

## Summary of Scientific Sessions and Workshops at PICES-2018

### Science Board Symposium (S1)

#### *Toward integrated understanding of ecosystem variability in the North Pacific*

Convenors: *Hiroaki Saito (SB), Se-Jong Ju (BIO), Xianshi Jin (FIS), Keith Criddle (HD), Chuanlin Huo/Thomas Therriault (MEQ), Jennifer Boldt (MONITOR), Emanuele Di Lorenzo (POC), Joon-Soo Lee (TCODE), Steven Bograd (FUTURE), Sukyung Kang (FUTURE), Igor Shevchenko (Russia), Motomitsu Takahashi (Japan)*

#### Invited Speakers:

*Kirstin Holsman (NOAA Alaska Fisheries Research Center, USA)*

*Michio Kondoh (Tohoku University, Japan)*

*Xiujuan Shan (Yellow Sea Fisheries Research Institute, CAFS, China)*

#### Background

The North Pacific marine ecosystem is an assemblage of many local marine ecosystems characterized by regional-specific environmental conditions and biological structures. The status of regional ecosystems is subject to the influence of local changes in various factors as well as interactions with adjacent local marine ecosystems and modifications by basin-scale processes. In recent decades, changes attributable to the influence of global warming have become more apparent, including extreme events in the atmosphere and the ocean that threaten marine ecosystems. Climate projections show monotonic increases in ocean warming and increased frequency of extreme events, such as marine heat waves. Measures to mitigate climate change and to achieve sustainable use of marine resources are integral to the Sustainable Development Goals adopted by the United Nations in 2015. Adaptation to present and anticipated marine ecosystem change is essential to enable humans to use ecosystem services in a sustainable manner. Consequently, policy makers need information about the status of regional marine ecosystems and forecasts of how they will change. Meeting that need requires information based on an integrated understanding of ecosystem variability in the North Pacific.

Papers on mechanisms of ecosystem responses to natural and anthropogenic forcing across the spectrum of time and space scales in the North Pacific, as well as monitoring, retrospective analysis, and forecasting ecosystem variability were encouraged. In particular, papers that characterize variability in each regional ecosystem and link them to basin and global scales are welcome. Anticipated changes in North Pacific marine ecosystems include changing water temperature and upwelling intensity, increased occurrence of hypoxia, harmful algal blooms, and ocean acidification, as well as broader impacts from pollutants and contaminants, coastal development, and fishing. In addition, papers on strategic options to forestall, mitigate, or adapt to ecosystem change were welcomed. Examination of interactions among regional marine ecosystems and relationships between regional and basin-scale ecosystem variability will provide an improved understanding of marine ecosystem structure and function in the North Pacific in the face of climate change.

#### Summary of presentations

The keynote talk of PICES-2018 was presented by Tomowo Watanabe (Japan). His title of talk is *Integrated understanding of warming in the western North Pacific*. Using more than 60 years of monitoring data, he described consistent warming trends around Japan. The steep trends are observed along the Kuroshio current

region, and the Sea of Japan is the hot spot of the warming. Because the western North Pacific and its marginal seas are among the hot spots strongly affected by global warming, practical information for adaptation based on scientific knowledge about the marine ecosystems is needed for sustainable development of fisheries. Sustainable monitoring and integrated evaluation of marine ecosystems in wider area from the subtropical waters to the subarctic waters in the western North Pacific is important for providing practical information about the adaptation of coastal fisheries and offshore fisheries.

The next speaker, Kristin Holsman (USA), was the first invited speaker of the Symposium. Using climate-enhance assessment models, she used forecasts to show the future environment of the Gulf of Alaska and the Bering Sea, and the impacts of warming to broad-scale ecosystem and society. She emphasized that carbon mitigation (RCP 4.5 scenario) is essential to avoid the risk of stock collapse of commercially important pollock and cod stock. The next invited speaker, Steven Bograd (USA), Co-Chair of the FUTURE Scientific Steering Committee, reported on the SSC's development of a framework for investigating interactions across disciplinary dimensions and scales, specifically within North Pacific Social-Ecological-Environmental Systems (SEES). He presented four case studies of SEES which demonstrates the complex responses of marine ecosystems to multiple forcings and how scientific knowledge can be used to solve and mitigate environmental issues.

Robert Suryan (USA) examined the influence of habitat complexity to the recent (2013–2016) heatwave in the Gulf of Alaska (GOA). He described how the impact of the heatwave reached from offshore epibenthic to intertidal species. The impact of the heatwave were spread over the ecosystems causing changes in growth rate, biomass and distribution of each ecosystem component and also foraging behavior and prey-predator interaction.

The first speaker after the lunch break was an early career scientist, Michael Jacox (USA). His talk highlighted the need to consider downscaled environmental variables in fisheries-based decision making in the California Current system noting the actual methods employed (and associated uncertainties) can result in very different predictions. For example, he highlighted how key uncertainties (scenario, model, and internal), ensemble size, and model bias contribute to differences between global and regional model outputs. Further, the choice of which variables, and at which scales, can introduce further biases linking regional and ecosystem models used for fisheries management. Ensuring these biases and uncertainties are communicated to fisheries managers will lead to better decision making. The S1 invited speaker from China, Xiujuan Shan, presented her study on the relationships between environmental impacts on Chinese fishery resources in coastal waters. There is growing awareness that human-mediated activities in the coastal zone can negatively impact important spawning and nursery areas that result in decreased species richness and lost productivity. In China, vulnerability assessments are being used in coastal provinces to aid management decision making. Shin-ichi Ito (Japan) then presented his paper that employed a novel stable isotope analysis to better understand migration rates of larval/juvenile commercial fish species in Japanese waters. Otolith microchemistry provided new insights to larval fish growth and survival that have important implications for both commercial fisheries resources but also better understanding of the many facets of climate variability impacts on marine living resources. The next speaker, SM Mustafizur Rahman (Korea), applied a multi-variable analysis to look at fisheries responses to regime shifts in the East Asian Marginal Seas. One goal was to attempt to identify synchrony among major climate indices and fisheries resources but the complexity of these relationships prevented the identification of large-scale patterns. Rather, specific stocks appeared to respond to specific climate variables during different periods. The next invited speaker was Michio Kondoh (Japan) who provided a very interesting presentation on environmental DNA (eDNA) that explored many potential applications including monitoring fisheries resources and detecting rare/endangered species. His talk highlighted the benefits over traditional sampling methods but also noted some of the challenges dealing with “Big Data”.

The impact of Three Gorges Dam (TGD) of the Changjiang River on the physical and chemical environments of the East China Sea (ECS) and southern Yellow Sea (SYS) has been well studied. However, it has not been well distinguished what the influence of warming and the TGD impacts are through short-term observations. Christina Kong (Korea) assessed long-term (1998–2012) variability in the primary productivity and physical environmental parameters by means of satellite remote sensing data. She and colleagues found high spatial heterogeneity in the impact of TGD, *i.e.*, increase in primary productivity in coastal regions of China, and a decrease in offshore region of ECS and SYS. They also found a gradual decrease in the productivity in continental slope region due to warming. It was suggested that anthropogenic forcings amplify the spatial and temporal variability in the ECS and SYS. From these findings, based on careful analysis of long-term data, she received the best presentation award by an early career scientist from PICES Science Board in S1.

Next talk was also based on long-term monitoring data. Using 40 years of sea bird monitoring in the Bering Sea, George Hunt (USA) and colleagues examined the influence of climate change on the sea bird community. They found that the timing of sea-ice retreat influences the density of some prey organisms such as *Thysanoessa*, *Calanus* and age-0 pollock, and sea bird species decreased in the year of early ice retreat. They also found the food-web to be disrupted under the recent warming trend, and anticipate a potential decline in the sea bird community in the Bering Sea under the global warming scenario.

Julie Kiester (USA) investigated the impact of the North Pacific Blob on the inland regions of the Salish Sea. She showed that the oceanic heat wave influenced the plankton community, biomass and phenology but the responses were different by region to region due to the distance from ocean, local mixing, stratification, *etc.* In general, the warmer condition in 2015 was beneficial for juvenile salmon survival probably due to higher growth rates supported by sufficient prey production.

Proportional egg production to spawning stock biomass of fish is a basic assumption of many stock management strategies. By means of two independent long time series of fishery-dependent stock assessment data and fishery independent egg survey data, Akinori Takasuka (Japan) argued the assumption of spawning stock biomass proportionality to total egg production for Japanese sardine and Japanese anchovy. Egg production of Japanese sardine per spawner is density-dependent. On the other hand, Japanese anchovy are sardine-density dependent at the time of spawning. He proposed to develop an egg-production-based framework on recruitment dynamics under climate variability.

Last talk of Day 1 of Session 1 was on the power of the state-of-art global earth system model. Many global models produce a large error of sea surface temperature anomaly (SSTA) in high latitude North Pacific. Fangli Qiao (China) presented a new atmosphere–ocean coupling global model which includes surface wave-induced vertical mixing. The inclusion largely improves the seasonal predictability of the model, especially 25°N–45°N in the North Pacific. As seasonal prediction is one of the key factors in FUTURE, he proposed to initiate operational prediction as soon as possible under a PICES framework.

Day 2 of the Symposium began with Albert Hermann generating regional forecasts from coarse-scale global forecasts through a hybrid dynamical-statistical approach. Once established the characteristic multivariate patterns of regional responses to both present and future large-scale forcing were applied to a much larger ensemble of global model realizations, using the large-scale multivariate patterns as predictors of the multivariate regional response. This generated a large ensemble of regional futures, helping to establish the statistics of such regional forecasts (*e.g.*, the probability of extreme events). This approach has been successfully applied to annual averages from multi-decadal biophysical projections of the Bering Sea to examine the paradigm that cold years are good for walleye pollock.

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Andrew Ross presented time-series measurements of micronutrient trace elements (Ni, Zn, Cd, Co, Fe, Cu) along Line P since 1997. The goal was to capture the impact of the marine heat wave (nicknamed the “Blob”– the warmest temperature anomaly ever observed in the Northeast Pacific, from 2013 to 2014) on the availability of micronutrients to marine phytoplankton. Many trace metals were depleted in surface waters during the Blob when the water column was strongly stratified and vertical mixing of nutrient-rich deep-water was minimized. The results suggested that climate-related changes in the duration and frequency of such events could affect phytoplankton ecology and productivity in the region.

Jerome Fiechter examined how alongshore variation in surface winds and coastal currents affect the distribution of phytoplankton biomass in the California current. He applied a coupled physical-biogeochemical simulation through downscaling a regional circulation reanalysis, which provides improved physical ocean state estimates (*i.e.*, regional- and basin-scale influences) at a high-resolution. The results showed that while stronger upwelling occurs near most major topographic features, substantial increases in phytoplankton biomass only ensue where local circulation patterns are conducive to on-shelf retention of upwelled nutrients. Locations of peak nutrient delivery and chlorophyll accumulation also exhibit interannual variability and long-term trends. The results not only provide a dynamical characterization of observed primary production patterns along the U.S. west coast, but additionally suggest that planktonic ecosystem response in the California Current System, and presumably other eastern boundary current upwelling regions, exhibit significant alongshore variability at local scales.

Jennifer Jackson presented the impact of the marine heatwave (“The Blob” nicknamed for the warmest temperature anomaly ever observed in the Northeast Pacific from 2013 to 2014) on coastal waters. Argo float and ship-based CTD data showed that warm conditions persisted below the surface mixed layer through March 2018. The results suggested that there was a lag of 1 to 3 years from The Blob’s deep manifestation to warming at the coast and impacts have persisted in coastal waters for at least 4 years after its onset. Similar timing of the increase in temperature and decreased sockeye salmon abundance requires further investigation.

Richard Brodeur presented results on the horizontal and vertical distribution, feeding ecology, and potential predators of the pyrosome, *Pyrosoma atlanticum*. This species is known as a subtropical cosmopolitan species and is generally restricted to oceanic tropical seas but has recently started appearing in coastal trawl surveys off Oregon and Washington in 2014. Their abundance continued to increase dramatically over the last four years causing problems for some commercial fisheries and washing up on beaches prompting public interest. The pyrosomes undergo diel vertical migration and, during the night, feed on picoplankton with very high clearance rates compared to other animals. Given that this tropical invader may remain in this productive temperate ecosystem indefinitely, understanding its ecology and potential impacts to the pelagic and benthic food webs may fill a critical gap.

Jennifer Fisher examined trends in seasonal and interannual abundance of the pteropod, *Limacina helicina*, relative to environmental variability. Data for over 20 years from two stations were located on the continental shelf and slope that are exposed to upwelled waters. Upwelled waters tend to have a low pH and aragonite saturation values <1.0, which may lead to pteropod shell dissolution, resulting in mortality. Summer upwelling was stronger on the shelf compared to the slope; therefore, more suitable pteropod habitat occurred on the slope compared to the shelf. Data indicated that the abundance of *L. helicina* was inversely correlated with the amount of corrosive water (upwelled water); however, no long-term trends in the abundance over the 20 year time series were found.

Mei Sato presented information on the diel vertical migration behavior of euphausiids in relation to hypoxia (oxygen saturation level <0.75 ml L<sup>-1</sup>) using acoustic data collected over 10 years through the Ocean Networks

Canada cabled observatory. The biomass of acoustically-observed vertically migrating euphausiids was 3 to 8 times higher when the bottom oxygen concentrations fell below  $0.75 \text{ ml L}^{-1}$  compared to the period with well-oxygenated bottom waters. In addition, she found that euphausiids spent 2–12% less time at the surface during low-oxygen conditions, thereby increasing their predation risk. The results provided the insight into the behavioral response of pelagic ecosystem under highly variable oxygen conditions like a seasonally hypoxic fjord.

Mitsuo Yamamoto investigated the effects of oceanic environmental changes on the distribution of seaweed beds around Tsushima Islands. Seaweed beds are more depleted in western (especially the southwest) areas compared to the eastern areas. The impacts of the input of terrestrial organic material were evaluated using stable carbon isotope analysis ( $\delta^{13}\text{C}$ ) of particulate organic matter (POM), together with measurements of iron, nitrogen, and phosphate in the water.  $\delta^{13}\text{C}$  values of seawater and local river water indicated that terrestrial water influenced the coastal environment in the southwestern area continuously; whereas, oceanic waters strongly influenced the environment in the northeastern area in some seasons. The difference in seaweed bed depletion between eastern and western Tsushima Islands could therefore be related to hydrodynamic fluctuations.

Robert Blasiak presented a novel study of the corporate control and global governance of marine genetic resources. The commercialization of genetic resources found in the ocean has resulted in the value of the marine biotech industry rapidly expanding. In this study, 38 million records of genetic sequences and associated patents were filtered to examine how many marine species and sequences have been patented along with information about which countries and companies account for most patent claims. The relevance for UN treaty negotiations on biodiversity in areas beyond national jurisdiction were discussed.

### List of papers

#### *Oral presentations*

#### **Integrated understanding of warming in the western North Pacific (Keynote)**

Tomowo Watanabe

#### **What is gained (and lost) through an integrated modeling approach: assessing climate change impacts on Bering Sea fish and fisheries (Invited)**

Kirstin Holsman, Anne Hollowed, Alan Haynie, Kerim Aydin, Al Hermann, Wei Cheung, Amanda Faig, Jim Ianello

#### **Understanding human and natural changes in North Pacific social-ecological marine systems: The FUTURE framework (Invited)**

Steven J. Bograd, Sukyung Kang, Emanuele Di Lorenzo, and FUTURE SSC

#### **Ecosystem variability and connectivity in the Gulf of Alaska following another major ecosystem perturbation**

Robert Survan, Stephani Zador, Mandy Lindeberg, Donna Aderhold, Mayumi Arimitsu, John Piatt, John Moran, Janice Straley, Heather Coletti, Dan Monson, Thomas Dean, Russell Hopcroft, Sonia Batten, Seth Danielson, Benjamin Laurel

#### **Seasonal- to centennial-scale projections of the California Current System in aid of fisheries management**

Michael G. Jacox, Mercedes Pozo Buil, Michael Alexander, Stephanie Brodie, Gaelle Hervieux and Sangik Shin

#### **Environmental changes induced population dynamics of marine species in North Pacific waters (Invited)**

Xiujuan Shan and Xianshi Jin

#### **A new integrated method to elucidate climate variability impacts on living marine resources**

Shin-ichi Ito, Tetsuichiro Funamoto, Osamu Shida, Yasuhiro Kamimura, Motomitsu Takahashi, Kotaro Shirai, Tomihiko Higuchi, Kosei Komatsu, Takaaki Yokoi, Tatsuya Sakamoto, Chenying Guo and Toyoho Ishimura

#### **Synchronicity of climate driven regime shifts among the East Asian Marginal sea waters and major fish species**

SM Mustafizur Rahman and Chung Il Lee

#### **Multi-site, high-frequency monitoring of marine ecosystems using environmental DNA (Invited)**

Michio Kondoh, Hitoshi Araki, Akihide Kasai, Reiji Masuda, Toshifumi Minamoto, Masaki Miya and Satoquo Seino

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### **Spatial and inter-annual variability in the primary productivity of the East China Sea and Southern Yellow Sea (1998-2012)**

Christina Eunjin [Kong](#), Sinjae Yoo and Chanjoo Jang

### **Millennial- to decadal-scale variability in the Bering Sea: changes in the density of seabird species in response to climate fluctuations**

George L. [Hunt, Jr.](#), Martin Renner, Lisa Eisner, Kathy Kuletz, Sigrid Salo, Patrick Ressler, Jarrod A. Santora, Carol Douglas Causey

### **Diagnosing the impacts of large-scale climate variability on local ecosystems in the Salish Sea, USA**

Julie E. [Keister](#), Amanda Winans, Bethellee Herrmann, Kimberly Stark, Gabriela Hannach, Julia Bos, and Todd Sandell

### **Density dependence at the time of spawning: disentangling density-dependent effects in the life histories of fish**

Akinori [Takasuka](#), Michio Yoneda, Yoshioki Oozeki

### **To initiate seasonal prediction for PICES FUTURE**

Fangli [Qiao](#), Zhao Yiding, Yin Xunqiang and Song Yajuan

### **Linking global to regional ocean forecasts: a hybrid dynamical-statistical approach**

Albert J. [Hermann](#), Wei Cheng, Georgina A. Gibson, Ivonne Ortiz, Kerim Aydin, and Samantha Siedlecki

### **Depletion of micronutrient trace metals in Line P surface waters during the 2014 warm water anomaly: implications for marine ecosystems and climate change in the NE Pacific**

Andrew R.S. [Ross](#), David Janssen, Jay Cullen, Jody Spence, Kyle Simpson and Marie Robert

### **Wind, circulation, and topographic effects on alongshore phytoplankton variability in the California Current**

Jerome [Fiechter](#), Christopher A. Edwards and Andrew M. Moore

### **Warming from recent marine heat wave lingers in deep British Columbia fjord**

Jennifer M. [Jackson](#), Gregory C. Johnson, Hayley V. Dosser and Tetjana Ross

### **Causes and consequences of the great pyrosome bloom in the Northern California Current**

Richard D. [Brodeur](#), Kim Bernard, Kelly R. Sutherland, Hilarie L. Sorensen, and Olivia N. Blondheim

### **Variable trends in pteropod abundance between the shelf and slope from two decades of observations off Newport Oregon, USA**

Jennifer L. [Fisher](#), William T. Peterson, Jay O. Peterson and Hongsheng Bi

### **Impacts of hypoxia on diel vertical migration of zooplankton**

Mei [Sato](#), David L. Mackas and John F. Dower

### **Estimation of the origins of particulate organic matter in coastal waters for understanding the oceanic environmental change around Tsushima Islands**

Mitsuo [Yamamoto](#), Akira Yamaguchi, Dan Liu, Aigo Takeshige and Shingo Kimura

### **Corporate control and global governance of marine genetic resources**

Robert [Blasiak](#)

## *Poster presentations*

### **The decomposition of wind-forced upwelling variability in the California Current through the application of cyclostationary empirical orthogonal functions**

Lev B. [Looney](#), Ryan R. Rykaczewski, and Benjamin Hamlington

### **The importance of peak river flow timing to copepod abundance in the Fraser River Estuary, Canada**

Joanne K. [Breckenridge](#) and Evgeny A. Pakhomov

### **Newly discovered role of heterotrophic nanoflagellate *Katablepharis japonica*, a predator of toxic or harmful dinoflagellates and raphidophytes and its interactions with common heterotrophic protists**

So Jin [Kim](#), Hae Jin Jeong and Se Hyeon Jang

### **Ichthyotoxic *Cochlodinium polykrikoides* red tides offshore in the South Sea, Korea in 2014: Temporal variations in three-dimensional distributions of red-tide organisms and environmental factors**

Hae Jin [Jeong](#), Se Hyeon Jang and So Jin Kim

### **Effects of fishing and environmental changes on the ecosystem of the Bohai Sea**

Qun [Lin](#), Jun Wang, Wei Yuan, Zhenhua Fan and Xianshi Jin

### **Fish condition and implications for recruitment in the Northeast Pacific**

Jennifer L. [Boldt](#), Christopher N. Rooper, Gerald Hoff, Robyn Forrest, Keith Bosley

**FIS/BIO Topic Session (S2)*****Fish production through food web dynamics in the boundary current systems***

Co-Convenors: *Motomitsu Takahashi (Japan) corresponding, Yuji Okazaki (Japan), Ryan Rykaczewski (USA), Akash Sastri (Canada)*

Invited Speaker:

*Chih-hao (Zac) Hsieh (National Taiwan University)*

Background

Trophic interactions from nutrients to fish are variable spatially and temporally in the North Pacific ecosystems. Fish production has been recognized generally as the grazing food chain: diatom-calanoïd copepod-fish. In addition, the microbial food chain and jelly-associated chain also work for maintaining biological production. Comparative studies on trophic interactions between the western boundary current (Kuroshio and Kuroshio Extension) and the eastern boundary current (California Current) would reveal biogeochemical characteristics in the North Pacific marine ecosystems. This session sought to reveal trophic interactions through nutrient supply to fish production and to compare the structures and function between the different boundary systems in the North Pacific. Interaction examples of nutrient supply, community structures of phyto- and zooplankton, food availability for fish larvae and the synergistic model in the ecosystem were highly encouraged. Presentations on trophic interactions using not only traditional approaches based on observations but also contemporary approaches including stable isotopes and DNA bar-coding analyses were also encouraged.

Summary of presentations

On behalf of his fellow co-convenors (Drs. Okazaki, Sastri, and Rykaczewski), Dr. Takahashi offered introductory comments regarding the scope of the session, time schedules for oral and poster presentations, and the invited speaker, Prof. Chih-hao Hsieh. Although sixteen oral presentations were planned originally, unfortunately three talks (two from China and one from Indonesia) were cancelled. Sixteen posters were presented in the evening. Four early career scientists were included in the oral presentations and three in the poster presentations. More than 40 people joined the session and participated in in-depth discussions on the trophic interactions in the Kuroshio and California Current ecosystems.

Prof. Hsieh *et al.* presented a synthesis of results based on in situ incubation experiments which demonstrated how zooplankton weight-specific growth rate and secondary production are affected by phytoplankton biomass, primary production and C:N:P molar ratios of prey in the East China Sea. They found that high-quality food enhances growth rate of zooplankton, and that consumer and prey composition further modify secondary production in marine food webs.

Prof. Kobari *et al.* analyzed interactions between phytoplankton and zooplankton in the Tokara Strait, off southwestern Japan and found that the mesozooplankton community was predominated by small copepods including calanoids, poecilostomatoids and nauplii. The results indicate that the transfer of organic matter and energy from nano-autotrophs to ciliates and then to copepods is a major trophic pathway in the planktonic food web and contribute to the diets of vulnerable life stages of fish larvae in the East China Seas and the Kuroshio regions.

Prof. Kume *et al.* demonstrated patterns in the seasonal occurrence and feeding habits of larval fish in the Kagoshima Bay area, off southwestern Japan. The fish assemblages were consistently different between the

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inner and outer part of the bay throughout the year, and the larval abundance and diversity generally were higher and lower in the bay, respectively.

Dr. Okazaki *et al.* explored the feeding habits of the larval and juvenile stages of multiple fish taxa collected in the Kuroshio region off Japan. The fish taxa were classified into eight groups and six outliers based on the food habitats. Four out of the eight groups consumed mainly calanoid or poecilostomatoid copepods, whereas two of the groups preyed mainly on ostracods or appendicularians. Based on the results, three major trophic pathways – grazing, microbial, and tunicate food chains – were suggested as links between the primary producers and the fish larvae or juveniles in the Kuroshio ecosystem.

Dr. Miyamoto *et al.* reported on the gut contents of age-1 Pacific saury collected broadly from 140°E to 140°W in early summer. Pacific saury fed mainly on *Neocalanus plumchrus* in the waters west of 170°E, and *Neocalanus cristatus* was a dominant component of their diet in the waters east of 170°W. The longitudinal difference in the gut contents were consistent with spatial change in the fatness of Pacific saury.

Dr. Sogawa *et al.* presented research on the community structure and species diversity of copepods in relation to oceanic environment from the Kuroshio to the Kuroshio Extension area. Community structures were divided into two groups: lower abundance and higher species diversity with high water temperature and salinity versus areas of higher abundance and higher nutrient and chlorophyll concentrations.

Dr. Watai *et al.* reported on growth trajectories of the young-of-the-year of Pacific bluefin tuna during 2011–2015. Larval growth rates of bluefin tuna collected in the Sea of Japan were highly variable compared to those collected in the Nansei Islands areas off Okinawa Archipelago. Uncoupling of larval growth rates from food abundance in the Sea of Japan were related with the thermal instability and the proximity of winter in relation to the spawning season in this area.

Dr. Ustinova *et al.* reported on the distribution patterns of saury, mackerels and sardine in relation to oceanographic conditions in the open waters of the Northwest Pacific. The spatial distribution of the species corresponded to the water-mass composition and hydrographic fronts.

Dr. Wang *et al.* examined distribution patterns of loligo squids (*Loligo* spp., mainly *Loligo japonica* and *Loligo beka*) in the Yellow and Bohai Seas and found that the abundance was higher in the south of Shandong Peninsula, particularly in the Haizhou Bay which is the primary spawning ground. Higher abundance occurred with SST (within 5–16°C) and salinity (>31 psu).

