessment in surface seawater of Bohai Bay, China, and demonstrated that it is required to manage

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pathogen pollution. Poster presentations included microplastic pollution and its biological effects, spatiotemporal distribution of persistent organic pollutants and heavy metals. Through this session, presenters and audience agreed that there is still a variety of marine pollution issues to be dealt with in the Pacific region. Legacy and emerging persistent organic pollutants and heavy metals and marine debris including microplastics are high priority issues and topics in the Pacific. There is a growing need to address these pollution issues in the North Pacific region through an expert group. Based on the proposal of the Study Group of *Marine Pollutants* (SG-MP), a new Working Group on *Emerging Topics in Marine Pollution* (WG-ETMP/WG 31) was established under the direction of the Marine Environmental Quality Committee during the Annual Meeting.

### List of papers

#### *Oral presentations*

**Sandra O'Neill, Gina Ylitalo, David Herman and James West** (Invited)

Persistent organic pollutant fingerprints in five Pacific salmon species (*Oncorhynchus* spp.): Evidence of distinct contaminant sources associated with their marine distribution and feeding

**Lorrie D. Rea, J. Margaret Castellini, Lucero Correa, Brian S. Fadely, Vladimir N. Burkanov and Todd M. O'Hara** (Invited)

Some maternal Steller sea lion diets elevate fetal mercury concentrations in the western Aleutian Island area of population decline

**Yutaka Watanuki, Ai Yamashita, Mayumi Ishizuka, Yoshinori Ikenaka, Shouta M.M. Nakayama, Chihiro Ishii, Takashi Yamamoto, Motohiro Ito, Tomohiro Kuwae and Philip N. Trathan**

Feathers of tracked seabirds reveal a spatial pattern of marine pollution

**Mikhail V. Simokon, Lidia T. Kovekovdova and Denis P. Kiku**

Arsenic in the coastal ecosystems of Far Eastern Seas

**Won Joon Shim, Nam Sook Kim, Sang Hee Hong, Gi Myung Han and Sung Yong Ha**

An almost successful story of TBT regulation to protect the coastal environments of Korea

**Hideaki Maki, Gen Kanaya, Shin-Ichi Fukuchi, Kazuki Miura, Hisao Sasaki, Nobuyuki Tanaka, Nobuo Chiba and Osamu Nishimura**

Petrogenic and pyrogenic PAHs contamination in the sediments in Tohoku coastal seas, Japan by the great tsunami on 3.11.2011

**Jean-Pierre Desforges, Moira Galbraith, Neil Dangerfield and Peter Ross**

Microplastics in the marine environment in coastal British Columbia

**Jingfeng Fan and Hongxia Ming**

The contamination and risk assessment of infective human enteric viruses in surface seawater from Bohai Bay, China

#### *Poster presentations*

**Sangjin Lee**

NOWPAP activities addressing marine litter

**Young Kyoung Song, Won Joon Shim, Mi Jang, Sang Hee Hong and Gi Myung Han**

Ship paint as a new input source of floating microplastics in surface microlayer

**Chunjiang Guan, Fengao Lin and Jingfeng Fan**

A public questionnaire survey of oil spill in 7.16 Dalian New Port

**Dong-Woon Hwang, Pyoung-Joong Kim, Minkyu Choi, In-Seok Lee, Sook-Yang Kim and Hee-Gu Choi**

Temporal trend and spatial distribution of trace metals in coastal sediment of Korean peninsula

**Jung-Hoon Kang, Oh-Youn Kwon, Kyun-Woo Lee and Won Joon Shim**

Marine floating microplastics around Geoje Bay in the Southern Sea of Korea

**Kyun-Woo Lee, Jung-Hoon Kang and Won Joon Shim**

Toxicity of micro polystyrene particle for marine copepod *Tigriopus japonicus*

**Yanin Limpanont, Kwang-Sik Choi, Hyun-Ki Hong and Chang-Keun Kang**

Histopathology of Manila clams *Ruditapes philippinarum* surveyed in Korean waters

**Guangshui Na, Zihao Lu, Wanru Zhang, Hui Gao, Jinqiu Du, Zhen Wang, Yaqi Cai, Ziwei Yao and Chuanlin Huo**

Occurrence and distribution of five types of antibiotics and antibiotic-resistant *Escherichia coli* in Liao River estuary, China

**Jianguo Du, Zhao Jiayi and Chen Bin**

Assessing ecological risks of heavy metals to marine organisms by species sensitivity distributions



**POC Topic Session (S4)**

***The changing carbon cycle of North Pacific continental shelves and marginal seas***

Co-sponsored by SOLAS

Co-Convenors: *Minhan Dai (China), Sophia Johannessen (Canada) and Dong-Jin Kang (Korea)*

Invited Speakers:

*Miguel Goni (Oregon State University, USA)*

*Kon-kee Liu (Institute of Hydrological and Oceanic Sciences, National Central University, Chinese-Taipei)*

Background

Coastal waters link the atmosphere, the land and the open ocean, both dynamically and biogeochemically. Consequently, the carbon cycle of the continental shelves and marginal seas that ring the North Pacific is particularly complex and prone to rapid changes induced by global climatic and regional anthropogenic forcing. Among others, these drivers include increasing temperature, ocean acidification, eutrophication, and deoxygenation of seawater. Such changes represent a potential for great harm to the ecosystems and fisheries that rely on these highly productive waters. This session invites presentations on ocean acidification, hypoxia, eutrophication and other topics related to the biogeochemistry of organic and inorganic carbon in Pacific continental shelves and marginal seas.

Summary of presentations

Session S4 (co-sponsored by SOLAS) took place over two days (morning sessions of October 16 and 17), as well as posters. The session was well subscribed, with a total of 22 abstracts representing all six PICES member countries. Invited speakers were Prof. Miguel Goni (USA) and Prof. K.K. Liu (China-Taipei).

Prof. Goni reviewed the role of terrestrial sources of carbon along the northwest coast of North America, noting that these are likely to change substantially in the future due to both climate and other anthropogenic forcing. Prof. Liu addressed changes on the other side of the Pacific, noting that the western North Pacific continental margin is the most densely populated in the world, and that both eutrophication of river waters and its impounding and diversion for irrigation affect productivity in the coastal zone and that this, in turn, affects the course of ocean acidification.

Other talks addressed air–sea fluxes of CO<sub>2</sub>, hypoxia impacts on zooplankton and fish, interdecadal changes in carbon flux and zooplankton abundance, and regions including the California Current, East/Japan Sea, East China Sea, Strait of Georgia, and Prince William Sound.

List of papers

*Oral presentations*

**Miguel A. Goni** (Invited)

Land-ocean conductivity in the carbon cycle of the Pacific Northwest margin

**Vadim Navrotsky, Valeriy Liapidevskii, Vyacheslav Lobanov and Elena Pavlova**

On small- and meso-scale dynamic processes responsible for long-term fluctuations of biological parameters of continental shelves and marginal seas

**Dong-Jin Kang, Jae-Yeon Kim, Tongsup Lee, Pavel Tischchenko and Kyung-Ryul Kim**

An application of TrOCA to the East/Japan Sea

**Minhan Dai, Jinwen Liu, Wenping Jing, Hongjie Wang, Xianghui Guo and Guizhi Wang**

Multiple stressors in the coastal ocean ecosystem

**Zhong-yong Gao, Heng Sun and Liqi Chen**

Distributions of pCO<sub>2</sub> and their decadal changes in the Bering Sea

## Session Summaries-2013

**Jerome Fiechter, Enrique Curchitser, Christopher Edwards, Fei Chai, Nicole Goebel and Francisco Chavez**

Spatiotemporal variability of air-sea CO<sub>2</sub> exchange in the California Current

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

Implication of different Nitrous oxide distribution patterns between Canadian and Greenland Basin on Global Deep Ocean water nitrous oxide Production

**Guimei Liu, Xuanliang Ji, Shan Gao and Hui Wang**

Temporal and spatial variability of carbon cycle in the Northwestern Pacific: A 3D physical-biogeochemical modeling study

**Kon-Kee Liu** (Invited)

Anthropogenic impacts on the carbon cycle and related biogeochemical processes of western North Pacific continental margins

**John A. Barth, Oscar Pizarro, Kate Adams and Nadin Ramirez**

Comparing hypoxia over the continental shelves off central Oregon, USA, and Concepción, Chile

**Sophia Johannessen, Diane Masson and Robie Macdonald**

Why the Strait of Georgia is not a dead zone

**Sonia Batten, Abigail McQuatters-Gollop and Dionysios Raitos Exarchopoulos**

Variability in lower trophic levels on the Alaskan Shelf

**Julie E. Keister, Anna McLaskey, Lisa Raatikainen, Amanda Winans and Bethellee Herrmann**

Species diversity in zooplankton responses to hypoxia and elevated pCO<sub>2</sub>

**Rui Yin and Atsushi Ishimatsu**

Effects of ocean acidification on the physiological profile of the Japanese pearl oyster *Pinctada fucata*

**Andrew M. Edwards, Holly E. Neate, Rowan Haigh, Carrie A. Holt and Debby Ianson**

Vulnerability of Canadian Pacific fisheries to ocean acidification

**Burke Hales, Katherine Harris, Wiley Evans and George Waldbusser**

Winter conditions in Oregon coastal waters as refugia from ocean acidification

### *Poster presentations*

**Yusuke Takatani, Atsushi Kojima, Kazutaka Enyo, Yosuke Iida, Toshiya Nakano, Masao Ishii, Daisuke Sasano, Naohiro Kosugi, Takashi Midorikawa and Toru Suzuki**

New empirical equations for total alkalinity in surface waters over the Pacific Ocean from the PACIFICA database

**Boram Sim, Dong-Jin Kang, Cho-Rong Moon, Young Gyu Park and Kyung-Ryul Kim**

Basin-to-basin comparison of radiocarbon in the East/Japan Sea

**Masao Ishii, Toru Suzuki, Daisuke Sasano, Naohiro Kosugi, Yusuke Takatani, Masahide Wakita, Akihiko Murata, Lisa Miller and Robert M. Key**

PACIFICA carbon data 2nd-level quality control

**Jae-Yeon Kim, Dong-Jin Kang, Tonsup Lee, Kyung-Ryul Kim, JeongHee Shim and Hee-Dong Jeong**

fCO<sub>2</sub> characteristics in the surface of marginal seas around Korea (East/Japan Sea and East China Sea)

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

***Marine ecosystem services and the contribution from marine ecosystems to the economy and human well-being***

Co-sponsored by *IMBER*

Co-Convenors: *Shang Chen (China), Keith Criddle (USA), Ekaterina Golovashchenko (Russia), Mitsutaku Makino (Japan), Jungho Nam (Korea), Minling Pan (USA) and Ian Perry (Canada)*

Invited Speakers:

*Leif Anderson (NOAA Fisheries, Northwest Fisheries Science Center, USA)\**

*Kai Chan (University of British Columbia, Canada)*

*Shang Chen (First Institute of Oceanography, SOA, PR China)*

*Dan Lew (NOAA Fisheries, Alaska Fisheries Science Center, USA)\**

\* Leif Anderson and Dan Lew were unable to attend PICES-2013 due to the U.S. government partial shutdown.

## Background

Marine ecosystem services are the benefits people obtain from the sea and ocean. Since the UN Millennium Ecosystem Assessment reports were published in 2005, the concept of ecosystem services has been broadly accepted by politicians, scientists, developers and the public. When politicians make policy decisions, they should know the value of the marine ecosystem services involved, and how much economic development and human well-being the marine ecosystem may support. As scientists, we have the responsibility to give the answers or the best estimates to these questions. The goals of this session are to provide scientists with a platform to exchange results from research on marine ecosystem services and to show how they contribute to the economy and human well-being. In turn, these research activities will be a demonstration of the contributions and significance of the work being done on this topic within PICES communities, including marine-related research institutes, universities, and management agencies, to marine science and national economies.

## Summary of presentations

This session was well-attended, with strong participation and questions. It was developed and led by members of PICES' Section on *Human Dimensions of Marine Systems*. Unfortunately, not all U.S. participants and invited speakers were able to attend. Kai Chan spoke about Integrating Ecological Considerations and Cultural Values into Decision-Making. He noted several prevailing assumptions regarding ecosystem services: we can identify what matters *a priori*; cultural and provisioning services are independent; values are commensurate; and change in ecosystem services is a function of ecological change. He proceeded to demonstrate that all four of these prevailing assumptions are false; that intangibles often drive success or failure of management; that key conditions for success include engaging interdisciplinary research teams; decision-makers/practitioners with resources are needed for long term partnerships; and a need to consider the planning/campaign horizon and its insulation from political pressures. He concluded by noting that integrating ecological considerations and cultural values into decision-making is not easy, but it is not an impossible quagmire. Shang Chen discussed marine ecological capital assessments in China. He noted that in the coastal waters of Shandong Province, each \$1 of living resources supports \$8 of service outputs, whereas in a particular location such as Dongshan Bay, each \$1 of living resources supports \$95 of service outputs. He concluded that: the value of ecosystem services shows decreasing trends from onshore to offshore; mariculture and recreational activities make major contributions to the value of ecosystem services; assessment methods developed for China appear to be valid to evaluate ecosystem services; and this approach can be used to assess ecosystem compensation values. Linda D'Anna spoke about the social values of marine ecosystem services and human well-being. In particular, she noted that well-being engages with the heterogeneity among stakeholders to inform decision-making. She described a case study for a specific marine social-ecological system in coastal British Columbia, asking how shellfish aquaculture might enhance or interrupt the flow of benefits supplied by ecosystem services, and how these changes may affect the well-being of the Baynes Sound social-ecological system (which produces one-half of all the shellfish cultured in B.C. Using a variety of techniques, including social surveys, she concluded that: changes in the flow of ecosystem services have several effects on social well-being, *e.g.*, on the environment, economy, and experience; perceptions about what matters about the effects of these changes are variable; and that changes like aquaculture that modify the delivery of ecosystem services are experienced and valued differently. The variability of the subjective component of social well-being can be a tool for discovering the spectrum of values affected by changes that modify the flow of ecosystem services. Ling Huang and colleagues evaluated the impact of sector management on the productivity of New England groundfish fisheries. They noted that these are considered as common pool resources in which management adopts a Sector rights-based approach. They concluded that joining sectors would increase productivity by 5.3% on average, and that sectors have different technical efficiencies which can change over time. Michio Kishi and colleagues described an ecosystem approach for management of artificial release of chum salmon from Japan coupled with the NEMURO and NEMURO.FISH ecosystem models. The purpose of their study was to examine how to maximize the income of Japanese fishermen by catching chum salmon, and therefore, how many chum salmon should be released from Japan and how this may change with future global warming. They calculated the suitable release number under present conditions and under conditions as they are expected

to evolve due to global warming. Results indicate that present release numbers are optimal under current conditions. Jianshi Jin and colleagues examined fisheries and stock enhancement in the Bohai Sea, China. He noted that large-sized demersal species have been replaced by low-valued and small-sized pelagic fish, that the community structure has changed considerably, with rapid species shifts, lower trophic levels, and a simpler food web. He noted that rebuilding or restocking of this ecosystem is needed, and that sea ranching and stock enhancement have been regarded since the 1980s as important measures to rebuild the depleted stocks. He concluded that control of intensive fishing is a key requirement, that restocking of depleted fishery stocks needs more input of both manpower and financing, and that an ecosystem based management approach is required. In a contributed presentation, Kai Chan and colleagues discussed the importance of considering ecosystem services in the presence of trophic cascades, using sea otters, kelp forests, and coastal communities on the west coast of Vancouver Island as their case study. They assessed the many ecological changes associated with otters and kelp forests, including ‘nutrient subsidies’ from kelp forests to adjacent and distant ecosystems and boosts to tourism, and how these can be represented in a spatial model that depicts the effects of various human interventions on ecosystems. Michael Melnychuk and colleagues generated much discussion by their examination of the potential consequences of overfishing and underfishing for food security and economic value in U.S. fisheries. Food security is threatened by overfishing in some cases, but by underfishing in others, and that overfishing and underfishing both result in less long-term catch than if populations were fished at their maximum sustainable yields. They reasoned that primary reasons for underfishing losses in the eastern Bering Sea include ecosystem catch limits and poor market conditions, whereas overfishing losses are incurred primarily by the slow recovery of some rebuilding stocks. They concluded that guards against overfishing are important, but analysis of trade-offs should also involve consequences of underfishing on food security. “Traditional” fisheries scientists expressed concern about the degree to which our understanding of and control over precise management controls might lead to excesses in either over- or under-fishing. Patricia MacDonald and colleagues concluded the session with their presentation on capturing social values in the seafood sector. They used the “Q Method” to examine an individual’s subjective understanding of his/her world. They concluded that not everyone in each fishery-related sector holds the same views of the environment. Instead, they identified 5 cross-cutting groups: collaborative pragmatists; local guardians; science and innovation champions; cautious traditionalists; and prosperity promoters. This was a satisfying presentation to conclude with as it underscored the diversity of attitudes and approaches that make evaluations of ecosystem services such a complex issue.