Dr. Smith *et al.* introduced a recently developed Trophic Level Variability (TLV) model of the dynamic fractionation of the stable isotope <sup>15</sup>N in lower-trophic-level ecosystem components of the North Pacific. The results imply that it is important to consider not only the average enrichment per trophic level, but also the dynamics of <sup>15</sup>N fractionation and the timing of observations.

Dr. Liu *et al.* demonstrated applications of nonlinear time-series models to forecast relative abundance indices of red snapper in the U.S. Gulf of Mexico and the structure of fish communities on Georges Bank. The tool revealed dynamic associations between zooplankton and fish linked to environmental variability and the driving processes of ecosystem dynamics on the Northeast Atlantic continental shelf.

Dr. Rykaczewski *et al.* examined relationships between nutrient supply and fisheries production using the global fisheries and marine ecosystem projections coordinated by Fish-MIP with the goal of understanding the underlying mechanisms and assumptions leading to variability in climate change projections. Climate change



projections were explored in two different model intercomparison projects (MIPs); CMIP and Fish-MIP. He suggested that knowledge of export production may be more useful for projecting fisheries production rather than net primary production.

Dr. Espinasse *et al.* demonstrated a model describing the spatial distribution of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) stable isotope signatures of large zooplankton species in the Gulf of Alaska. The  $\delta^{15}\text{N}$  was highly variable. Low production resulted in relatively stable  $\delta^{13}\text{C}$  values. Distance to the coast, sea level anomaly, and sea surface temperature were selected as significant parameters to model  $\delta^{13}\text{C}$ , while mixed layer depth was also important for  $\delta^{15}\text{N}$ .

## List of papers

### *Oral presentations*

#### **Prey stoichiometry influences growth rate and production of marine zooplankton (Invited)**

Pei-Chi Ho, Esther Wong, Fan-Sian Lin, Akash R. Sastri, Carmen García-Comas, Noboru Okuda, Fuh-Kwo Shiah, Gwo-Ching Gong, Rita S.W. Yam and Chih-hao Hsieh

#### **Trophic pathways of plankton food web to support food availability for vulnerable life stages of migratory fishes in the Kuroshio: as a key for the Kuroshio paradox**

Toru Kobari, Taiga Honma, Takeru Kanayama, Fukutaro Karu, Wataru Makihara, Takahiro Kawafuchi, Kie Sato, Koji Suzuki, Daisuke Hasegawa, Naoki Yoshie, Hirohiko Nakamura and Gen Kume

#### **The importance of the north Satsunan area, southern Japan as the spawning and nursery ground for small pelagic fish**

Gen Kume, Toru Kobari, Mutsuo Ichinomiya, Tomohiro Komorita, Junya Hirai, Maki Aita-Noguchi, Fujio Hyodo, Tsutomu Takeda, Taichi Shigemura, Hiroumi Kuroda, Shohei Yoshinaga, Kei Nakaya and Atsushi Narumi

#### **Feeding habits of multiple larval and juvenile fish taxa collected in the Kuroshio off Japan**

Yuji Okazaki, Hiroomi Miyamoto, Koji Suzuki, Hiroaki Saito, Kiyotaka Hidaka and Tadafumi Ichikawa

#### **Feeding ecology of age-1 Pacific saury during northward migration in June and July with remarks on difference of feeding habits by migration routes**

Hiroomi Miyamoto, Kazuaki Tadokoro, Satoshi Suyama and Hideaki Kidokoro

#### **Spatio-temporal distribution of planktonic copepods and planktonic stages of small pelagic fishes: copepod community structure and species diversity in egg- and larvae-rich Kuroshio and Kuroshio Extension area**

Sayaka Sogawa, Kiyotaka Hidaka, Yasuhiro Kamimura, Masanori Takahashi, Hiroaki Saito, Yuji Okazaki, Yugo Shimizu, Takashi Setou and Ichikawa Tadafumi

#### **Comparative analysis of the early growth history of Pacific bluefin tuna *Thunnus orientalis* from different spawning grounds and nursery areas**

Mikio Watai, Yuko Hiraoka, Taiki Ishihara, Izumi Yamasaki, Tomoko Ota, Seiji Ohshimo, Carlos Augusto Strüssmann

#### **Oceanographic conditions and the spatial distribution of saury, sardine and mackerels in the open waters of the Northwest Pacific based on the fishery-independent R/V “Hokko-maru” survey data**

Elena Ustinova, Hideaki Kidokoro, Dmitry Antonenko and Hiroomi Miyamoto

#### **Spatial-temporal variations in the distribution and abundance of loligo squids in Shandong offshore of Yellow Sea and Bohai Sea in relation to environmental factors**

Bin Wang, Yongjun Tian, Yumeng Pang, Caihong Fu, Peng Sun, Chi Zhang, Shuyang Ma, Rong Wan and Jianchao Li

#### **Modeling seasonal and inter-annual variability of trophic transfer and $^{15}\text{N}$ stable isotope enrichment within the planktonic food chain**

S. Lan Smith, Yoshikazu Sasai and Chisato Yoshikawa

#### **A predictive modeling approach for single stocks, fish community and fisheries ecosystems**

Hui Liu, George Sugihara

#### **Future of nutrients, fish, and fisheries in the California and Kuroshio Currents: a multi-model approach**

Tyler D. Eddy and Ryan R. Rykaczewski

#### **Defining isoscapes in the Northeast Pacific as an index of ocean productivity**

Boris Espinasse, Brian Hunt, Sonia Batten and Evgeny Pakhomov

*Poster presentations*

**Trophic sources and links of mesozooplankton and fish larvae in the Kuroshio based on stable isotope ratios**

Kanako Saito, Toru [Kobari](#), Maharu Shinyashiki, Gen Kume, Minoru Kitamura, Maki Aita-Noguchi, Fujio Hyodo, Hiroomi Miyamoto and Yuji Okazaki

**Trophic sources and linkages of mesozooplankton and fish larvae in the Kuroshio based on metabarcoding analysis**

Ibuki Sato, Toru [Kobari](#), Shohei Yoshinaga, Gen Kume and Junya Hirai

**Mesozooplankton feeding on phytoplankton and protozoans in the Kuroshio**

Fukutaro [Karu](#), Toru Kobari, Taiga Honma, Takeru Kanayama and Gen Kume

**Impact of microzooplankton grazing on phytoplankton community in the Kuroshio: a major trophic pathway of plankton food web**

Takeru [Kanayama](#), Toru Kobari, Taiga Honma, Fukutaro Karu and Gen Kume

**The influence of sporadic oceanic water inflow into Kagoshima Bay, southern Japan on larval fish assemblage**

Kei [Nakaya](#), Gen Kume, Toru Kobari, Tsutomu Takeda, Mutsuo Ichinomiya and Tomohiro Komorita

**Feeding habits of larval fish in the mouth of Kagoshima Bay, southern Japan**

Hiroumi [Kuroda](#), Gen Kume, Toru Kobari, Tsutomu Takeda, Mutsuo Ichinomiya, Tomohiro Komorita, Junya Hirai, Maki Aita-Noguchi and Fujio Hyodo

**The assemblages and feeding habits of larval fish in the Kuroshio and the adjacent waters, southern Japan**

Shohei [Yoshinaga](#), Gen Kume, Kaori Yamanoue, Norika Tanonaka, Toru Kobari, Junya Hirai, Maki Aita-Noguchi and Fujio Hyodo

**Dense occurrence of *Fritillaria pellucida* (Appendicularia: Fritillaridae) around the Kuroshio**

Kiyotaka [Hidaka](#), Takashi Setou, Atsushi Nishimoto, Tadafumi Ichikawa and Hiroya Sugisaki

**Numerical experiments using a coupled physical–biochemical ocean model to study the Kuroshio-induced nutrient supply on the shelf and slope region south of Japan: Case study of Tosa Bay facing the Kuroshio**

Hiroshi [Kuroda](#), Akinori Takasuka, Yuichi Hirota, Taketoshi Kodama, Tadafumi Ichikawa, Daisuke Takahashi, Kazuhiro Aoki and Takashi Setou

**Dietary patterns of walleye pollock, *Gadus chalcogramma* inhabiting the East/Japan Sea: the influences of water depth, fish size and season**

Joo Myun [Park](#), Hae Kun Jung and Chung Il Lee

**Distribution characteristics of primary feed in typical oceanic ranches and its response to the environmental changes**

Xiaoke [Hu](#), Caixia Wang, Yibo Wang and Pengyuan Liu

**Effects of photophysiology and chlorophyll *a* abundance on phytoplankton group-specific primary production in Japanese waters using remote sensing**

Takafumi [Hirata](#) and Koji Suzuki

**Distribution, reproduction, and feeding of *Symbolophorus californiensis* (Teleostei: Myctophidae) mature adults in the Kuroshio region during late winter: evidence of a southward spawning migration**

Chiyuki [Sassa](#) and Takasuka Akinori

**Relationship between abundance of young-of-the-year black sea bream *Acanthopagrus schlegelii* and eelgrass bed *Zostera marina* vegetation in central Seto Inland Sea, Japan**

Kentaro [Note](#), Kentaro Yoshikawa and Jun Shoji

**Spatial variations in community structure of haptophytes across the Kuroshio front in the Tokara Strait**

Hisashi Endo and Koji [Suzuki](#)

**FUTURE Topic Session (S3)*****Science communication for North Pacific marine science***

Convenors: *Toyomitsu Horii (Japan), (MEQ / FUTURE SSC), corresponding, Ekaterina Kurilova (Russia), (HD), Mitsutaku Makino (Japan), (HD / FUTURE SSC), Jackie King (Canada), (FIS, FUTURE SSC, S-CCME)*

Invited Speaker: *Alan Haynie (Alaska Fisheries Science Center, National Marine Fisheries Service, USA)*

Background

Science communication between researchers and society is increasing in importance for PICES' integrated marine science. For example, natural scientific information about sustainable uses of ecosystems cannot be meaningful if the social and economic expectations of the users are not considered. The goal of ecosystem conservation activities, or sustaining "a good ecosystem", cannot be decided without deliberate discussions that include society. In addition, each country or society has a specific view of "a good ecosystem" which could benefit from larger-scale coordination and comparison within the North Pacific basin. Conducting multi-disciplinary integrated marine ecosystem studies, such as those supporting the FUTURE Science Program, requires close and effective interaction of concepts, methodologies, models, and data, from various disciplines. Dissemination of that complex scientific information to society can be difficult. The PICES' scientific community would benefit from hearing examples of successful scientific communication. An example of communication to society includes providing scientific information about the fish stock sustainability and is often used by fish consumers with impacts on market demand which can ultimately decide the fishing pressure on the marine resources. A better understanding by stakeholders of the scenarios of future ecosystem states is an important step towards a society resilient and adaptable to global changes. This Topic Session invited studies about science communications such as those above. Theoretical studies, case studies, experiences, and perspectives for better science communication for the PICES activities were encouraged.

Summary

A key activity of FUTURE Science Program is communication of our science. This FUTURE session was created to provide positive examples of effective science communication. There were only five presentations, indicating that effective communication can be difficult and perhaps case studies are few to find. However, the session presenters were able to convey their enthusiasm and fulfillment in their interactions with various audiences. As scientists, we have a passion and curiosity for what we study. We also know that science is fundamental to societal well-being--however, we have a responsibility to inform our various audiences why our science matters. Audiences can range from policy makers, scientists of other disciplines, citizens, consumers and fishing communities. The difficulty for scientists is often that we do not feel comfortable engaging in conversations with all types of audiences. The session presentations on successful scientific communication offered common solutions: 1-get personal, get to know your audience personally or make a human connection in some manner, perhaps with a personal story; 2-lose your scientific language, our audiences are smart but are not familiar with our jargon; 3-keep your message simple, and try to keep it to a single message only; 4-reach out to your audience, do not assume that they will come to you; we must all make the effort. The take home message is "Get outside your comfort zone". To continue the advancement of communicating science, FUTURE Science Program hopes to host a 1 day workshop at PICES 2019 where science communication experts will actively teach us skills for engaging through social media, curriculum, media interview or summaries for policy makers. Hopefully it will help PICES build additional examples of effective communication.

List of papers

*Oral presentations*

**Reaching our audience: how do we better communicate interdisciplinary marine science? Lessons and challenges from the U.S. North Pacific and beyond (Plenary)**

Alan Haynie

**From evidence to action: challenges and solutions for working across the science-policy interface**

Abigail McQuatters-Gollop

**Fate of antibiotic resistance in estuaries and marine environment**

Guangshui Na, Linxiao Zhang, Hui Gao, Ruijing Li, Shuaichen Jin, Qianwei Li, Caixia Wang and Wanli Zhang

**Citizen engagement through shoreline cleanup litter data: British Columbia case study**

Vanessa R. Fladmark, Cassandra Konecny and Santiago J. De La Puente

**Outreach program for encouraging sustainable use of fish stock resources by consumers around Japan: Sustainable, Healthy and “Umai” Nippon seafood (SH“U”N) Project**

Yoshioki Oozeki, Toyomitsu Horii, Tatsu Kishida, Ryutaro Kamiyama, Mitsutaku Makino, Mai Miyamoto, Nami Miyamoto, Yuko Murata, Takumi Mitani, Aigo Takeshige, Yasuji Tamaki, Shinji Uehara, Hiroki Wakamatsu, Shingo Watari and Shiroh Yonezaki

**An overview of stakeholder directed communication in the Pacific Islands**

Siri Hakala, Jamison Gove, and Rebecca Ingram

**BIO Topic Session (S4)**

***Indicators for assessing and monitoring biodiversity of biogenic habitats***

Convenors: *Anya Dunham (Canada) corresponding, Hye-Won Moon (Korea)*

Invited Speaker:

*Yves-Marie Bozec (The University of Queensland, Australia)*

Background

Biogenic habitats formed by corals, sponges, and other structure-forming taxa support high species abundance and biodiversity, including socio-economically important fishes and invertebrates. These habitats are also known to be vulnerable to disturbances from human impacts and climate change. Predicting, assessing, and monitoring shifts in habitat-forming species and associated communities in response to natural and anthropogenic forcing require suites of measurable indicators. The goal of this session was to improve our understanding of ecologically relevant, sensitive, observation-based indicators for assessing and monitoring biogenic habitats. Presentations on indicators encompassing single or compound metrics of the marine biota in a broad sense (from physiological to species, community and habitat levels) which could be measured to indicate the condition of biogenic habitats and monitor changes to the habitats and communities they support were invited. Empirical studies and literature reviews on indicator development, assessment, and/or application were invited. WG 32 members and collaborators also presented a literature review of documented functional associations between commercially important fish and invertebrate species and biogenic habitats and address methods to incorporate these associations into indicator development. This session was intended to help improve our understanding and ability to identify and characterize changes in biogenic habitats, as well as their recovery potential. The results of this session will help inform management and policy decisions and marine spatial planning processes that can maintain ecosystem biodiversity, structure, and function.

Summary of presentations

The session consisted of 9 oral presentations (three of which were cancelled) and 3 posters that covered a wide variety of biogenic habitat indicators. Oral presentations were given during a half-day session on October 30 and included three presentations by early career scientists. The Session's invited speaker, Yves-Marie Bozec, presented his research on mechanistic indicator of dynamics in coral reef habitats under multiple disturbances such as overfishing and global warming. He showed implications for reef monitoring and indicators and forecasting structural complexity through simulation modelling. Go Suzuki suggested a new method to assess species diversity and dominance of shallow water corals using environmental DNA; he presented the results of an experimental study to detect of eDNA in coral tanks that showed promise and suggested further testing of the technique in the open water. Mai Miyamoto presented a novel application of association analysis for identifying VME indicator taxa using sea floor visual images from the Emperor Seamount (method that minimizes the impacts on the sea floor via examining visual images without sampling). Composition of benthic community varied depending on the bottom substratum; gorgonians were dominant taxa. Anya Dunham showed the results of a review paper on the methods for assessing habitat-forming species and associated biodiversity, outlined a systematic assessment and monitoring survey protocol, and walked the audience through an application of this protocol to a case study of glass sponge reefs, a new biogenic habitat type not previously assessed in a quantitative way. Jackson Chu reported on the environmental niche space and distributions of cold-water corals and sponges in the northeast Pacific Ocean, highlighting the correlation of cold-water corals and sponge distribution with low oxygen zones. Finally, Hyeong-Gi Kim discussed his findings on the differences in nematode assemblages associated with *Sargassum muticum* in its native range in South Korea and as an invasive species in the English Channel. Discussion centered on the broad range of indicator approaches developed (from eDNA to visual survey techniques to modelled distributions) and on the challenges and progress made on developing quantitative approaches. Based on high quality of oral presentations and posters, diversity of indicator approaches, and level of attendance (~85 participants), the Topic Session "*Indicators for assessing biodiversity of biogenic habitats*" at PICES-2018 was deemed to be a success.

List of papers*Oral presentations***Identifying mechanistic indicators of coral reef resilience (Invited)**Yves-Marie Bozec**Assessment of species diversity and dominance of shallow water corals using environmental DNA**Go Suzuki, Hiroshi Yamashita, Yuna Zayasu and Chuya Shinzato**Application of association analysis for identifying VME indicator taxa based on sea-floor visual images**Mai Miyamoto and Masashi Kiyota**Marine biogenic habitats: assessing benthic cover and species-habitat associations**Tse-Lynn Loh, Stephanie K. Archer, Anya Dunham**Modelling the environmental niche space and distributions of cold-water corals and sponges in the northeast Pacific Ocean**Jackson W.F. Chu, Jessica Nephin, Samuel Georgian, Anders Knudby, Chris Rooper and Katie S.P. Gale**Comparison of nematode assemblages associated with *Sargassum muticum* in its native range in South Korea and as an invasive species in the English Channel**Hyeong-Gi Kim, Lawrence E. Hawkins, Jasmin A. Godbold, Chul-Woong OH, Hyun Soo Rho and Stephen J. Hawkins

## Session Summaries – 2018

### *Poster presentations*

#### **Transcriptome study of scleractinian coral *Alveopora japonica***

Seonock Woo, Sung-Jin Hwang, In-Young Cho and Min-Sup Kim

#### **Predictive modeling methods for deep-sea sponges in the North Pacific Ocean**

Fiona Davidson, Anders Knudby

#### **Changes in the fish community in seagrass bed on the Pacific coast of northeastern Japan before and after (2009-2017) the tsunami following the 2011 off the Pacific coast of Tohoku Earthquake**

Kentaro Yoshikawa, Hikaru Nakano and Jun Shoji

### **POC Topic Session (S5)**

#### **Seasonal to interannual variations of meso-/submeso-scale processes in the North Pacific**

Co-sponsor: OMIX

Convenors: Annalisa Bracco (USA) corresponding, Sachihiko Itoh (Japan), Elena Ustinova (Russia)

Invited Speaker:

*Yu-Lin Eda Chang (Japan Agency for Marine-Earth Science and Technology, JAMSTEC)*

*Bo Qiu (Department of Oceanography, University of Hawaii at Manoa)*

### Background

Recent observations and model simulations suggest that the ocean currents and biogeochemistry at and near the ocean surface undergo prominent seasonal variability at the submesoscales (scales of 0.1–10 km). The submesoscale seasonal variability is a function of the ratio of lateral to vertical density gradients and, in the open ocean, depends primarily on the mesoscale activity of the flow. Consequently, in the open ocean numerous submesoscale cyclonic eddies can form in winter and the vorticity distributions are skewed towards positive values typical of cyclonic structures. This skewness is highly reduced from spring to fall. In coastal areas, on the other hand, density gradients can be forced not only by mesoscale circulations but also by freshwater fluxes from rivers or melting glaciers, resulting in a seasonal cycle that may differ significantly from region to region, and in interannual variability controlled in part by hydrological and cryospheric processes. Implications of such variability for the ocean biogeochemistry and nutrient distributions are poorly understood. This session sought to characterize the variability of mesoscale and submesoscale circulations and its linkages with the marine ecosystem in the PICES region at seasonal-to-interannual scales. Contributions about future changes in mesoscale variability or in mixed-layer depth and its buoyancy, and therefore in submesoscale variability, in warming climate scenarios were welcomed.

### Summary of presentations

The session comprised one plenary, one invited, 15 oral and 4 poster presentations. It was very well attended, with more people than the room could accommodate during the morning presentations. PICES members from five countries (all but Canada), contributed to the session.

In advance of S5, a plenary talk by Dr. Yu-Lin Eda Chang discussed possible causes of the declining recruitment of Japanese eels, *Anguilla japonica*, recorded in recent decades. Using a three-dimensional particle-tracking method, Dr. Chang showed how decadal changes in recruitment may be attributed to changes in ocean circulation, with physical trapping of larvae in mesoscale eddies playing a very important role in larval migration.

An invited talk by Dr. Bo Qiu presented results from a numerical simulation at  $1/30^\circ$  horizontal resolution obtained using the OFES (OGCM for the Earth Simulator) model. Dr. Qiu's presentation focused on the PICES region and on the dynamics that the forthcoming Surface Water and Ocean Topography (SWOT) mission will help explore, and detailed their seasonal variability. Dr. Humio Mitsudera followed with a talk on the generation and interannual variability of the quasi-stationary jets that form between the subtropical and subarctic gyres in the western North Pacific and on their signature in surface temperature and salinity (SST and SSS) fields. Dr. Sung Yong Kim then presented a new characterization of the regional variability over the region off the east coast of Korea using surface chlorophyll concentrations collected hourly and at a 0.5 km resolution for a period of five years (2011 to 2015). His analysis allowed for quantifying the role of mesoscale and submesoscale circulations to chlorophyll blooms in the area of interest. A contributed talk by Dr. Elena Ustinova investigated the impacts of mesoscale circulations on the spatial distribution of sardines and mackerels using observations from CTD and acoustic-trawl surveys conducted by TINRO-Center R/Vs in early and late summer in the Northwest Pacific, east of the Kuril Islands. The distributions of mackerels and sardines closely depend on the physical conditions and on the season, with high concentrations confined to the high-gradient zone of the Northern Subarctic Front in June, and in the subarctic area in July. High concentrations of mackerels were also found in an anticyclonic eddy off the Bussol Strait. The aggregations of both species followed closely the topography of the thermocline upper boundary layer. A presentation by Dr. Guimei Liu concluded the morning portion of S5, presenting new results from a regional simulation of the South China Sea. The 11-year-long run allowed for evaluating the interannual variability of the mixed-layer depth, while also integrating a biogeochemical module. Modeled chlorophyll was shown to display two concentration peaks, in winter and summer, as in the observations, and to depend strongly on wind.

Dr. Andreev opened the afternoon presentations, describing the mesoscale circulations that are observed in the Navarin Canyon area of the Bering Sea. His study made use of AVISO satellite altimetry, drifters, Argo buoys and shipborne data to show that the strength of the anticyclonic eddies that form along the shelf slope in spring and summer is determined by the wind stress in March–April. He also investigated the relationship between the mesoscale eddies and pollock abundance. The following contributed talk by Dr. Olga Trusenkovna focused on the generation and seasonal evolution of eddies and inertial oscillations along the continental slope off the Russian east coast along the Primorye Current. She used satellite images to link these dynamical structures to SST anomalies. The next presentation by Dr. Hiromichi Ueno investigated the mesoscale variability at interannual scales in the western subarctic North Pacific, tracking anticyclonic eddies from their generation to their decay. Long-lived eddies are often found in the area south of the Aleutian Islands, between  $170^\circ\text{E}$  and  $175^\circ\text{E}$ . A contributed talk by Dr. KyungJae Lee introduced the audience to observations, satellite and *in-situ*, of a very long-lived anticyclonic eddy in the region off the east coast of Korea that formed in fall 2014 and decayed nearly three years later, in August 2017. Dr. Jun Choi then presented a report on a 35-drifter deployment in the Korea Strait between the East China Sea and southbound of Korea that took place in August 2018. Drifter statistics were also compared to satellite chlorophyll-*a* concentrations and HR-radar data. The early career scientist, Erin Satterthwaite, contributed a presentation on the impact of seasonal changes in hydrography on invertebrate larval assemblages in the northern Monterey Bay.

During the last portion of the session, a contributed talk by Dr. Annalisa Bracco showed how submesoscale circulations undergo not only seasonal but also diurnal changes using regional ocean simulation and drifter data. A talk by Dr. Sachihiko Itoh focused on a high-resolution field campaign that took place in 2013 across the front between the Tsugaru Warm Current and the Oyashio, where turbulent kinetic dissipation rates were determined, and mechanisms responsible for it identified. The following presentation, by early career scientist, Hiroto Abe, used Aquarius sea surface salinity and Argo data to investigate how heavy precipitation and mesoscale eddies interact in the subtropical North Pacific. Dr. Eko Siswanto investigated the relationship between mesoscale dynamical structures and the chlorophyll concentration response in the Kuroshio Extension

## Session Summaries – 2018

region using satellite data and during a 13-year-long period (2000–2012). Finally, Dr. Elena Shtraikhert used SST and ocean color satellite data to analyze the relationship between river run-off from the Razdolnaya and Tumannaya Rivers and chlorophyll-*a*, organics and suspended matter contents between 2010 and 2014, linking dynamical (physical) and ecosystem variables.

Four poster presentations (one presenter could not be at the poster session due to a cruise planning meeting) completed the session.

The presentations contributed a broad overview of observational and numerical approaches to understand ocean transport and mixing processes and the mesoscale and submesoscales, their variability and their impacts on biogeochemistry and climate in the North Pacific. PICES scientists are contributing important new studies to identifying mesoscale and submesoscale circulations, and attributing their impacts on the marine ecosystem over a broad range of spatial and temporal scales.

### List of papers

#### *Oral presentations*

##### **Potential impact of ocean circulation on Japanese eel larvae migration (Plenary)**

Yu-Lin Eda [Chang](#), Yasumasa Miyazawa, Michael J. Miller and Katsumi Tsukamoto

##### **Seasonality in Transition Scale from Balanced to Unbalanced Motions in the World Ocean (Invited)**

Bo [Qiu](#), Shuiming Chen, Patrice Klein, Jinbo Wang, Hector Torres, Lee-Lueng Fu, and Dimitris Menemenlis

##### **Formation and interannual variations of baroclinic quasi-stationary jets in the transitional domain between the subtropical and subarctic gyres in the western North Pacific**

Humio [Mitsudera](#), Toru Miyama, Hajime Nishigaki, Takuya Nakanowatari, Hatsumi Nishikawa, Tomohiro Nakamura, Taku Wagawa, Ryo Furue, Yosuke Fujii, and Shin-Ichi Ito

##### **Turbulent characteristics of the satellite-sensed submesoscale surface chlorophyll concentrations**

Eun Ae Lee and Sung Yong [Kim](#)

##### **Mesoscale and large-scale dynamic features and the spatial distribution of sardine and mackerels east of the Kuril Islands in early and late summer**

Elena [Ustinova](#), Mikhail Kuznetsov, Eugeny Basyuk and Eugeny Syrovatkin

##### **Preliminary Study of MLD and SCML in the SCS using 3-D physical-biogeochemical model**

Guimei [Liu](#), Xuanliang Ji

##### **Mesoscale dynamics and walleye pollock catches in the Navarin Canyon area of the Bering Sea**

Andrey G. [Andreev](#), Maxim V. Budyansky, Michael Yu. Uleysky and Sergey V. Prants

##### **Short-lived anomalies of hydrophysical characteristics at the continental slope off the Russian coast in the northwestern Japan/East Sea from spring through early fall**

Olga [Trusenkova](#), Alexander Ostrovskii, Alexander Lazaryuk, Vyacheslav Dubina, Svetlana Ladychenko, and Vyacheslav Lobanov

##### **Spatio-temporal variation of anticyclonic eddies in the western subarctic North Pacific**

Hiromu Ishiyama, Isao Fujita and Hiromichi [Ueno](#)

##### **An extremely long lived Ulleung Warm Eddy from 2014 to 2017 (UWE 2014-II) in the southwestern East Sea (Japan Sea)**

KyungJae [Lee](#), SungHyun Nam

##### **Surface drifter observations in the Korea Strait in spring**

Jun [Choi](#), Wonkook Kim, Kyu Min Song, Joon Seong Park and Young Gyu Park

##### **Effects of seasonal variation in oceanography on larval assemblages in the northern Monterey Bay, California upwelling system**

Erin V. [Satterthwaite](#), Steven G. Morgan, John P. Ryan, Julio B.J. Harvey, Robert C. Vrijenhoek

##### **The diurnal cycling of submesoscale circulations: A Lagrangian and Eulerian perspective**

Annalisa [Bracco](#), Daoxun Sun and Jun Choi

##### **Fine-scale structure and mixing across the front between the Tsugaru Warm and Oyashio Currents in summer along the Sanriku Coast, east of Japan**

Sachihiko [Itoh](#), Hitoshi Kaneko, Miho Ishizu, Daigo Yanagimoto, Takeshi Okunishi, Hajime Nishigaki and Kiyoshi Tanaka



**Aquarius reveals eddy stirring after a heavy precipitation event in the subtropical North Pacific**

Hiroto Abe, Naoto Ebuchi, Hiromichi Ueno, Hiromu Ishiyama and Yoshimasa Matsumura

**Impacts of eddy variability on phytoplankton dynamics in the Kuroshio Extension region**

Eko Siswanto and Yoshikazu Sasai

**Seasonal and interannual variations in the spread of the Razdolnaya and Tumannaya Rivers runoffs (Peter the Great Bay, Japan/East Sea) according to the satellite data on SST and ocean color**

Elena A. Shtraikhert and Sergey P. Zakharkov

*Poster presentations*

**Characteristic of subsurface oxygen maximum in oligotrophic western North Pacific**

Naohiro Kosugi, Masao Ishii and Daisuke Sasano

**Variability of the Pacific North Equatorial Current based on a 1/8° Pacific Model Simulation**

Zhichun Zhang, Huijie Xue, Fei Chai and Yi Chao

**Submesoscale dynamics in the Northeastern Subtropical Pacific Ocean**

Hideharu Sasaki, Patrice Klein, Yoshikazu Sasai and Bo Qiu

**Interannual variability of marine ecosystem in the Kuroshio Extension region**

Yoshikazu Sasai, Makio C. Honda, Eko Siswanto, Hideharu Sasaki and Masami Nonaka

**FUTURE Topic Session (S6)**

**The FUTURE of PICES: Next steps in understanding, forecasting and communicating climate impacts on North Pacific marine ecosystems**

Convenors: *Sukyung Kang (Korea), Steven Bograd (USA)*

Background

‘Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems’ (FUTURE) is the flagship integrative Scientific Program undertaken by the member nations and affiliates of PICES. Since its inception in 2009, FUTURE has contributed to guiding PICES science to understand how marine ecosystems in the North Pacific respond to climate change and human activities, to forecast ecosystem status based on a contemporary understanding of how nature functions, and to communicate new insights to its members, governments, stakeholders and the public. FUTURE is scheduled to conclude in 2019, so this is a good time to reflect on its accomplishments, to identify remaining gaps in fulfilling its research objectives, and to contemplate new directions for PICES science. In this session, a FUTURE ‘Mini-Symposium’ was conducted to update the PICES community on FUTURE progress and to coordinate activities amongst the PICES Expert Groups. Each Expert Group provided a brief review of their past, current and planned activities as they relate to the FUTURE science program, which was followed by a plenary discussion on the future path of PICES science in the coming years.

Summary of presentations

The ½-day FUTURE plenary session was held on October 31 in Yokohama, Japan. The session was convened by Sukyung Kang (Korea) and Steven Bograd (USA). A total of 10 short presentations were made during the plenary session. In the beginning of the session, Dr. Bograd provided an overview of the FUTURE science program, highlighting recent advances and ideas for planning the next integrative science program.

## Session Summaries – 2018

The agenda for the session included reports from Expert Groups (WG 35, WG 36, WG 37, WG 38, WG 40, WG 41, S-CC) reporting to FUTURE SSC and two FUTURE-related presentations (Shin-ichi Ito and Robin Brown), followed by general discussion. This year's FUTURE plenary session was particularly effective, in part because each Expert Group gave its presentation in a similar format in which they presented completed and anticipated FUTURE activities and products.

Peter Chandler (Canada, Co-Chair of WG 35) reported the progress of the third North Pacific Ecosystem Status Report (NPESR3) and database of Ecosystem Time Series Observations (ETSOs). Xiujuan Shan (China, Co-Chair of WG 36) reported on the recent activities of WG-36 and plans for the future. Toru Kobari (Japan, Co-Chair of WG-37) presented the ongoing and planned activities on zooplankton production methodologies, applications and measurements in PICES regions. Annalisa Bracco (USA, co-chair of WG-38) introduced ongoing activities including a synthesis review paper with a regional characterization of meso/submesoscale processes. The presentation by Antonietta Capotondi (USA, co-chair of WG-40) was well matched with FUTURE research theme 2, which is how do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future? Dan Lew (USA, co-chair of WG 41) presented the concept of marine ecosystem services (MES) and their activities. James Christian (Canada, co-chair of S-CC) introduced the PICES Special Publication 6 on ocean acidification and deoxygenation in the North Pacific Ocean. Shin-ichi Ito (Japan) presented a new integrated method of using stable isotopes to elucidate climate variability impacts on living marine resources. Robin Brown (PICES) pointed out that the direction of the UN Decade of Ocean Science for Sustainable Development (2021-2030) and the FUTURE program are highly complementary, and there is a need to discuss how PICES will contribute to the UN Decade of Ocean Science.

Following these presentations, Steven Bograd led a lively plenary discussion for about one hour, organized around several topic questions including: how can communication amongst PICES Expert Groups be improved? Are there emerging scientific issues that FUTURE and PICES should address? A number of recommendations were presented by PICES community members, including a suggestion for an Expert Group chair's forum and joint intersessional workshops among Expert Groups; how to aggregate and synthesize FUTURE products; the need for more activities related to mariculture; and how to develop the next PICES integrative science program.

### **POC/FUTURE Topic Session (S7)**

#### **Ecological responses to variable climate changes and their applicability to ecosystem predictions**

Co-sponsor: CLIVAR

Convenors: *Ryan Rykaczewski (CLIVAR/USA), Akinori Takasuka (PICES/Japan), Chan Joo Jang (PICES/Korea)*

Invited Speaker:

*Susan Allen (University of British Columbia (UBC), Canada)*

#### Background

In the North Pacific, regional and large-scale climate forcing impacts a range of physical and ecological characteristics including temperature, stratification, ocean circulation, upwelling, biogeochemical properties, and primary and secondary production. These characteristics, in turn, can impact the distribution, composition,

and productivity of fisheries resources. However, the accuracy of many climate-ecosystem relationships derived from historical observations deteriorates when faced with new observations. Reducing the uncertainty associated with climate-ecological relationships requires an understanding of the mechanisms that govern empirical correlations. In this session, we seek presentations focused on climate-ecosystem relationships and whether such relationships can be expected to persist under future (*e.g.*, months to decades) climate conditions. Many regional and large-scale properties of the physical ocean state can be skillfully predicted over scales of seasons (and years for some properties), and we hope that such ability, with further clarification of predictable properties in different regions on different timescales, can be used in combination with understanding of robust climate-ecosystem relationships to provide forecasts of marine ecosystems that will be useful to resource management and utilization.

### Summary of presentations

Session 7 was aimed at highlighting relationships between climate properties and key ecological characteristics in PICES regions. This session was motivated primarily by the goals of PICES WG 40 on *Climate and Ecosystem Predictability*. Members of WG 40 had noted that while numerical models and observations of some surface-ocean properties have improved the community's understanding of predictability in the physical aspects of ocean ecosystems, relating these predictions to changes in biological populations remains challenging. Participants presenting in S7 were encouraged to identify climate-ecosystem relationships, discuss whether such relationships can be expected to persist under future (*e.g.*, months to decades) climate conditions, and highlight factors which contribute to uncertainty in these relationships.

Susan Allen was a plenary speaker for the session who shared some lessons learned from her efforts to forecast the timing of the spring bloom in the Strait of Georgia over the past 12 years using a one-dimensional model. This work served as an example of the combination of observational science and experimental prediction that is required to forecast ecosystem changes. The variety of data sources (*e.g.*, weather data, freshwater input, wave action, and vessel-based observations) used to parameterize the model and test its skill was impressive. The phenology of the spring bloom in the region has implications for herring recruitment and zooplankton succession, and the ability to predict bloom timing could be useful for fisheries and ecosystem management.

The remainder of the session consisted of 15 talks and six poster presentations. To open the session, Ryan Rykaczewski introduced the motivations and objectives of the aims on behalf of the session Co-Convenors (Akinori Takasuka and Chan Joo Jang) and other members of WG 40. The session was well attended, with more than 40 attendees throughout the day. The presenters and their topics represented the diversity of interests in developing predictive capabilities in the PICES regions (with contributions from scientists from each member country). Of the 21 total presentations, eight were presented by early career scientists.

The topics of the oral presentations were arranged to flow (roughly) from projects that focused on prediction of more physical aspects of marine ecosystems to those that addressed end-to-end modeling efforts, issues concerning upper trophic-level-organisms (*e.g.*, targeted fish species and seabirds), or issues of direct societal relevance (like harmful algal blooms). Antonietta Capotondi opened the S7 with a talk on the optimal conditions and patterns that are associated with robust relationships between tropical conditions and warming along the west coast of the United States. Understanding of the conditions which promote a strong teleconnection between the tropics and the mid-latitudes can improve predictive capabilities and offer some understanding of when relationships will fail.

Yong Sun Kim presented results from work that explores the statistical relationships between warming in the Yellow and East China Seas with warming patterns in the southeast Pacific. Interannual anomalies in sea-

surface temperatures (SSTs) in these western Pacific marginal seas can range by more than 5°C, and so exploring the capacity for prediction of such anomalies could be useful. Although the statistical relationships that Kim presented were clear, the mechanisms of such interhemispheric teleconnections require continued research.

The third presentation was delivered by Youngji Joh. She proposed a hypothesis for the links between anomalies in the Kuroshio Extension (KE) and the Pacific Meridional Mode (PMM) that operates through anomalies in surface wind forcing and is associated with El Niño-Southern Oscillation (ENSO). Because ecological anomalies are often linked with changes in temperature and water-mass formation that are influenced by the KE and the PMM, understanding the relationship between the KE and PMM could facilitate predictability of ecological anomalies.

The next three talks shared a common geographic domain: the California Current. Michael Jacox presented work that demonstrated ENSO-dependent skill of oceanographic forecasting efforts for the west coast of North America. By recognizing the conditions under which forecasting models exhibit skill and the mechanisms that are associated with such skill, we can better understand when ecosystem predictions are expected to be accurate.

Numerical circulation models that assimilate observational data offer another approach to improving marine forecasts. Christopher Edwards discussed this approach and its utility for understanding ecosystem responses to physical drivers, using the 2014–2015 “blob period” in the California Current as an example. Dr. Edwards’ group is routinely providing data assimilation model output for this region of the California Current.

When considering the responses of fish and fisheries to climate variability and change, shifts in distribution or migration patterns is an important consideration. Kenneth Rose discussed the complications in moving beyond physical and biogeochemical predictions towards predictions of the distributions of fish and fishing operations, as the latter clearly exhibit behaviors that have poor mechanistic underpinnings. Variable representation of movement in predictive models is a key source of uncertainty (but also an area of opportunity for model improvement) in predictions of ecological responses to environmental cues.

Shifting to the northwestern Pacific, Heeseok Jung discussed the configuration and performance of a new prediction system for the physical conditions in the seas around Korea focused on the one-to-twelve-month timescale. Anomalies in physical factors in the region have biological and socioeconomic impacts, and the one-to-twelve-month timescale is recognized as particularly challenging, as it is dependent on accurate representation of both initial and boundary conditions.

Yury Zuenko discussed the relevance of physical oceanographic conditions for the recruitment and landings of walleye pollock in the Primorye region in the Sea of Japan. Dr. Zuenko highlighted the combined use of standard density-dependent stock-recruitment relationships and carrying capacity, empirical correlations between the environment (temperature of sub-surface ocean layers) and recruitment, competition with other species that have recently shifted their distribution (*i.e.*, Japanese common squid), and patterns of temporal variability in the region to make forecasts of recruitment to the stock.

Kirill Kivva presented work led by Boris Kotenev regarding the dynamics of three herring stocks in the northwest Pacific. Relationships between catches of these stocks and both SST and anomalies in atmospheric pressure are evident at various lags. Although these relationships may be useful for exploring past variability, more research concerning the mechanisms that might underpin such relationships are required before they could be used in a predictive manner.

Shifting back to the northeastern Pacific, Brian Beckman presented results addressing responses of a physiological proxy for juvenile salmon growth and the abundance of some of their key prey items to the “warm blob” in recent years. These results exhibited unexpected relationships, with increased growth during the warm period. This is opposite the typical inverse relationship between temperature and salmon growth that has been documented at decadal timescales. Identifying when accepted relationships deteriorate is useful for constraining the skill and expectations of environmental predictions.

The next speaker, Chih-hao (Zac) Hsieh, demonstrated the use of a Takens’ Theorem approach to examine complex and changing relationships in marine ecosystems. Dr. Hsieh emphasized that the approach can help to identify interactions among species. This network of interacting species is dynamic over time. Not all species interact with each other, and resolving the critical interactions among key species in a system can help to identify the characteristic of an ecosystem that need to be measured in order to improve ecosystem forecasts.

Anne Hollowed presented work from the Alaska Climate Integrated Modeling team that is examining the impacts of climate variability and change on the distribution and productivity of fish species in the Bering Sea. The general additive model approach that was applied demonstrates the differing sensitivities of various species distributions to environmental change. The marine heat wave during the past several years allowed a test of the approach, generally performing well. Caveats of the methods applied were also discussed.

The presentation of Yutaka Watanuki addressed issues further up the trophic chain, examining shifts in the diet composition of seabirds in response to changes in physical conditions and their impacts on seabird productivity. Climate variability had a significant impact on the composition of seabird diets, and such climate-related shifts can influence both seabird production and the mortality rates of forage fishes.

Douding Lu discussed trends in environmental properties and the occurrence of specific species of harmful algae in the coastal waters of China during the past two decades. Mechanistic relationships between the environment and the algae remain unresolved, but shared trends in temperature and the blooms of these species suggest that such a relationship may be present and has generated several hypotheses. These algal blooms have a tremendous socioeconomic impact on the region.

The final oral presentation in the parallel session was that of Karyn Suchy whose work addresses bottom-up processes that may be related to declines in coho and Chinook salmon in the Strait of Georgia in the northeast Pacific. The portion of the work presented in S7 examines the differing environmental factors that can control the timing of remotely sensed chlorophyll blooms. Although relationships between physical conditions and chlorophyll were present, these relationships differed across subregions within the Strait of Georgia. This work demonstrates the diversity in physical-environmental relationships, even within a small geographic region.

The variety of research efforts presented in S7—including the broad ranges of their geographic focus, the methods applied, and the portion of the marine ecosystem considered—is a testament to the interest in improving ecosystem predictions and their potential utility to issues of societal and economic relevance. Identifying physical-ecological relationships that are robust through time remains challenging, and in many cases, such relationships may be non-stationary through space and time. Although the PICES community currently has few examples of relationships between upper-trophic-level species and physical climate conditions that can be utilized for operational predictions, we have grown to recognize the need to understand the circumstances under which these relationships change. Perhaps a first step towards making predictions of fisheries distribution and productivity is recognizing when/where climate-biology relationships can be expected to exhibit skill and when/where those relationships may be weak.

List of papers

*Oral presentations*

**Twelve years of forecasting the spring bloom in the Strait of Georgia: Lessons learned (Plenary)**

Susan Allen, Doug Latornell and Rich Pawlowicz

**Optimal tropical precursors of US West Coast marine warming**

Antonietta Capotondi, and Prashant D. Sardeshmukh

**Interhemispheric teleconnection between Yellow and East China Seas and tropical southeast Pacific sea surface temperatures through a recent change in El Niño-Southern Oscillation in the boreal summer**

Yong Sun Kim, Minho Kwon and Chan Joo Jang

**Decadal predictability linked to teleconnections between the Kuroshio Extension and North Pacific Meridional Modes**

Youngji Joh and Emanuele Di Lorenzo

**Mechanisms of marine ecosystem predictability along U.S. coasts**

Michael G. Jacox and the NOAA/MAPP Marine Prediction Task Force

**Using a coupled biogeochemical/physical data assimilation system in the California current system to study ecosystem impacts from variable climate**

Christopher A. Edwards, J. Paul Mattern, Patrick T. Drake, Jerome Fiechter, Andrew M. Moore

**Predicting fish movement and migration in response to changing climate**

Kenneth A. Rose

**Development of the ocean mid-range prediction system for the seas around Korea**

Heeseok Jung, Chan Joo Jang

**Dynamics of walleye pollock recruitment at Primorye (Japan/East Sea) under climate change**

Yury Zuenko, Vladimir Nuzhdin

**Present and future dynamics of herring stocks in the Northwest Pacific in association with large-scale climate variability**

Boris Kotenev, Nikolay Antonov, Oleg Bulatov, Kirill Kivva, Andrey Krovnin, George Moury

**The PDO, The Blob and juvenile coho salmon growth in the Northern California Current 2000 – 2017.**

Brian Beckman, Cheryl Morgan, and Meredith Journey

**Fluctuating interaction network and time-varying stability of a natural fish community**

Masayuki Ushio, Chih-hao Hsieh, Reiji Masuda, Ethan R Deyle, Hao Ye, Chun-Wei Chang, George Sugihara, Michio Kondoh

**Multi-model inter-comparison study for elucidating uncertainty and mechanistic understanding of climate change impacts on Bering Sea fishery resources**

Anne B. Hollowed, Kerim Aydin, Alan Haynie, Kirstin Holsman, Paul Spencer, Jonathan Reum, Andrew Whitehouse

**Climate regime cycle affects the productivity of a pursuit-diving seabird and its predation on forage fish**

Yutaka Watanuki, Mariko Yamamoto, Jumpei Okado and William Sydeman

**Spatio-temporal analysis of environmental drivers and patterns of satellite-derived chlorophyll *a* in the Strait of Georgia, Canada, from 2003-2016.**

Karyn D. Suchy, Andrea Hilborn, Maycira Costa and R. Ian Perry

**Expansion of *Cochlodinium polykrikoides* in Chinese coastal waters, what can be linked to?**

Douding Lu, Pengbin Wang, Xinfeng Dai, Feng Zhou and Fei Chai

*Poster presentations*

**Assessing the oceanographic variability impact in the western North Pacific on fishery resources in Japan using FORA-WNP30**

Gloria S. Duran, Takeyoshi Nagai, Luis A. Icochea and Yuhei Mori

**Characterizing time-series of bioacoustics, physical and biogeochemical properties in Saanich inlet (British Columbia, Canada): multi-scale temporal dynamics, causal relationships and forecasting**

Lu Guan, Akash Sastri, Chih-hao Hsieh and Richard Dwey

**Sediment-associated phytoplankton release from the seafloor in response to wind-induced currents in the Bering Strait**

Hiroto Abe, Makoto Sampei, Toru Hirawake, Hisatomo Waga, Shigeto Nishino and Atsushi Ooki

**Responses of Japanese anchovy (*Engraulis japonica*) catch to environmental changes in the South Sea of Korea in recent decades: a generalized additive model approach**

Minkyung Bang, Chan Joo Jang and Sukyung Kang

**Reconstructing foraging conditions experienced by salmon on the high seas**

Boris Espinasse, Brian Hunt and Evgeny Pakhomov

**Simple bio-optical proxies for phytoplankton abundance and compositions in complex coastal waters**

Justin Del Bel Belluz, Jennifer M. Jackson, Angelica Peña, Brian P.V. Hunt

**POC/FUTURE/MONITOR Topic Session (S8)**

**Internal tides, nonlinear internal waves, and their impacts on biogeochemistry, climate and marine ecosystems via ocean turbulent mixing processes**

Co-sponsor: OMIX

Convenors: *Shin-ichi Ito (Japan)*, *SungHyun Nam (Korea)*, *John Barth (USA)*, *Annalisa Bracco (USA)*

Invited Speakers:

*Kristen Davis (University of California, USA)*

*Yign Noh (Yonsei University, Korea)*

*Ichiro Yasuda (The University of Tokyo, Japan)*

Background

Mixing in the ocean occurs over a broad range of scales and plays a major role in the exchanges of water, nutrients, carbon and heat, thus controlling ocean biogeochemistry and climate. Ocean turbulent mixing is often associated with internal tides and nonlinear internal waves, however the internal wave generation, propagation, and dissipation mechanisms in most of the North Pacific are not well understood due to limited observations and model capabilities. Intense ocean mixing generally occurs in presence of tidal movements around rough bottom topography such as that found on continental shelves, in straits, atop ocean ridges, and around island chains. Strong internal tides and nonlinear internal waves are commonly found in the North Pacific, particularly in shallow seas, outer and inner shelves, and nearshore zones. Recently, a periodic fluctuation of seawater properties, nutrients and oxygen concentrations synchronous with the 18.6-year nodal tide has been observed in the subarctic and subtropical oceans in the North Pacific. Some studies have suggested that the 18.6-year nodal tide might regulate a basin wide climate mode in the North Pacific that has the potential to accelerate or decelerate climate warming depending on the phase. Given the key role played by ocean mixing in controlling biogeochemical interactions and global climate variability, it is our urgent task to elucidate mechanisms of ocean turbulent mixing processes and its impacts.

Participation involving multiple PICES committees and focusing on internal tides, nonlinear internal waves, ocean mixing processes, and their impacts on biogeochemistry, climate and marine ecosystems were welcomed, specifically, presentations on topics such as (a) observational and numerical approaches to understand internal tides, nonlinear internal waves, ocean mixing processes and their distribution, (b) turbulent mixing impacts on biogeochemistry, climate and marine ecosystems, (c) future projections of North Pacific considering 18.6-year nodal tide.

### Summary of presentations

About 70 persons attended and one plenary, two invited, 13 oral and 7 poster presentations were made. PICES members from five countries, absent Canada, contributed the presentations. The session started with a brief introduction by Dr. Shin-ichi Ito, outlining the need to elucidate the mechanisms of ocean turbulent mixing processes and its impacts.

In advance of S8, a plenary talk by Dr. Kristen Davis showed an application of a novel observation system, “Distributed Temperature Sensing (DTS) System”, to observe nonlinear internal wave arrival and reflection at a coral shelf in the South China Sea. The observations successfully captured high spatio-temporal variability of nonlinear internal waves within a range of a few kilometers. Combining numerical simulation analyses, Dr. Davis concluded that local water column density and shear structure determine whether the nonlinear internal waves were transmitted into shallow waters or reflected back offshore which highly influence the distribution of energy, heat, and nutrients on the coral atoll. During S8, an invited talk by Dr. Ichiro Yasuda introduced an ongoing integrated scientific program entitled “Ocean mixing processes: impact on biogeochemistry, climate and ecosystem (OMIX)” and showed basin-wide microstructure measurements in the North Pacific with a new turbulence observing system using fast response thermistors attached to CTD/rosette packages. OMIX has conducted many *in-situ* observations and has found mixing hot spots along the Kuroshio axis that are controlling biogeochemical cycles and biological production. Dr. Yasuda also pointed out that observed mixing intensity is much weaker than estimated by models. The second invited talk by Dr. Yign Noh showed a Large Eddy Simulation (LES) application to the ocean mixed layer. Using LES model parameter sensitivity, Dr. Noh implied the importance of the Coriolis force in the formation of both seasonal and diurnal thermoclines through interaction between inertial oscillations and wind-generated surface shears. Dr. Noh also presented a LES ecosystem model development in which the nutrient is treated as a passive scalar and phytoplankton are represented by Lagrangian particles. The model allows us to investigate plankton dynamics directly by following the life cycle of each phytoplankton particle as it grows, decays and eventually settles to the deeper ocean. The details of the LES application to the mixed layer were shown by the contributions of early career scientists including Yeonju Choi for the determination factor of the mixed layer depth and Ashley Brereton for plankton thin layer formation.

Dr. Takeyoshi Nagai showed diapycnal nutrient flux at the Tokara Strait caused by Kuroshio-induced turbulence. The results indicated 10 mega molN/day nutrient flux and 5 GW kinetic energy dissipation at the Tokara Strait. Indeed, a talk by Dr. Toru Kobari showed high biological production, including up through meso-zooplankton, downstream of the Tokara Strait. A contributed talk by early career scientist, Chanhung Jeon, showed near-inertial waves advected to downstream by the Kuroshio upstream of the Tokara Strait. In addition, a contributed talk by early career scientist, Suyun Noh, showed internal wave modulations under varying mesoscale variability for 18 years from 2000 to 2017 off the east coast of Korea.