#### List of papers

##### *Oral presentations*

**Kai M.A. Chan, Anne Guerry, Patricia Balvanera, Sarah Klain, Terre Satterfield *et al.*** (Invited)

Not impossible: Integrating ecological considerations and cultural values into decision-making

**Shang Chen and Tao Xia** (Invited)

Marine ecological capital assessment: Methods and application in China seas

**Linda D’Anna, Grant Murray and Sarah Dudas**

Social value of marine ecosystem services: Insights from multi-dimensional subjective well-being

**Ling Huang, Subhash Ray, Kathleen Segerson and John Walden**

Evaluating the impact of sector management on the productivity of New England groundfish

**Michio J. Kishi, Kenta Awa, Takeshi Miwa, Seokjin Yoon and Toru Nagasawa**

Ecosystem approach for management of artificial release of chum salmon from Japan coupled with NEMURO and NEMURO.FISH

**Xianshi Jin, Xiu-Juan Shan, Jun Wang, Yunzhong Wang, Zhenliang Zhao, Shengrao Qiu and Jing Dong**

Fisheries and stock enhancement in the Bohai Sea, China

**Kai M.A. Chan, Russell Markel, Rebecca G. Martone, Jessica Clasen, Jordan Levine, Brock Ramshaw, Gerald G. Singh, *et al.***

Sea otters, kelp forests, and coastal communities: Ecosystem services amongst trophic cascades

**Ekaterina V. Golovashchenko and Andrey I. Solomin**

Bioeconomic modelling of the marine resource — Towards stable exploitation in the western Bering Sea marine ecosystem

**Michael C. Melnychuk, Jeannette A. Banobi and Ray Hilborn**

Overfishing and underfishing consequences for food security and economic value in U.S. fisheries

**Patricia MacDonald, Michele Patterson and Grant Murray**

Capturing social values in the seafood sector: New tools for new times

*Poster presentations*

**Tatiana N. Semenova**

Ecotourism — An effective means of contributing to the economy and human well-being

**Ryotaro Okazaki and Yasunori Sakurai**

Influence of SST and PDO on the catches of walleye pollock, pink salmon and Japanese common squids in Rausu, Shiretoko World Natural Heritage, Japan

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

***Recent trends and future projections of North Pacific climate and ecosystems***

Co-Convenors: *Jack Barth (USA), James Christian (Canada), Enrique Curchitser (USA), Chan Joo Jang (Korea) and Angelica Peña (Canada)*

Invited Speakers:

*Jason Holt (National Oceanography Centre, UK)*

*William Merryfield (Canadian Centre for Climate Modelling and Analysis, Environment Canada)*

Background

The North Pacific Ocean experiences change on a range of timescales, and is among the most difficult regions of the world ocean in which to detect secular climate trends associated with anthropogenic forcing against the background of natural variability. Understanding impacts on ecosystems and the human communities dependent on them requires understanding of the magnitudes of climate variability and change. Sustained observations of past and present states, modeling of future states with global climate models (GCMs), and downscaling of GCM projections to the regional scale are all key components of the scientific effort to understand impacts and inform adaptation efforts. Downscaling efforts are likely to include a variety of methods, both statistical and dynamical, including high-resolution regional ocean circulation models with embedded ecosystem/biogeochemical models, statistical models relating local population statistics to climate forcing or climate indices, and multi-species models forced by temperature or oxygen anomalies from regional or global models. This session dealt with papers on time-series of observations of the North Pacific Ocean in the context of recent climate variability and change, and future projections of changes including statistical and dynamical downscaling.

Summary of presentations

Overall the session was extremely well subscribed and well attended, and the quality of the science was very good. An S6 presenter, Dr. Youngji Joh (Korea), received the MONITOR Best Oral Presentation award for a MONITOR-sponsored Topic Session (for more details, see the last page of this document). There was good representation from almost all of the PICES countries (two presenters from China withdrew in August due competing commitments). At most times there were in excess of 50 people present. The session was extended from a full day to an additional half day to accommodate all of the presenters.

Dr. Jason Holt (National Oceanography Centre, UK) started off the session with an invited talk about how to downscale global climate model predictions to the scale of shelf seas in order to get the shelf ecosystem response right. He reviewed how shelf seas differ from the deep ocean in their response to climate change projections, including that shallow shelf seas are more in thermal equilibrium with the atmosphere than is the

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deep ocean and that horizontal fluxes are particularly important in shelf seas, especially those contributing to ocean–shelf exchange. Dr. Holt pointed out that isolated seas are vulnerable to single drivers and concluded by reinforcing the need to compare the model results with long time series that are available from the European shelf seas.

Two speakers reviewed the use of regional climate models for both the western (Dr. Chul Min Ko, Korea) and eastern (Dr. Michael Foreman, Canada) North Pacific. They both pointed out that global climate models don't get the regional dynamics right and that downscaling was necessary. They both used the “pseudo global warming” technique where future-minus-contemporary anomalies were added to the initial and forcing fields of their regional models. Dr. Foreman pointed out that summertime winds off the British Columbia coast are not projected to be very different in the future and that global models do not resolve the California Undercurrent, which carries nutrient-rich, oxygen-poor waters from the south.

Dr. Ryan Rykaczewski (USA) used a suite of IPCC models to examine the Bakun (1990) hypothesis that winds off the U.S. west coast should become stronger with global warming. He found no evidence for this in the models and noted that the atmospheric pressure gradient between ocean and land does not increase as hypothesized by Bakun. Dr. William Crawford (Canada) showed how subsurface dissolved oxygen concentrations across the eastern North Pacific exhibit coherent interdecadal variation, with increases from the 1950s to the 1980s and a decline after the 1980s.

Two speakers demonstrated the importance of getting the details of the regional circulation correct in order to understand interannual and interdecadal variability in the Japan/East Sea. Dr. Dmitry Stepanov (Russia) focused on the deep circulation in the Japan Basin as influenced by the basin geography and Dr. Yuri Oh (Korea) described how nutrient fluxes through the Korea Strait influenced productivity in the southern Japan/East Sea (JES). Dr. Joo-Eun Yoon (Korea) further addressed this topic later in the day with an analysis of the mechanisms controlling interannual variability of primary production in the JES over 1998–2007 and the importance of Tsushima Current transport.

The second invited speaker, Dr. William Merryfield (Canada) reviewed the (very new) science of seasonal-to-interannual and decadal climate prediction, the areas of North Pacific climate that are amenable to prediction, and the particular challenges encountered in the North Pacific relative to other ocean areas. Dr. Youngji Joh (Korea) reviewed the ability of CMIP5 models to simulate the PDO, ENSO, and mechanisms underlying tropical-extratropical teleconnections, and found them substantially improved over CMIP3. Dr. James Christian (Canada) discussed the challenge of detecting an anthropogenic signal in ocean biogeochemical data, illustrated by sampling CMIP5 model simulations. Dr. Vera Pospelova (Canada) showed how dinoflagellate cysts can be used as an index of past primary productivity, using data mostly from the California Current region. Dr. Sanae Chiba (Japan) discussed the effects of climate variability on the mean size of the copepod community using over 10 years of CPR data, noting that there is a size dependence of the efficiency of trophic transfer to higher trophic levels. The copepod community showed significant interannual-to-interdecadal variability over this period, which was different in the eastern and western North Pacific.

The second day was equally well attended and again featured speakers from most of the PICES countries. Dr. Taeki An (Korea) discussed seasonal shifts of ecosystem structure in the JES, which show coherent fluctuations across trophic levels from phytoplankton to fish. Dr. Neil Banas (USA) considered similar shifts of ecosystem structure in the Bering Sea, and suggested that future climates will likely be unfavourable for pollock due to reduced production of large copepods. Dr. Andrei Krovnin (Russia) considered the effect of climate variability on pollock and pink salmon recruitment and noted that North Pacific climate variability may also be related to the Arctic and North Atlantic oscillations. Dr. Hae Kun Jung (Korea) considered records of a variety of fisheries around Korea in relation to multiple climate indices over 1960–2010, concluding that there are multiple ‘cold’ and ‘warm’ periods that are relatively, but not entirely, consistent across indices and in their effects on fisheries. Dr. Tony Koslow (USA) examined CalCOFI ichthyoplankton survey data from 1950–2010, and found that mesopelagic fishes have coherent fluctuations across ecotypes that are correlated with subsurface oxygen concentration. He further noted that advection (California Current transport) and water mass structure are important factors in climate control of fish and plankton assemblages.

List of papers*Oral presentations*

**Jason Holt, Icarus Allen, Yuri Artioli, Laurent Bopp, Momme Butenschon, Heather Cannaby, Ute Daewel, Bettina Fach, James Harle, Dhanya Pushpadas, Baris Salihoglu, Corinna Schrum and Sarah Wakelin** (Invited)

Physical processes mediating climate impacts in shelf sea ecosystems

**Chul Min Ko, Chan Joo Jang, Chun Yong Jung and Cheol-Ho Kim**

A Regional Climate Coupled Model for the western North Pacific: Assessment of a present climate simulation

**Michael Foreman, Wendy Callendar, Diane Masson, John Morrison and Isaak Fain**

Regional ocean climate model projections for the British Columbia continental shelf

**Ryan R. Rykaczewski, John Dunne, Charles A. Stock, William J. Sydeman, Marisol Garcia-Reyes, Bryan A. Black and Steven J. Bograd**

Investigating the upwelling intensification hypothesis using climate-change simulations

**William Crawford and Angelica Peña**

Decadal changes in dissolved oxygen concentration in the thermocline of the Northeast Pacific

**Dmitry V. Stepanov, Victoria I. Stepanova and Nikolay A. Diansky**

Interdecadal variability of circulation in the northern Japan/East Sea based on numerical simulations

**Yuri Oh, Chan Joo Jang, Sinjae Yoo and Chul Min Ko**

Effects of nutrient transport through the Korea Strait on the seasonal and interannual variability in the East Sea (Japan Sea) ecosystem

**William Merryfield** (Invited)

How predictable is the North Pacific?

**Youngji Joh, Chan Joo Jang, Minho Kwon, Ho-Jeong Shin and Taewook Park**

An improvement of reproducibility of Pacific decadal oscillation in CMIP5

**James R. Christian**

Detection of anthropogenic influences on ocean biogeochemistry in the North Pacific

**Vera Pospelova**

Environmental and primary productivity change in coastal waters of the eastern North Pacific revealed from the sedimentary phytoplankton record

**Joo-Eun Yoon, Young Baek Son and Sinjae Yoo**

Primary productivity and its interannual variability in the East Sea, 1998-2007

**Sanae Chiba, Sonia Batten, Tomoko M. Yoshiki, Tadafumi Ichikawa and Hiroya Sugisaki**

Climate induced variation in the basin scale zooplankton community structure in the North Pacific

**William T. Peterson and Jennifer L. Fisher**

The influence of ten El Niño events on pelagic ecosystem structure in the northern California Current

**Hiroshi Kuroda, Taku Wagawa, Yugo Shimizu, Shin-ichi Ito, Shigeho Kakehi, Takeshi Okunishi, Sosuke Ohno, Hiromi Kasai and Akira Kusaka**

Interdecadal decreasing trend of the Oyashio on the continental slope off the southeastern coast of Hokkaido, Japan

**Taeki An, Hyun Je Park, Jung Hyun Kwak, Chung Il Lee, Hae Won Lee, Kangseok Hwang, Jung Hwa Choi and Chang-Keun Kang**

Seasonal shift of ecosystem structure around the Ulleung Basin of the East/Japan Sea

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

Recent trends of air and water temperature and ice cover in the Far-Eastern Seas

**Neil S. Banas, Robert G. Campbell, Carin Ashjian, Evelyn Lessard, Alexei Pinchuk, Evelyn Sherr, Barry Sherr and Jinlun Zhang**

Linking sea-ice retreat and increasing water temperature to plankton community structure and function in the eastern Bering Sea

**Andrei Krovnin, Boris Kotenev and George Moury**

Climatic variability in the Northwest Pacific: Regimes, mechanisms, trends, impact on commercial fish populations

**Hae Kun Jung, Chang-Keun Kang and Chung Il Lee**

Regional differences in the response of ocean environment and fisheries resources in Korean waters to the North Pacific regime shift and possible mechanisms

**J. Anthony Koslow, Peter Davison, Ana Lara-Lopez and Mark D. Ohman**

Epipelagic and mesopelagic fishes in the southern California Current System: Ecological interactions and oceanographic influences on their abundance

*Poster presentations*

**Sayaka Yasunaka, Yukihiro Nojiri, Tsuneo Ono, Shin-ichiro Nakaoka and Frank A. Whitney**

Monthly maps of sea surface nutrients in the North Pacific: Basin-wide distribution and seasonal to interannual variations

**Minwoo Kim, Cheol-Ho Kim and Chan Joo Jang**

Effects of grid refinement in the global ocean circulation experiments

**Cheol-Ho Kim, Chan Joo Jang and Minwoo Kim**

Sea level projection of the North Pacific Ocean using a non-Boussinesq ocean-sea ice model in the SRES A1B scenario

**Olga Trusenkova and Dmitry Kaplunenko**

Patterns of interannual to decadal sea level variability in the Japan/East Sea

**SM M. Rahman, Chung Il Lee and Chang-Keun Kang**

Regional differences in oceanic and fisheries variability in the East/Japan Sea related to north Pacific climate-ocean variability

**Allison R. Wiener, Marisol García-Reyes, Ryan R. Rykaczewski, Steven J. Bograd and William J. Sydeman**

Statistical downscaling of an ensemble of Global Climate Models output for the California upwelling region

**Wu Shuangquan, Gao Zhigang, Yang Jinkun and Yu Ting**

Numerical simulation of ocean ecological dynamics in Taiwan Strait

**BIO/FIS/MEQ/TCODE/FUTURE Topic Session (S8)**

***Ecosystem indicators to characterise ecosystem responses to multiple stressors in North Pacific marine ecosystems***

Co-Convenors: *Vladimir Kulik (Russia), Chaolun Li (China), Ian Perry (Canada), Jameal Samhoury (USA)\*, Peng Sun (China), Motomitsu Takahashi (Japan) and Chang-Ik Zhang (Korea)*

\* Jameal Samhoury was unable to attend PICES-2013 due to the U.S. government partial shutdown.

Invited Speakers:

*Isabelle Côté (Simon Fraser University, Canada)*

*Yunne-Jai Shin (Institut de Recherche pour le Développement, France)*

*Mingyuan Zhu (First Institute of Oceanography, SOA, PR China)*

**Background**

Multiple natural and human stressors on marine ecosystems are common throughout the North Pacific, and may act synergistically to change ecosystem structure, function and dynamics in unexpected ways that can differ from responses to single stressors. These stressors can be expected to vary by region, and over time. Understanding the impacts of multiple stressors, and developing indicators which capture their behaviours and changes, are major challenges for an ecosystem approach to the North Pacific and for the PICES FUTURE project. The objective of this session was to present potential indicators of ecosystem responses to multiple stressors in the North Pacific (with the focus on multiple, rather than single, stressors). One goal of the session was to determine if these proposed ecosystem indicators can provide a mechanistic understanding of how ecosystems respond to multiple stressors. For example, 1) are responses to stressors simply linear or are changes non-linear such that small additional stressors result in much larger ecosystem responses; 2) do different parts of the ecosystem respond differently (*e.g.*, across trophic levels); 3) how do stressors interact and can these interactions be adequately captured by the proposed indicators? Conceptual, empirical and model-based analyses are welcome. The results of this session contribute to the work of PICES Working Group 28 on *Ecosystem indicators for multiple stressors on the North Pacific*.

The session was deeply saddened by the untimely death of Dr. Mingyuan Zhu, and a moment of silence was held in his honour. He was a very important scientist for PICES.