Dr. John Barth introduced an intensive field experiment conducted from the mid-continental shelf, through the inner shelf and into the surf zone near Point Sal, California, USA, from September to October 2017. The intensive field deployed 160 moorings and conducted multi-ship surveys. Nonlinear internal bores which are coherent alongshore for more than 40 km were observed from two offshore energy generation sites and 80% of them reached to the 15 m depth contour. Dr. Eiji Masunaga’s talk also focused on non-linear internal tides and showed suspension sediments, offshore transport of suspended sediments transported by a convergent flow on the main pycnocline, which results in intermediate nepheloid layers, using a numerical simulation. Dr. James Leichter noted spatial heterogeneity in high-frequency temperature variability associated with internal tides using high resolution water column temperature time series data collected from multiple sites along the coastline of San Diego, California. He hypothesized that the internal tides possibly altered patterns of nutrient



exposure at kelp forest sites in this region. Dr. Alex Wyatt described the cooling effects of internal wave breaking on structure and function of coral reef ecosystems by comparing two observational sites in the Japanese Iriomote Island. Dr. Vadim Navrotsky reported on internal wave effects on biological production in the Peter the Great Gulf.

In addition, Dr. Hidekatsu Yamazaki reported on the development of two types of fluorescence probe, LED (~2 cm resolution) and laser (~2 mm resolution) which can be mounted on a free-fall microstructure profiler. The observational data showed high variability of fluorescence with mm-length scale which represent aggregation of planktons. Dr. Satoshi Osafune described a numerical study of the impacts of the 18.6-year modulation of tide-induced mixing on biogeochemical variables.

In poster presentations, early career scientist, Seung-Woo Lee, showed internal wave observational results. Dr. Takahiro Tanaka showed internal hydraulic jump observations. Early career scientist, Taiga Honma, and Dr. Naoki Yoshie gave additional evidence of impacts on ecosystems by the nutrient inputs at the Tokara Strait, and early career scientist, Jianchao Li, noted the influence of cold water mass on Pacific cod. Dr. Marika Takeuchi showed marine aggregate observations from a seafloor optical measurement system off the east coast of Japan and a poster presentation by Dr. Konstantin Rogachev described amplified current variability associated with the 18.6-year lunar nodal cycle.

From the above presentations, we found (a) various observational and numerical approaches to understand internal tides, nonlinear internal waves, ocean mixing processes and their distribution, and studies on (b) turbulent mixing impacts on biogeochemistry, climate and marine ecosystems and importance of (c) 18.6-year nodal tide variability in the North Pacific. PICES scientists are vigorously studying mixing process and their impacts on marine ecosystems over a variety of scales from millimeters to the North Pacific basin scale, and using a variety of approaches including *in situ* observations, remote sensing, and numerical modeling. We look forward to future progress and discussion of this topic.

## List of papers

### *Oral presentations*

#### **Fate of internal waves on a shallow shelf (Plenary)**

Kristen A. [Davis](#), Robert S. Arthur, Justin Rogers, Oliver Fringer, Emma C. Reid, Thomas M. DeCarlo, and Anne L. Cohen

#### **Progress report: Ocean mixing processes: impact on biogeochemistry, climate and ecosystems (OMIX) (Invited)**

Ichiro [Yasuda](#)

#### **Role of turbulent mixing in plankton dynamics simulated by large eddy simulation (LES) (Invited)**

Yign [Noh](#)

#### **The scaling of the mixed layer depth under surface heating by using LES**

Y. [Choi](#) and Y. Noh

#### **Diapycnal nutrient flux caused by the Kuroshio induced turbulence in the Tokara Strait**

Takeyoshi [Nagai](#), Daisuke Hasegawa, Hirohiko Nakamura, Ayako Nishina, Toru Kobari, Naoki Yoshie, Ryuichiro Inoue and Eisuke Tsutsumi

#### **The interactions between phytoplankton, nutrients and turbulence simulated by a large-eddy simulation (LES) ecosystem model with Lagrangian phytoplankton**

Ashley [Brereton](#) and Yign Noh

#### **Internal waves, tides, eddies and wind-driven currents across the inner shelf**

John A. [Barth](#), James A. Lerczak, Jacqueline McSweeney and Stephen D. Pierce

#### **Mixing and transports induced by nonlinear internal wave breaking in coastal regions**

Eiji [Masunaga](#), Robert S. Arthur, Oliver B. Fringer and Hidekatsu Yamazaki

## Session Summaries – 2018

### **Near-inertial waves advected by the Kuroshio from observation and simulation**

Chanhyung Jeon, Jae-Hun Park, Hirohiko Nakamura, Ayako Nishina, Xiao-Hua Zhu, Hong Sik Min, Dong Guk Kim, Sok Kuh Kang, Hanna Na, and Naoki Hirose

### **Observations on internal wave modulations under varying mesoscale variability for 18 years from 2000 to 2017 off the east coast Korea**

Suyun Noh and SungHyun Nam

### **Thermocline dynamics and modulation of a nutrient exposure for Eastern Pacific kelp forests in Southern California**

James J. Leichter

### **Linking internal wave dynamics and the structure and function of coral reef ecosystems**

Alex S.J. Wyatt, James J. Leichter, Toshihiro Miyajima and Toshi Nagata

### **Numerical study on impacts of the 18.6-year modulation of tide-induced mixing on biogeochemical variables based on ESTOC**

Satoshi Osafune, Toshimasa Doi, Shinya Kouketsu, Tadashi Hemmi, Shuhei Masuda

### **On energy and matter exchange between near-shore and out-of-shelf waters defining shelf ecosystems state**

Vadim Navrotsky

### **Turbulent nitrate flux stimulates plankton productivity and trophodynamics even in the oligotrophic Kuroshio**

Toru Kobari, Taiga Honma, Gen Kume, Daisuke Hasegawa, Koji Suzuki, and Naoki Yoshie, Xinyu Guo, Hirohiko Nakamura, Ayako Nishina, Eisuke Tsutsumi and Takeshi Matsuno

### **Phytoplankton distribution at a meter scale and a millimeter scale**

Hidekatsu Yamazaki, Marika Takeuchi, Mark Doubell, Herminio Foloni-Neto and Mamoru Tanaka

## *Poster presentations*

### **Response of plankton standing stocks and productivity to turbulent nitrate flux in the Kuroshio across the Tokara Strait**

Taiga Honma, Toru Kobari, Takeru Kanayama, Fukutaro Karu, Naoki Yoshie, Daisuke Hasegawa, Ayako Nishina, Hirohiko Nakamura

### **Effects of strong turbulent mixing on phytoplankton around the Tokara strait**

Naoki Yoshie, Miwa Nakagawa, Hayato Mizuguchi, Taisei Kanda, Ieo Mutou, Eisuke Tsutsumi, Toru Kobari and Xinyu Guo

### **Characteristics of mode-1 and mode-2 nonlinear internal waves observed in the northern East China Sea**

Seung-Woo Lee, and SungHyun Nam

### **Amplified diurnal currents over the shallow banks and 18.6-year variability of salinity of the intermediate waters in the Western Subarctic Pacific**

Konstantin Rogachev and Natalia Shlyk

### **Size distributions of marine aggregates in different aquatic systems**

Marika Takeuchi, Mark J. Doubell, George A. Jackson and Hidekatsu Yamazaki

### **Elevated mixing in the Tsugaru Strait through internal hydraulic jump**

Takahiro Tanaka, Daisuke Hasegawa, Takeshi Okunishi, and Hitoshi Kaneko

### **The influence of Yellow Sea cold water mass on the early life history process of young Pacific cod (*Gadus macrocephalus*)**

Jianchao Li, Rui Wu, Feng Jiang, Chi Zhang, Yongjun Tian, Xiaolin Yu, Rong Wan

## **HD Topic Session (S9)**

### **Integration of science and policy for sustainable marine ecosystem services**

Convenors: *Shang Chen (China), Daniel K. Lew (USA), Jungho Nam (Korea)*

#### Background

The provisioning, cultural, regulating and supporting services are the major benefits people obtain from the coastal and marine ecosystems. The identification, quantification, valuation and management of ecosystem services are key scientific questions, and have attracted more concerns from both the major intergovernmental organizations (such as PICES, ICES, IMBeR, IPBES) and the environmental organizations (such as WWF, TNC, ESP). The goals of this session were: (1) to provide a venue for marine scientists and social scientists to exchange results from research on identification, quantification, valuation and management of ecosystem services, and (2) to provide a platform to share and discuss the integration of ecosystem service science into policy-making of marine affairs. This session will continue providing strong support to the TORs of HD committee and contribute a greater understanding of social and economic status of the North Pacific ecosystem and fill the gaps to achieve the FUTURE Objectives.

#### Summary of presentations

On Tuesday, October 30, 2018, the Working Group on Marine Ecosystem Services (WG-MES) convened a 1-day topic session on “Integration of science and policy for sustainable marine ecosystem services.” Co-Convenors, Dr. Shang Chen (China) and Jungho Nam (South Korea) were unable to attend, so the session was chaired by Dr. Dan Lew (USA), who provided an introduction that included a description of the session and its goals and introductory material on marine ecosystem services. The session was well-attended, with 30+ people in the morning session and about 25 in the afternoon session. Thirteen speakers were originally scheduled to give presentations, but three cancelled and one that was expected did not show up.

Following the morning presentations, the presenters and audience engaged in a discussion about challenges related to ecosystem-based management (EBM), including challenges in the measurement of values (economic as well as cultural ones), challenges to engaging indigenous peoples in the EBM process, and other key topics. The afternoon presentations resulted in extended discussions during the question and answer time for each speaker.

#### List of papers

##### *Oral presentations*

##### **Arctic Council and Ecosystem Approach to Management: Integrating ecosystem service science into guidelines**

Elizabeth Logerwell, Hein Rune Skjoldal

##### **Evolution of district marine policies in China: The case of Shandong Province**

Meng Su, Ying Yang

##### **Vulnerability to impacts of climate change on marine fisheries and food security**

Qi Ding, Xinjun Chen, Ray Hilborn and Yong Chen

##### **Environment and culture in an island community: some insights for re-building the framework of cultural ecosystem service**

Aoi Sugimoto

## Session Summaries – 2018

### **Study on eco-compensation mechanism based on valuation of ecosystem services in Marine Protected Areas**

Keliang [Chen](#), Yuliang Li, Heng Liu

### **Estimating the potential of Japanese fisheries: Upside bioeconomic analysis**

Gakushi [Ishimura](#), Kanae Tokunaga, Shigehide Iwata, Keita Abe, Jennifer Couture, Merrick Burden, Kristin Kleisner, Rod Fujita, Kazuhiko Otsuka

### **Maritime spacial planning in Russia: Problems and prospective**

Iana [Blinovskaia](#), Elena Mazlova

### **Crafting science-based ocean policy for sustained ecosystem services: balancing place, people, and profits**

Franklin B. [Schwing](#)

### **Using choice models to assess the economic value of large marine protected areas off the U.S. west coast**

Kristy [Wallmo](#) and Rosemary Kosaka

### *Poster presentations*

#### **Preliminary analysis of the Jimo coastal ecosystem with the Ecopath model**

Meng [Su](#)

#### **The value of ecosystem services of the West Bering Sea**

Artyom Y. [Tadzhibaev](#), Olga N. Lukyanova

## **POC/BIO Topic Session (S10)**

### **Ocean acidification and deoxygenation and their impact on ocean ecosystems: Synthesis and next steps**

Co-sponsor: ICES

Convenors: *Tsuneo Ono (Japan), Jim Christian (Canada), Silvana Birchenough (ICES)*

Invited Speakers:

*Christopher Harley (Department of Zoology, University of British Columbia, Canada)*

*Shoshiro Minobe (Faculty of Science, Hokkaido University, Japan)*

### Background

Studies of ocean acidification (OA) are showing progress, in particular, monitoring of oceanic acidification status (ca. pH, pCO<sub>2</sub> and Ω aragonite, Ω calcite) in the various PICES countries has significantly progressed in recent years. Progress has also been achieved in the field of biological OA impact. The importance of interactions with other stressors (temperature, deoxygenation, *etc.*), interspecific interaction (*e.g.*, OA effects on prey species), and biological ability to adapt to OA stress, are increasingly recognized. The session welcomed presentations from the fields of OA monitoring and impact experiments, to construct new perspective on present OA status in the North Pacific, as well as presentations on future projections, and about plans for further progress in our understanding, such as continuous carbon system monitoring by new technologies, new experimental studies for OA adaptation, and field observation of biological responses to existing OA and deoxygenation events.

### Summary of presentations

POC/BIO Topic session on “Ocean acidification and deoxygenation and their impact on ocean ecosystems: Synthesis and next steps,” co-sponsored by ICES, was held on November 1, 2018, at the PICES-2018 in

Yokohama. One plenary talk (Shoshiro Minobe), 16 oral presentations, including one invited speaker (Christopher D.G. Harley) and five poster presentations were made during a full-day session. The room with a seating capacity of 70 was at times completely filled, and the session was conducted briskly but with a congenial atmosphere. This session follows a previous sess at PICES-2016 that covered changes in carbon chemistry and its consequences for ocean ecosystem, but further enhanced the scope to include other issues such as ocean deoxygenation and changes in alkalinity.

Dr. Minobe presented excellent overview of ocean deoxygenation studies in North Pacific regions, pointing out an urgent question on discrepancies between observation and model simulations. More detailed analysis of ocean deoxygenation in regions off from the Canadian continental margin and its consequences for seamount ecosystems were reported by Tetjana Ross. Angelica Peña and Amber M. Holdsworth introduced future projections of ocean acidification and deoxygenation along the Canadian continental margin. These talks illustrated that this area will be faced with severe ocean acidification (OA) and deoxygenation in the next 50 years. Jessica Cross showed that alkalinity is also changing in the North Pacific as a consequence of biological shifts caused by ocean warming. James Christian presented distribution of alkalinity in ocean models, which are still very limited in their ability to reproduce the observed distribution.

The afternoon session started with an overview by Christopher Harley on multi-level complexity of biological response to multiple stressors including ocean acidification. Kunsan Gao presented a more detailed overview of phytoplankton response to OA, introducing results of a series of field and laboratory experiments carried out in China. William Cochlan described another aspect of OA effects on phytoplankton communities: the change in toxicity of some diatoms with ocean acidification.

Our session covered OA studies in both the Arctic and Antarctic oceans. Di Qi introduced Chinese OA monitoring studies in Arctic Ocean, while Taewon Kim reported on results of a culture experiment which assessed the response of Antarctic amphipods to ocean freshening and acidification. Masahiko Fujii presented a detailed description of coastal pH variations observed along Japanese subarctic coast at Oshoro Bay, as well as efforts in developing coastal models that can simulate the observed pH variations. Haruko Kurihara further extended this, introducing the organized OA monitoring network along the Japan coast.

The last four presentations of the afternoon session discussed studies on natural CO<sub>2</sub> seeps. Jason Hall-Spencer made a good review of natural CO<sub>2</sub> seep studies across the world oceans, pointing out the general loss of biodiversity and spatial complexity in the acidified ecosystem. Shigeki Wada and Shingo Kurosawa introduced results of field observations at the natural seep site at Shikinejima Island, Japan. They showed that both standing stock and productivity of phytobenthos in the acidified area were the same as the surrounding areas, but the flora had changed to species that are more movable with water flow in the acidified area. Ben Harvey demonstrated the potential risk to gastropods inhabiting acidified areas, from losing their protective coloration by dissolution of their shell surface.

In addition to the oral presentations, we had four poster presentations regarding deoxygenation in the Japan Sea (Toshiya Nakano), OA response of organisms in the North Pacific subsurface (Tsuneo Ono), model studies of pCO<sub>2</sub> (Akihiko Ishida) and pH (Miho Ishizu) in the North Pacific region, and studies on communications between OA scientists and policy makers (Abigail McQuatters-Gollop). These excellent presentations demonstrate that our understanding of ocean acidification and deoxygenation has steadily progressed, but many key questions are still unresolved, and prediction of the state of future ocean ecosystems is difficult. We will continue holding sessions on OA and deoxygenation studies at future PICES meetings, hoping that our understanding will further progress.

List of papers

*Oral presentations*

**O<sub>2</sub> trends in the last six decades (Plenary)**

Shoshiro Minobe

**The large-scale distribution of dissolved inorganic carbon, alkalinity and oxygen in the North Pacific: a global ocean modelling perspective**

James R. Christian, A.M. Holdsworth, W.G. Lee, O.G.J. Riche, A. Shao, N. Swart, and D. Yang

**Long-term variability in the Oxygen Minimum Zone and carbonate chemistry in the North East Pacific and potential impacts on seamount communities**

Tetjana Ross, Cherisse Du Preez, Debby Ianson, Tammy Norgard and Marie Robert

**Ocean acidification impacts on biogeochemistry and the decadal variability of Total Alkalinity**

Jessica N. Cross, Brendan R. Carter, Samantha A. Siedlecki, Simone R. Alin, Nina Bednarsek, Andrew G. Dickson, Richard A. Feely, Richard H. Wanninkhof, Alison M. Macdonald, Sabine Mecking, and Lynne D. Talley

**A model simulation of future biogeochemical conditions along the British Columbia Continental Shelf**

Angelica Peña, Isaac Fine, and Wendy Callendar

**High resolution biogeochemical modelling of Canadian Northeast Pacific Waters**

Amber M. Holdsworth, James R. Christian and Youyu Lu

**Confronting the complexities of ecological responses to ocean acidification (Invited)**

Christopher D.G. Harley

**Effects of ocean acidification on phytoplankton physiology and primary productivity**

Kunshan Gao

**Increase in acidifying water in the western Arctic Ocean**

Di Qi, Liqi Chen, Baoshan Chen, Zhongyong Gao, Wenli Zhong, Richard A. Feely, Leif G. Anderson, Heng Sun, Jianfang Chen, Min Chen, Liyang Zhan, Yuanhui Zhang, Wei-Jun Cai

**Evaluation and prediction of the influences of ocean acidification to the subarctic coast**

Takuto Yamaka, Shintaro Takao and Masahiko Fujii

**Effects of ocean freshening and acidification on benthic animals of Antarctica**

Taewon Kim, Seojeong Park, Eunchong Sin, Boong-ho Cho, In-young Ahn

**Effects of ocean warming and acidification on the growth and toxicity of Pseudo-nitzschia australis from the California Current Upwelling system**

William P. Cochlan, Christopher E. Ikeda, Charles J. Wingert and Vera L. Trainer

**Evaluation of carbon chemistry along the near-shore coast of Japan**

Haruko Kurihara, Naoko Yasuda, Michiyo Yamamoto-Kawai, Shota Shimizu, Masahiro Nakaoka and Hyojin Ahn

**Photosynthetic activity of early successional phyto-benthos at a shallow CO<sub>2</sub> seep off Shikine Island, Japan**

Shigeki Wada, Agostini Sylvain, Ben Harvey, Yuko Omori, Jason Hall-Spencer

**The ecological effects of ocean acidification in the North Pacific Ocean**

Jason Hall-Spencer, Ben Harvey, Shigeki Wada, Koetsu Kon, Marco Milazzo, Kazuo Inaba, Sylvain Agostini

**Effects of ocean acidification on net community production in coastal ecosystems: In situ assessment in natural CO<sub>2</sub> seeps**

Shingo Kurosawa, Shigeki Wada, Sylvain Agostini, Ben Harvey, Marco Milazzo and Jason Hall-Spencer

**Dissolution: the Achilles' heel of gastropods in an acidifying ocean**

Ben P. Harvey, Sylvain Agostini, Shigeki Wada, Kazuo Inaba and Jason M. Hall-Spencer

*Poster presentations*

**Communicating ocean acidification in East Asia: what are the key messages for policy makers and society?**

Abigail McQuatters-Gollop and Jason Hall-Spencer

**Recent deoxygenation in the Japan Sea Proper Water in the northeastern Japan Basin**

Toshiya Nakano, Daisuke Sasano, Takahiro Kitagawa, Naoki Nagai, Yoshiteru Kitamura, Michio Aoyama and Masao Ishii

**Temporal variation of the saturation state of carbonate in intermediate waters of western North Pacific**

Tsuneo Ono, Katsunori Kimoto, and Yuji Okazaki

**A marine carbon model coupled with an operational ocean model product for ocean acidification studies in the North Western Pacific**

Miho [Ishizu](#), Yasumasa Miyazawa, Tomohiko Tsunoda, Xinyu Guo

**Long-term Trends in surface ocean pCO<sub>2</sub> seasonality in the northwestern North Pacific**

Akio [Ishida](#)

**MONITOR Topic Session (S11)**

**Influence of climate and environmental variability on pelagic and forage species**

Convenors: *Matthew Baker (USA), Sei-Ichi Saitoh (Japan), Mary Hunsicker (USA), Elizabeth (Ebett) Siddon (USA)*

Invited Speaker:

*Haruka Nishikawa (Japan Agency for Marine-Earth Science and Technology, Japan)*

Background

Climate and environmental variability have profound effects on pelagic ecosystems from zooplankton to fish and invertebrate stocks. The dynamics of fish species within the pelagic environment may be particularly responsive to environmental drivers, including temperature and salinity, as well as biological drivers, such as prey production and phenology. In addition, differential species responses to environmental and biological drivers may alter fish condition and interactions. Understanding the mechanisms that drive pelagic fish dynamics is important for estimating fish survival and recruitment. This session's aim was to integrate research that elucidates mechanisms linking climate with recruitment, survival and condition of forage species, larval and juvenile pelagic stages of ground fish, and pelagic fishes more generally. Papers were encouraged in a wide range of topics relevant to environmental and biological conditions and pelagic species or stages, particularly those in the following areas: biophysical interactions; recruitment fluctuations in response to climate and environmental conditions; shifts in species dynamics, distribution and behavior related to environmental forcing; research on critical life history stages in the pelagic environment; and modeling approaches to improve understanding of environmental effects using climate hindcasts and time series analyses and/or forward projections and climate forecasts.

List of papers

*Oral presentations*

**Present situation and future prospects of study on sardine and climate change (Invited)**

Haruka [Nishikawa](#)

**Practical procedure for potential fishing zone prediction of neon flying squid (*Ommastrephes bartramii*) in the north western North Pacific**

Sei-Ichi [Saitoh](#), Irene Alabia, Hiromichi Igarashi, Yoichi Ishikawa, Masafumi Kamachi and Yutaka Imamura

**Recent decline in winter stock of Japanese flying squid, *Todarodes pacificus* related to climate change during winter-spring**

Yasunori [Sakurai](#)

**Analysis of monthly variation of fishing zone for Pacific saury using Multi-Sensor satellite and fishery data**

Yang [Liu](#), YongJun Tian, Hao Tian, Guanyu Chen, Jianchao Li, Shigang Liu, Luxin Yan, Yuan Li and Long-Shan Lin

**Spatial distributions and catch rates variability of Bigeye tuna (*Thunnus obesus*) cohorts related to oceanographic and climatic indices in the Pacific Ocean**

Tzu-Hsiang Lin, Kuo-Wei Lan

**Climate and potential impacts on distribution and life history: Arctic cod and saffron cod, and Pacific sand lance and Pacific herring**

Matthew R. Baker, Mike Sigler, Bob Lauth, Beth Matta, Erin Horkan, Nicole Parris

**Biogeographic patterns of marine communities in the Pacific Arctic under a warming ocean**

Irene D. Alabia, Jorge García Molinos, Sei-Ichi Saitoh, Takafumi Hirata, Toru Hirawake, and Franz J. Mueter

**Ecosystem stress test: what an ice-free winter might mean for the eastern Bering Sea**

Janet Duffy-Anderson, Elizabeth Siddon, Phyllis Stabeno, Alex Andrews, Alison Deary, Corey Fugate, Colleen Harpold, David Kimmel, Jesse Lamb and Steve Porter

**Community and trophic impacts of the unprecedented North Pacific marine heatwave on forage taxa in the northern California Current**

Richard D. Brodeur, Mary E. Hunsicker, Toby D. Auth, and Todd W. Miller

**Application of time series analysis to detect the effect of multi-scale climate indices on global yellowfin tuna population**

Yan-Lun, Wu, Kuo-Wei Lan

**Long-term variations and hotspots in habitat of Japanese-Spanish mackerel (*Scomberomorus niphonius*) based on spatial analysis**

Peng Lian, Yongjun Tian, Jianchao Li, Haiqing Yu, Yang Liu, Caihong Fu, Xindong Pan, Qinghuan Zhu, Chi Zhang, Zhenjiang Ye

**The potential effects of climate change on suitable habitat for the fourfinger threadfin (*Eleutheronema rhadinum*) in the coastal waters of Taiwan**

Sheng-Yuan Teng, Ming-An Lee and Nan-Jay Su

**Climate variability with impacts on habitat suitability of chub mackerel *Scomber japonicus* in the East China Sea**

Wei Yu, Xinjun Chen, Weiguo Qian and Yuesong Li

**Application of bulk and compound specific isotopes to resolving regional productivity regimes experienced by Pacific Herring (*Clupea pallasii*) on the coast of British Columbia, Canada**

Brian P. V. Hunt, Evgeny A. Pakhomov, Wade Smith

**Seasonal dynamics in pelagic fish abundance around Set-net in Kochi prefecture**

Yanhui Zhu, Kenji Minami, Yuka Iwahara, Kentaro Oda, Koichi Hidaka, Osamu Hoson, Kouji Morishita, Sentaro Tsuru, Masahito Hirota, Hokuto Shirakawa and Kazushi Miyashita

**Long-lived marine fish employing broadcast spawning may be resilient to environmental variability: a selective sieve hypothesis**

Jacek Maselko

**The effect of oceanographic variability on pelagic larval fishes of the Northern Bering and Chukchi Seas**

Elizabeth Logerwell, Morgan Busby, Kathy Mier, Heather Tabisola and Janet Duffy-Anderson

**Effects of environmental variabilities on the early life stage of Pacific chub mackerel *Scomber japonicus* in the Northwest Pacific**

Chenyng Guo and Shin-ichi Ito

**Influence of climate warming for migration, growth and survival of Japanese chum salmon in the North Pacific Ocean and the Okhotsk Sea**

Masahide Kaeriyama and Yusuke Urabe

**Large zooplankton abundance as an indicator of Walleye Pollock recruitment in the southeastern Bering Sea**

Lisa Eisner, Ellen Yasumiishi and Alex Andrews

***Calanus sinicus* and its relationship with climate variability in the northern Yellow Sea**

Qing Yang, Jinqing Ye, Hui Liu

**Physical factors influencing the recapture rate and yield of the edible jellyfish in the Liaodong Bay, China**

Liping Yin, Xiujian Shan, Chang Zhao, Guansuo Wang, Fangli Qiao

**Seabird density relative to their prey and water mass distributions around St. Lawrence Island, northern Bering Sea during summer**

Bungo Nishizawa, Haruka Hayashi, Nodoka Yamada, Hiromichi Ueno, Tohru Mukai, Toru Hirawake, and Yutaka Watanuki



*Poster presentations*

**Spatiotemporal variations of chaetognaths associated with hydrographic features in the coastal waters off southwestern Taiwan**

Wentseng Lo and Wenting Luo

**Why the body size of walleye pollock larvae in Funka Bay and the adjacent waters, Hokkaido was large in 2016?**

Mitsuhiro Ishino, Tomonori Hamatsu, Masayuki Chimura, Hiroshige Tanaka and Yuuho Yamashita

**Changes in the fish species composition seasonality and in the coastal zones of the Tsushima warm current during periods of climate change: Observations from the set-net fishery of Chiba Prefecture in Japan**

Ching-Hsien Ho and Nobuyuki Yagi

**On the relationship between sea temperature and fishing ground formations of chub mackerel in the region off Sanriku, northwestern Pacific**

Takeshi Okunishi, Daisuke Hasegawa, Chikako Watanabe, Ryuji Yukami and Kazuyoshi Watanabe

**Occurrence of Japanese whiting *Sillago japonica* in the shallow coastal waters of the central Seto Inland Sea**

Yuji Terada and Jun Shoji

**Assessing the availability and accessibility of prey for the Southern Resident Killer Whales**

Mei Sato and Andrew W. Trites

**Photobehaviors of the marine calanoid copepod *Calanus sinicus* under wavelength-specific light**

Zhencheng Tao, Mengtan Liu and Wuchang Zhang

**Salmon and people in a changing world: Introducing the International Year of the Salmon (IYS)**

Mark Saunders, Madeline Young and Suam Kim

**Distribution of demersal fishes in the southern Chukchi Sea and Northern Bering Sea after low ice conditions**

Ringo Nishio, Yuki Takemuro, Bungo Nishizawa, Tsubasa Nakano, Toru Hirawake and Orio Yamamura

**Effects of climate variability on body condition of forage fish sampled by puffins in the Gulf of Alaska**

Sarah Ann Thompson, Marisol García-Reyes, William J. Sydeman, Mayumi L. Arimitsu, Heather M. Renner, Scott A. Hatch, and John F. Piatt

**FIS Topic Session (S12)**

**Applying ecosystem considerations in science advice for managing highly migratory species**

Co-sponsor: ISC

Convenors: *Steve Teo (ISC/USA, Carolina Minte-Vera (IATTC), Gerard DiNardo (PICES/USA)*

Invited Speaker:

*Yong Chen (School of Marine Sciences, University of Maine, USA)*

Background

Large-scale oceanographic processes and bioenergetic requirements determine the distribution and productivity of many pelagic fish populations in the North Pacific. For example, highly migratory species (HMS), such as albacore tuna (*Thunnus alalungus*) and Pacific sardine (*Sardinops sagax*), have environmental thresholds and preferences, as well as energetic requirements to sustain growth and survival that drive their distribution and productivity. Managing HMS has traditionally focused on maintaining the sustainability of targeted stocks and, as such, comprehensive data sets on the catches, biology and ecology of many exploited stocks exists. In many cases, there are limited quantitative data describing ecosystem impacts on HMS, social and economic impacts on HMS fisheries due to ecosystem variability, and limited formal consideration of the roles of external drivers (e.g., oceanographic variability) in the context of sustainability and governance. Beyond these limitations there

is also the challenge to identify linkages and important relationships both within ecosystems (including exploited stocks), and across social, economic and governance facets of fisheries management. This workshop provided an overview of contemporary research on the topic, including the identification of statistical modeling approaches that link spatially explicit environmental data (e.g., satellite derived SST) to distributional fish data (e.g., fishery-dependent and fishery-independent), methods to assess impacts of oceanographic variability on fish productivity and socioeconomic decision making, methodologies that explicitly incorporate environmentally driven dynamics into HMS stock assessments, and challenges facing governance when applying ecosystem considerations.

### Summary of presentations

This topic session was convened by WG 34: Joint PICES-ISC Working Group on *Oceanographic Conditions and the Distribution and Productivity of Highly Migratory Fish*. The invited speaker was Yong Chen (University of Maine, USA), who gave a plenary presentation on “Challenge and opportunity for fisheries stock assessment in changing environments”. He described how changing environmental conditions can challenge traditional stock assessment methods, but also described some future paths forward, to address some of these issues.

Shingo Kimura described a new method of detecting changes in otolith oxygen stable isotope ratios in Pacific bluefin tuna. The Secondary Ion Mass Spectrometry (SIMS) technique can recreate hindcast potential water temperatures experienced by fish at much higher temporal resolution than previously, including estimation of water temperatures at the time of spawning.

Early career scientist, Ayako Suda, reported on the identification of male-specific DNA markers in Pacific bluefin tuna. A PCR-based method was shown to correctly identify the sex of 131 individual fish, which will contribute to determining optimum sex ratios for aquaculture of this valuable species.

Early career scientist, Kento Nakatsugawa, presented on some apparent spatial changes in the distribution of North Pacific albacore over the last several decades. A westward shift in the distribution of this species may be related to fluctuations in key prey species in the central-western North Pacific, including Japanese sardine, and Japanese anchovy.

Barbara Muhling also described results from a study on North Pacific albacore, showing how migration paths in this species may be related to both optimum temperature ranges, and primary production, which can be used as a proxy for foraging conditions. These may also drive some of the latitudinal shifts in albacore off the western North American coast.

Gerard DiNardo presented results of a study led by Desiree Tommasi, on a management strategy evaluation of North Pacific albacore. Simulation results showed how the likelihood of meeting a range of target conditions identified by stakeholders depended on a combination of harvest guidelines, and reference points adopted.

Ning Chen showed estimates of fishing mortality (F), and FMSY for Fang’s blenny in Haizou Bay, China, using length-based assessment methods implemented by two different R software packages. The advantages of each package depended on the amount of survey data available to inform them.

Early career scientist, Oxana Mikhaylova, presented on the stock assessment of northern shrimp off Kamchatka, Russia. She described how improving information on the age of the shrimp has allowed several methodological improvements in the assessment over time.

Early career scientist, Xindong Pan, closed the oral session by describing life-history connectivity in Japanese Spanish mackerel from otolith chemistry. Results of his study suggested that immature fish mixed substantially after spawning, and local mackerel assemblages which support fisheries may derive recruitments from multiple geographic locations.

List of papers

*Oral presentations*

**Challenge and opportunity for fisheries stock assessment in changing environments (Plenary)**

Yong Chen

**Effects of global warming on spawning behavior of the Pacific bluefin tuna based on otolith oxygen stable isotope analysis**

Shingo Kimura, Yulina Hane, Yusuke Yokoyama, Yosuke Miyairi, Takayuki Ushikubo and Nobuhiro Ogawa

**Development of male-specific DNA markers in the Pacific bluefin tuna (*Thunnus orientalis*): Potential applications for sex ratio control in aquaculture and contribution to tuna resource management**

Ayako Suda, Tsubasa Uchino, Issei Nishiki, Yuki Iwasaki, Masashi Sekino, Tetsuya Akita, Nobuaki Suzuki and Atushi Fujiwara

**Spatio-temporal distribution of albacore *Thunnus alalunga* and its relationship with environmental changes in the Pacific Ocean**

Kento Nakatsugawa, Hidetada Kiyofuji and Shingo Kimura

**Migration paths and habitat use of albacore in the eastern North Pacific, with implications for surface fisheries**

Barbara Muhling, Desiree Tommasi, Owyn Snodgrass, Heidi Dewar

**A management strategy evaluation framework to assess robustness of harvest guidelines for North Pacific Albacore tuna to variable productivity and distribution**

Desiree Tommasi, Barbara Muhling Steve Teo, and Gerard DiNardo

**Evaluating the performance of two methods for estimating fishing mortality rate of Fang's blenny (*Pholis fangi*) based on size frequency data**

Ning Chen, Chongliang Zhang, Ming Sun, Binduo Xu, Ying Xue, Yiping Ren, Yong Chen

**Commercial stock assessment and forecast of northern shrimp *Pandalus eous* on the south-western Kamchatka**

Oxana G. Mikhaylova and Oleg I. Ilyin

**Life-history connectivity in a highly migratory fish, Japanese Spanish mackerel (*Scomberomorus niphonius*), implications from otolith chemistry**

Xindong Pan, Chi Zhang, Zhenjiang Ye, Binduo Xu, Yang Liu and Yongjun Tian

*Poster presentations*

**Changes in Pacific cod (*Gadus macrocephalus*) size distribution in the North Pacific Ocean over 6 millennia: possible impacts of fishing pressure or environmental variability**

Catherine F. West, Michael A. Etnier, Megan A. Partlow, Steven Barbeaux, Alexei Orlov

**Variation in the catch rate and distribution of swordtip squid (*Uroteuthis edulis*) associated with factors of the oceanic environment in the southern East China Sea**

Jia-Huei Lin, Kuo-Wei Lan and Cheng-Hsin Liao

**Review of stock status of Japanese domestic fisheries and new harvest control rule in Japanese domestic fisheries management**

Momoko Ichinokawa and Hiroshi Okamura

**Role of shallow channel to space-time variation of coastal fisheries resources - Relationship between coastal fisheries resources and oceanographic condition in Hyuga-Nada, Japan**

Tsutomu Tokeshi, Kenji Nakanishi and Hirotaka Toyama

## BIO Contributed Paper Session

Convenors: *Se-Jong Ju (Korea), Debora Iglesias-Rodriguez (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. This session welcomed all papers on the biological aspects of marine science within the PICES region. Contributions from early career scientists were especially encouraged.

### Summary of presentations

The BIO Paper Session at PICES-2018 had the most presentations of any Committee-sponsored Paper Session, with a total of 9 oral and 27 poster presentations. Oral presentations were held during the morning and were well attended (over 30 participants). The talks focused on relatively lower trophic levels of biological issues, *i.e.*, phytoplankton (2), zooplankton (5), and energy transfer (2). However, poster presentations covered a broad spectrum of biological topics, from bacteria to seabirds and mammals. 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.

Early career scientist, Mr. Se Hyeon Jang, presented the sequencing results of flagellum genes of the fast-swimming dinoflagellate *Ansanella granifera*. The results showed that the number of expressed flagellar structural and functional genes of *A. granifera* were not markedly different from those of other dinoflagellates or motile small flagellates, but much greater than those of non-motile species. Furthermore, the phylogenetic tree based on the flagellar genes is likely to give a clue to resolve the problem of separation in a big clade of a dinoflagellate order, which has existed in the phylogeny based on ribosomal DNA.

The second early career scientist presenter, Mr. Junya Hirai, described the result of molecular approaches to reveal reproductive isolation of oceanic copepods (species- and population-level for *Pleuromamma abdominalis* and *Cosmocalanus darwini*, respectively) because an appropriate evaluation of reproductive isolation is important to determine species boundary and population structure of marine planktonic copepods, leading to further understanding of global biodiversity. In his study, a restriction site-associated DNA sequencing (RAD-Seq) method was applied and genome-wide single nucleotide polymorphisms (SNPs) data were analyzed. The genetic clades based on SNP data corresponded with those based on COI sequences, supporting species-level isolations among mtDNA clades. Although there were no sequence variations in COI sequences, SNP data revealed distinct population-level isolations between the North and South Pacific. The results suggested that genome-wide SNP data provide new insights on not only species boundary/population structure but also species/genetic diversity of oceanic copepods.

The next early career scientist, Dr. Lei Xu, described the results of speciation of Ostracods (Crustacea, Ostracoda) in the South China Sea using molecular tools (the mitochondrial COI gene). The results showed that sequence divergence among species varies within a large range, from 12.93% to 35.82%. Sixteen of the taxonomic units recovered by DNA taxonomy agree well with morphology, but *Paraconchoecia oblonga*, *Conchoecia magna* and *Halocypris brevisrostris* split into two clades each, each of which contains cryptic species. Moreover, the results suggested that *Porroecia spinirostris*, a dominant species of ostracods in the

South China Sea, can achieve long distance dispersal with mild genetic differentiation among populations in the South China Sea, where population genetic structure is strongly impacted by colonization patterns.

Early career scientist, Mr. Yuki Takemuro, showed the sampling efficiency and size-selectivity of three gears (bongo net: 0.7 m diameter, 0.505 mm mesh; Matsuda-Oozeki-Hu-Trawl net (MOHT): 2 m<sup>2</sup> mouth opening, 1.4 mm mesh; ring net: 1.3 m diameter, 2.0 and 0.33 mm mesh) for an ichthyoplankton survey in the northern Bering Sea. The bongo net was the most effective in terms of total numerical density; average density obtained by the bongo net was 4- and 36-fold higher than that of MOHT and ring net, respectively. Species composition also differed by gear, with higher fraction of *Hippoglossoides* spp. in bongo samples. Furthermore, the body sizes of larvae collected by bongo net appeared to be smaller than those of MOHT. Based on the results, the bongo net is recommended for sampling ichthyoplankton in this study area (if targeted body length of larvae is >13 mm, MOHT is recommended).

Early career scientist, Mr. Lianggen Wang, presented the role of pelagic micro-copepods (<1 mm in length) as diets for fish larvae and macro-zooplankton by analyzing the net data obtained during the seasons in 2014 in the central South China Sea. Sixty-seven taxa were identified, with low abundance which is similar to oceanic zones in Pacific Ocean. Abundance and distributions changed seasonally along with the surface current driven by a monsoon reversal. The composition of the micro-copepod community was not only affected by environmental changes but also by the composition of potential predators, including larval fishes. Particularly, some micro-copepod taxa seem to be closely related with the abundance of larval squids. Those indicated that micro-copepods play an important role to supply nutrition to larval fishes and squids.

Early career scientist, Ms. Siyu Jiang, reported on results of microzooplankton (2–200 µm) grazing experiments on phytoplankton in the subtropical North Pacific gyre to understand transferring efficiency of primary production to microzooplankton. The phytoplankton community growth (chl-*a*) was decoupled with mortality by grazing activity but positively correlated with net growth rate. The phytoplankton community showed a relatively high net growth rate under nitrogen limitation due to the dominance of prokaryotic phytoplankton, especially *Prochlorococcus* which are accustomed to circumstances of lower nutrients. Both higher growth and lower mortality of *Prochlorococcus* rendered their higher net growth and much contribution to the community biomass. In the contrast, three eukaryotic phytoplankton groups (diatoms, haptophytes and pelagophytes) contribute less to the community biomass, with lower net growth. This also implied that there are the different grazing pressures of microzooplankton on eukaryotic and prokaryotic phytoplankton.

The final early career scientist to present was Mr. Jiajia Ning who described the results of a study on assessing the energy flow through a mangrove food web in the Zhanjiang Mangrove National Nature Reserve of China, using stable isotopes. The results showed that the primary organic carbon sources of the consumers were benthic algae, followed by particulate organic matter in water bodies, while the mangrove leaves made a minor contribution with seasonal variability (wet vs. dry season). Estimates of consumer trophic positions indicated ~4 trophic levels. Mollusks occupied lower trophic levels, while crustaceans and fishes varied from intermediate to top consumers. The trophic positions of most of fishes were higher in the dry season compared with the same species in wet season, whereas mollusks and crustaceans were lower. The results suggested that the consumers exhibit plasticity in their feeding strategies to utilize organic carbon sources.

Dr. Amatzia Genin presented the processes determining the timing of spring phytoplankton blooms in the subtropical oligotrophic Gulf of Aqaba, northern Red Sea using a 30-year-long time series and *in situ* experiments. Neither the Sverdrup's Critical Depth mechanism nor the Dilution-Recoupling hypotheses explained the timing of the spring phytoplankton bloom. Therefore, a simple alternative, the "Dispersion-Confinement Mechanism" was proposed. In the spring, once mixing stops, the cells are no longer vertically

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dispersed, allowing their accumulation in the upper layer, generating a bloom. High specific growth rates, necessary to maintain the increase of the entire (integrated) phytoplankton biomass during the deepening of the mixed layer (the “Dispersion Phase”) as well as supporting their rapid growth during the bloom (the “Confinement Phase”) are possible due to the entrainment of nutrients by the deep vertical mixing. Although this mechanism is proposed here for the case of a subtropical, oligotrophic sea, its relevance for temperate oceans deserves further consideration.

Dr. Carol Ladd showed the results of the relationship between interannual variability of the timing of blooms of coccolithophores and environmental parameters (nutrients and strength of water stratification) by comparing between *in situ* and satellite data and an annual Coccolithophore Bloom Index (1997–2017) for the eastern Bering Sea shelf. The results showed a significant non-linear relationship with summer stratification: the CBI was higher during years with either very low or very high stratification with little spatial variability of blooming (low vs. high stratification, inner and middle shelf, respectively). However, non-conclusive evidence was found that nutrient availability plays a role in bloom formation and location. It seems the location of the bloom may be more closely related with nutrients, particularly  $\text{NH}_4^+$ .

### List of papers

#### *Oral presentations*

##### **De novo transcriptome assembly of the mixotrophic dinoflagellate *Ansanella granifera*: Spotlight on flagellum-associated genes**

Se Hyeon [Jang](#), Hae Jin Jeong and So Jin Kim

##### **Reproductive isolation in oceanic copepods revealed by genome-wide SNP data**

Junya [Hirai](#)

##### **Diversity of marine planktonic ostracods in South China Sea: a DNA taxonomy approach**

Lei [Xu](#), Lianggen Wang, Jiajia Ning, Hong Li, Yingying Ji, Feiyan Du

##### **Sampling efficiency of ichthyoplankton in the northern Bering Sea: an inter-gear comparison**

Yuki [Takemuro](#), Haruka Hayashi, Nodoka Yamada, Bungo Nishizawa, and Orio Yamamura

##### **Seasonal variation of micro-copepod assemblages and impact of ichthyoplankton in South China Sea**

Lianggen [Wang](#), Feiyan Du, Xuehui Wang, Jiajia Ning, Lei Xu, Yafang Li

##### **Microzooplankton selective grazing on phytoplankton in the subtropical North Pacific Ocean**

Siyu [Jiang](#), Fuminori Hashihama and Hiroaki Saito

##### **Contribution of different organic carbon sources to the food web of a subtropical mangrove ecosystem, China**

Jiajia [Ning](#), Yafang Li, Xuehui Wang, Lianggen Wang, Yangguang Gu, Feiyan Du

##### **Mixing, stratification and spring bloom in an oligotrophic sea**

Amatzia [Genin](#), Margarita Zarubin and Yoav Lindemann

##### **Spatial and temporal variability of coccolithophore blooms in the eastern Bering Sea**

Carol [Ladd](#), Lisa Eisner, Sigrid Salo, Calvin Mordy, and Debora Iglesias-Rodriguez

#### *Poster presentations*

##### **Biomass and community composition of microzooplankton with reference to their nutritional mode in the North Pacific Ocean**

Emiko [Takano](#), Sachiko Horii, Yasuhide Nakamura and Kazutaka Takahashi

##### **Community structure of mesozooplankton during spring and summer in the Ulleung island, Korea**

Minju [Kim](#) and Jung-Hoon Kang

**The role of ammonium excretion of small planktonic copepods in epipelagic nitrogen cycle in the subtropical North Pacific Ocean**

Ken-ichi Nakamura, Kazutaka Takahashi, Fuminori Hashihama and Ken Furuya

**Appearance characteristics of harmful algal bloom species related with coastal environments caused by different water mass in southern sea of Korea**

Seung Ho Baek, Jin Ho Kim, Minji Lee, and Kyoungsoon Shin

**Succession phenomenon of *Cochlodinium polykrikoides* and *Alexandrium affine* related with changes of coastal environments in the southern sea of Korea in summer**

Young Kyun Lim, Seung Ho Baek, Jin Ho Kim, Minji Lee, Young Ok Kim, and Hyun Ho Shin

**The rapid kit and its digital reader for harmful algal detection**

SeungshicYum, Kyoungsoon Shin, and Seung Ho Baek

**Copepod community structure and energy flow around subpolar front in the East Sea (Japan Sea)**

Dong-Hoon Im, Seung-Kyu Kim, and Hae-Lip Suh

**Geographical variation of UV protective compounds in zooplankton in the subtropical North Pacific Ocean**

Sijun Chen, Kazutaka Takahashi, Victor S. Kuwahara, Tomoyo Katayama

**Seasonal occurrences and diel color changes of planktonic copepods Sapphirinidae (Copepoda, Cyclopoida) in Sagami Bay, Japan**

Kana Otaka, Kazutaka Takahashi, Tomohiko Kikuchi, Tatsuki Toda and Shinji Shimode

**Plankton diversity and community structure based on a cabled observatory data**

Gabriel R. Freitas, Hidekatsu Yamazaki, Rubens Lopes, Leandro Tielia and Takeyoshi Nagai

**Nitrogen isotope landscape in primary producers in the Pacific Ocean**

Sachiko Horii, Kazutaka Takahashi, Takuhei Shiozaki, Iwao Tanita, Yoshiki Kato, Taketoshi Kodama, Tsuneo Ono, Hiroaki Kurogi and Ken Furuya

**Can an embayment copepod accumulate in the body?**

Minamo Hirahara, Tatsuki Toda

**Distribution and environmental characteristics of harmful dinoflagellate *Karenia digitata* on the coast of Japan**

Setsuko Sakamoto, Shizuka Ohara and Kazuhiko Koike

**Molecular Phylogenetic of *Oithona* based on mitochondrial COI and 18S gene**

Du Feiyan, Wang Xingxia, Xu Lei, Wang Lianggen, ChenXiao, Wang Xuehui

**Pelagic ostracods in Suruga Bay, Japan: their species diversity and population dynamics**

Haruka Sato, Hiroyuki Matsuura, Takashi Yoshikawa, Rumi Sohrin, Yumiko Obayashi and Jun Nishikawa

**Local forage fish availability and the reproductive performance of Rhinoceros Auklets in Hokkaido, Japan**

Jumpei Okado, Motohiro Ito, Makoto Hasebe, Akiko Shoji, Haruka Hayashi, Nobuhiko Sato, Yosuke Koshino, Ui Shimabukuro, Akinori Takahashi, Kenta Watanabe, Tomohiro Kuwae, Yutaka Watanuki

**Food concentration as an explanatory variable for naupliar ingestion rates**

Noriaki Natori and Tatsuki Toda

**Nitrogen fixation and diazotroph community structure in the high latitude region around Hokkaido, northern Japan**

Takuya Sato, Yukiko Taniuchi, Hiromi Kasai, Takuhei Shozaki and Kazutaka Takahashi

**Breeding performance and diet of Black-tailed gulls on Hongdo Island, Republic of Korea**

Miran Kim, Mi-jin Hong, Young-Soo Kwon, Ho Lee and Sang-moon Joe

**A new Long-term Ecological Research (LTER) site in the Northern Gulf of Alaska**

Russell R. Hopcroft, Ana Aguilar-Islas, Seth Danielson, Jerome Fiechter, and Suzanne Strom

**Functional variants of the melanocortin-4 receptor associated with the Odontoceti and Mysticeti suborders of cetaceans**

Liyuan Zhao, Xiaofan Zhou, Antonis Rokas, Roger D. Cone

**Analysis of phytoplankton community change according to continuous observation pattern of chlorophyll-*a* concentration**

Hye Jung Han, JunSu Kang, Hyun-Jung Kim, Donhyug Kang and Seung Won Jung

**Mapping distribution of cysts of recent dinoflagellate and *Cochlodinium polykrikoides* using next-generation sequencing and morphological approaches in South Sea, Korea**

Seung Won Jung, Hyun-Jung Kim, and Taek-Kyun Lee

## Session Summaries – 2018

### Effects of temperature and nutrients on changes in genetic diversity of bacterioplankton communities in a semi-closed bay, South Korea

Hyun-Jung Kim, Seung Won Jung and Taek-Kyun Lee

### Changes in environmental factors and bacteria community caused by harmful algal blooms of *Akashiwo sanguinea* (Dinophyta)

JunSu Kang, Hyun-Jung Kim, Seung Won Jung, and Seok-Jin Oh

### Variation of microsatellite loci in herring (*Clupea pallasii*) from the Japan and Okhotsk seas

Denis S. Kurnosov, Svetlana Yu.Orlova Valeria Al Soshnina

### Mitochondrial DNA polymorphism of the Far Eastern sardine (*Sardinops melanostictus*) in the northwestern Pacific Ocean and Sea of Japan

Denis S. Kurnosov, Svetlana Yu.Orlova, Andrey I.Alferov

## FIS Contributed Paper Session

Convenors: *Xianshi Jin (China), Jackie King (Canada)*

### Background

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

### Summary of presentations

This session consisted of 9 oral and 20 poster presentations. The first oral presentation was given by Dr. Gordon H. Kruse from University of Alaska Fairbanks, USA, who talked about the reproductive biology and fishery management of snow (*Chionoecetes opilio*) and Tanner crab (*C. bairdi*) stocks in the eastern Bering Sea. These two stocks support male-only fisheries and show periodical ups and downs in recruitment and total population size. Dr. Kruse first introduced that female snow and Tanner crabs possess paired spermathecae to store sperms from previous matings. For Tanner crab, he found that mean sperm cell counts of primiparous females by location were negatively correlated with an exploitation rate index, suggesting male-only harvest decreases the levels of stored sperm available for fertilization of a subsequent clutch. For snow crab, fecundity increases with increasing female size and decreases for older multipara (age), likely due to senescence. These results can help to improve estimates of reproductive potential of snow and Tanner crabs, thereby benefiting sustainable fishery management of these stocks.