## Summary of presentations

The session was well-attended, and with strong participation in questions and discussions. All of the presenters were congratulated for leaving time for questions after their presentations. The session introduced much new information and new ideas, all of which are relevant for the work of Working Group 28. A number of presentations proposed ecologically-based indicator sets and/or methods to evaluate the efficacy of the indicators. A number of talks also discussed how multiple stressors can interact. One important finding from a meta-analysis was that 35% of studies examined found that multiple stressors interacted synergistically, and that antagonistic interactions occurred in 42% of the studies examined. The conclusion from this analysis was that interactions were not additive in the majority of analyses studied, which is usually the default assumption in frameworks examining the impacts of multiple interacting stressors. An important implication of these results is that management actions may not produce the intended result because such actions may alter the interactions among multiple stressors, in particular if the interactions are antagonistic. Overall, discussions questioned how well existing indicators can address temporal scaling issues and the interactions of processes at larger (and smaller) temporal and spatial scales. The issue of sub-lethal stressors and their effects was also discussed, with the potential for indirect stressors to interact with direct stressors. It was recognised that many indicators can be proposed; when developing indicators of human actions and responses an inclusive process is needed. Overall, the consensus was that a good job is being done currently of beginning to model and evaluate responses of indicators to observed and modelled ecosystem changes, although questions remain as to whether these models can adequately address the three types of stressor interactions (additive, synergistic, antagonistic). Participants felt the current state of the art was doing a better job simulating fishing and climate interactions in models. Participants also concluded that no single indicator will be adequate and the use of multiple models was recommended to reduce model-based uncertainties. But an important question was raised: how, and whether, multiple indicators can be combined into smaller sets of summary indicators. At present, it seems the most common way to assess the impacts of more than two stressors is via expert opinion, and sometimes modelling. These techniques have their own important limitations and biases.

## List of papers

### *Oral presentations*

**Isabelle M. Côté and Emily S. Darling** (Invited)

Testing and predicting synergy between multiple stressors

**Stephen Ban**

Expert elicitation of a Bayesian Belief Network for climate change effects on the Great Barrier Reef

**Helen J. Gurney-Smith, Catherine A. Thomson, Dan S. Sanderson, Jennifer Kimball and Stewart C. Johnson**

A functional genomics approach to assessing ecosystem health and resilience in keystone bioindicator species

**Andrew Day, Thomas A. Okey, Micha Prins and Stephanie King**

Developing social-ecological indicators for Canada's Pacific Marine regions: Steps, methods, results and lessons

**Joanna Smith, Charlie Short, Steve Diggon, John Bones, Matthew Justice, Andrew Day and Stephanie King**

Ecosystem-based management indicators for a marine planning process in BC's north coast- Marine Planning Partnership (MaPP)

**Cathryn Clarke Murray, Megan E. Mach, Rebecca G. Martone, Gerald G. Singh, Kai M.A. Chan and Miriam O**

Assessing direct and indirect risk from human activities to significant ecosystem components in the Northeast Pacific

**Rebecca G. Martone, Melissa M. Foley, Megan E. Mach, Corina I. Marks, Carrie V. Kappel, Kimberly A. Selkoe and Benjamin S. Halpern**

Groundtruthing cumulative impact models in nearshore ecosystems of the California Current

**Yunne-Jai Shin, Jennifer Houle, Alida Bundy, Marta Coll, Penny Johnson, Chris Lynam, Lynne Shannon and Laure Velez** (Invited)

A multi-model evaluation of ecosystem indicators' performance

**Caihong Fu and Yunne-Jai Shin**

Exploring ecological indicators to evaluate fishing and environmental impacts on ecosystem attributes

**Vladimir V. Kulik**

Comparing environmental changes over the past 10 years with the states and trends of the ecosystem indicators proposed by IndiSeas in the Sea of Okhotsk

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### **Kirstin K. Holsman and Stephani Zador**

Methods to characterize risk of Alaskan marine habitats to multiple stressors and establish ecosystem reference points

### **Stephen B. Brandt and Cynthia Sellinger**

Growth rate potential as a quantitative ecosystem indicator of habitat quality

### **Doug Hay, Jake Schweigert, Jennifer L. Boldt, Jaclyn Cleary, Thomas A. Greiner and Kyle Hebert**

Decadal change in eastern Pacific herring size-at-age and gonad size: A climate connection?

### **Kisaburo Nakata**

The pelagic and benthic coupled biogeochemical cycle model study for Mikawa Bay estuary

### **Kyung-Su Kim, JeongHee Shim and Suam Kim**

The combined effects of elevated CO<sub>2</sub> and temperature on the survival, growth and skeletal formation of olive flounder larvae *Paralichthys olivaceus*

### **Skip McKinnell**

A quantitative method for assessing the interactions of multiple stressors; How I learned to compare apples and oranges

### **Motomitsu Takahashi and Mingyuan Zhu**

Ecosystem responses to anthropogenic activities and natural stressors in the East China and Yellow Seas

### **R. Ian Perry, Jameal F. Samhuri and Motomitsu Takahashi**

Developing indicators for ecosystem responses to multiple pressures: Case studies between the eastern and western North Pacific

### **Sarah Ann Thompson, William J. Sydeman, Heather Renner and John F. Piatt**

Regionalizing seabirds as indicators of forage fish in Alaska

### **Yuxue Qin, Yuichi Shimizu and Masahide Kaeriyama**

Risk management for recovering chum salmon populations in the Iwate coastal ecosystem after the Tohoku catastrophic earthquake and tsunami

### **Yongjun Tian**

Interannual-decadal variability in the large predatory fish assemblage in the Tsushima Warm Current regime of the Japan Sea with an emphasis on the impacts of climate regime shifts

### *Poster presentations*

### **R. Ian Perry and Diane Masson**

A statistical approach to the development of ecosystem indicators for multiple pressures in the Strait of Georgia, Canada

### **Peng Sun, Zhenlin Liang, Yang Yu, Yanli Tang, Fenfang Zhao and Liuyi Huang**

Trawl selectivity induced evolutionary effects on age structure and size at age of hairtail (*Trichiurus lepturus*) in East China Sea, China

### **Guanqiong Ye, Jie Liu and Loke M. Chou**

Designing a network of coral reef marine protected areas in Hainan Island, South China

**MONITOR Topic Session (S9)*****Cost-effective, cooperative ocean monitoring***

Co-convenors: *Steven J. Barbeaux (USA)\*, Jennifer Boldt (Canada), Martin Dorn (USA)\* and Jaebong Lee (Korea)*

## Invited Speakers:

*Sonia Batten (Sir Alister Hardy Foundation for Ocean Science, UK/Canada)*

*Chris Rooper (NMFS-Alaska Fishery Science Center, USA)\**

\* Steven J. Barbeaux, Martin Dorn, and Chris Rooper were unable to attend PICES-2013 due to the U.S. government partial shutdown.

Background

Long-term monitoring is a key component of an ecosystem-based approach to fisheries management. Data time series enable the examination of changes in oceanographic and community metrics. In addition to costly ocean monitoring systems with sensor arrays and autonomous vehicles, low cost cooperative monitoring efforts would enhance our understanding of marine ecosystems, as well as help insure their long-term viability. An important consideration for sustainable long-term ocean monitoring is the development of affordable solutions to deploying and retrieving sensors. Sustainable long-term ocean monitoring is successfully being implemented at regional scales with low-cost options as presented in the 2012 PICES Annual Meeting session entitled “Monitoring on a small budget: Cooperative research and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring“. Researchers from many nations are now working with other ocean going stakeholders such as fishers and mariners to collect oceanographic and fisheries data for little to no deployment and retrieval costs. This session provided a forum for researchers to present the development and results of cooperative monitoring projects world-wide.

Summary of presentations

This session was well attended, despite several presentation cancellations. There were four oral presentations in this session; all presentations included excellent examples of cooperative observation programs. Each presentation was followed by a discussion regarding successes, challenges encountered, and lessons learned in cooperative monitoring programs. Successes common to all presentations included the cooperation of people associated with ships and equipment of opportunities, as well as the successful collection of data. Challenges included that data collection is not the main priority for shared sampling platforms. Also, there were some technical difficulties in some sensors due to conditions of opportunistic sampling. Regardless of these challenges, lessons learned indicate that cooperative programs can successfully provide low-cost monitoring of ecosystem attributes.

Dr. Sonia Batten was an invited speaker for this session and provided information on the Continuous Plankton Recorder (CPR) program in the North Pacific. CPRs have been deployed from vessels of opportunity on their regular routes of passage for multiple decades and in several of the world's oceans. These surveys generate spatially and temporally referenced quantitative data on the abundance and distribution of many zooplankton and larger phytoplankton taxa, providing insights into the base of the marine food chain and lower trophic level responses to hydroclimatic variability. Benefits and limitations of the approach were discussed. In more recent years, the CPR has itself become a sampling platform with instrumentation added to the towed body which autonomously collects physical data (T, S, D) and chlorophyll fluorescence, or microplankton via a self-contained water sampler. The North Pacific CPR survey has also, in the past, made use of marine bird and mammal observers onboard the vessel. There is thus the potential to develop large-scale, multi-trophic level monitoring programs with some supplemental physical data. While microscopic processing of all CPR survey data can take several months to complete, a more recently a near-real-time approach has been adopted along

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some transects with data available within 60 days. The CPR program has contributed significantly to oceanographic monitoring.

Dr. Kyung-Il Chang described a cooperative monitoring project that makes use of snow crab traps as sampling platforms for deep sea monitoring in the East/Japan Sea. A system was devised to monitor the deep sea environment and acquire full-depth profiles of water properties regularly, like an Argo float, using snow crab fishing boats. The Korean snow crab fishing activities are widespread in the southwestern East Sea at about 40 locations in a depth range between 500 and 1500m. The deployment and recovery of traps take place regularly approximately once a week if the sea state permits. The system consists of a Microcat with dissolved oxygen sensor and a data logger. The Microcat, attached to a trap, profiles CTD and dissolved oxygen while the trap is deployed and recovered. It records water properties for about a week while it stays near the seabed with the trap. Once the trap is on the vessel's deck, data inside the Microcat are automatically transferred to the compact logger set in the bridge of the boat, and then transferred to the lab via any available communication system.

Dr. Tony Koslow presented a model for cooperative observation programs as the basis for ecosystem-based management, ocean climate research and assessment of ecosystem change. A meta-analysis of Pacific Ocean observation programs indicated that while the physics is generally well-monitored, biological monitoring remains inconsistent, fragmented, *ad hoc*, and with critical data access issues still unresolved. He proposed the CalCOFI program as a model for cooperative monitoring between government fisheries and ocean agencies and academic oceanographic institutions which can provide the basis for fisheries stock assessment within the context of the physical and biological oceanographic environment. This partnership enhances ecosystem-based management and the development of robust ocean climate and ecosystem research that is able to provide time series for the ocean environment 'from winds to whales'.

The final presentation was given by Dr. Francis Juanes. The project described was aimed at understanding the marine soundscape off Vancouver Island by exploring passive acoustic data from the NEPTUNE Canada cabled ocean observing system in the Northeast Pacific Ocean. Elevated anthropogenic noise in marine soundscapes and their potential to decrease communication efficacy of marine organisms is of increasing global concern. The deep sea soundscape is particularly vulnerable to increasing anthropogenic noise while at the same time the ecosystem is being subjected to increasing pressures from resource users. Using passively-collected acoustic data collected at two sites over a one-year period, the levels of ambient noise were quantified, including vessel traffic, and biological sounds, including potential fish sound production. Complications due to extensive self-generated instrument noise were discussed.

In addition to the four oral presentations, three posters were presented as part of this session. Hisashi Yamaguchi and co-authors utilized satellite remote sensing data to examine the seasonal variation of chlorophyll *a*, which might be an index of the growth of cultured scallop in Mutsu Bay. Tomoko Yoshiki and co-authors examined the spatial and temporal variation of the copepod community structure, abundance and biodiversity in the western subarctic North Pacific during 2001–2010, using Continuous Plankton Recorder (CPR) data. The final poster stated that the tsunami caused by the Great East Japan Earthquake on 11 March 2011 destroyed monitoring systems important for aquaculture operations in Japan's Iwate Prefecture. Shin-ichi Ito and co-authors showed that monitoring systems at two ports (Kamaishi and Noda) were reconstructed, and there are plans to reconstruct four other systems.

### List of papers

#### *Oral presentations*

**Sonia Batten** (Invited)

Ship of opportunity sampling of lower trophic levels

**Kyung-Il Chang, Ki-Wan Kim and Sang-Uk Lee**

Use of snow crab traps as sampling platforms for deep sea monitoring in the East/Japan Sea

**J. Anthony Koslow and Jennifer Couture**

Are current ocean observation networks adequate? A model for cooperative observation programs as the basis for ecosystem-based management, ocean climate research and assessment of ecosystem change

**Carrie C. Wall, Rodney A. Rountre and Francis Juanes**

Understanding the marine soundscape off Vancouver Island: An exploration of passive acoustic data from the NEPTUNE Canada ocean observing system

*Poster presentations*

**Hisashi Yamaguchi, Hiroshi Murakami, Xu Yongjiu, Takayuki Kusunoki and Masahito Ebina.**

Understanding the estimated error of the satellite chlorophyll a in Mutsu Bay

**Tomoko M. Yoshiki, Sanae Chiba, Tadafumi Ichikawa, Hiroya Sugisaki and Sonia Batten**

Geographical shift of warm water species distribution in western subarctic North Pacific based on CPR sample during 2001-2010

**Shin-ichi Ito, Kazushi Tanaka, Yuki Endoh, Takeshi Yamanome, Shinnosuke Kaga, Taku Wagawa and Shigeo Kakehi**

Reconstruction of coastal sea water temperature monitoring systems and real-time broadcast to fishermen in Iwate Prefecture

**FIS/TCODE Topic Session (S10):**

***Banking on recruitment curves; returns on intellectual investment***

Co-sponsored by *ISC (International Scientific Committee on Tunas and Tuna-like Species)*

Co-Convenors: *Anne Hollowed (USA)\*, Skip McKinnell (PICES), Hiroshi Okamura (Japan), Cisco Werner (ISC)*

Invited Speakers: *Louis Botsford (University of California at Davis, USA), Jon Brodziak (NOAA/PIFSC, USA)\**

\* Anne Hollowed and Jon Brodziak were unable to attend PICES-2013 due to the U.S. government partial shutdown.

Background

During the first half of the 20th century, one of the fundamental issues in the then nascent discipline of fisheries science was determining how many individuals could be removed from a fish population without affecting its ability to keep producing fish for a fishery. In the 1950s, theoretical solutions to this problem were discovered in mathematical formulations that emerged from the work of Ricker, Beverton, Holt and others. These closed-form solutions led to widespread adoption as electronic computing technology became widely available in fisheries labs in the 1960s. Concepts that emerged from their equations underpin current estimation of biological reference points used to set harvest strategies for many of the world's fisheries. Spawner-recruitment (S-R) curves serve as the foundation for what of a fish population remains to be conserved. With so much at stake, it is surprising that their application in contemporary fisheries is taken for granted. This session will delve into the good, the bad, and the ugly consequences of using recruitment curves, with an idea of determining whether an intellectual course correction is needed for the next 50 years. This topic session seeks papers that introduce new approaches to modeling the relationship between spawners and recruitment including: (1) incorporating predator prey interactions in S-R models, (2) use of coupled bio-physical models in identifying mechanisms linking spawners and recruitment, (3) consideration of the role of cohort resonance, (4) techniques for incorporating environmental variability into S-R functions, (5) stage-based S-R approaches, (6) comparative studies testing the performance of different methods relative to observations, and (7) decision rules regarding how to utilize knowledge of S-R relationships in formulating harvest advice. Enthusiasm for this topic session will be used to seek publication in a Special Issue in a primary journal.

### Summary of presentations

The 22<sup>nd</sup> Annual Meeting of PICES was unique in many ways, but the greatest of the anomalies was the shutdown of the United States government which prevented NOAA employees from attending. Jon Brodziak of the NOAA/Pacific Islands Fisheries Science Center was nominated as the ISC invited speaker, but was unable to attend to present his views (with Mark Mangel) on “*Understanding and predicting population resilience via steepness*”. Nevertheless, the session was quite successful, especially due to the efforts of several early career scientists. Only the contributed talk by Ron Heintz and Edward V. Farley, Jr. was withdrawn because of the shutdown. Perhaps the most disappointing aspect of the session was the lack of enthusiasm to publish the results in a primary journal.

Louis Botsford, invited speaker from the University of California, Davis, focused on cohort resonance which refers to the greater spectral sensitivity of populations to slowly changing environmental variability and to variability on generational time scales. He and his colleagues described how populations have greater sensitivity to lower frequencies and generational frequencies. Overall variance and sensitivity increases with fishing although populations tend to be stable about an equilibrium on the compensatory part of a stock-recruitment curve. This may provide an explanation for cycles in sockeye salmon. The effect is just as strong in populations with hatcheries. Specific spectral sensitivity also appears in marine birds, where low (high) frequency of ENSO increases (decreases) population variance.

Some good collaborations among Japanese oceanographers, modelers and fishery biologists are producing useful tools for understanding Pacific saury migrations in the western North Pacific Ocean. Michio Kishi gave a nice presentation on the Pacific saury migration model and its relation to stock and recruitment and future climate change. Cheryl Harrison, David Siegel, and Satoshi Mitarai revisited the tattered curtain hypothesis that coastal jets limit cross-shelf benthic larval transport. Model results indicated that the upwelling jet along the U.S. West Coast partially retains material released over the shelf, broken up by filaments, that strong upwelling winds tear this jet, moving material offshore in complex patterns, and that the response of the jet to wind is nonlinear, making predictability limited in this high energy region. La Treese Denson, David Sampson, and Andi Stephens used environmental data to inform assumptions of spatial stock assessments (of a *Sebastes*-like fish) with Stock Synthesis. Preliminary results suggest that under some conditions, environmental data may help to describe the distribution of recruits and improve the estimation of reference points. Accounting for abrupt environmental change seemed to provide the greatest benefit to stock assessments that included environmental change. Increased intensity of environmental influence on recruitment may provide more information for the estimation process. Kirstin Holsman, Kerim Aydin and Jim Ianelli pooled their effort to examine the use of multi-species food-web and assessment models to evaluate climate change impacts on fisheries. Multi-species models (MSM) can provide annual estimates of natural mortality, and can be used to derive multi-species Biological Reference Points (BRP). BRPs are highly variable and depend on control rules. Climatic variability introduces some differences but they are less than what is introduced by control rules, at least for walleye pollock. For species with low predation, they found that MSM models were approximately equivalent to single species assessment models. Gordon Kruse presented Jonathan Richar’s work, in collaboration with Albert J. Hermann and Enrique Curchitser on the effects of shifting population demographics, oceanography, and predation on apparent stock-recruitment relationships for Tanner crab in the Eastern Bering Sea. They estimated stock-recruit relationships for Tanner crabs in the eastern Bering Sea, and estimated potential relationships between recruitment and groundfish predators in the eastern Bering Sea. One interpretation of results was that Tanner crab had a strong density-dependent relationship. Potential mechanisms included cannibalism. In abundant years, female distribution expands to the outer shelf and to the northwest. ROMS modeling suggests larvae from these regions are vagrants. An alternative interpretation was that recruitment is environmentally driven with autocorrelated variability with periodicity about twice the mean generation time. Evidence for a predation effect is weak or mixed. A positive relationship with cod is contrary to expectations from top-down control, no relationship with yellowfin sole suggests no effect, and a dome-shaped relationship with flathead sole could suggest prey switching behavior. Finer-scale spatial models may be necessary owing to interannual shifts in distributions.

After the lunch break, the theme switched briefly to Pacific salmon. Catherine Michielsens, Mike Lapointe and Carl Walters explored density dependence, delayed density dependence and time varying productivity to explain a decrease in productivity of Fraser River sockeye salmon. Kalman filter or recursive Ricker models are excellent for evaluating productivity trends over time across a wide range of stocks but may not be the most appropriate for particular stocks, *e.g.*, those displaying cyclic dominance. They found that the Kalman filter or recursive Ricker model will attribute the low recruits per spawner on the dominant cycle as lower overall productivity. Recursive versions of alternative models may be more appropriate, *e.g.*, recursive Larkin model. It is easy to derive benchmarks based on recursive Ricker models but difficult to do the same for recursive Larkin models. Using recursive Ricker models to derive benchmarks may not be appropriate for some of the stocks.

Skip McKinnell went back to the drawing board with a simple polynomial model framework for assessing salmon production and setting escapement targets that avoided the use of Ricker or Beverton-Holt type production models. Using examples from multiple populations of Fraser River sockeye salmon, he found no significant evidence of curvature (density-dependent survival) in spawner-return data in most stocks, and inferred that optimum spawner abundance is unknown in them. Fishing prevents knowing optimum yield because spawner abundance is never high enough often enough, so most stocks are on ~linear part of the production curve. He suggested that current spawner abundance optimum arises from the types of curves that are used routinely, and perhaps OLS fitting, rather than the production data. Production and conservation goals might be achieved jointly by increasing spawner abundance, but the current generation of fishers won't benefit. Only the Chilko L. stock had statistically significant evidence of curvature.

Robyn E. Forrest (and co-authors Murdoch McAllister, Steven Martell and Carl Walters) received a Best Presentation award in a TCODE-sponsored Topic Session for her talk on "*Modelling the effects of density-dependent mortality in juvenile red snapper caught as bycatch in Gulf of Mexico shrimp fisheries: Implications for management*" (see the list of recipients at the end of these summaries). She asked what was needed to assess status of a fish stock and predict its response to fishing. They found that failure to account for density-dependent mortality occurring simultaneously with bycatch can lead to biased fishery reference points, underestimation of impacts of directed fishery, and overestimation of impacts of bycatch. They concluded that management plans cannot rely solely on bycatch reduction and should include directed fishery. Finally, that the definition of reference points is problematic in the presence of numerous sources of mortality affecting different demographic components of population.

The two final talks of the session were presented by Cody S. Szuwalski. The first was work with Katyana Vert-Pre, Andre Punt, Trevor Branch and Ray Hilborn, examining common assumptions about recruitment dynamics for most marine fisheries. Their advice to management was to "play to the mean" using proxies for FMSY and BMSY and change expectations for recruitment based on the regime state. Instead of target biomasses, they suggested using target fishing mortalities. Proxies for F could be based on life history, and risk analysis for target biomass. As Anne Hollowed was unable to attend, Cody also presented her talk on setting biological reference points under a changing climate. She concluded that the first step is to set goals and objectives for future fisheries management and identify strategies to achieve goals and objectives. These strategies should then be evaluated relative to achieving goals and identify trade-offs of changes in harvest strategies. She felt that it is necessary to acknowledge that management systems will continue to evolve, but develop suites of tests to identify shifts in dynamics – focus on quantifying holistic risk (and reward) using one-way trips to peer into the future. She asked, "Are we at the mercy of climate change?" How can we set a target for something for which we have never seen?" Developing suites of tests to identify when and how dynamics are changing is important.

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### List of papers

#### *Oral presentations*

**Louis W. Botsford, J. Wilson White, Alan Hastings, Lauren Yamane, Flora Cordoleani, Patrick Kilduff and Allison Dedrick** (Invited)

Stock-recruitment and population variability in a changing, uncertain world

**Michio J. Kishi, Seokjin Yoon, Takeshi Terui, Satoshi Suyama, Masayasu Nakagami and Shin-ichi Ito**

A Lagrangian modeling approach for Pacific saury migrations

**Cheryl S. Harrison and David A. Siegel**

The tattered curtain hypothesis revisited: Coastal jets limit cross-shelf benthic larval transport

**La Treese S. Denson and David B. Sampson**

Using environmental data to inform spatial stock assessments with Stock Synthesis

**Jonathan I. Richar, Gordon H. Kruse, Albert J. Hermann and Enrique Curchitser**

Effects of shifting population demographics, oceanography, and predation on apparent stock-recruit relationships for Tanner crabs in the eastern Bering Sea

**Catherine J.G. Michielsens, Mike Lapointe and Carl J. Walters**

Exploring density dependence, delayed density dependence and time varying productivity to explain decreased productivity of Fraser River sockeye salmon

**Kirstin K. Holsman, Kerim Aydin and Jim Ianelli**

Using multi-species food-web and assessment models to evaluate climate change impacts on fisheries

**Skip McKinnell**

A simple model framework for assessing salmon production and setting escapement targets

**Robyn E. Forrest, Murdoch K. McAllister, Steven J.D. Martell and Carl J. Walters**

Modelling the effects of density-dependent mortality in juvenile red snapper caught as bycatch in Gulf of Mexico shrimp fisheries: Implications for management

**Cody S. Szuwalski, Katyana A. Vert-Pre, Andre E. Punt, Trevor A. Branch and Ray**

Environment drives recruitment dynamics for most marine fisheries

**Anne B. Hollowed and Cody S. Szuwalski**

Setting biological reference points under a changing climate

### **BIO Paper Session**

Co-Convenors: *Atsushi Tsuda (Japan) and Michael Dagg (USA)*

### Background

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

### Summary of presentations

The BIO Paper Session at PICES-2013 had high participation, with a total of 16 oral presentations and 10 poster presentations (2 cancellations). Oral sessions were divided over two days and were well attended (over 40 participants). Presentations spanned a wide range of biological issues focusing around phytoplankton (1), zooplankton (8), forage fish (1), marine birds and mammals (5), and other issues (1). Similarly, poster presentations covered a broad spectrum of biological topics. The convenors recognized that this regular session provides important opportunities for PICES scientists to present their results and for early career scientists to participate in PICES activities.



List of papers*Oral presentations*

**Huamei Shao, Yuka Morita, Shiori Sonoki, Kenji Minami, Norishige Yotsukura, Masahiro Nakaoka and Kazushi Miyashita**

Spatiotemporal analysis of kelp forest distribution characteristics in sea desertification areas using acoustic and direct sensing methods

**Angelica Peña and Nina Nemcek**

Phytoplankton and nutrient dynamics along Line P in the NE subarctic Pacific

**Woo Yul Yi, Hyung-Ku Kang, Bome Song and Joong Ki Choi**

Egg production rate and hatching success in relation to feeding rate of the planktonic copepod *Paracalanusparvuss*.l. at a fixed station, southeastern coast of Korea

**Rui Saito, Atsushi Yamaguchi, Hiromichi Ueno, Hiromu Ishiyama, Hiroji Onishi, Ichiro Imai and Ichiro Yasuda**

Influence of Aleutian eddies on calanoid copepods south of the western Aleutian Islands during summer

**Corinne Pomerleau, Brian P.V. Hunt, R. John Nelson, Akash Sastri and William J. Williams**

Spatial patterns in zooplankton communities and stable isotope ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) in relation to oceanographic conditions in the sub-Arctic Pacific and Western Arctic regions during the summer of 2008

**Yoshiyuki Abe, Masafumi Natsuike, Kohei Matsuno, Takeshi Terui, Atsushi Yamaguchi, Michio J. Kishi and Ichiro Imai**

Variation in assimilation efficiencies of dominant *Neocalanus* and *Eucalanus* copepods in the subarctic Pacific: Consequences for population structure models

**Ah-Ra Ko and Se-Jong Ju**

Seasonal and spatial variations of food sources of krill *Euphausia pacifica* in Yellow Sea using fatty acids analysis

**Jeffrey G. Dorman, Ramona L. Zeno, Jarrod A. Santora and William J. Sydeman**

Modeling krill 'hotspots' in the central California Current: Results from variation in diel vertical migration schemes

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

A tale of two krill: Who, when, where, and how many? The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA

**Se-Jong Ju, Ah-Ra Ko, E.J. Yang, William T. Peterson and C. Tracy Shaw**

Understanding the food selectivity of *Euphausia pacifica* in Yellow Sea: *in-situ* live feeding experiment with natural food assemblages

**Jessica A. Miller, William T. Peterson, Louise Copeman, Marisa N.C. Litz, Angela L. Sremba and Laurelyn Perry**

Is the growth of larval and early juvenile northern anchovy (*Engraulismordax*) related to the biochemical climatology of the Northern California Current?

**Strahan Tucker, Mark Hipfner, John R. Candy, Colin Wallace, Terry D. Beacham and Marc Trudel**

Stock-specific and condition based predation of juvenile pink, chum and sockeye by rhinoceros auklets (*Cerorhinca monocerata*)

**Jarrod A. Santora, Isaac D. Schroeder, John C. Field, Brian K. Wells and William J. Sydeman**

Melding space and time: Mesoscale structuring of predator-prey relationships off central California

**Mayuko Otsuki, Kazuo Amakasu, Minoru Kitamura, Shigeto Nishino, Takashi Kikuchi, Yoko Mitani and Kazushi Miyashita**

The presence of fin whale vocalizations is correlated with zooplankton abundance in the southern Chukchi Sea

**Szymon Surma**

Ecological interactions between forage fish, rorquals, and fisheries in Haida Gwaii

**Trevor W. Joyce and Lisa T. Ballance**

Effects of El Niño/La Niña–Southern Oscillation oceanographic variation on the at-sea distribution and foraging ecology of piscivorous seabirds in the oceanic eastern tropical Pacific

*Poster presentations*

**Daichi Arima, Atsushi Yamaguchi, Yoshiyuki Abe, Kohei Matsuno, Rui Saito, Hiroki Asami, Hiroshi Shimada and Ichiro Imai**

Seasonal changes in the zooplankton community and number of generations per year of small copepods in Ishikari Bay, Sea of Japan

**Wen-Tseng Lo, Shwu-Feng Yu and Hung-Yen Hsieh**

Epipelagic siphonophores associated with summer mesoscale hydrographic features in the waters around Taiwan, western North Pacific Ocean

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### **Moira Galbraith and Sonia Batten**

Interannual variability in the abundance of *Pseudocalanus* spp.

### **Kyoungsoo Shin, Bonggil Hyun, Keun-Hyung Choi, Pung-Guk Jang, Min-Chul Jang and Woo-Jin Lee**

Effects of increased CO<sub>2</sub> and temperature on the growth of diatoms in laboratory experiments

### **Bonggil Hyun, Kyoungsoo Shin, Keun-Hyung Choi, Woo-Jin Lee, Pung-Guk Jang, Min-Chul Jang and Chang-Ho Moon**

Changes in coastal phytoplankton community structure under future climate conditions: A mesocosm study

### **Seokjin Yoon, Michio J. Kishi, Satoshi Nakada, Yoichi Ishikawa, Tomonori Isada and Sei-Ichi Saitoh**

Estimating carrying capacity for scallop aquaculture using a bioenergetics model

### **Erin J. Fedewa, Jessica A. Miller and Thomas P. Hurst**

Interannual variation in pre- and post-settlement processes of northern rock sole (*Lepidopsetta polyxystra*) in relation to temperature variability in the Gulf of Alaska

### **Oleg N. Katugin, Mikhail A. Zuev and Gennadyi A. Shevtsov**

Distribution patterns of *Gonatus onyx*, *G. pyros* and *G. berryi* (Gonatidae, Teuthida) in the northwestern Pacific Ocean and adjacent marginal seas

### **German Novomodny**

Is unexpected 2013 flood on the Amur River an evidence of future probable drastic, unprecedented changes in the Amur bioresources state?

## FIS Paper Session

Co-Convenors: *Xianshi Jin (China) and 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 FIS-sponsored Topic Sessions.

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\* Elizabeth Logerwell was unable to attend PICES-2013 due to the U.S. government partial shutdown.