Dr. Olga Novikova from the Kamchatka Research Institute of Fisheries and Oceanography (KamchatNIRO), Russia, presented the biomass dynamics of four major demersal fish families (*i.e.*, Gadidae, Pleuronectidae, Cottidae and Clupeidae) on the West Kamchatkan shelf during the years 1960–2017. The biomass composition of these families for recent decade (2008–2017) obviously differed from that in the 1980s, although the total biomasses of bottom fish were equally high during these two periods. For instance, the contributions of Gadidae and Cottidae to the total biomass of demersal fish largely decreased, whereas Pleuronectidae contributed 1.4 times more in recent decade, when compared to that in 1980s.

Dr. Shufang, Liu from the Yellow Sea Fisheries Research Institute (YSFRI), China, gave a presentation on the application of DNA metabarcoding on biodiversity research of the nekton community, including fish, marine mammals, cephalopods and crustaceans. She emphasized that DNA metabarcoding outperformed the DNA barcode in automatic species identification from a large sample complex of nekton and suggested international



cooperation in the construction of a nekton DNA metabarcoding database to advance the wide application of the DNA metabarcoding technique.

Early career scientist, Dr. Seonggil Go, from Jeju National University, Korea, shared with us the development of a temperature-dependent Gompertz-Laird growth equation for chub mackerel (*Scomber japonicus*) larvae in Korean waters, considering the effect of temperature variability on the growth of this species at early life stages. Dr. Go and his colleague expect this temperature-dependent growth equation being used to evaluate and project climate-change effects on the recruitment, spatial distribution and potential catch of chub mackerel, when combined with bio-physical coupling models.

Dr. Nadezda A. Rastyagaeva from KamchatNIRO, shared with us the interesting monitoring results on Pacific salmon biology at the hatcheries of Kamchatka, including evaluation of epizootic aspects at the hatcheries, control of biological conditions of juvenile salmon, otolith marking of juvenile fish before release, identification of hatchery salmon in the control and commercial catches, and estimation of the maximum possible releases in view of carrying capacity of the acceptor-rivers. Based on these results, Dr. Rastyagaeva and her colleagues provided practical recommendations to enhance the efficiency of Pacific salmon artificial production.

Dr. Binduo Xu from the Ocean University of China presented the work of his graduate student on the effects of sample size and distribution characteristics of survey data on estimation of the abundance index of a fish population using the delta-distribution model. They found that 1) the performance of the delta-distribution model varied with sample sizes and was also affected by the distribution characteristics of the original survey data, 2) increases in the proportion of zero values and skewness or coefficient of variation of non-zero values would cause a decline in stability and accuracy for estimating abundance indices using delta-distribution model. The effects of any of these factors on the estimation of the abundance index could not be described by a simple linear function.

Early career scientist, Dr. Kyunghwan Lee, and his colleagues from Jeju National University reported that catches of Japanese anchovy (*Engraulis japonicus*) suddenly decreased in Korea in the early 2010s. In this context, they developed and applied a daily simulation-based yield-per-recruit (Y/R) model for the anchovy stock in the Korea Strait to provide biological reference points for better management of this stock with a short life history cycle (maximum age is 2 years). The Y/R model showed that yield per recruit could be maximized when the minimum fork length at first capture ( $L_c$ ) ranges between 42 and 60 mm (annual catch = ~ 1.2 million tons) and the maximum fork length allowed to capture > 88 mm. Also, they found that it is more efficient to protect small size fish rather than large fish for sustainable management of Japanese anchovy.

Early career scientist, Dr. Wei Yu from the Shanghai Ocean University, China, talked about climate-driven abundance variability and geographical distribution shift of the winter–spring cohort of neon flying squid in the Northwest Pacific Ocean. He showed very rich results, for instance, 1) the CPUE of neon flying squid was positively correlated with SST, PAR and the areas of suitable ( $HIS \geq 0.6$ ) and optimal ( $HIS \geq 0.8$ ) habitats occupying the whole fishing ground, but negatively related to the SSHA; 2) the annually declining CPUE over 2006–2015 was highly consistent with the expansive poor habitats and contractive suitable and optimal habitats, and 3) the south-approaching latitudinal center of gravity coincided with the southward migration pattern of the latitude of area with HSI in the range of 0.9–1.0.

Miss Jia Wo from the Ocean University of China presented her study on evaluating the effect of data transformation and size, number of clusters and three different clustering methods on the reliability and stability of clustering analysis.

## Session Summaries – 2018

Overall, these oral presentations included wide topics on the biology, monitoring, population dynamics and management of various fishery stocks in the North Pacific. Also, some of these presentations emphasized the effects of climate change on spatial and temporal dynamics of fishery stocks, especially short-life-history stocks like flying squid. Climate effects should be considered for better fisheries stock assessment and management in the future. In addition, the poster presentations attracted wide attention from worldwide scientists to the fishery sciences in the North Pacific.

### List of papers

#### *Oral presentations*

**Reproductive biology and fishery management of snow and Tanner crabs in the eastern Bering Sea**

Gordon H. Kruse, April Rebert, Jonathan I. Richar, Laura M. Slater and Joel B. Webb

**The dynamics of the biomass of the bottom fish major families in the eastern part of the Sea of Okhotsk in 1960-2017**

Olga Novikova

**Application of DNA metabarcoding on biodiversity research of nekton community**

Shufang Liu and Zhimeng Zhuang

**Estimation of a temperature-dependent Gompertz-Laird growth equation of chub mackerel (*Scomber japonicus*) larvae**

Seonggil Go, Sukgeun Jung

**Biological monitoring of Pacific salmon at the hatcheries of Kamchatka region**

Nadezda A. Rastyagaeva, Svetlana L. Rudakova, Olga O. Kim, and Natalia N. Romadenkova

**Effects of sample size and distribution characteristics of survey data on estimation of abundance index of fish population using delta-distribution model**

Jian Liu, Jing Wang, Binduo Xu, Chongliang Zhang, Ying Xue and Yiping Ren

**Stock assessment of Pacific anchovy (*Engraulis japonicus*) biomass in the Korea Strait based on Simulation-based yield-per-recruit analysis**

Kyunghwan Lee, Seonggil Go and Sukgeun Jung

**Habitat suitability modeling reveals climate-driven abundance variability and geographical distribution shift of winter-spring cohort of neon flying squid in the Northwest Pacific Ocean**

Wei Yu, Xinjun Chen, Qian Yi and Yong Chen

**Evaluating the effect of data manipulation on clustering analysis on fish abundance**

Jia Wo, Chongliang Zhang, Binduo Xu, Ying Xue, Yiping Ren

#### *Poster presentations*

**The Bering Sea pollock environmentally-dependent spawning diversity, fluctuation of recruitment, migration and spatial distribution**

Mikhail A. Stepanenko, Elena V. Gritsay

**The distribution and the size composition of *Myoxocephalus jaok* Cuvier, 1829 and *M. polyacanthocephalus* Pallas, 1814 on the west coast of Kamchatka**

Andrei Matveev

**The review of the fisheries of pacific capelin (*Mallotus villosus catervarius*) in Russian Far Eastern Seas in 2010–2017**

Tatiana N. Naumova

**Population complexes of sockeye salmon (*Oncorhynchus nerka*) on the Asian Pacific Coast**

Anastasia M. Khrustaleva and James E. Seeb

**Adaptive variability at MHC class II gene Onne-DAB in two largest sockeye salmon (*Oncorhynchus nerka*) populations in Asia**

Anastasia M. Khrustaleva

**Development and application of DNA barcode electronic microarray for species identification of fishes of the family Clupeidae (Osteichthyes: Clupeiformes)**

Shufang Liu and Zhimeng Zhuang

**Genomic sequence diversity and population structure of Longfin Smelt (*Spirinchus thaleichthys*) in the Nooksack River using 2b-RAD**

Rachel J. Arnold

**A statistical approach to estimate optimal habitat suitability of walleye pollock off the northeastern coast of Japan**

Hikomichi Igarashi, Yoichi Ishikawa, Yusuke Tanaka, Takehisa Yamakita, Misako Matsuba, Yumiko Yara and Katsunori Fujikura

**Transpacific distribution of micronektonic fish community in the subtropical open water**

Yutaro Nagatomo, Kazutaka Takahashi, Tetsuya Sado, Masaki Miya, Fuminori Hashihama, Sachiko Horii and Junya Hirai

**Characterizing spatial structures of larval fish assemblages at multiple scales in relation to environmental heterogeneity in the Strait of Georgia (British Columbia, Canada)**

Lu Guan, John Dower and Pierre Pepin

**Interannual variations in distribution and abundance of yellowtail *Seriola quinqueradiata* larvae in the East China Sea: southward expansion of spawning ground**

Chiyuki Sassa, Motomitsu Takahashi, Yoshinobu Konishi, Yoshimasa Aonuma and Youichi Tsukamoto

**Pacific Flatnose (*Antimora microlepis*, Moridae, Gadiformes) in the North Pacific: an overview of their distribution, genetic diversity, otoliths, and parasites**

Alexei M. Orlov, Svetlana Yu. Orlova, Alexei A. Baitaliuk, Ilya I. Gordeev, Pavel K. Afanasiev, Nikolai B. Korostelev

**Interactions within fisheries eco-/econo-system and impact of participatory research in a coastal community: in the model area of Indonesia**

Naoki Tojo, Takaaki Mori, Ayumi Kanaya, Mitsutaku Makino, Mark Wells, Vladimir Kulk, Joon-Soo Lee, Shion Takemura, Charles Trick, Chang-an Xu, Suhendar Sachoemar

**Participatory research in resource production for sustainable fisheries and estimation of option value in Indoramayu Indonesia**

Ayumi Kanaya, Takaaki Mori, Naoki Tojo, Mitsutaku Makino, Mark Wells, Vladimir Kulk, Joon-Soo Lee, Shion Takemura, Charles Trick, Chang-an Xu, Suhendar Sachoemar

**Changes in the specific gravity of Pacific cod *Gadus macrocephalus*, during the early life stages**

Hwa Hyun Lee and Suam Kim

**Increase in abundance of mottled spinefoot *Siganus fuscescens* in seagrass bed in central Seto Inland Sea, Japan, for recent years**

Ketaro Kubo and Jun Shoji

**Day-night change in fish community in sandy shore in the central Seto Inland Sea, Japan**

Ryusei Shigemoto and Jun Shoji

**Species variation of early growth history pattern of grey mullet in Taiwan**

Chia-Hui Wang, Yu-ling Nien and Kang-Ning Shen

**Using otolith microchemistry to discriminate wild and released red snapper**

Chia-Hui Wang, Chian-Yu Lu, Yu-Ling Nien and Ming-Tsung Chung

**Recovery of Pacific oyster, *Crassostrea gigas* raised in an intertidal rack-suspended culture system in terms of growth and reproduction 3 years after the Hebei Spirit oil spill accident off the west coast of Korea**

Jeonghwa Kim, Jong Seop Shin, Hyun-Ki Hong, Hye-Mi Lee, Young-Ghan Cho, Heung-Sik Park, and Kwang-Sik Choi

## HD Contributed Paper Session

Convenors: *Keith R. Criddle (USA), Mitsutaku Makino (Japan)*

### Background

This session invited papers addressing the promotion, coordination, integration and synthesis of research activities related to the contribution of the social sciences to marine science, and to facilitate discussion among researchers from both the natural and social sciences.

### Summary of presentations

This well-attended ½-day session on November 2, 2018, included interesting presentations on a variety of HD topics. Natalie Ban (Canada) reported on a project that documented historical and contemporary marine conservation strategies of the Kitasoo/Xai'xais First Nation in British Columbia and described steps being taken towards co-management of important marine resources. Kim Juniper (Canada) described new developments in coastal and ocean observing in nearshore waters in the Salish Sea and western coast of Vancouver Island. Suhendar I Sachoemar (Indonesia) provided an update on the Sustainable Integrated Multi Tropic Aquaculture project in Indonesia. Recent accomplishments include design and testing of closed culture systems and open culture systems. These experimental systems increased production revenue and improved water quality vis à vis earlier IMTA experiments and traditional monoculture production systems. Early career scientist, Peng Sun (China), reported on a bioeconomic analysis of optimal mesh size in the stow net fishery in Haizhou Bay, China. While catch in fine-mesh nets consisted of smaller fish, in this instance, the increased catch-per-unit effort of smaller fish in fine-mesh gear more than offset price premiums paid for larger fish given the reduced catch-per-unit-effort in large-mesh nets. Two presenters (Wei Liu and Yang Han) were unable to attend the HD-Paper Session. Keith Criddle spoke on legal and economic aspects of attenuation of limited entry permits and individual quotas and on efforts to rebuild depleted stocks in U.S. fisheries. The latter presentation stimulated a wide-ranging discussion among session participants focused on the interplay of biological characteristics of depleted fish stocks and social choices regarding reference points that trigger rebuilding requirements, the rebuilding targets, and rebuilding schedules.

### List of papers

#### *Oral presentations*

##### **Historical and contemporary Indigenous marine conservation strategies in the North Pacific**

Natalie C Ban, Emma Wilson and Doug Neasloss

##### **Observing Canada's Pacific coastal ocean: Networks, programs and pathways to operationalization**

S. Kim Juniper, Akash Sastri, Charles Hannah, Jennifer Jackson, Bryan Hunt

##### **Development of Sustainable Integrated Multi Tropic Aquaculture (IMTA) as a model of sato umi concept in the coastal area of Indonesia**

Suhendar I Sachoemar, Mark L. Wells, Mitsutaku Makino, Ratu Siti Aliah, Warih Hardanu, Masahito Hirota, Ian Perry and Tetsuo Yanagi

##### **Bioeconomic consequences of stow net selectivity in Haizhou bay, China**

Peng Sun, Runlong Sun, Xiaozi Liu, Yanli Tang, Liuyi Huang, Yongjun Tian

##### **Successes and failures of regulatory requirements to rebuild depleted stocks in U.S. fisheries**

Keith R. Criddle

##### **Attenuating durable use rights to public resources**

Keith R. Criddle, Arthur R. Wardle

## MEQ Contributed Paper Session

Convenors: *Chuanlin Huo (China), Thomas Therriault (Canada)*

### Background

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

### List of papers

#### *Oral presentations*

**Retrospect and prospect of status of coastal eutrophication in China Seas**

Baodong Wang, Ming Xin, Qinsheng Wei

**Persistent organic pollutants in bottom and pelagic fish from the Sea of Okhotsk**

Olga N. Lukyanova, Vasily Yu. Tsygankov and Margarita D. Boyarova

**Fate of floating debris released from Major rivers around Korea**

Seongbong Seo, Young-Gyu Park

**The Plankton Index: A regional pelagic biodiversity indicator for ecosystem-based management**

Abigail McQuatters-Gollop, Angus Atkinson, Jacob Bedford, Mike Best, Eileen Bresnan, Kathryn Cook, Michelle Devlin, Richard Gowen, David G. Johns, Clare Ostle, Cordula Scherer, and Paul Tett

**Are zooplankton ingesting microplastics in the Arctic?**

Lauren M. Howell, Marie Noël, Leah Bendell and Peter S. Ross

**Harmful algal blooms (HABs) may trigger and accelerate hypoxia zone formation at the Pearl River Estuary**

Pengbin Wang, Douding Lu, Leo Lai Chan, Xinfeng Dai and Jiajun Wu

**Characterization of oceanic Noctiluca blooms not associated with hypoxia in the Northeastern Arabian Sea**

Vera L. Trainer, Aneesh Lotliker, S.K. Baliarsingh, Mark Wells, Cara Wilson

**Increase in anthropogenic nitrogen and mercury in marginal sea sediments of the Northwest Pacific Ocean**

Haryun Kim, Kitack Lee, Dhong-Il Lim, Seung-Il Nam, Seunghee Han, Tae-Wook Kim, Kyung-Hoon Shin, Young Ho Ko, Jihun Kim, Jin-Yu T. Yang, Yanxu Zhang

**Fukushima-derived <sup>137</sup>Cs and <sup>134</sup>Cs in the Northwest Pacific Ocean in 2017**

Wu Men, Jianhua He, Wen Yu, Fenfen Wang, Feng Lin, Fangfang Deng, Jing Lin, Tao Yu

**Marine Environmental monitoring with GF satellite data**

Bin Zou, Lijian Shi and Qimao Wang

**Technology of assessing marine fishery losses caused by oil spills in China**

Zhengguo Cui, Keming Qu and Bijuan Chen

**Impact of Water-Sediment Regulation Scheme on seasonal and spatial variations of biogeochemical factors in the Yellow River estuary**

Yujue Wang, Dongyan Liu, Kenneth Lee, Zhijun Dong, Baoping Di, Yueqi Wang and Jingjing Zhang

**An assessment of the marine eco-civilization performance in Oujiang River Estuary area, Zhejiang, China**

Ying Lin, Huawei Zhang, Guanqiong Ye, Jingang Jiang

**Long-term temporal and spatial variation of macrobenthos in a semi-enclosed bay under human disturbance**

Ya-fang Li, Jia-jia Ning, Liang-gen Wang, Lei Xu and Fei-yan Du

**Research on indicator species of bio-blogging on Nuclear Power Cold Source Water**

Jinhui Wang, Hong Chen, Yafei Tang

*Poster presentations*

**Distributions of organic matter and heavy metal in Korean coastal sediments and their pollution assessment**

Dong-Woon Hwang, Pyoung-Joong Kim, Seong-Gil Kim, Byoung-Seol Koh, Sang-Ok Ryu, Jung-No Kwon

**Marine environment quality assessment of the coastal areas around Vladivostok, using biological and chemical data analyses (the Sea of Japan/East Sea)**

Alexander Moshchenko, Tatyana Belan, Boris Borisov and Tatyana Lishavskaya

**Abundance and community structure of ammonium monooxygenase (amoA) genes in Liaohe estuary sediments**

Hongxia Ming, Zhang Huizhen, Su Jie and Fan Jingfeng

**Trends of sediment accretion and carbon sequestration in Liaohe estuarine wetland**

Jinqiu Du, Daoming Guan, Ziwei Yao, Guangshui Na and Zhen Wang

**Spatial characteristics of microplastic in the zooplankton samples collected from the Yellow Sea**

Jung Hoon Kang, Oh-Youn Kwon, Minju Kim, Sang Hee Hong, Won Joon Shim

**Atmospheric long-range transport of microplastics: a preliminary result of atmospheric fall-out samples from a remote island (Daechong Is.), South Korea**

Su-Hyun Kim and Seung-Kyu Kim

**Stimulated phosphorus utilization by possible increase of dust deposition in the western North Pacific**

Tamaha Yamaguchi, Kazutaka Takahashi, Mitsuhide Sato and Ken Furuya

**Distribution of harmful algae, nutrients and iron in Bungo Channel, western Seto Inland Sea, Japan**

Kanako Naito, Nodoka Kai, Setsuko Sakamoto and Masahiro Maruo

**Radiological investigation in the Far Eastern seas of Russia**

Galina S. Borisenko, Sergey P. Dudkov, Anna S. Vazhova

**Assessing the severe eutrophication status and spatial trend in the coastal waters of Zhejiang Province (China)**

Qutu Jiang, Junyu He, Jiaping Wu, Xinyi Hu, Guanqiong Ye, George Christakos

**Impacts of marine debris on seabirds in South Korea**

Mi-jin Hong, Young-soo Kwon, Ho Lee, Gil-pyo Hong, Sang-moon Joe and Miran Kim

**POC Contributed Paper Session**

Convenors: *Emanuele Di Lorenzo (USA)*, *Yury I. Zuenko (Russia)*

Background

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

Summary of presentations

The POC Paper Session gathered a great number of presentations – 23 posters and 8 oral ones. Unfortunately, 2 oral reports (T. Lian and K. Komatsu) were cancelled at the last moment and only one of them was replaced.

Different aspects of physical oceanography were discussed, mostly regional processes, though some of them are important for the entire ocean. Several authors presented results of their studies on the western boundary of the North Pacific where oceanic waters interacted with the flows from the Okhotsk Sea (Y. Zuenko, M. Kashiwai) and Japan Sea (M. Kashiwai, D. Hasegawa). A circulation model for this region was presented by G. Vlasova. In other presentations, physical processes of medium scale were considered for the Japan Sea (V. Lobanov) and the Canadian waters (C. Hannah).

Another issue of the session was new technologies of oceanographic studies. Q. Wang presented a review of Chinese satellites available to monitor the ocean surface; great progress in satellite oceanography in China was noted. Development of satellite data assimilation methods using tools of ecosystem modeling was discussed by H. Song, using an example of chlorophyll measurements at Californian coast.

Poster presentations regarded mostly local processes and phenomena in different areas of PICES. Among them, the study of S.-C. Cha was distinguished by a vaster spatial and temporal scale: the tropical processes influence on the North Pacific was analyzed.

Though the POC Paper Session had no aim to solve any specific problem, it provided a background for professional exchanges by new findings in a wide spectrum of oceanographic issues, so was quite useful and successful.

### List of papers

#### *Oral presentations*

##### **Recent changes in producing of the Intermediate water in the Okhotsk Sea**

Yury Zuenko, Alexander Figurkin, Vladimir Matveev

##### **Stirring and up-lifting of deep water at the entrance straits of Sea of Okhotsk --- shown by data including flagged 'questionable' or 'bad'.**

Makoto Kashiwai

##### **Sub-surface temperature variability along the west coast of Canada**

Charles Hannah and Stephen Page

##### **Subduction and Mixing processes of the front between the Oyashio and the Tsugaru Warm Current**

Daisuke Hasegawa, Takahiro Tanaka and Takeshi Okunishi

##### **Data assimilation of physical and chlorophyll-*a* observations in the California Current System using two biogeochemical models**

Jann Paul Mattern, Hajoong Song, Christopher A. Edwards, Andrew M. Moore and Jerome Fiechter

##### **Chinese ocean satellites and application**

Qimao Wang, Bin Zou and Lijian Shi

##### **Winter season submeso-scale processes at the Peter the Great Bay, northwestern Japan Sea: Direct observations of deep cascading**

Vyacheslav Lobanov, Aleksandr Sergeev, Igor Gorin, Aleksandr Voronin, Pavel Semkin and Elena Pavlova

#### *Poster presentations*

##### **Estimation of the hydrodynamic regime of water in the spring transitional season for half a century in the Kamchatsky Strait (the Aleutian island system)**

Svetlana Marchenko, Galina Vlasova and Natalia Rudykh

##### **The role of regional atmospheric processes in the formation of the structure of currents in region of the straits surrounding Urup island (Kuril island system)**

Galina Vlasova

##### **The South Okhotsk Sea water thermal regime variability under influence of the water dynamic and atmospheric circulation in summer**

Valentina V. Moroz, Tatyana A. Shatilina

##### **Water characteristics peculiarities formed by tides in the South Okhotsk Straits and adjacent areas**

Valentina V. Moroz

##### **Temperature change along the Russian coast of the Japan Sea from 1991 to 2017**

Larissa A. Gayko

## Session Summaries – 2018

### **Kuroshio warm water intrusion observed by high-resolution survey**

Daiki [Ito](#), Yugo Shimizu and Daisuke Ambe

### **Mechanisms of future upwelling change in the equatorial Pacific using CMIP5 models**

Mio [Terada](#), Shoshiro Minobe and Curtis Deutsch

### **A numerical study on the circulation, wave and suspended sediment in the Yellow and East China Seas**

Kyeong Ok [Kim](#), Igor Brovchenko, Vladimir Maderich, Hanna Kim, Mee Kyung Kim and Kyung Tae Jung

### **Sea ice extent retrieval with HY-2A Scatterometer data and its assessment**

Lijian [Shi](#)

### **The real-time warning system against rip currents occurred at Korean peninsula**

Jimin [Ko](#), Yong Huh and Junwoo Choi

### **Seasonal and longer-term variation of the Kuroshio temperature and salinity based on repeat observation along 138°E**

Yugo [Shimizu](#), Keiichi Yamazaki, Takeshi Okunishi, Akira Kusaka, Daisuke Ambe, Daiki Ito, Takashi Setou, Kiyotaka Hidaka, Atsushi Nishimoto and Sayaka Sogawa

### **Reproducing the sea level in the last 30 years to predict in the Northwest Pacific using a numerical model**

Kwang-Young [Jeong](#), Eunil Lee, Ho-Kyun Kim, Yang-Ki Cho, Myeong-Taek Kwak, Yong-Yub Kim

### **Impact of ARGO observation data on a sub meso-scale forecast based on ROMS**

Takashi [Setou](#), Hiroshi Kuroda, Takeshi Okunishi, Hitoshi Kaneko, Yugo Shimizu, Kiyotaka Hidaka, Takahiko Kameda, Kazuhiro Aoki, Atsushi Nishimoto, Sayaka Sogawa and Takeshi Taneda

### **Features of cyclonic activity over the Pacific Ocean and the Far Eastern Seas in spring and summer in 1995-2015**

Glebova S. [Yu](#).

### **Climate-related decadal sea level and heat content shifts in the tropical Pacific**

Sang-Chul [Cha](#), Jae-Hong Moon

### **Effect of surface gravity waves on upper-ocean mixing in the northern East China Sea in summer using an ocean-wave coupled modeling system**

Ji Seok [Hong](#), Jae Hong Moon, Joon Ho Lee and Su Bin Kim

### **Decadal salinity variation in the western North Pacific correlated with the North Pacific Gyre Oscillation and the strength of the Kuroshio Extension**

Hitoshi [Kaneko](#), Takeshi Okunishi, Shinya Kouketsu, Sachihiko Itoh, Takashi Setou, Hiroshi Kuroda and Yugo Shimizu

### **Instrumental observations in Peter the Great Bay during more than 100 years: what changed**

Natalia I. [Rudykh](#)

### **Spatio-temporal fusion of multi-resolution satellite sea surface salinity (SSS) products using Bayesian Maximum Entropy method**

Mingjun-[He](#)

### **Evaluation of mixed layer depth in the northern Indian Ocean simulated by CMIP5 climate models**

Muhammad Y. Musabbiq, Chan Joo [Jang](#), Minwoo Kim and Cheol-Ho Kim

### **70 year long time series analysis of Bute Inlet water properties in British Columbia**

Jessy Barrette and Jennifer [Jackson](#)

### **Interannual to decadal variability of the upper-ocean heat content in the western North Pacific and its relationship to oceanic and atmospheric variability**

Hanna [Na](#), Kwang-Yul Kim, Shoshiro Minobe and Yoshi N. Sasaki

### **Evolution of chemical properties in the bottom shelf water during its movement across the shelf of Peter the Great Bay**

Anna S. [Vazhova](#) and Yury I. Zuenko



## GP - General Poster Session

### Poster presentations

**Age determination and growth estimation of the white-spotted conger eel, *Conger myriaster* (Brevoort, 1856) in marine waters of South Korea**

J. H. Bae, M. U. Lee, P. G. Jung, J. H. Na and C. W. Oh

**The environmental analysis for sustainable seaweed aquaculture management in Ariake Sea, Japan**

Sangyeob Kim, Naoki Fujii

**Results of a longterm monitoring of the hatchery marked juvenile pacific salmon identification during autumn migrations in the basin of the Sea of Okhotsk**

Alexandra I. Chistyakova, Alexandr V. Bugaev, and Shigehiko Urawa

**Assessment of reproductive development in female Pacific halibut (*Hippoglossus stenolepis*)**

Josep V. Planas, Claude L. Dykstra, Tracee Geernaert and Timothy Loher

**Identification of molecular growth signatures in skeletal muscle of juvenile Pacific halibut (*Hippoglossus stenolepis*) for monitoring growth patterns in the Pacific halibut population**

Josep V. Planas and Thomas P. Hurst

**Electronically monitoring release method as a proxy for Pacific halibut discard mortality rates in the directed Pacific halibut longline fishery**

Claude L. Dykstra, Timothy Loher, Ian J. Stewart, Allan C. Hicks and Josep V. Planas

**Effects of biocides of antifouling paints and by-products from vessels on embryos of a sea urchin, *Strongylocentrotus nudus***

Jin-Young Seo, Jeong-Hyeon Kim, Jin-Woo Choi

**The influence of moisture content on cloud growth when tropical cyclones occur in the maritime continent of Indonesia**

Wishnu A. Swastiko, Yesi Ratnasari

**Assessing the vulnerability on fishes in the Yellow Sea and Bohai Sea**

Yunlong Chen, Xiujuan Shan, Xianshi Jin and Fangqun Dai

**Ocean deoxygenation enhances the efficiency of CO<sub>2</sub> concentrating mechanisms in a diatom with stimulated photosynthetic performances**

Jiazhen Sun, John Beardall, Ruiping Huang, Tifeng Wang, Di Zhang, Kunshan Gao

**Coastal fishing of Pacific halibut (*Hippoglossus stenolepis*) and its prospects of development in the Asian part of the areal.**

Roman Novikov

**Community organization of macrobenthic sessile organisms responding to the submerging time of artificial panels in the embayment of the East China Sea, South Korea**

Jeong Hyeon Kim, Jin Young Seo and Jin Woo Choi

**Behavior of microplastics in primary, secondary, tertiary, and sludge treatment processes in wastewater treatment plants in Japan**

Masaki Kakita, Shuhei Tanaka, Yuji Suzuki, Satoru Yukioka, Yoshiki Nabetani, Taishi Ushijima, Shigeo Fujii and Hideshige Takada

**Morphology and phylogeny of bloom-forming *Takayama* sp. associated with the recent fish kill events in the Philippines**

Garry Benico, Kazuya Takahashi, Rhodora Azanza and Mitsunori Iwataki

**Statistical modeling for exploring diel vertical distribution and spatial correlations of marine fish species — A new perspective to look at species interactions**

Lisha Guan, Xiujuan Shan, Xianshi Jin

**Unarmored dinoflagellate *Kapelodinium* sp. with chloroplast derived from haptophyte *Chrysochromulina* sp.**

Kazuya Takahashi and Mitsunori Iwataki

**Temporal and spatial characteristics of bacterial diversity in the environments of cage and kelp cultural area in Xiangshan Bay, China**

Qiufen Li, Yan Zhang and Yuze Mao

**Assessing the outcomes of stocking hatchery-reared juveniles of *Girella punctate* in the northeastern coast of Taiwan**

Li-Xiang Li, Kuo-Wei Lan

**Age and growth of the herbivorous fish, *Kyphosus bigibbus*, determined by accurate age determination techniques, for elucidating the effects on algal ecosystems in the Northwest coast of Kyushu, Japan**

Yoshimi Ogino, Keisuke Furumitsu, Takanari Kiriya and Atsuko [Yamaguchi](#)

**Use of empirical orthogonal functions for monitoring coccolithophores in the upper layer of sea water**

Georgiy S. [Moiseenko](#)

**Ultrastructure and phylogeny of *Chattonella subsalsa* and *C. marina/ovata/antiqua* collected from various countries**

Wai Mun [Lum](#), Kazuya Takahashi, Garry Benico, Hong Chang Lim, Po Teen Lim, Chui Pin Leaw, Rhodora Azanza, Elsa Furio, Sandric Chee Yew Leong, Thaithaworn Lirdwitayaprasit, Hikmah Thoha and Mitsunori Iwataki

**Accumulation of tsunami debris on the seafloor depends on tsunami impact, bathymetry and ocean velocity**

Misako [Matsuba](#), Yusuke Tanaka, Takehisa Yamakita, Yoichi Ishikawa and Katsunori Fujikura

**Can a deep-sea copepod trophically utilize bacterial bioluminescence and chitinolysis?**

Hirano [Katsushi](#), Kentaro Takada, Hideto Fukushima, Toshihiro Nakai, Yoshihiro Sanbongi and Susumu Ohtsuka

**Characteristics of dissolved organic matter in Submarine Groundwater Discharge (SGD) in Jeju Island**

Jin-Wook [Song](#), Tae-Hoon Kim

**Monthly distribution of organic matter in precipitation of Jeju Island**

Min-Young [Lee](#), Tae-hoon Kim

**Microplastic pollution in freshwater ecosystem -A case study of inland lakes in Japan**

Yoichi [Era](#) and Haruhiko Nakata

**Identification of terrestrial sources of microplastics into the aquatic environment**

Ken-ichi [Kitahara](#) and Haruhiko Nakata

**Taxonomic profiles in metagenomic analyses of marine dinoflagellate communities in Jinhae Bay, Korea**

Jinik [Hwang](#), Eun Young Yoon, Seung Joo Moon, Eun Joo Kim and Jaeyeon Park

**Absolute quantification of *Oxyrrhis marina* and *Oxyrrhis maritima* in Korean waters using chip-based digital PCR (dPCR) as a novel detection method**

Jun-Ho [Hyung](#), Jinik Hwang, Eun Young Yoon and Jaeyeon Park

**Influence of submarine groundwater discharge on feeding and growth of fish**

Koji [Fujita](#) and Jun Shoji

**Influence of ammonium derived from hot spring drainage on downriver and estuarine ecosystems**

Shohei [Takemoto](#), Ryo Sugimoto, Makoto Yamada, Hisami Honda and Jun Shoji

**Distribution and population structure of *Euphausia pacifica* in Korean waters**

Bo ram [Lee](#), Wongyu Park and Jung Hwa Choi

**VoCC: A new R package for calculating the velocity of climate change and related landscape climatic metrics.**

Jorge García [Molinos](#), David S. Schoeman, Christopher J. Brown, Naoki H. Kumagai, and Michael T. Burrows

**NEAR-GOOS: Developing sustained ocean observations for enhanced services in the northeastern Asian marginal seas**

Norio Baba, Masakazu [Higaki](#), Heedong Jeong, Vyacheslav Lobanov, Heeyoon Park, Oleg Sokolov, Ting Yu, Zhihua Zhang and Wenxi Zhu

**Influence of variability of thermal conditions on the development of shellfish on marine farms (North-Western part of the Sea of Japan)**

Larissa [Gayko](#)

**BIO Workshop (W1)****Ecological roles of gelatinous zooplankton: Evaluation, integration and future prospects in a more gelatinous ocean**

Convenors: *Shin-ichi Uye (Japan), Chaolun Li (China), Brian Hunt (Canada), Richard Brodeur (USA)*

## Invited Speakers:

*Russell Hopcroft (University of Alaska Fairbanks, USA)*

*Dhugal Lindsay (Japan Agency for Marine-Earth Science & Technology (JAMSTEC))*

Background

Gelatinous zooplankton, consisting of taxonomically diverse groups such as cnidarians, ctenophores and pelagic tunicates, represent a conspicuous component of the zooplankton communities throughout the pelagic zone. Owing to their characteristic reproductive methods and high somatic growth rates, they can rapidly build a large population biomass, as typically demonstrated by recurrent blooms of cnidarian jellyfish (*e.g.*, *Aurelia*, *Chrysaora* and *Nemopilema*) in the PICES region. Recent studies on their biology and ecology, particularly to elucidate the mechanisms of their problematic blooms, have enhanced our knowledge, yet there is still a large gap in understanding potential ecological roles of gelatinous zooplankton in pelagic ecosystems. Although it is inherently difficult to determine their biomass, spatio-temporal distributions and physiological rates, they may play important roles in transferring materials and energy from picoplankton and zooplankton up to commercially-important fish and other top trophic levels. This workshop sought contemporary studies on gelatinous zooplankton to evaluate their functional roles, and invited contributions on diverse taxonomic groups and from diverse ecosystems. Studies using new technologies, such as acoustic and optical instruments, remotely-operated and autonomous vehicles, biochemical markers, and molecular approaches, were also encouraged.

Summary of presentations

The BIO Workshop on “Ecological roles of gelatinous zooplankton: Evaluation, integration and future prospects in a more gelatinous ocean” was held on September 25, 2018, in Yokohama, Japan, during the PICES-2018. The workshop was co-convened by Drs. Shin-ichi Uye (Japan), Chaolun Li (China), Brian Hunt (Canada) and Richard Brodeur (USA), and attended by approximately 40 people.

Shin-ichi Uye gave the opening remarks by mentioning the recent trends of jellyfish population outbreaks in the East Asian Marginal Seas, which had been reviewed in the recently-completed final report of PICES Working Group 26 on *Jellyfish Blooms around the North Pacific Rim: Causes and Consequences*, which recognized the increasing roles of gelatinous zooplankton in the marine ecosystem. Dr. Russell Hopcroft (University of Alaska, USA) delivered the first invited talk on “Gelatinous zooplankton in Alaskan waters: From nets to ROVs”, followed by the second invited presentation by Dr. Dhugal Lindsay (JAMSTEC, Japan) on “The perils of bad taxonomy for leading edge science: A case study with the genus *Aegina*, and the consequences for Deep Learning”. Both invited speakers emphasized the usefulness of novel techniques such as ROVs, various high-tech imaging systems, molecular sequencing, and AI technology in gelatinous zooplankton studies, particularly in the deep oceans. Dr. Lindsay highlighted the urgent need for improved taxonomy of gelatinous plankton, underscoring the importance of both morphological and genetic taxon descriptions. Following these invited talks, 8 oral presentations were given covering various topics of gelatinous zooplankton, from the hitherto understudied ecology of tiny (< 1 mm) soft-bodied phaeodarians and radiolarians to the bloom forecast of the giant (> 1 m) jellyfish which have been carried out at various

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locations around the North Pacific rim. Numerical circulation models were shown to be effective means of examining jellyfish dispersal in coastal waters. Several studies have started to assess jellyfish impacts on ecosystems by using ecosystem models. In the case of *Nemopilema nomurai*, it was repeatedly noted that lack of understanding of the polyp phase of this important species remains a continued hindrance to understanding and modelling its population dynamics and dispersal.

It became apparent that jellyfish have been increasing in a number of ecosystems around the world and that with current scenarios of ocean change due to warming, overfishing, eutrophication, and habitat modification, we can expect to see this trend continue in the future. The fishing industry is beginning to adapt to these changing conditions by employing jellyfish excluder devices on trawls and finding new markets for jellyfish products. These contributed talks were followed by brief introductions of the 5 posters associated with this session, most of which were by early career scientists.

In the general discussion that followed, participants compared the advantages and disadvantages of the various sampling techniques presently used (nets, ROVs and unmanned submersibles, aerial including drone observations, acoustics, predator sampling) and some that are not presently utilized to a great extent (environmental DNA). The substantial size range over which gelatinous zooplankton occur (millimeters to several meters) pose unique challenges not faced by the better studied crustacean zooplankton. Visual observations have provided some of the best data on densities of gelatinous organisms especially in the deep sea, and perhaps the only source of information on morphology, behavior patterns, as well as trophic interactions and commensal associations for some extremely fragile taxa. As gelatinous zooplankton populations increase worldwide under projected warming ocean conditions, we may need to utilize a broader spectrum on sampling devices and technologies to fully understand their impacts on the ecosystem.

### List of papers

#### *Oral presentations*

##### **Gelatinous zooplankton in Alaskan waters: from nets to ROVs (Invited)**

Russell R. Hopcroft

##### **The perils of bad taxonomy for leading edge science: a case study with the genus *Aegina*, and the consequences for Deep Learning (Invited)**

Dhugal J. Lindsay, Mary Grossmann, Mitsuko Hidaka-Umetsu, Jun Nishikawa, Hiroshi Miyake, Ryo Minemizu, Russell Hopcroft, Bastian Bentlage, Allen Collins, Takehisa Yamakita, Hiroyuki Yamamoto

##### **Ecological importance and new findings of phaeodarians and radiolarians in the North Pacific region**

Yasuhide Nakamura and Akihiro Tuji

##### **Gelatinous zooplankton in Pacific Canadian waters since 1990: trends and ecosystem implications**

R. Ian Perry, Moira Galbraith, Kelly Young and Tamara Fraser

##### **Identification of pelagic and demersal fish predators on gelatinous zooplankton in the Northeast Pacific Ocean**

Richard D. Brodeur, Troy W. Buckley, Richard E. Hibshman, John C. Buchanan, and Douglas L. Draper

##### **Using Unmanned Aerial Vehicles (UAV's) to measure jellyfish aggregations: an inter comparison with net sampling**

Brian P. V. Hunt, Jessica Schaub, Lucy Quayle, Evgeny A. Pakhomov, Keith Holmes and Yuhao Lu

##### **Trophic ecology of the neustonic cnidarian *Velella velella* in the northern California Current during an extensive bloom year: insights from gut contents and stable isotope analysis**

Samantha M. Zeman, Marco Corrales-Ugalde, Richard D. Brodeur and Kelly R. Sutherland

##### **Hyposalinity and incremental micro-zooplankton supply in early-developed *Nemopilema nomurai* polyp survival, growth, and podocyst reproduction**

Song Feng, Jianing Lin, Song Sun, Fang Zhang, Chaolun Li

**Monitoring of two scyphozoan jellyfish species in the adjacent waters of a power plant, Liaodong Bay, China**

Chaolun Li, Yantao Wang, Nan Wang, Song Sun, Fang Zhang

**Blooms and non-blooms of the giant jellyfish *Nemopilema nomurai* in the East Asian Marginal Seas: 12-year monitoring using ships of opportunity**

Shin-ichi Uye, Hideki Ikeda, Mariko Takao, Hiroko Okawachi, Miwa Hayashi, Manabu Shimizu, Takashi Setou

*Poster presentations*

**Ecological impact of jellyfish fishery on symbionts of jellyfish in Thailand**

Yusuke Kondo, Susumu Ohtsuka, Khwanruan Srinui, Toshihiko Fujita and Jun Nishikawa

**Morphological and molecular examination of *Aurelia* sp. in Orido Bay, Japan**

Akane Iida, Kana Tozawa, Kenji Nohara and Jun Nishikawa

**Degradation of gelatinous zooplankton carcass by microbial community in seawater**

Yumiko Obayashi, Kana Imanaka and Jun Nishikawa

**Carbon distribution strategy of *Aurelia coerulea* polyps in the strobilation process in relation to temperature and food supply**

Nan Wang, Chaolun Li, Yantao Wang, Song Feng

**Jellyfish fauna changes before and after 2011 Tohoku earthquake and tsunami in southern part of Sanriku coast, Iwate, Japan**

Hiroshi Miyake, Yume Sakuma, Kei Onochi, Neo Nishikawa, Kouki Sugimoto, Futaba Motoishi, Shiho Honda, Tomoya Saito, Hironori Yokoba and Yoshimi Hamatsu

**MONITOR/FIS Workshop (W2)**

**PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment (Second)**

Convenors: *Sei-Ichi Saitoh (Japan), Hyoung Chul Shin (Korea), Lisa Eisner (USA), Gordon Kruse (USA)*

Invited Speaker: *Hein Rune Skjoldal (Institute of Marine Research, Norway)*

Background

The Central Arctic Ocean (CAO) is in rapid transition, largely driven by North Pacific change, has become accessible to a range of activities. Rapid loss of sea ice cover has opened up the Central Arctic Ocean (CAO) for potential fishing opportunities. Debate and policy initiatives have been launched for regulating fisheries that are anticipated to begin in the CAO. Scientific research in the CAO, however, remains scarce in contrast to an abundance of research in the neighboring North Pacific. To inform and support policy decisions in the CAO, an integrated ecosystem assessment is the foremost task. PICES joined with ICES and PAME for such an assessment by forming WG 39 (*Integrated Ecosystem Assessment for the Central Arctic Ocean*) with its mission period ending 2018. WG 39, despite its late start, provided significant Pacific input for the assessment at the third meeting of the Joint Group in May 2018, and also to the final report expected toward the end of 2018. Two workshops were held in 2018. The first one, which was technical in nature and for experts, was organized in March and was mostly in preparation for the third meeting of the Joint Group. As a follow-up to this, a half-day workshop took place at PICES-2018 to consolidate our findings and advice, connect it to those from ICES and to report to the wider PICES community. The major theses of the second workshop at PICES-2018 was: key locations in the Pacific Arctic and the critical processes to determine biological production; characterization of major changes for recent decades; ramifications for ecosystem monitoring and management in the region. One of the tasks for WG 39 in doing this will be to explore for and make use of a pool of databases, aided by the general findings of previous reports and literature survey.

Summary of presentations

The workshop was attended by 15 participants from 4 PICES member countries (Canada, China, Japan, and USA) and Norway. Sei-Ichi Saitoh welcomed participants and provided opening comments. Six oral presentations were given and two presentations (by Hyoung Sul La and Hyoung Chul Shin) were cancelled.

Hein Rune Skjoldal talked about an “Integrated ecosystem assessment of the Central Arctic Ocean – work of an ICES/PICES/PAME working group.” He described the oceanography, including differences between four depth layers as well as difference between Atlantic and Pacific gateways. Finally, he characterized biotic ecosystem components (plankton, ice biota, benthos, fish, birds, marine mammals) and vulnerability to climate, pollution, fisheries, and shipping.

Shigeto Nishino spoke about the “PICES contribution to WGICA: Climate, physical and chemical oceanographic, and lower trophic level ecosystem aspects in the Pacific gateway of the Arctic Ocean.” His talk focused on nutrients and primary production. The Pacific gateway leads to a biological hotspot, where nutrients are supplied from the Bering Sea, fueling a spring bloom that settles to the seafloor where it supports a large benthic biomass. On the contrary, the fall bloom is supplied by resuspended nutrients. During fall, waters are under-saturated with aragonite. Some fishable areas were identified north of Siberia and Alaska. Surveys conducted in those areas revealed enhanced ocean circulation (Beaufort Gyre) in recent years due to the loss of sea ice. More freshwater accumulated, leading to less nutrients north of Alaska and Canada, whereas nutrients increased on the Siberian side which is expected to enhance biological activity in that region.

Zhongyong Gao presented information on “Carbon uptake in bi-polar regions and their responses to climate change.” The Arctic carbon sink was contrasted with the Southern Ocean carbon sink, as well as climate feedbacks and the role of both polar regions on climate change. During the last two decades of rapid change in the Arctic, the carbon sink in the Chukchi Sea retained strong carbon uptake, owing to a steady supply of nutrients from the Pacific. However, the Canada Basin, which did not benefit from nutrients from the Pacific, responded differently. When the area is covered by ice, it does not serve as a carbon sink. However, as the Canadian Basin changes to ice-free, it will become a carbon sink.

Travis Tai gave a presentation on “Evaluating current and future Arctic marine fisheries in Canada under climate change.” He considered two questions concerning Arctic fisheries in Canadian waters: (1) what are current fisheries harvests and how do they compare to current estimated potential for fisheries? and (2) how will future scenarios of climate change affect fisheries potential? He addressed these questions with a dynamic bio-climatic envelope model to simulate potential current and future abundance and distribution of 72 commercially valuable species under high and low climate change scenarios. His model considered changes in temperature and hypoxia and their effects on scope for growth, population growth rate, *etc.* He estimated a potential current catch in Canadian waters of 710 t, but currently only 189 t are taken. Finally, he estimated 63% higher catch potential in the future under the high climate change scenario.

Xiaoyang Li gave a talk on “Characteristics of environmental risks caused by navigation in the Central Arctic Ocean.” He identified three potential Arctic shipping routes: (1) northern sea route, (2) northwest passage, and (3) North Pole route. Of these, only the northern sea route is currently practical. His talk considered status and trends of Arctic shipping, identification of environmental risks, and shipping regulations. Ships were grouped by type; predominant ships are general cargo ships and tankers. Shipping peaks in August and September. There was a recent increase in tankers of mid- and high-ice class, and general cargo ships with mid-ice class mainly due to increased shipping originating from Russia. It is projected that liquid natural gas will become the dominant cargo by tankers. Major risks to the Central Arctic Ocean were identified: cargo release (*e.g.*, oil,

LNG, chemicals), discharge (*e.g.*, garbage, sewage, ballast water), exhaust emissions and noise. The IMO Polar Code requires double hulls for all oil tankers, discharge of oil is prohibited, disposal of plastics is banned, and ballast water standards must be maintained. Treated sewage and food waste can be discharged >12 nm of nearest land. As risks rise with more Arctic shipping, monitoring for compliance with regulations will become increasingly important.

Finally, Fujio Ohnishi gave a presentation, titled “Improvement or deviation? Assessing the agreement on unregulated fishing in the Central Arctic Ocean from the perspective of international politics.” Five Arctic coastal states (Canada, Denmark, Norway, Russia, USA) and five non-Arctic coastal players (China, the European Union, Iceland, Japan and South Korea) completed negotiations on an agreement to prevent unregulated commercial fishing in the high seas area of the central Arctic Ocean on November 30, 2017. The agreement still needs to be ratified. No fishing activities are allowed in the Central Arctic Ocean before a Regional Fishery Management Organization is established. Additionally, there is a need to establish a joint program for scientific research and monitoring. A number of current organizations conduct some work in the Arctic, many with a fisheries focus. Efforts are underway to expand the spatial breadth, ecological depth, and stakeholder relevance of research projects and frameworks. Coordination through diplomacy remains an important foundation for the Central Arctic Ocean.

During a discussion at the end of the session, it was noted that the potential to develop new high seas fisheries in the Central Arctic Ocean is very low. Most increase in fisheries will occur within the Exclusive Economic Zones of neighboring countries. Extension of fisheries into the Central Arctic Ocean would occur mainly on straddling stocks, which are already covered by international agreements. So, fisheries in the Central Arctic Ocean may be an issue of relatively low importance.

#### List of papers

##### *Oral presentations*

##### **Integrated Ecosystem Assessment of the Central Arctic Ocean – work of an ICES/PICES/PAME working group (Invited)**

Hein Rune [Skjoldal](#)

##### **PICES contribution to WGICA: Climate, physical and chemical oceanographic, and lower trophic level ecosystem aspects in the Pacific gateway of the Arctic Ocean**

Shigeto [Nishino](#)

##### **Carbon uptake in bi-polar regions and their responses to climate change**

Zhongyong [Gao](#), Heng Sun, Liqi Chen, Qi Li

##### **Evaluating current and future Arctic marine fisheries in Canada under different scenarios of climate change**

Travis C. [Tai](#), Nadja Steiner, William W.L. Cheung and U. Rashid Sumaila

##### **Characteristics of environmental risks caused by navigation of the Central Arctic Ocean**

Natsuhiko Otsuka, Lawson Brigham, Xiaoyang [Li](#) and Sei-Ichi Saitoh

##### **Improvement or deviation? Assessing the agreement on unregulated fishing in the Central Arctic Ocean from the perspective of international politics**

Fujio [Ohnishi](#)

### **TCODE Workshop (W3)**

#### **Development of a systematic approach to data management in PICES**

Convenors: *Joon-Soo Lee (Korea), Peter Chandler (Canada), Igor Shevchenko (Russia)*

Invited Speaker:

*Yutaka Michida (Atmosphere and Ocean Research Institute, The University of Tokyo, Japan)*

#### Background

Since its establishment in 1992, PICES has produced observation data, experimental data, and model data for scientific purposes through expert group activities and projects, and analyzed the results to produce papers, reports, and data products. Some of the data are also available online. However, PICES data and data products have not been systematically managed and are expected to increase more and more in an unmanaged status in the future. In this regard, there is an urgent need to discuss how to manage the current PICES data and data products as well as how to manage them in the future. Therefore, the aim of this workshop was to identify problems in the sustainable management and use of PICES data and data products, to seek better management structure and system, and to improve the linkage among PICES data producers, scientists and data managers.

#### Summary of presentations

Dr. Joon-Soo Lee (Korea), Mr. Peter Chandler (Canada), and Dr. Igor Shevchenko (Russia) convened the 1-day workshop on October 25. A total of 21 participants attended the workshop and there were 10 presentations followed by round table discussions.

Ms. Fangfang Wan on behalf of Ms. Chun-hua Han presented the Chinese marine data resources management system based on the big data technology. Joon-Soo Lee, TCODE Chair, reviewed the past and present activities of TCODE, and suggested possible options for future direction. After the two presentations, there was a round table discussion about the future of TCODE moderated by Mr. Robin Brown, PICES Executive Secretary.