### List of papers

#### *Oral presentations*

#### **Nadezhda V. Yarosh and Victor F. Bugaev**

Seasonal growth of juvenile coho salmon *Oncorhynchus kisutch* scales in the Bolshaya River, West Kamchatka

#### **Cameron Freshwater, Marc Trudel and Francis Juanes**

Effects of body size, marine entry timing, and marine growth on the migration of juvenile sockeye salmon

#### **Beverly A. Agler, Gregory T. Ruggione, Lorna Wilson and Edward V. Farley, Jr.**

Size-selective mortality of Kvichak River, Bristol Bay, Alaska sockeye smolts in relation to smolt characteristics, ocean conditions, and sockeye productivity

#### **Gregory T. Ruggione and Brendan M. Connors**

Are there too many pink salmon in the ocean? The productivity and life history of Fraser River sockeye in relation to pink and sockeye salmon abundance across the North Pacific

#### **Eric Hertz, Marc Trudel, Strahan Tucker, Terry D. Beacham, Chuck Parken and Asit Mazumder**

Implications of the interannual variability in the feeding ecology of juvenile Chinook salmon

#### **Marisa N.C. Litz, Robert L. Emmett, Andrew M. Claiborne, Jessica A. Miller and David J. Teel**

Seasonal variability in juvenile fish and invertebrate prey available to Columbia River salmon entering the ocean

#### **Christine C. Stawitz, Timothy E. Essington, Anne B. Hollowed, Trevor A. Branch, Melissa A. Haltuch, Paul D. Spencer and Nathan Mantua**

Can we predict synchronous production dynamics? Applications to somatic growth

#### **Megan M. Stachura, Timothy E. Essington, Nathan J. Mantua, Anne B. Hollowed, Melissa A. Haltuch, Paul D. Spencer, Trevor A. Branch and Miriam J. Doyle**

Linking recruitment synchrony to environmental variability

**Kiva L. Oken and Timothy E. Essington**

Using surplus production models to study predation in age-structured populations

**Osamu Tamaru, Go Takayama, Hideo Takahara and Toshihiro Watanabe**

Constructing a 3-D simulation model of squid schooling behavior at jigging operations with the Boids Algorithm

**Irene D. Alabia, Sei-Ichi Saitoh, Hiromichi Igarashi, Yoichi Ishikawa, Norihisa Usui, Masafumi Kamachi, Toshiyuki Awaji and Masaki Seito**

Persistent summer pelagic hotspots of neon flying squid (*Ommastrephes bartramii*) in the western North Pacific

**Haruka Nishikawa, Yoichi Ishikawa, Takahiro Toyoda, Shuhei Masuda, Yuji Sasaki, Mitsuo Sakai and Toshiyuki Awaji**

Impact of climate variability on the neon flying squid (*Ommastrephes bartramii*) winter-spring cohort stock

**Chen-Yi Tu, Yongjun Tian and Chih-hao Hsieh**

Climate effects on spatial-temporal variation of the demersal fish assemblage in the Tsushima Warm Current region of the Japan Sea

**Chiyuki Sassa, Motomitsu Takahashi and Youichi Tsukamoto**

Distribution, growth, and mortality of larval *Benthoosema pterotum* (Pisces: Myctophidae) in the shelf region of the East China Sea

**Jennifer L. Boldt, Jake Schweigert, Jaclyn Cleary, Linnea Flostrand, Vanessa Hodes, Gordon McFarlane, Stephane Gauthier, Moira Galbraith and Dave Mackas**

Potential for competitive interactions between Pacific sardine and Pacific herring in British Columbia, Canada

**Tetsuichiro Funamoto, Lorenzo Ciannelli and Kazushi Miyashita**

Non-stationary effects of environmental conditions on walleye pollock larval distribution

*Poster presentations*

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

Annual variability of pollock resources, distribution, reproduction and environment in the Bering Sea

**Xiu-Juan Shan, Peng-Fei Sun, Qiang Wu, Yun-Long Chen and Xianshi Jin**

Seasonal variations in fish community structure in Laizhou Bay and the Yellow River Estuary, China

**Chiyuki Sassa, Yoshinobu Konishi and Youichi Tsukamoto**

Late winter larval fish assemblage in the southern East China Sea, with emphasis on spatial relations between mesopelagic and commercial pelagic fish larvae

**Ah Reum Kim, Ho Jin Bae and Chul-Woong Oh**

Age and growth of filefish *Thamnaconus modestus* off the Jeju Island

**Yang Liu, Sei-Ichi Saitoh, Yu Ihara, Toru Hirawake, Katsuhisa Baba and Kanamori Makoto**

Development of the 3-D growth prediction model for Japanese scallop in Funaka Bay, Japan

**Lyse Godbout, Carrie A. Holt, Peter Tchaplinski, Don Mcubbing, James Irvine and Marc Trudel**

Climate change, emigration timing to sea and salmon marine survival

**Hiroko Sasaki, Irene D. Alabia, Koji Matsuoka, Hiromichi Igarashi, Yoichi Ishikawa, Norihisa Usui, Masafumi Kamachi, Toshiyuki Awaji, Masaki Seito and Sei-Ichi Saitoh**

Potential habitat overlap between neon flying squid (*Ommastrephes bartramii*) and marine mammals in the western North Pacific: Possible trophic linkages

**Xun Zhang, Sei-Ichi Saitoh, Toru Hirawake, Satoshi Nakada, Koji Koyamada, Toshiyuki Awaji, Yoichi Ishikawa and Hiromichi Igarashi**

Potential fishing zone prediction map of Japanese common squid in the coastal water, southwestern Hokkaido, Japan

**David G. Stormer and Francis Juanes**

Overwintering ability of juvenile ocean-type Chinook salmon: Effect of water temperature and food deprivation on growth, energetics and survival

**Nadezhda L. Aseeva**

Some features of *Lycodes soldatovi* biology and parasitology in the Okhotsk Sea

**PilSoo Kim, Jae Bong Lee and Jin-Woo Bae**

Metagenomic analysis of the fish gut microbiota

**Nadezhda A. Rastvagaeva**

Some results of salmon origin identification and of figuring out the age structure of identified stocks by different methods

**A. Jason Phillips, Lorenzo Ciannelli, Richard D. Brodeur, William G. Pearcy and John Childers**

Spatio-temporal associations of albacore catches in the Northeastern Pacific with regional and climate environmental variables

**Sunkil Lee, Jae Bong Lee, Dae-Soo Chang and Jong-Bin Kim**

Comparisons of trophic level in ecosystem by effects of fishing in Korean waters

## Session Summaries-2013

### MEQ-Paper Session

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

Other Co-Convenors, Elizabeth Logerwell (USA), Olga Lukyanova (Russia) and Lyman Thorsteinson (USA) were absent at PICES-2013.

Invited Speaker: *Stanley (Jeep) Rice (retired, NOAA)*

#### Background

The Marine Environmental Quality Committee (MEQ) has a wide range of interests spanning from traditional research areas to emerging marine environmental issues. Papers were invited on all aspects of marine environmental quality research in the North Pacific and its marginal seas, except those covered by MEQ-sponsored Topic Sessions. According to the adjusted Scientific Program and schedule, MEQ/FIS/FUTURE Topic Session (S7: Science needs for offshore oil and gas development in the North Pacific) was cancelled, and 4 submitted abstracts were moved to this MEQ Paper Session.

A total of 12 papers were approved and scheduled in this session before the Annual Meeting, in which 8 papers were about the assessment of marine radioactivity around the North Pacific (NP), 4 papers were about science needs for offshore oil and gas development in the NP. However, 2 presentations (Leslie Holland-Bartels and Lyman Thorsteinson: *“An evaluation of science needs to inform decisions on outer continental shelf energy development in the Chukchi and Beaufort seas, Alaska”*; Dee Williams: *“Monitoring effects related to offshore petroleum development in Coastal Alaska”*) were cancelled, as the speakers were unable to attend the Annual Meeting due to the U.S. government partial shutdown.

Furthermore, since the Working Group on *Assessment of Marine Environmental Quality of Radiation around the North Pacific* (WG 30) was approved by the Governing Council and launched on August 1, 2013, scientists and potential WG 30 members from PICES member countries were encouraged to submit papers and to attend PICES-2013. Scientists from five PICES member countries attended this session and gave oral presentations relevant to radioactivity. The scientist from the Russia, who submitted an abstract, was not able to attend the Annual Meeting.

#### Summary of presentations

The MEQ Paper Session at PICES-2013 had good participation and was well attended, with a total of 8 oral presentations in a half-day. Oral presentations were given during the afternoon of October 15. Before the coffee break there was only one talk on the science needs for the oil development in the Arctic given by invited speaker (Dr. Stanley Rice, U.S. retired NOAA). Since the other two speakers were not able to attend, Dr. Rice gave a detailed presentation followed by many questions from an appreciative audience.

The second half of the Paper Session consisted of 6 talks, all on the radioactivity, which covered a wide variety from methodology to the assessment of the radioactivity distribution in seawater, sediment and organisms. Two talks from the USA dealt with relating radiation dose to effect, and with bio-magnification of radiocesium in jellyfish. From China, one talk was on the characteristics of radionuclides in the sediment, and another talk was the combination of two papers, one on the measured distribution of seawater radioactivity, and one about the radioactivity of marine cephalopoda and fish species in the Northwest Pacific Ocean from/after Fukushima Dai-ichi nuclear power plant accident. Following these two talks was a presentation from a Japanese scientist on the estimation of river discharges and fluxes of suspended substances to the North Pacific after the Fukushima Dai-ichi nuclear power plant accident. The last presentation was from Dr. John N. Smith, Canada, on the detection of radioactivity from the 2011 Fukushima accident in the Eastern North Pacific and Arctic Oceans, which was another presentation relating Arctic Oceans. This, and Dr. Rice's presentation, stressed concern about the marine environment of Arctic from different aspects of artificial activities, marine oil exploration and the emerging disaster.

The convenors acknowledged that the MEQ Paper Session was able to provide important opportunities for PICES scientists to present their studies not only on known areas, but on emerging marine environmental issues, and for early career scientists to participate in PICES activities. They also recognized that all the participants showed the interest and concern about the marine environmental impact of the Fukushima Dai-ichi nuclear power plant accident.

### List of papers

#### *Oral presentations*

**Stanley D. Rice** (Invited)

Oil development in the Arctic: What are the science needs?

**Kathryn Higley, Elizabeth Ruedig, Emily Caffrey, Mario Gomez-Fernandez, Michelle Comolli and Delvan Neville**

Relating radiation dose to effect: The importance of accurate dosimetry in assessing the impact of radioactivity on marine organisms

**Jinqiu Du, Ziwei Yao, Hui Gao, Guangshui Na and Chuanlin Huo**

Characteristics of radionuclides in sediment samples from coastal waters of Dalian Bay and Liaodong Bay

**Delvan Neville, Kathryn Higley and Richard D. Brodeur**

Radiocesium and jellyfish: Where's the biomagnification?

**Wen Yu, Men Wu, Jianhua He, Yusheng Zhang and Tao Yu**

Measured distribution of seawater radioactivity from Fukushima Daiichi Nuclear Power Plant in North Pacific

**Jianhua He, Wen Yu, Men Wu, Tao Yu and Yusheng Zhang**

Radioactivity of marine cephalopoda and fish species after 2011 Fukushima Daiichi Nuclear Power Plant accident in the Northwest Pacific

**Shin-ichi Ito, Hiroshi Kutsukake, Kazuhiro Takeuchi, Hideki Kaeriyama, Masashi Kodama, Shigeo Kakehi, Kazuhiro Aoki, Hiroshi Kuroda, Hiroshi Yagi, Ambe Daisuke and Tsuneo Ono**

Estimation of river discharges and fluxes of suspended substances to the North Pacific after the Fukushima Dai-ichi nuclear power plant accident

**Vyacheslav Lobanov, Vladimir Goryachev, Aleksandr Sergeev, Dmitry Kaplunenko, Natalia Shlyk, Natalia Treshcheva, Sergei Prants and Maksim Budyansky**

Fukushima 2011 derived radionuclides in the Japan and Okhotsk seas and subarctic front region of the Northwestern Pacific, one year later

**John N. Smith, Robin Brown, Marie Robert, Bill Williams and Richard Nelson**

Detection of radioactivity from the 2011 Fukushima accident in the Eastern North Pacific and Arctic Oceans

### **POC Paper Session**

Co-Convenors: *Kyung-Il Chang (Korea), Michael G. Foreman (Canada)*

#### Background

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

#### Summary of presentations

The session consisted of 6 oral presentations and 5 posters. Dr. Kyung-Il Chang chaired the ½-day oral presentation period.

The session began with Dr. Rong-shuo Cai presenting a study that found the East Asian Monsoon experienced a climatic jump in 1976/1977, weakening after 1976, and this shift in atmospheric forcing influenced the marine environmental changes of physical properties of seawater, major currents, and coastal sea level. Dr. Kirill Kivva presented observational evidence of coastal upwelling in the Bering Sea based on CTD and chemical data, and estimated that the observed coastal upwelling accounts for about 20% of the primary

production in the region. Mr. Seung-Tae Yoon calculated bi-monthly heat contents for 35 years in the upper 500 m in the southwestern Japan/East Sea, and highlighted a decreasing trend of the heat content in the lower layer from 100 m to 500 m while the upper heat content changed little or increased slightly. This decrease in the lower layer heat content is due to a persistent negative anomaly since 2000. Dr. Jae-Hun Park talked about the seasonal variation of semi-diurnal internal tides in the Japan/East Sea based on numerical model results. He showed that the barotropic–baroclinic energy conversion is high in summer, and the internal tides propagate far to the north in summer, due to changes in stratification and wavelength. Dr. Young-Gyu Park investigated internal tides based on observations and their possible role in vertical mixing by calculating the Thorpe scale in the southwestern Japan/East Sea. Although he and colleagues observed strong internal tide signals, their contribution to vertical mixing is weak. Dr. Viktor Kuzin presented results of the Arctic Ocean climate simulations of present and future periods focusing on ice-cover and circulation using a 3-dimensional ocean circulation model coupled with a sea ice model. The simulated ocean condition is shown to be linked with NAO index, and model results predicted that the Arctic Ocean will be partially covered by ice until 2050 although its coverage will be reduced.

### List of papers

#### *Oral presentations*

**Rong-shuo Cai and Jun-pen Zhang**

The role of the East Asian monsoon in the responses of the marine environment in the East China Sea to the East Asian climatic jump around 1976/77

**Kirill Kivva and Denis Chulchekov**

Evidence of local upwellings in the north-western Bering Sea in 2012

**Seung-Tae Yoon and Kyung-II Chang**

Heat content variations in the southwestern East/Japan Sea

**Chanhyung Jeon, Jae-Hun Park, Sergey Varlamov, Jong-Hwan Yoon, Young-Gyu Park, Young Ho Kim, Seong Bong Seo, Hong Sik Min and Jae-Hak Lee**

Seasonal effects on generation and propagation of semi-diurnal internal tides in the East/Japan Sea

**Seong Bong Seo, Young-Gyu Park, Jae-Hun Park, Chang-Woong Shin and Chanhyung Jeon**

Properties of internal tides observed in the southwestern part of the East Sea

**Viktor Kuzin, Elena Golubeva and Gennady Platov**

Some results from the use of the numerical model in the Arctic Ocean climate simulation

#### *Poster presentations*

**Hiromichi Ueno**

Decadal variation of temperature inversions along Line P

**Kyung-Jae Lee and Kyung-II Chang**

Mesoscale eddies in the East/Japan Sea: Detection algorithms and characteristics of eddy properties

**Qing-hua Qi and Rong-shuo Cai**

Spatial-temporal evolution of SSTA in the South China Sea (SCS): An implication for the SCS summer monsoon outbreaks

**Chang-Woong Shin and Dong Guk Kim**

Trends of the coastal upwelling index along the southeastern coast of Korea

**Tsuyoshi Wakamatsu, Yusuke Tanaka and Yoichi Ishikawa**

Detection of attracting Lagrangian coherent structures in the Oyashio and the Oyashio-Kuroshio transition zones using the ocean data assimilation system

**Workshop (W1)*****Comparison of size-based and species based ecosystem models***

Co-sponsored by ICES

Co-Convenors: *Jeffrey Polovina (USA)\*, Anne Hollowed (USA)\*, Shin-ichi Ito (Japan) and Myron Peck (Germany)*

\* Jeffrey Polovina and Anne Hollowed were unable to attend PICES-2013 due to the U.S. government partial shutdown.

Invited Speakers: *Julia Blanchard (University of Sheffield, UK), Julia K. Baum (University of Victoria, Canada), Villy Christensen (University of British Columbia, Canada)*

Background

Size-based and species-specific ecosystem models are two different approaches to ecosystem modeling, based on different assumptions and designed to address somewhat different questions. In recent years considerable development of size-based models has occurred within the ICES community while the PICES community has typically focused on species-specific models for its applications. The objective of this workshop was to bring together the two communities of modelers to: (1) advance our understanding of the advantages and limitations of these two modeling approaches, especially in the context of modeling climate impacts on ecosystems, (2) make direct comparisons of the predictions of ecosystem structure and dynamics, both top-down and bottom-up, from both these model types applied to the same regional ecosystem, where possible under climate change forcing, and (3) discuss the benefits and feasibility of developing hybrid size-based and species-specific models. The workshop was structured with a series of talks to kick off discussion on these 3 topics.

Summary of the workshop

Since the U.S. government was partly closed, scientists from NOAA, including co-convenors, Jeffrey Polovina and Anne Hollowed, could not attend the workshop. Another co-convenor, Myron Peck, also could not attend. Skip McKinnell kindly accepted to act as a co-convenor with Shin-ichi Ito.

About 40 persons attended and seven presentations were made. The session started with a brief introduction of the session: needs of comparison of two different ecosystem modeling approaches, size-based and species-specific ecosystem models.

An invited talk by Villy Christensen reviewed the brief history of the Ecopath with Ecosim modelling (EwE) and introduced the newest version of Ecospace model, which includes temporal and spatial dynamics bridging environmental factors to marine ecosystems through the food web. James Watson showed an example of a global simulation of fish biomass distribution using a simple size-based food web model coupled to simulations of global ocean physics and biogeochemistry and the result revealed the importance of fish movement dynamics to predict the fish distribution. The second invited speaker, Julia Blanchard, made her presentation through internet connection and showed several examples of model comparisons between size- and species-based food web models. There are many different types of food web and multispecies models from species- to size-based models (some of them are mixture of both models). She emphasized the importance of model comparison for improvement of our process-based understanding. The third invited speaker, Julia Baum, showed that trophic pyramids and size spectra are, in fact, interchangeable representations of the same information and mentioned a potential of size spectra as a central concept in ecosystem ecology to understand baseline expectations of community structure. Marc Hufnagl made a presentation in place of Myron Peck regarding the influence of size spectrum slope of prey sizes on fish early life stages. Shin-ichi Ito made the presentation for Nis Sand Jacobsen and colleagues on the comparison of ecosystem models under different fisheries managements. The results showed importance of multi-model approaches for fisheries management,

especially for multi-species fisheries. Guimei Liu showed an example of species-specific model for jellyfish in the Northwestern Pacific. Three papers from NOAA employees were cancelled due to the U.S. government shutdown.

After these oral presentations, the afternoon session consisted of a group discussion focused on three objectives of the workshop; (1) advance our understanding of the advantages and limitations of these two modeling approaches, especially in the context of modeling climate impacts on ecosystems, (2) make direct comparisons of the predictions of ecosystem structure and dynamics, both top-down and bottom-up, from both these model types applied to the same regional ecosystem, where possible under climate change forcing, and (3) discuss the benefits and feasibility of developing hybrid size-based and species-specific models. Thirteen participants contributed to the group discussion (Table 1).

Table 1 Participants of afternoon discussion.

Name	Affiliation
Julia Baum	University of Victoria, Canada
Alida Bundy	Fisheries and Oceans Canada, Canada
Villy Christensen	University of British Columbia, Canada
Andrew Edwards	Fisheries and Oceans Canada, Canada
Cheryl Harrison	Oregon State University, USA
Marc Hufnagl	University of Hamburg, Germany
Shin-ichi Ito	FRA, Japan
Sukyung Kang	National Fisheries Research and Development Institute, Korea
Skip McKinnell	PICES Secretariat, Canada
Colleen Petrik	University of Alaska Fairbanks, USA
James Robinson	University of Victoria, Canada
Yunne-Jai Shin	IRD, France and UCT, South Africa
James Watson	Princeton University, USA

*(1) Advance our understanding of the advantages and limitations of these two modeling approaches, especially in the context of modeling climate impacts on ecosystems.*

Advantages and limitations of size-based and species-specific ecosystem models were discussed. First, it was recognized that a purely body-sized model and purely species-based model are the extremes and there are many models in the middle that contain both dimensions. Many different structures and assumptions are used in those models. Therefore, it was difficult to simply list up the advantages and limitations of both types of models although several points were listed (Tables 2 and 3). Andrew Edwards presented methods to estimate size spectrum slope and showed risk of simply fitting straight lines to log-log histograms. Likelihood methods were recommended. Adding to the advantages and limitations, the following opinions and questions were pointed out;

- Continuum of models between species-based and size-based. Distinguishing of model is difficult since recent model developments tend to incorporate both dimensions;
- Embracing trait-based models of which size is only one dimension;
- Sampling bias at large/small size affects size spectra;
- Do inverted trophic pyramids exist?
- Changing primary productivity changes size-spectrum and the extent depends on migration characteristics;
- Spatial resolutions of marine ecosystem models have been increased. Is advection of size spectrum



- meaningful in high-resolution models?
- Need to model how climate change and anthropogenic forces affect species interactions to a greater extent than food web effects.
- Climate change affects species interactions. Would size-based models be a better reflection of the changes?

Table 2 Advantages and limitations of size-based model.

Advantages	Limitation
Coverage of ecosystem is greater since size-based models can represent continuous distribution of biota from small phytoplankton to large top predator fish.	Core of many size-based models is metabolic theory (allometric scaling) and cannot resolve detail biological processes.
Species interactions are emergent (large species prey upon small ones).	Interactions defined by differences and overlap in body size and specific strong interactions between species may not be included.
Climate impacts are possible to be incorporated.	Climate impacts on primary productivity is limited by intercept change of the size spectrum line.
Useful for global assessment of climate change impacts on marine ecosystems since size-based models are able to be applied without local species composition.	<ul style="list-style-type: none"> <li>- Representation of regional ecosystems may be limited.</li> <li>- Adaptation of species may be difficult to reveal.</li> </ul>

Table 3 Advantages and limitations of species-specific model.

advantages	limitation
Suited to focused interests in certain species.	Species interactions pre-defined by species/model group pairs and species that do not interact will not interact in a model.
Species interactions determined by functional response settings.	Cannot resolve size-based processes (large predate on small).
<ul style="list-style-type: none"> <li>- Climate impacts are possible to be incorporated.</li> <li>- Adaptation effects may be possible to be incorporated with high computational cost.</li> </ul>	<ul style="list-style-type: none"> <li>- Changing primary production changes are represented by change in functional phytoplankton groups.</li> <li>- Size and space are implicit in species-based models with diet information.</li> </ul>
Useful for global assessment of specific species regarding spatial distribution and biomass change.	Representation of global ecosystems may be impossible.

(2) *Make direct comparisons of the predictions of ecosystem structure and dynamics, both top-down and bottom-up, from both these model types applied to the same regional ecosystem, where possible under climate change forcing.*

A lot of effort has been devoted for comparisons of marine ecosystem models. The presentation of Julia Blanchard made a theoretical comparison between size-based and species-specific models. It also compared population and community responses to fisheries using multispecies size spectrum models in which growth and predation mortality processes are different. The presentation of Nis Sand Jacobson compared the responses of fish species to the fisheries using EwE and a size- and trait-based model. The two presentations gave the audiences the difficulties of the comparisons. During the afternoon discussion, the following points were suggested:

- Comparisons need multiple ecosystem models and multiple marine ecosystems;
- Comparisons should focus on specific questions and/or scenarios (e.g., Steller sea lion – what caused the

decline);

- Comparisons need initial tunings of models to test the climate impacts;
- Theoretical comparisons are needed before applying to a specific question;
- It is possible to get similar answers from different models for very different reasons. We need to understand these differences before applying them to policy questions;
- Density-dependence is one of the most important factors for species-specific models. It is needed to explore how density-dependence is implemented in each model.

*(3) Benefits and feasibility of developing hybrid size-based and species-specific models.*

There is a variety of marine ecosystem models and continuum of models between species-based and size-based. Some of them are hybrid size-based and species-specific models. Depending on scientific focus, it is feasible to apply different type of models.

At the end of the workshop, workshops of PICES FUTURE Open Science Meeting were introduced. Call for papers to Progress in Oceanography special volume on “Modeling and observational approaches to understanding marine dynamics” was announced. Finally, participants agreed to contribute to the workshop report.

List of papers

*Oral presentations*

**Villy Christensen, Jeroen Steenbeek, Joe Buszowski, Marta Coll and Carl J. Walters** (Invited)  
Modeling food web dynamics and spatial-temporal environmental variability

**James R. Watson, Charles A. Stock and Jorge L. Sarmiento**  
The role of movement in determining the global distribution of marine biomass

**Julia Blanchard** (Invited)  
Contrasting size- and species-based food web model responses to fishing and environmental change

**Rowan Trebilco, Julia K. Baum, Anne Salomon and Nick Dulvy** (Invited)  
Size-based constraints on the pyramids of life

**Myron A. Peck, Klaus B. Huebert, Markus Kreuz and Johannes Pätsch**  
Examining trophodynamic consequences of climate variability on the growth and survival of North Sea fish larvae: A coupled model approach utilizing size spectrum theory

**Nis Sand Jacobsen, Tim Essington and Ken Haste Andersen**  
Comparing ecosystem models in fisheries management

**Xuanliang Ji, Guimei Liu and Shan Gao**  
Parameter sensitivity study of the ecosystem model in the Northwestern Pacific

**POC/BIO/MONITOR/FUTURE Workshop (W2)**

*Identifying mechanisms linking physical climate and ecosystem change: Observed indices, hypothesized processes, and “data dreams” for the future*

Co-conveners: *Jack Barth (USA), Emanuele Di Lorenzo (USA), Marc Hufnagl (Germany) Jacquelynne King (Canada), Arthur Miller (USA), Shoshiro Minobe (Japan), Ryan Rykaczewski (USA) and Kazuaki Tadokoro (Japan)*

Invited Speakers: *Jürgen Alheit (Leibniz Institute for Baltic Sea Research, Germany) Bryan Black (University of Texas, USA), Carolina Parada (Instituto de Investigación Pesquera, Chile) Hans-O. Pörtner (Alfred-Wegener-Institute, Germany)*

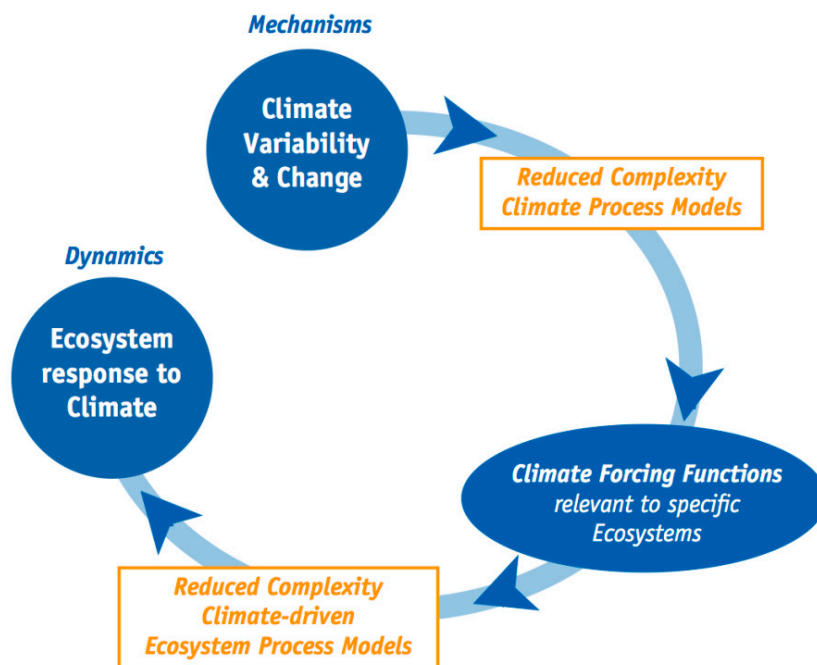
Background

Climate variability and change in the ocean is now recognized as a significant driver of marine ecosystem response, from primary production to zooplankton composition, and through the trophic chain

to fish, marine mammals and other top predators. Past studies have often relied upon existing datasets to draw correlative conclusions (associated with indices and discovered time-lags in the system) regarding the possible mechanisms that may control these linkages. In this workshop, we seek to identify and model key processes that enable us to succinctly and quantifiably explain the mechanisms underlying the correlative relationships in physical-biological datasets, both in the North Pacific and North Atlantic. The description and modeling of these key processes may (a) involve few or several variables (but not full complexity), (b) use dynamical (*e.g.*, eddy-resolving ocean models, NPZ, IBM, etc.) or statistically based methods (*e.g.*, Bayesian, linear inverse models, *etc.*), (c) explain variability in low or high tropic levels (although we seek to emphasize secondary and higher producers), and (d) include uncertainty estimation. We also solicit ideas and hypotheses concerning new mechanisms of physical-biological linkages that can only be tested by establishing novel long-term observational strategies, where the harvest of understanding will eventually be reaped by future generations of ocean scientists, as well as by developing creative modeling datasets, where ecosystem complexities can be effectively unraveled. The workshop format will be a mixture of talks and group discussions that aim at enriching the exchange of ideas and concepts between physical and biological ocean scientists. The ultimate goal is to deliver: (1) a set of new hypotheses of the mechanisms of marine ecosystem response to climate forcing, and (2) a description of the observational and modeling datasets required to test these hypotheses using process models.

Summary of the workshop

The main goal of the PICES/ICES session was to (1) identify mechanisms controlling the marine ecosystem response to climate forcing, (2) isolate the climate forcing functions that are relevant to the specific ecosystem being studied, and (3) link these climate forcing functions to the dynamics of large- and regional scale climate variability. Furthermore, in this session we were seeking talks that would allow us to synthesize the complex interaction dynamics between climate and marine ecosystem by providing reduced complexity models or understanding of the dynamics. This concept is illustrated in the diagram below.



The workshop was very well attended with about 100–200 participants. Several talks were able to target different aspects of the above diagram and provided important insight on the nature of climate forcing to which ecosystems are sensitive to, and the dynamics of ecosystem response to environmental perturbations. Below is a synthesis of the main findings.

*1. Sensitivity of ecosystem to physical drivers changes with season*

During different months of the season different physical drivers become important in driving ecosystem variability. Therefore, using regional indices that track the seasonal sensitivity of the ecosystem leads to better predictions than using climate indices. In future studies it is critical to examine if IPCC class models can resolve the dynamics of the regional forcing functions.

*2. Lower-trophic levels variability tracks regional and local physical forcing*

Ecosystem properties of lower trophic level (*e.g.*, nutrient fluxes and primary productivity) are typically sensitive to few environmental drivers and often track indices of climate variability that are regional or locally defined. These regionally defined indices allow the capture of both the local-scale environmental variability as well as the impacts of large-scale climate variability.

*3. Higher-trophic levels integrate multiple forcing and track large-scale climate modes*

Ecosystem functions of higher trophic levels (*e.g.*, sardine) are typically sensitive to multiple stressors. Hence higher trophic levels have the ability to integrate multiple sources of environmental variability and exhibit the tendency to align their variability with that of the large-scale climate modes, which capture the shared low-frequency variance among the different environmental forcing.

*4. Changes in large-scale and regional scale circulation play a dominant role in driving ecosystem variability*

Changes in large-scale and regional scale circulation play a dominant role in driving ecosystem variability both at the lower and higher trophic levels. Resolving the circulation dynamics with a regional climate model is key to allowing a proper understanding of how coastal ecosystems respond to climate forcing. It will be important in the future to develop adequate data archives of ocean currents and advection pathways that can be used by ecosystem scientists to test hypothesis on the ecosystem response to environmental oceanic forcing. These data archives will likely be assembled using the output of regional scale model hindcast. Resolving eddies at the regional scale is critical, but it also introduces a random component in the variability associated with the degree of intrinsic nature of the eddy-scale circulation. Future eddy resolving models will need to perform an ensemble hindcast in order to separate the fraction of variance that is deterministically forced *vs.* the internal variance.

*5. Spatial dimension is key for understanding the links between physical variability and ecosystem response*

As we develop reduced complexity models of the marine ecosystem response to climate forcing, it will be critical to incorporate the spatial dimension (*e.g.*, associated with fish distributions). This topic has already emerged in the Section on *Climate Change Impacts on Marine Ecosystems* (S-CCME) and is currently an important topic for research/discussion. Although several talks showed examples of how the spatial dimension plays an important role, no systematic approach was presented to incorporate the spatial dimension in reduced complexity models. During the discussion a Linear Inverse Model methodology was suggested as one approach to model the spatial dimension of fish distribution in the context of a changing climate.

List of papers

*Oral presentations*

**Bryan A. Black** (Invited)

From the trees to the seas: Multi-species perspectives on long-term climatic and ecological variability

**Emanuele Di Lorenzo, Mark D. Ohman and Salvador Lluch-Cota**

A filtering hypothesis to explain climate synchrony in fish populations

**Kenneth Denman**

Modelling the changing structure of marine ecosystems in response to changes in the physical climate

**Jürgen Alheit** (Invited)

How the coupled ocean-atmosphere system of the North Atlantic impacts on dynamics of small pelagic fish populations and ecosystem regime shifts in the eastern North and Central Atlantic by modulating multi-decadal climate variability

**Colleen M. Petrik, Janet T. Duffy-Anderson, Franz Mueter, Katherine Hedstrom, Seth Danielson and Enrique Curchitser**

How eastern Bering Sea climate variability affects the distribution of walleye pollock early life stages

**Carolina Parada** (Invited)

Biophysical gauntlet regulating young walleye pollock survival in the Gulf of Alaska: Emphasis on meso and submesoscale eddies

**Hans-O. Pörtner** (Invited)

An integrated view of climate sensitivity in marine organisms: The need for proxies indicating molecular to ecosystem-level changes

**Jennifer L. Fisher and William T. Peterson**

Listen while the copepods speak: How different copepod indices respond to environmental indices in the northeast Pacific (Newport, Oregon, USA)

**Cheryl S. Harrison and David A. Siegel**

Coastal retention in upwelling currents: Mechanisms and sensitivity to wind forcing

**Kazuaki Tadokoro, Shigeo Kakehi, Akinori Takasuka, Kiyotaka Hidaka, Tadafumi Ichikawa, Yuichi Hirota, Haruyuki Morimoto, Takahiko Kameda, Satoshi Kitajima, Kou Nishiuchi and Hiroya Sugisaki**

Geographical and temporal variations in mesozooplankton biomass around Japan, western North Pacific

**Albert J. Hermann**

A rapid multivariate method for estimating regional forecast uncertainty

**Shoshiro Minobe**

Some changes of marine ecosystem in the 21st century in model projections

**Yury Zuenko, Vladimir Rachkov and Victoria Nadtochy**

Coastal ecosystem response to climate change in Peter the Great Bay (Japan Sea): Advances and failures of long-term monitoring

**Frank A. Whitney**

Some implications of ocean deoxygenation in the subarctic Pacific

*Poster presentations*

**David Timothy and Robie Macdonald**

Climatology and long-term trends of sediment flux and composition in the subarctic Northeast Pacific Ocean

## BIO Workshop (W3)

### Marine bird and mammal spatial ecology

Co-Convenors: *Robert Suryan (USA), William Sydeman (USA), Yutaka Watanuki (Japan) and Rolf Ream (USA)\**

\* Rolf Ream was unable to attend PICES-2013 due to the U.S. government partial shutdown.

Invited Speaker: *Martin Renner (Tern Again Consulting, USA)*

#### Background

Marine birds and mammals (MBMs) are highly mobile, yet relatively easily observed and tracked to determine their spatial distribution throughout the North Pacific Ocean. They are important marine top predators that consume substantial amounts of zooplankton and fish, and are susceptible to changes in marine food web structure, productivity, and a variety of anthropogenic impacts. Therefore, MBMs are highly visible sentinels of ecosystem health and its change. To incorporate MBMs into ecosystem based management and meet objectives of FUTURE, the PICES Advisory Panel on MBM (AP-MBM) proposed to focus on MBM spatial ecology and conservation as a priority topic for their 2012–2014 activities.

Over the past several decades, a wide variety of research programs have collected observational and tracking data of MBMs throughout the North Pacific. Portions of these data have been compiled into large databases, such as the North Pacific Pelagic Seabird Database (NPPSD). Other data sets, however, still need to be integrated for more complete coverage of the PICES regions. Holding the proposed workshop is an important first step to compiling and integrating these massive datasets. In February 2012, we held discussions with several of the main data holders/contributors and they expressed broad support for this effort. Workshop invitees were contacted over the past year which included data holders, spatial analysis experts, and end product users.

#### Summary of the workshop

There were 29 attendees at the workshop (Table 1). The structure of the workshop was organized to address three main objectives: 1) Datasets, 2) Applications, and 3) Integration.

##### *1. Datasets*

The first four presentations highlighted examples of existing databases that include data representing large spatial scales (100,000s km<sup>2</sup>) spanning multiple decades. Examples of these large databases include the NPPSD that contains over 370,571 records (3 km transect segments) covering 282,035 km<sup>2</sup> spanning 1974–2012. Total counts of organisms include over 17 million seabirds and 241 thousand marine mammals. Spatial coverage from this dataset is best within or adjacent to the Exclusive Economic Zones of Pacific Rim countries where the majority of cruises have occurred. Other datasets include additional regions such as the Eastern Tropical Pacific. Regions of limited vessel survey coverage include the low to mid latitude central and Western Pacific. Individual tracking data from marine birds and mammals will help to fill some of these gaps, as well as provide greater temporal coverage in some instances, for example during winter.

##### *2. Applications*

Three presentations provided examples of individual studies describing how distributional patterns of birds (Cassin's auklets) and whales (minke, sei, and Bryde's) can change over time, affecting the types of prey that they consume or in response to changing prey distribution and abundance. A fourth presentation used a larger animal tracking dataset from the Tagging of Pacific Predators (TOPP) program and a cumulative human impact assessment to identify areas of highest cumulative impact. Interestingly, they found that marine sanctuaries were hotspots for use and risk. It was also discussed that birds and mammals do not always co-occur in the areas of greatest prey abundance since their relationship with prey is typically non-linear, only requiring enough to satisfy their immediate needs.

### 3. Integration

Three of the four presentations described regional studies in the Western Pacific, Bering Sea, and California Current where both vessel-based survey data and individual tracking data exist for a model species. One study where only a single vessel cruise through a region in a given year showed how restrictive vessel survey data can be relative to individual tracking. At the broad scale, there was some coherence in distribution where the ship and bird tracks overlapped. However, habitat models from vessel- and tracking-based data were quite different. In other regions, longer time series of repeated vessel-based surveys demonstrate how powerful these datasets are relative to the often shorter-duration tracking datasets. Presenters agreed that survey and tracking data are very different, yet highly complementary, especially for filling data gaps in perceived species habitat use and seasonal occurrence. A fourth presentation described an approach using tracking and environmental data to model habitat use, producing a density grid that shows similar patterns to density estimates from vessel surveys in regions where vessel and tracking data overlap.

#### Decisions from the workshop

##### 1. Datasets

Compiling all available vessel survey and tracking data into single databases for each data type is much needed. This is, however, an enormous undertaking. The NPPSD represents one such effort occurring over many years, yet does not include tracking data. Although there are still many datasets that have yet to be included in this database, the database is extremely comprehensive and represents the best single data source for many species of marine birds and mammals in the North Pacific. The most comprehensive database for individual tracking data is the Tagging of Pacific Predators, but this database does not include data from multiple independent programs over many years, like the NPPSD. It was agreed that our group's effort moving forward should be focused on compiling a list of existing datasets, their temporal and spatial extent, and contact information for the data holder. This could be used in future efforts to secure much needed funding for integrating these data into central databases and proposing additional studies to fill the spatial or temporal gaps in the data.

##### 2. Applications

Comprehensive distribution and abundance maps for the North Pacific are extremely valuable for many scientific and conservation efforts. In addition, it was noted that such accurate and comprehensive species abundance and distribution maps for marine birds and mammals are unique among marine organisms owing to the relative ease of collecting these data. Furthermore, because broad scale distribution of micronekton is poorly understood, the distribution and intensity of MBM aggregations may be valuable indicators of key micronekton. From the AP-MBM perspective, the first application of these data layers is to revisit prey consumption estimates for North Pacific marine birds and mammals (*e.g.*, Hunt *et al.*) With more comprehensive distribution and diet information, the spatially explicit prey consumption estimates will be greatly improved over previous efforts, which have received wide usage to date, indicating the value and demand for these efforts.

Additional uses for comprehensive marine bird and mammal distribution data include calibrating outputs from regional and basin scale ocean models and projecting future impacts of changing marine ecosystems. This is particularly relevant for identifying conservation hotspots and spatial distribution of contaminants in upper trophic level consumers (*e.g.*, Ross, Watanuki *et al.*).

An important consideration is to produce distribution data layers in metrics that are most relevant to modelers and other end product users, especially within the PICES community (*e.g.*, FUTURE).

##### 3. Integration

The group was unanimous in the conclusion that the two types of data are highly complementary, but for various sampling and empirical reasons it is not prudent to integrate vessel survey and tracking data outright, either quantitatively or qualitatively. Instead, the two types of data should first be used independently to create habitat use models, then secondarily combined in habitat use models to create a single predicted distribution (or density) layer from the two datasets.

## Session Summaries-2013

### Report outline and section leads:

The report documenting MBM AP's three year "spatial ecology" effort will follow the outline of the workshop with the respective section leads.

Introduction: R. Suryan (lead), B. Sydeman, R. Ream, Y. Watanuki

Chapter 1: Datasets, R. Ream (lead), R. Suryan, with contributions from many others

Chapter 2: Integration, R. Suryan (lead), Y. Watanuki, E. Hazen, M. Renner

Chapter 3: Habitat Modeling, Y. Watanuki (lead), J. Santora, R. Suryan, E. Hazen, M. Renner

Chapter 4: Uses, W. Sydeman (lead), A. Trites

Acknowledgements: We thank the presenters for taking the time to summarize their data for presentation, travel to attend the workshop, and contribute to a fruitful discussion. We would especially like to thank those individuals who contributed additional time to analyze new datasets specifically for this workshop. We thank BIO, Science Board and the PICES Secretariat for supporting the workshop and for providing travel for our invited speaker.

Table 1 Workshop W3 attendees.

Sonia Batten	Canada
Douglas Bertram	Canada
Bryan Black	USA
Carrie Eischens	USA
Jerome Fiechter	USA
Marisol Garcia-Reyes	USA
Tracee Geernaert	USA
Kaoru Hattori	Japan
Elliott L Hazen	USA
George Hunt	USA
Trevor Joyce	USA
Ken Morgan	Canada
Chad Nordstrom	Canada
Patrick O'Hara	Canada
Mayuko Otsuki	Japan
Corinne Pomerleau	Canada
Martin Renner	USA
Tamara Russell	Canada
Ryan Rykaczewski	USA
Hiroaki Saito	Japan
Jarrod Santora	USA
Hiroko Sasaki	Japan
Melanie Smith	USA
Huamei Shao	Japan
William Sydeman	USA
Tsutomu Tamura	Japan
Andrew Trites	Canada
Atsushi Tsuda	Japan
Yutaka Watanuki	Japan



List of papers

*Oral presentations*

**Tracee O. Geernaert**

Trends in seabird occurrence on Pacific halibut assessment surveys (2002-2012)

**Lisa T. Ballance, Jay P. Barlow and Trevor W. Joyce**

At sea marine mammal, seabird, and ecosystem assessment surveys in the eastern Pacific: An overview of Southwest Fisheries Science Center's 23-year time series

**Tsutomu Tamura, Kenji Konishi, Koji Matsuoka and Takashi Hakamada**

Geographical and temporal distribution of common minke, sei and Bryde's whales in the western North Pacific in relation to prey availability

**Sara M. Maxwell, Elliott L. Hazen, Steven J. Bograd, Benjamin S. Halpern, Greg A. Breed, Barry Nickel, Nicole M. Teutschel, Larry B. Crowder, Scott Benson, Peter H. Dutton, Helen Bailey, Michelle A., Carey E. Kuhn, Michael J. Weise, Bruce Mate, Scott A. Shaffer, Jason L. Hassrick, Robert W. Henry, Ladd Irvine, Birgitte I. McDonald, Patrick W. Robinson, Barbara A. Block and Daniel P. Costa**

Understanding spatial overlap of human impacts and marine predator distributions

**Hiroko Sasaki, Hiroto Murase, Koji Matsuoka, Yoko Mitani and Sei-Ichi Saitoh**

Seasonal shift of Bryde's and sei whale habitat in the western North Pacific

**D.F. Bertram, Dave Mackas, D.W. Welch, W.S. Boyd, J.L. Ryder and A. Hedd**

Interannual variation in zooplankton prey distribution determines marine breeding distributions of Cassin's Auklet in the proposed Scott Islands National Marine Wildlife Area in Canada

**Martin Renner** (Invited)

Combining tracking and transect data - Issues and possible solutions

**Yutaka Watanuki, Bungo Nishizawa, Takashi Yamamoto, Elizabeth Labunski, Kathy Kuletz, Catherine Meathrel and R.A. Phillips**

Distribution of short-tailed shearwaters in the northern North Pacific: A comparison between geolocator-based tracking of individuals and boat-based surveys

**Jarrod A. Santora, Josh Adams, Bill Henry, K. David Hyrenbach, Jim T. Harvey and David G. Ainley**

Comparative habitat use and spatial overlap of sooty shearwaters using shipboard surveys and satellite-tracking

**Helen Bailey, Steven J. Bograd, Elliott L. Hazen, Bruce Mate, Ladd Irvine, Daniel M. Palacios, Karin A. Forney and Evan Howell**

Whale Watch: Integrating blue whale satellite telemetry and oceanographic data to develop habitat models for conservation management

MEQ Workshop (W6)

***Economic impacts of HABs on fisheries and aquaculture***

Co-Convenors: Vera Trainer (USA), Chang Hoon Kim (Korea)

Invited speaker: *Daniel Huppert (University of Washington, USA)*

There were 20 scientists in attendance:

Background

Harmful algal blooms (HABs) have adverse economic and social impacts on the aquaculture industry, human health, coastal economies, and wild fisheries. HABs have prompted routine closures of both commercial and recreational shellfish harvesting as well as contributing to the death of aquaculture finfish resulting in financial losses in coastal communities. But the economic impacts generated by these events extend far beyond the industry itself. Obtaining more realistic estimates of HAB economic impacts, and the costs of preventing and managing them, calls for an integrated assessment approach that comprises the following: the economic impact of HABs on the aquaculture industry, the secondary integrated industries, and consumers, on both local and regional scales; some valuation of the costs and benefits of taking any recognized steps to lessen the HAB problem (*e.g.*, reducing coastal pollution and

other human-related activities); and weighing the costs and benefits of enhanced monitoring and surveillance that potentially reduces the magnitude of the impacts (*e.g.*, by limiting shellfish harvesting closure windows or alteration in the timing of finfish harvesting). This workshop comprised 2 parts, with the first being a presentation of what is known about the economic and social impacts of HABs in the eastern and western Pacific, by both HAB researchers and invited speakers who could inform on cutting edge approaches and methodologies for assessment of HAB and other marine economic impacts (*e.g.*, oil spills). In Part 2 participants identified specific steps for developing improved and more comprehensive economic impact assessments of HABs on fisheries and aquaculture in the North Pacific.

### Summary of the workshop

The primary goal of the session was to provide PICES scientists with a better understanding of the economic and social impacts of both toxin-producing and high biomass blooms in PICES member countries. It was proposed, due to the quality of presentations and the novel information that they contained, that they be consolidated into a PICES Scientific Report entitled “Economic impacts of HABs on fisheries and aquaculture in PICES member nations”.

The scheduled session consisted of six oral presentations and one poster, representing authorship from five PICES member countries: Canada, Japan, Korea, Russia, and the United States. There were three last minute cancellations primarily due to the U.S. government shutdown. Attendance at the ½-day session was good, with approximately 20 participants. The workshop entailed lively discussions and questions among participants.

Invited speaker, Dr. Dan Huppert (University of Washington, USA) talked about the regional economic impacts of razor clam beach closures on Washington State’s Pacific beaches. Closures occur when the risk of ASP and PSP is high. Washington has short razor clamming seasons on the weekends. Dr. Huppert’s work assessed the impacts of HABs from fall 2007 to fall 2008. Research questions were: 1. How much do clammers spend in the coastal region? 2. How does spending change when razor clam beaches are closed? 3. How does change in spending impact local income and employment? A total of 450 surveys were distributed by the Washington Department of Fish and Wildlife and 240 were returned by mail. Total expenditures were added including hotel, camping, restaurant, groceries, gas, ferry, other items. The average expenditure per clammer day was \$100. Almost \$25 million in total estimated expenditures was estimated for 2007–2008 clamming season. Reaction to closures included: Only 14% would have stayed at the beach and 67% would go home if there was a closure. If more closures occur in the future, 52% would go to the same beach less frequently. The total expenditure for a 1-day opening at all 4 coastal beaches was ~\$4,500. An Input-Output (I-O) model was used to estimate income and employment impacts with calculation of direct and indirect impacts. An example of a direct impact is: a clammer spends money and changes local income. An example of an indirect impact is: local community members spend less because they have less income. The local economic impact of a 1-year beach closure (all beaches) = \$11.36 million. Reduced employment is ~364 jobs. The net benefit of the clam fishery to the coastal community would be calculated differently.

The group discussed how to assess the cultural and social impacts of fisheries closed due to HABs and how to assess true benefit of monitoring. Dr. Takfumi Yoshida (NOWPAP) discussed HABs in NOWPAP region. An integrated report on HABs for the NOWPAP region was published in 2011. It provides information on HAB monitoring and HAB occurrences. The negative impacts of HABs are on fisheries/aquaculture, human health, and tourism. Total economic loss in fisheries from 2006–2012 was US \$94 million for Korea, Japan, and China. In the Yatsushiro Sea in 2009 and 2010, there were huge economic losses incurred by blooms of *Chattonella antiqua*. The losses were US \$3.3 billion in 2009 and \$4 billion in 2010. In 2013 in South Gyeongsang Province, Korea, US \$28 million was lost by October 2013. The green tide in China has cost US \$30 million for cleanup and \$100 million in fisheries losses. To mitigate HAB damage, China is conducting regular monitoring to detect red tide in the early stage. This program has reduced economic loss by \$14.7 million in 2002 (J.People.com). In Japan, the fisheries cooperative, university, and local fishery agency contribute to a portal website. The result is a reduction in economic loss of \$US 35,000 per year to no dollars lost, and the number of early red tide detections has increased from 71 to 181. The operational cost of this website is \$4,500 per year.

Dr. Nicky Haigh (Vancouver Island University, Canada) reviewed the economic losses to the British Columbia salmon aquaculture industry due to HABs 2009–2012. Salmon is the largest agricultural export in British Columbia at an \$800 million dollar value. There are 130 farm leases with 75–80 usually in operation. Fish killing HAB species include raphidophytes (*Heterosigma akashiwo*, *Chattonella cf. marina*), dictyochophytes (*Dictyocha speculum*, *Dictyocha fibula*, *Pseudochattonella cf. verruculosa*), diatoms (*Chaetoceros*), Dinoflagellates (*Cochlodinium fulvescens*, *Alexandrium catenella*), Haptophytes (*Chrysochromulina* spp.). The relative economic loss is characterized in the following categories:

- Low: 10s of fish killed
- Mod: 100s of fish killed
- Hi: tons of fish killed.

Hi losses are usually due to *Heterosigma* or *Chattonella*.

- Losses due to HABs \$2.6 million CAN (2009), \$1.9, 3.1, 6.4 million (2012).
- Total direct losses ~CAD \$16 million (primarily *Heterosigma*, *Chaetoceros*, *Chattonella marina*)

Other losses are due to mitigation including:

- Lost production – withholding feed during blooms which results in less growth
- Mitigation – barrier curtains and upwelling or bubbling equipment, compressors, fuel (Costs \$1-2 million CAD annually per company)

Future needs are to:

- clearly identify HAB species,
- elucidate toxins and toxicity. What makes them toxic?
- understand the effects of environmental factors on HAB species prevalence
- understand the effects of climate change (warming, acidification) on different HAB species
- use better monitoring methods – especially for small species like *Chrysochromulina*. Some species are harmful at low levels, *i.e.*, *Chattonella cf. marina*

Dr. Meg Chadsey (University of Washington, USA) presented on cooperation of science and management for HABs. The Washington State razor clam fishery has 250,000 digger trips to the coast every year. The tribal clam harvest is estimated at \$7 million per year. The conceptual framework for environmental management includes community, scientists, and managers who, through institutional arrangements, seek to mitigate environmental problems. The standard method of management was to collect and analyze shellfish. This method resulted in emergency closures. The Quileute tribe contacted the University of Washington in 1995 to ask for assistance with the HAB problem. This resulted in convening of a stakeholder meeting in 2000 that resulted in the establishment of the Olympic Region Harmful Algal Bloom (ORHAB) partnership. ORHAB objectives were to study bloom dynamics, build credibility for funding, and assess economic impacts of HABs on the State's coastal economies. The overall goal was to develop local capacity and affordable tools for DA monitoring. ORHAB brought agencies together and helped to coordinate information regarding seafood safety. In 2003, a tax to shellfish license fees allowed the project to be transitioned to State funding. The funding request was \$150k which now is not enough to support all ORHAB costs. “Use inspired basic research” resulted in scientific papers responsive to management needs.

Dr. Hao Guo (Dalian Maritime University, China) examined the economic cost of HABs in China from 2008–2012. China's coastline is 32,000 km long of which the continental coastline is 18,000 km. China has 144 monitoring agencies. A national HAB monitoring system was established in 2002 and monitoring zones are focused in aquaculture areas as well as in ecologically protected areas. Financial losses due to the frequency and scale of red tides reached a high level during 2003–2006. Over the past 20 years, the occurrence of red tides and affected areas is basically stable. Approximately 57% of HABs are in the East China Sea, and large-scale HABs occur near the Yangtze River. The majority of HABs occur in May and June. The total economic loss from HABs in China during the years 2008–2012 was \$364 million USD. The East China Sea has suffered the largest direct economic effect (91%) in the last 5 years. *Noctiluca scintillans* has caused disasters through high levels of ammonium resulting in mass mortalities of cultivated shellfish. *Prorocentrum donghaiense*, common in the East China Sea, has resulted in problems with reproduction, survival and hatching rate in fish and scallops. Recurrent blooms of *Karenia mikimotoi* have been associated with massive

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deaths of fish and shellfish. In 2012, these blooms caused massive damage to abalone, causing a direct economic loss of more than \$330 million USD. In 2010, *Mesodinium rubrum* spread to a 20 km<sup>2</sup> area, causing great economic loss. *Cochlodinium geminatum* produced ichthyotoxins causing major losses in fisheries and shellfisheries. Approximately \$500,000 million US was lost in August 2011 due to this organism. From 2009–2012, the *Aureococcus anophagefferens* brown tide caused damage to scallop culture in Hebei Province by causing loss of feeding. A total of \$364 million US was lost due to HAB occurrences encompassing a total area of 53,000 km<sup>2</sup> from 2008–2012. The worst hit species were cultivated abalone and fish.

Shigeru Itakura explored the economic impacts of HABs on fisheries and aquaculture in western Japan. The Ministry of Agriculture Forestry and Fisheries (MAFF) collects economic impact data in Japan for both toxic blooms and red tides. Extensive damage has been caused by HABs in Japan. From 1972 to the present there have been many HABs including *Chattonella*, *Karenia*, *Heterocapsa*, *Cochlodinium*, and diatoms which affect yellowtail, red sea bream, pearl oyster, oyster, and porphyra. *Chattonella* is the most harmful alga in Japan. *Chattonella* was responsible for causing the most damage to fisheries in Seto Inland Sea from 1980–2008. *Heterocapsa* and *Cochlodinium* became problem NABs starting in 1995, and diatoms became a problem after 1990. The amount of fisheries damage on the Kyushu coast increased up to 1999, then appeared to decrease. *Cochlodinium* damage appears to be on the decrease in recent years. The economic loss due to toxic red tides is difficult to quantify but includes such factors as:

1. unrecognized financial losses,
2. halts in hiring,
3. damage of wild aquatic resources,
4. reluctance to buy fisheries products due to rumors,
5. the cost of countermeasures and mitigation.

### List of papers

#### *Oral presentations*

**Karen Dyson and Daniel D. Huppert (Invited)**

Regional economic impacts of razor clam beach closures due to Harmful Algal Blooms (HABs) on the Pacific coast of Washington

**Takafumi Yoshida and Hiroshi Ono**

Economic impacts of Harmful Algal Blooms in the NOWPAP region

**Nicola Haigh and Svetlana Esenkulova**

Economic losses to the British Columbia salmon aquaculture industry due to Harmful Algal Blooms 2009–2012

**Hao Guo, Dewen Ding and Chunjiang Guan**

The economic cost of Harmful Algal Blooms in China from 2008-2012

**Meg Chadsey, Vera L. Trainer and Thomas Leschine**

Cooperation of science and management for Harmful Algal Blooms: Domoic acid and the Washington Coast razor clam fishery

**Shigeru Itakura and Ichiro Imai**

Economic impacts of Harmful Algal Blooms on fisheries and aquaculture in the western Japan – An overview of interannual variability and interspecies comparison

**MEQ Workshop (W7)*****Traditional seafoods of coastal aboriginal communities in the North Pacific: Insight into food, social and ceremonial uses at Snuneymux'w First Nation in Nanaimo, British Columbia***

*Co-Convenors: Peter Ross (Canada) and local community members*

Background

Seafoods are integral part of the nutritional, social and cultural fabric of many aboriginal communities inhabiting coastal regions of the North Pacific Ocean. The Snuneymux'w First Nation in Nanaimo, BC, is home to 1,200 residents who have relied heavily on seafoods for thousands of years. Despite now living in an urban environment with ready access to supermarket foods, it has been recently estimated that the average individual from this aboriginal community consumes 12 to 15 times as much seafood as the average Canadian. Much of this is harvested locally by native fishers. Community members routinely express concerns about the quality and quantity of their local seafoods. It is becoming increasingly evident that the availability of nutritious and uncontaminated seafoods is important for food, social and ceremonial purposes in this other coastal communities in BC.

Summary of workshop

A one-day PICES workshop (W7) on indigenous seafoods was held in the traditional territory of the Snuneymux'w First Nation near Nanaimo, British Columbia (BC), on Friday October 11, 2013. The workshop touched on aspects of marine stewardship, marine resource management, seafoods, and local aboriginal culture. Seafoods are an integral part of the nutritional, social and cultural fabric of aboriginal communities inhabiting coastal regions of the North Pacific Ocean. The Snuneymux'w First Nation in Nanaimo is home to 1,200 residents who have relied heavily on seafoods for thousands of years. Despite now living in an urban environment with ready access to supermarket foods, it has been recently estimated that the average individual from this aboriginal community consumes 12 to 15 times as much seafood as the average Canadian. Much of this is harvested locally by native fishers. Community members routinely express concerns about the quality and quantity of their local seafoods. It is becoming increasingly evident that the availability of nutritious and uncontaminated seafoods is important for food, social and ceremonial purposes in this other coastal communities in BC.

The morning session took place at the Vancouver Island University First Nations *Shq'aqpthut* ('Gathering Place'; <http://www.viu.ca/gatheringplace/gallery.aspx>). This session featured an opening prayer and song by Geraldine Manson, the Vancouver Island University elder-in-residence from Snuneymux'w. Geraldine described the importance of seafoods to her community, and recounted stories told by her parents and grandparents on topics of harvesting, cooking and stewardship. Geraldine then introduced Gary Manson, also an elder from Snuneymux'w. Gary described the historical importance of the Nanaimo River estuary for shellfish, crab and chum salmon harvesting. He also described the annual journey by canoe over the Strait of Georgia to the Fraser River for sockeye salmon harvesting. The importance of Gary's role as elder 'knowledge keeper' for the Snuneymux'w was evident in the afternoon when he led workshop participants on a tribal canoe journey over to salmon petroglyphs at Jack Point across the estuary.

John Rampanen, "naas-a-thluk", then described his family history in the Nuuchah-nulth Nation - Ahousaht and Tla-o-qui-aht territories. John is an advocate for traditional foods and medicine. He combines traditional ecological knowledge with contemporary approaches and is dedicated to providing a strong sense of traditionally-oriented understanding and knowledge amongst First Nations youth and non-Native community partners. With a background in traditional medicinal practices, healthcare, counseling and indigenous foods, John has redeveloped a presence on his traditional territory (located on the western coast of Vancouver Island) where he now lives with his growing family.

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After the tribal canoe journey, some workshop members feasted on tasty smoked and barbequed chum salmon at Snuneymux'w beach hosted by Paul Wyse-Seward and Chris Good. The success of the workshop was due to the kind assistance of Vancouver Island University (Geraldine Manson, Michele Patterson, Grant Murray, Cathy Fee and students), Snuneymux'w First Nation (Gary Manson, Chris Good, Paul Wyse-Seward and Theodore Barker), and the entire staff of the PICES Secretariat.



*A one-day workshop on traditional seafoods was held at the PICES-2013 in Nanaimo. Clockwise from top left: Geraldine Manson, a Snuneymux'w Elder-in-Residence at Vancouver Island University opened the workshop with heartfelt prayer, song and stories; a visit to nearby petroglyphs highlighted the historical importance of chum salmon to the Snuneymux'w; John Rampanen described the strong inter-relationship between marine life and his communities on the west coast of Vancouver Island; some workshop participants got some exercise paddling a tribal canoe from downtown Nanaimo to Jack Point, where Gary Manson described the cultural importance of the 'salmon ceremony' at this site; a visit to a local smokehouse poignantly underscored the importance of chum salmon to the Snuneymux'w. Photo credits: Cathy Fee and Peter S. Ross.*

## Best Presentations for Committee/Program-sponsored Topic Sessions or Workshops at PICES-2013

### *Science Board Best Oral Presentation*

**Hans-O. Pörtner** (Alfred-Wegener-Institute, Bremerhaven, Germany) on “An integrated view of climate sensitivity in marine organisms: The need for proxies indicating molecular to ecosystem-level changes”

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

**Jeffrey G. Dorman** (University of California, Berkeley, USA) on “Modeling krill ‘hotspots’ in the central California Current: Results from variation in diel vertical migration schemes” co-authored with Ramona L. Zeno, Jarrod A. Santora and William J. Sydeman

### *Best Poster for the BIO-sponsored Contributed Paper Session*

**Daichi Arima** (Hokkaido University, Hakodate, Japan) on “Seasonal changes in the zooplankton community and number of generations per year of small copepods in Ishikari Bay, Sea of Japan” co-authored with Atsushi Yamaguchi, Yoshiyuki Abe, Kohei Matsuno, Rui Saito, Hiroki Asami, Hiroshi Shimada and Ichiro Imai

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

**Megan M. Stachura** (University of Washington, Seattle, USA) on “Linking recruitment synchrony to environmental variability” co-authored with Timothy E. Essington, Nathan J. Mantua, Anne B. Hollowed, Melissa A. Haltuch, Paul D. Spencer, Trevor A. Branch and Miriam J. Doyle

### *Best Poster for the FIS-sponsored Contributed Paper Session*

**Yang Liu** (Hokkaido University, Hakodate, Japan) on “Development of the 3-D growth prediction model for Japanese scallop in Funka Bay, Japan” co-authored with Sei-Ichi Saitoh, Yu Ihara, Toru Hirawake, Katsuhisa Baba and Kanamori Makoto

### *Best Oral Presentation by an early career scientist for the MEQ-sponsored BIO/FIS/MEQ/TCODE/FUTURE Topic Session (S8) on “Ecosystem indicators to characterize ecosystem responses to multiple stressors in North Pacific marine ecosystems”*

**Cathryn Clarke Murray** (WWF Canada, Vancouver, Canada) on “Assessing direct and indirect risk from human activities to significant ecosystem components in the Northeast Pacific” co-authored with Megan E. Mach, Rebecca G. Martone, Gerald G. Singh, Kai M.A. Chan and Miriam O

### *Best Poster for the MEQ-sponsored MEQ/FUTURE Topic Session (S3) on “Status, trends and effects of pollutants in coastal ecosystems: Implications for wildlife and humans”*

**Won Joon Shim** (Korea Institute of Ocean Science and Technology, Geoje, Korea) on “Ship paint as a new input source of floating microplastics in surface microlayer” co-authored with Young Kyoung Song, Mi Jang, Sang Hee Hong and Gi Myung Han

### *Best Oral Presentation by an early career scientist for the POC-sponsored POC/BIO/MONITOR/FUTURE Workshop (W2) on “Identifying mechanisms linking physical climate and ecosystem change: Observed indices, hypothesized processes, and “data dreams” for the future”*

**Colleen M. Petrik** (University of Alaska Fairbanks, AFSC NOAA, Seattle, USA) on “How eastern Bering Sea climate variability affects the distribution of walleye pollock early life stages” co-authored with Janet T. Duffy-Anderson, Franz Mueter, Katherine Hedstrom, Seth Danielson and Enrique Curchitser

### *Best Poster for the POC-sponsored Contributed Paper Session*

**Hirofumi Ueno** (Hokkaido University, Sapporo, Japan) on “Decadal variation of temperature inversions along Line P”

### *Best Oral Presentation by an early career scientist for the MONITOR-sponsored BIO/POC/TCODE/MONITOR/FUTURE Topic Session (S6) on “Recent trends and future projections of North Pacific climate and ecosystems”*

Youngji **Joh** (Korea Institute of Ocean Science and Technology, Ansan, Korea) on “An improvement of reproducibility of Pacific decadal oscillation in CMIP5” co-authored with Chan Joo Jang, Minho Kwon, Ho-Jeong Shin and Taewook Park

### *Best Poster for the MONITOR-sponsored Topic Session (S9) on “Cost-effective, cooperative ocean monitoring”*

**Tomoko M. Yoshiki** (National Research Institute of Fisheries Science, Yokohama, Japan) on “Geographical shift of warm water species distribution in western subarctic North Pacific based on CPR sample during 2001-2010” co-authored with Sanae Chiba, Tadafumi Ichikawa, Hiroya Sugisaki and Sonia Batten

### *Best Oral Presentation by an early career scientist for the TCODE-sponsored Topic Session (S10) on “Banking on recruitment curves: Returns on intellectual investment”*

**Robyn E. Forrest** (Fisheries and Oceans Canada, Nanaimo, Canada) on “Modelling the effects of density-dependent mortality in juvenile red snapper caught as bycatch in Gulf of Mexico shrimp fisheries: Implications for management” co-authored with Murdoch K. McAllister, Steven J.D. Martell and Carl J. Walters