Invited Speaker, Prof. Yutaka Michida, IOC/IODE Co-Chair, gave a presentation on the IODE's roles and activities, and possible collaboration between PICES and IODE. Dr. Igor Shevchenko reviewed the history of the PICES metadata federation and explained the current metadata system based on the GeoNetwork open source. He suggested the establishment of a study group for the future of PICES metadata federation. Dr. Toru Suzuki presented the history of PACIFICA dataset which was released in 2013 by the Section on *Carbon and Climate* (S-CC), and gave the latest information on the dataset. Mr. Peter Chandler reported the activities of Working Group on *Third North Pacific Ecosystem Status Report* (WG 35/WG NPESR3) and a database of Ecosystem Time Series Observations (ETSOs). Dr. Sonia Batten presented the history of the North Pacific Continuous Plankton Recorder (CPR) Survey and current status of CPR data management, and discussed the roles of PICES for the data. Dr. Hideaki Maki presented the one of the PICES (completed) special projects, ADRIFT (Assessing Debris Related Impact From Tsunami), and the current status of the products. Dr. Thomas Therriault reviewed the activities and products of the Working Group on *Non-Indigenous Aquatic Species* (WG 21). Dr. Mitsutaku Makino explained another completed PICES special project, Marine Ecosystem Health and Human Well-Being (MarWeB) and briefly introduced the contents of the MarWeB database. Following the eight presentations, there were discussions on the "PICES data inventory" and "PICES Data Policy" moderated by Dr. Joon-Soo Lee and Mr. Robin Brown.



As workshop outcomes, the PICES data inventory was updated and the PICES Data Policy was revised through a lot of advice and comments from the workshop participants

### List of papers

#### *Oral presentations*

**The marine data resources management strategy under the background of big data era**

Chun-hua [HAN](#)

**Future of TCODE**

Joon-Soo [Lee](#)

**Enhancing collaborations between PICES and IOC/IODE in open data access (Invited)**

Yutaka [Michida](#)

**PICES metadata federation: past, present, and future**

Daniil Glushenko, Georgy Moiseenko, Igor [Shevchenko](#)

**Contribution PICES data activities to global data products**

Toru [Suzuki](#)

**The Data Management System for Working Group 35: The Third North Pacific Ecosystem Status Report (WG-NPESR3).**

Peter [Chandler](#), Jeanette Gann

**Data from the North Pacific Continuous Plankton Recorder Survey.**

Sonia [Batten](#)

**ADRIFT (Assessing Debris Related Impact From Tsunami) Project – outline and legacy products**

Cathryn Clarke Murray, Thomas W. Therriault, Nancy Wallace, Hideaki [Maki](#) and Alexander Bychkov

**Data from the PICES Project on Marine Ecosystem Health and Human Well-being (MarWeB)**

Mitsutaku [Makino](#), Ian Perry

### **POC/FIS/BIO Workshop (W4)**

#### **Synthesizing projected climate change impacts in the North Pacific**

Co-sponsor: *ICES*

Convenors: *Anne Hollowed (PICES/USA), Shin-ichi Ito (PICES/Japan), Jacquelynne King (PICES/Canada), Myron Peck (ICES/Germany)*

Invited Speakers:

*William Cheung (The University of British Columbia, Canada)*

*Taketo Hashioka (Japan Agency for Marine-Earth Science and Technology (JAMSTEC))*

### Background

Scientists have endeavored to project the implications of climate change on marine ecosystems throughout the North Pacific. As many researchers had completed these projections by June 2018 in anticipation of the 4th “Effects of Climate Change on the World’s Oceans” symposium, this workshop was used to compare and synthesize results from that international projection modeling effort. The workshop provided a forum for discussions of: a) Projection outcomes under different modeling approaches; b) Opportunities for comparative studies looking at projected impacts on selected species or fisheries in different LMEs; c) How modeling teams

addressed the uncertainty landscape including issues of scenario, parameter and model uncertainty; and d) The range of potential harvest strategies selected and their performance relative to different national value systems. It is anticipated that a manuscript will be generated from this session which will be submitted to a peer reviewed journal.

### Summary of presentations

This half-day workshop provided a forum for discussion of ongoing work to project climate-driven changes in key characteristics of marine ecosystems (from phytoplankton to fisheries) in the North Pacific and elsewhere. There were two invited talks as well as a coordinated discussion of the next steps in how PICES and ICES science will best continue its work on climate impacts on socio-ecological systems. The workshop was attended by 33 participants from 10 countries.

William Cheung was an invited speaker. He presented modelling results on the future of North Pacific ecosystems and human responses that can help ensure a sustainable ocean in a future climate. A challenge of modelling a complex ocean system is the layers of uncertainties that provide combine in the projections, namely scenario (*e.g.*, climate and societal changes), model structure (*e.g.* single species to food web models) and internal (*e.g.*, inter-annual and decadal variability) variability. However, using knowledge on uncertainties to explore effective climate adaptation strategies and options can help scenario planning for coupled human-natural marine systems in the North Pacific. Typically, the scenario uncertainty is larger than the internal variability, and therefore drives much of the uncertainty surrounding projections. Additionally, across fish or ecosystem models, there may be difference between model projections, but there is agreement in the direction of change. Since they are forced by the same GCM outputs, it illustrates that there is much variability among models. Coupled to the fish population model uncertainty is the importance to consider exploitation scenarios. By considering fishing scenarios, it is possible to provide adaptation scenarios to fisheries management in order to continue sustainable fishing under climate change.

Taketo Hashioka provided results of multi-model ensemble approach for projecting phytoplankton community structure changes. Twelve models from MAREMIP and CMIP5 were used to calculate the multi-model median of future projections. Multi-model medians indicate a decrease in Chl-*a* concentration in the North Pacific, North Atlantic and equatorial regions, but an increase in the Southern Ocean. Additionally, future changes in nutrients suggest increased areas (and type) of nutrient limitation. Taken together, these results suggest that Large Marine provinces will change, with potential new provinces that are P limited and therefore acting as ecosystem hotspots of change. Across models, there is large differences in projected lower level changes—indicating large differences in uncertainty connecting climate change model outputs to lower trophic levels across models. The importance of comparing how bottom-up and top-down processes are depicted in models was highlighted to help explain inter-model variability in projections.

A third talk by Myron Peck summarized ongoing efforts within Europe to examine the effects of climate change on fisheries and aquaculture in marine and freshwater areas. Two, large-scale projects are ongoing - CERES “Climate Change and European Aquatic RESources” program and ClimeFish. The focus of CERES is to determine the opportunities and risks that will develop under climate change for the fishing and aquaculture industries. CERES has completed drivers and scenarios with physical and biogeochemical projections under RCP 4.5 and 8.5 to 2070 or 2100. PESTEL (political, economic, social, technical, environmental and legal) analyses have been applied to frame future trajectories of change in to be tested including marine spatial planning. The differences in spatial resolution and management advice required between capture fisheries and aquaculture highlight the need for inclusion of aquaculture foci in S-CCME. Communicating climate change impacts on fisheries and aquaculture to industry has been a large focus of CERES, and Bayesian Belief

Network and BowTie analyses have been a useful tool to communicate complexity of issues. Biological projections will be finished in January 2019 (report, not yet published/submitted papers), with projections discussed in March 2019 at its annual project meeting. Socio-economic projections will be finished in June 2019.

During the discussion period, Anne Hollowed reviewed the status of regional climate change research programs under the umbrella of S(I)-CCME as well as those ongoing in FISH-MIP. She posed a number of questions that were discussed. Participants in S(I)-CCME provided information on 36 completed projects across 22 Regions (plus global models) which employed GCMs and RCPs to project climate change impacts on fish and shellfish and their fisheries. The approaches range from end-to-end models (e.g. Atlantis, FEAST) to vulnerability assessments. Missing across the projects is the inclusion of RCP 2.6. This may indicate that RCP 2.6 is not considered to provide a large signal. Also, it appears that, across regions, there is little overlap of the GCMs applied. Synthesizing results across projects, several take home messages emerged. Global model spatial resolution is inadequate on the continental shelves, particularly for ocean circulation. It would be a useful exercise to look at what additional information is gained in projections when higher resolution ROMs are used as opposed to GCMs in shelf regions. In the Bering Sea, using only the global model was investigated, and results indicated that trends were still well captured but that seasonal variability was under-represented. Uncertainty, however, may still be well bounded by using a GCM. The selection of GCMs and RCP makes a difference and needs to be taken into account when attempting to compare projections across regions / projects. Fishing can mitigate or enhance some effects of climate change and it is important to test various management and economic scenarios. Additionally biology matters, and since bio-climatic windows are not the whole story, future work will need to move beyond that focus.

Meaningful stakeholder engagement requires great time and effort – and these consultations can be difficult in mixed user groups where there will be benefits for some and trade-offs for others. Meaningful engagement requires social scientist and economist involvement, typically missing from regional projects. Computing requirements are still too expensive or limited in availability. Managers and stakeholders are interested in realistic options and solutions for potential impacts of climate change on living marine resources. Across the models there was a gradient in the amount of inclusion or communicating with stakeholders to understand what they required in options. There are differences between the management options required by wild fisheries and aquaculture. In the case of aquaculture, responses are adjusted by industry so there is less interest in management scenarios, and more interest in physical changes. The wild capture fisheries require national and international evaluation of trade-offs, highlighting the need to meet often.

A large, ongoing effort is to best align regional efforts to be able to compare and synthesize results. There are several challenges such as how to stitch together the boundaries between ROMs. The fact that management scenarios for capture fisheries need to reflect regional laws and harvest policies, making comparison difficult. Additionally, time scales required by management (short-term forecasts) are not well addressed by the longer-term projections currently in hand. Moreover, it would be interesting to attempt to “downscale” global model outputs to different regions. Work is ongoing in Fish-MIP to compare the projections made by global and regional modelling efforts. Needed are the sub-seasonal to seasonal forecasts.

The GCMs and ESMs (Earth System Models) are rapidly advancing and it is important to keep pace with these developments. ROMS/MOMS will need to be run with CMIP6. So far, there have been only modest attempts to compare results with different NPZ models. The CMIP6 models are (largely) not yet available, but higher spatial resolution can be expected. Three will be variables (e.g., oxygen, nutrients) at higher temporal resolution, that are more relevant to living organisms that weren't available with CMIP5. There will be more ESMs included. The SSP (Shared Socio-economic Pathways) will be employed, which do map onto the RCPs.

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It might be beneficial for S-CCME to actively engage the climate modellers to understand and successfully employ CMIP6. We will need to compare CMIP5 to CMIP6 results to be able to be consistent in scenarios; in the Bering Sea, there is a plan to do this.

S-CCME plans for AR7 should include a wider view of how fisheries fit within the larger array of human activities occurring in (and services provided by) ocean ecosystems. Deoxygenation will be a large topic to include, lack of empirical data has only recently been addressed with field-based observations helping to address this topic. In addition, the Argo group decided to launch biogeochemical Argo profiling floats equipped with DO, PAR, nutrients, pH, chl-*a*, and backscatter sensors. Since global data of those variables will be available until the AR7 process, skills of global and regional biogeochemical and marine ecosystem models are expected to be improved. Efforts to engage those improved models are essential. For increased engagement with stakeholders and participatory approach in S-CCME science, it is important that models match the spatial scales relevant to both the biology and ecology of fish as well as the activities of wild capture fisheries.

S-CCME could communicate climate change projections similar to NPESR (North Pacific Ecosystem Status Report); it could be an expanded effort to the current Chapter 6: North Pacific in FAO Technical Paper 627 (<http://www.fao.org/3/I9705EN/i9705en.pdf>). NPESR has sections on climate impacts, so S-CCME could provide input.

The results of S-CCME Phase II as synthesized through this workshop will be developed in a peer reviewed manuscript, with Anne Hollowed as Lead Author.

### List of papers

#### *Oral presentations*

##### **Building confidence in projecting future marine biodiversity and fisheries under climate change (Invited)**

William W.L. [Cheung](#)

##### **Diagnostically projected future changes of phytoplankton community structure and their growth limitation based on a multi-model ensemble (Invited)**

Taketo [Hashioka](#), Takafumi Hirata, Maki N. Aita, Sanae Chiba

#### *Poster presentations*

##### **Projected changes in the sea surface wind in the east asian marginal seas from regional climate models**

Wonkeun [Choi](#), Chan Joo Jang

**FUTURE Workshop (W5)****Identifying common reference points and leading indicators of ecosystem change**

Convenors: *Mary Hunsicker (USA), Xiujuan Shan (China), Vladimir Kulik (Russia)*

Invited Speaker:

*Caihong Fu (DFO, Canada)*

Background

Abrupt nonlinear change in ecosystem structure and function can dramatically alter human-derived benefits from the system and can have negative impacts on people's livelihoods and well-being. A growing number of driver-response relationships in marine ecosystems are being identified as strongly nonlinear, indicating that they are potentially prone to inflection points and threshold dynamics. Better knowledge of where such thresholds occur can advance our ability to anticipate future conditions and critically inform what management actions can maximize ecological, social or economic benefits. Moreover, thresholds common across analogous systems can be used to develop robust sets of reference points to prevent ecosystem components from tipping into undesirable states. A major goal of the Working Group on *Common Ecosystem Reference Points across PICES Member Countries* (WG 36/WG-CERP) is to 'determine shapes or functional forms of driver - response relationships from available datasets, and quantify thresholds to identify potential ecosystem reference points' in North Pacific ecosystems (TOR 4). This workshop is an important step for completing this goal and for making comparisons among the focal ecosystems selected for WG 36 activities. The workshop also allowed WG 36 to make progress in 'identifying ecosystem components that respond earliest to changes in biophysical drivers and could potentially serve as leading indicators of loss of resilience and ecosystem change' (TOR 5). In addition, the workshop gave WG 36 members an opportunity to work together to ensure that the methods and R code generated for the WG activities can be easily used by PICES member countries as well as other nations to identify potential target or limit reference points and early warning signs of ecosystem change. The specific objectives of the workshop were to: 1) Conduct analyses for TOR 4 to 'determine shapes or functional forms of driver-response relationships from available datasets, and quantify thresholds to identify potential ecosystem reference points' in North Pacific ecosystems; 2) Identify differences and commonalities among thresholds/ecosystem reference points in the focal ecosystems of WG 36 activities; 3) Select common methods for systemwide comparisons to identify leading indicators of ecosystem; 4) Develop, test and share R code via shared GitHub repository that is generalizable for other ecosystems; 5) Begin applying leading indicator analyses to focal ecosystems of PICES member countries (TOR 5).

Summary of presentations

WG 36 held a workshop (W5) on October 25, 2018 in Yokohama, Japan. It was chaired by Xiujuan Shan and Vladimir Kulik. Mary Hunsicker participated by remotely. The main objective of the workshop was to familiarize all WG members with the R programming language and the R scripts needed to run analyses to complete TOR 4 (Determine shapes or functional forms of driver - response relationships from available datasets, and quantify thresholds to identify potential ecosystem reference points).

Invited speaker, Caihong Fu (Canada), provided a talk on her research with Indicators for the Seas (IndiSeas). She summarized research conducted by the two phases of IndiSeas (IndiSea1 and IndiSeas2). Research conducted as part of IndiSeas1 resulted in the evaluation of the ecological status of marine ecosystems relative to fishing. One lesson learned was that it is difficult to distinguish between fishing and environmental effects. For IndiSeas2, climate, biodiversity, and human dimensions indicators were also examined. Dr. Fu conducted

model-based simulations to test indicator behavior and performance under controlled environmental conditions and compared these across models, ecosystems, and fishing strategies to account for different sources of uncertainty. Dr. Fu also applied a variety of methods to look for nonlinearities and identify inflection points in time series. She pointed out the challenge of identifying thresholds, because inflection points do not necessarily reflect ecosystem tipping points.

Lisha Guan could not attend the workshop but she provided a talk (given by Xiujuan Shan) on indicators used in China. She summarized the main indicators used to assess the state of marine ecosystems. Physical indicators often used in China include, for example, chlorophyll a, dissolved inorganic nitrogen and phosphate, rate of denitrification and nitrification, pH, dissolved oxygen, and others. Ecological indicators included, for example, growth rate, age or size at maturity, natural mortality, mean size or age, diet composition, survey-based relative abundance index, abundance of surveyed community, mean length in surveyed community, and others. She summarized results from a case study examining nine fish and shrimp species in the Yellow Sea. As part of this case study, she examined the spatial correlation between encounter probabilities and between positive catch rates for predators and competitors.

Workshop participants had several questions for each speaker and there was a lively discussion about the indicators that were used in the presenters' analyses.

For the workshop, members built a GitHub repository that includes three test scripts and a test dataset from the California Current that were tested at the Yokohama PICES meeting. Elliott Hazen led the workshop participants through an R tutorial and reviewed the R code and documentation (on GitHub). Each member country was able to try some if not all the code on data from the U.S portion of the California Current from Samhouri *et al.* 2017. The workshop environment enabled members to help each other with issues and troubleshooting. The GitHub repository created for WG 36 (<https://github.com/elhazen/WG-36>) includes:

1. Test data – “coastwide data for reference points.csv”
2. Dynamic Factor Analysis code - "DFA code v2.0\_ELH.R" that will create plots and create a clean dataset that will be used in the next two scripts.
3. Single factor Generalized Additive Model code “Single\_Driver\_ResponseGAM\_v2.R” - GAM and inflections to identify non-linear thresholds.
4. Gradient Forest Analysis code – “gradientForestAnalysis.R” - a multi-factor regression approach to identify non-linear thresholds.
5. INDperform package – “IndicatorPerformancePackage.R” - A method for testing redundancy and utility of indicators presented by Saskia Otto at the ECCWO4 W11.

The workshop participants also discussed exploring the “minerva” package that Vladimir Kulik has explored and introduced. This would allow exploring the effects of multiple indicators.

Workshop participants discussed observations, issues, and preliminary results from the R tutorial. Most if not all of the WG members were able to install RStudio, run R code on the California Current time series and reproduce results from the Samhouri *et al.* 2017 paper. Some members were able to apply the analyses to data sets from their own nations as well. From the discussion the participants listed several conclusions and outlined next steps.

**Canada:** Jennifer Boldt ran the R code for a single-driver and response on IndiSeas indicators and no significant responses between the short list of IndiSeas indicators were found. The list of indicators to be used in her analysis is being expanded to include more of the WG 28 (*Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*) recommended indicators and to update the time

series. One consideration in moving forward with WG analyses is the issue of spatial scale, for example, large-scale climate forcing indicators vs. regional survey data that may miss some species vs. point estimate data.

**China:** For the China's preliminary analyses, Xiujaun Shan successfully ran the R code using total landings as proxy for human activities, and different taxa landings as the ecological indicators. The NOI, NPGO, PDO were included as the oceanographic indicators. More indicators will be added following the meeting.

**Korea:** From Korean side, RStudio and R code were successfully installed and loaded. Preliminarily, the R code was run with temperature and chlorophyll-a in surface coastal waters in Korea retrieved monthly from MODIS satellite from 2002 to 2014. There is no distinct relationship between them. One concern is the availability of long-term data in Korean water, especially regarding ecological aspects. Most ecological data, such as biodiversity, biomass, population structure of marine mammals, have been obtained temporarily in short term, such as 1 or 2 years. There is various fishery data on landings and model-derived potential landings of mackerel. Next steps include analyzing relationships between indicators suggested by WG 28, including human and climate pressures, and environmental and ecological variables.

**Russia:** The relationship between marine trophic level (MTI) and catches of dominant objects of fishing in the Russian part of the Region 19 were checked using the R code. There was no significant inflection point found, but the best model was the GAM (thin-plate regression spline over catches). From previous preliminary cross-correlation studies it is known that the strongest effect of catches on the MTI in this case can be found after 3 years. After shifting MTI 3 years forward and rerunning the code the relationship became linear and significantly negative ( $r = -0.7$ ,  $p < 0.001$ ). Obviously, inflection point couldn't be found again. We'll need more time to check other possible relationships between submitted ETSOs for NPESR3.US

**U.S. west coast:** Many of the driver-response relationships have been tested and presented by Samhouri *et al.* 2017 (both GAMs and Gradient Forest Analysis). The next steps for U.S. members are to the expand the GAM and Gradient Forest Analysis using a broader set of indicators, i.e. those indicators suggested by WG 28, and to apply DFA and INDperform to the regional data sets.

From the discussion the participants raised several issues that require further thought and deliberation:

- Some members ran analyses using independently developed code and found that responses to individual pressures were sometimes different than the shape of the same response to multiple indicators. For example, a response to a single driver may be nonlinear, but the response became linear when two drivers were considered.
- Responses to drivers may be lagged.
- How to account for interaction terms and their combinations? This question may need to be considered for each ecosystem. Gradient forest method is appropriate for this (for multiple responses and drivers) and we should pay attention to this.
- Spatial scale of indicators is important to consider (*e.g.*, pollution indicators have different spatial scale than other indicators, such as fishery indicators)
- Multiple other statistical analyses (*e.g.*, factor analysis, MDS, etc.) may be worth examining

From the discussion the participants also outlined next steps:

- Members will continue to collate and update indicators (from the WG 28 list); document indicators, time series, and rationale for the drivers-responses selected;
- Members will carry out analyses on their ecosystems using the R code;
- One of the WG members will review Samhouri *et al.* (2017);

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- WG members agreed on the need for regular deadlines, updates, and meetings to keep up momentum on analyses (in addition to intersessional workshop).



From left: Eko Siswanto, Suzan Yeh, Chi-lu Sun, Alexandra Zavolokin, Jennifer Fisher, Mary Hunsicker (by phone), Steve Teo, Gerard DiNardo, Xiujuan Shan, Vladimir Kulik, Jennifer Boldt, Jackie King, Jongseong Ryu, Elliott Hazen, Sukyung Kang, Caihong Fu, Barbara Muhling

### List of papers

#### *Oral presentation*

#### **Marine ecosystem responses to anthropogenic and environmental pressures: Linear or nonlinear?**

Caihong Fu

### **BIO Workshop (W6)**

#### **Regional evaluation of secondary production observations and application of methodology in the North Pacific**

Convenors: *Akash Sastri (Canada), Toru Kobari (Japan)*

Invited Speaker:

*Koichi Ara (Nihon University, Japan)*

### Background

Zooplankton production represents a quantitative proxy for the functional response of marine ecosystems to regional and global climate change, because material and energy scattering in the lower food web is integrated by zooplankton communities. Although a variety of methodologies for measuring zooplankton production have been developed and applied over the last half century, our knowledge of which approaches are applicable to a diverse range of organisms and habitats remains limited. Recent advances in biochemical methods for measuring zooplankton production have been reviewed, however, such information is still lacking for the traditional methodologies. The purpose of this workshop was to share the current status on zooplankton production methodologies and measurements, reported by the working group members representing each PICES country. In addition, presentations and discussion on advantages, applications and limitations of



traditional methodologies on zooplankton production applicable to natural zooplankton populations and communities were also encouraged.

### Summary of presentations

Drs. Akash Sastri and Toru Kobari (Co-Chairs, Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions*, WG 37) convened a workshop (W6) “Regional evaluation of secondary production observations and application of methodology in the North Pacific” in the morning of October 25 during PICES-2018 in Yokohama. About 25 participants from 5 countries joined this workshop. Nine talks and 4 posters were presented.

Drs. K. Ara (Japan), K. Tadokoro (Japan) and A. Sastri (Canada) demonstrated applications of some empirical models to zooplankton population or community in nature and emphasized that the models would be the most practical to existing zooplankton data sets among the contemporary methodologies. Drs. C.H. Hsieh and H. Liu reviewed the artificial cohort method which were widely used and described their results comparing with those by the other methods. Dr. L.E. Kwong introduced a good example of intercalibration for zooplankton productions between normalized biomass size spectra and chitobiase activity. Dr. S. Zeman demonstrated egg productions of two copepod species associated with environmental changes at the Oregon coast. Status reports of zooplankton productivity measurements in the Canadian and Japanese waters were done by Drs. A. Akash and T. Kobari, respectively. At the end of the workshop, the following issues were discussed.

- What kind of information is necessary for promoting zooplankton production measurements?
- How should we promote zooplankton production measurements?

Dr. C.H. Hsieh proposed that the regional model for zooplankton growth or production applicable to the PICES region should be developed by sharing data-sets of the direct measurements and environmental variables. Also, participants confirmed that such data exchanges would be good collaborations to promote zooplankton production measurements. The Co-Chairs continued to discuss these issues at the Working Group meeting.

### List of papers

#### *Oral presentations*

#### **Traditional approaches for estimating zooplankton production rate and food requirement in the neritic area of the North Pacific (Invited)**

Koichi [Ara](#) and Akihiro Shiomoto

#### **Spatial and temporal variation of mesozooplankton productivity in the Seto Inland Sea, Japan**

Kazuaki [Tadokoro](#), Akihide Kasai, Katsuyuki Abo, Kazutaka Miyahara, Keigo Yamamoto, and Kazuhiko Koike

#### **Copepod community growth rates in relation to body size, temperature, and food availability in the East China Sea: A test of metabolic theory of ecology**

Kuan-Yu Lin, Akash R. Sastri, Gwo-Ching Gong, and Chih-hao [Hsieh](#)

#### **An overview of artificial cohort method for estimating zooplankton production in the ocean**

Hui [Liu](#), Russell R. Hopcroft

#### **Evaluation of the application of empirical growth rate models toward a long-term zooplankton biomass/production time-series on the southern shelf of Vancouver Island.**

Akash R. [Sastri](#), Moira Galbraith, and R. Ian Perry

#### **A status report on Canadian marine zooplankton production rate measurements**

Karyn D. [Suchy](#) and Akash R. Sastri

## Session Summaries – 2018

### **Status report on zooplankton productivity measurements in the western North Pacific Ocean and its neighboring waters**

Toru [Kobari](#) and Kazuaki Tadokoro

### **An intercalibration of chitobiase and biomass size spectra zooplankton production estimates**

Lian E. [Kwong](#), Karyn D. Suchy, John F. Dower, Evgeny A. Pakhomov

### ***Calanus marshallae* and *Calanus pacificus* egg production in relation to environmental variables in a productive upwelling zone in the northern California Current**

Samantha [Zeman](#), Jay Peterson, Jennifer Fisher, William Peterson

### *Poster presentations*

### **Zooplankton secondary production in high nutrient low chlorophyll (HNLC) and seasonally productive regions in the North Pacific**

Lian E. [Kwong](#), Evgeny A. Pakhomov

### **Estimation of egg production rate of *Calanus sinicus* from preserved samples**

Takashi [Fushima](#), Takafumi Yamaguchi, Kiyotaka Hidaka, Mana Mikawa, Minamo Hirahara, Tomohiko Kikuchi, Tatsuki Toda and Shinji Shimode

### **Diel rhythm of egg spawning of the planktonic copepod *Calanus sinicus* in Sagami Bay, Japan**

Yuji [Yoshinaga](#), Tomohiko Kikuchi, Tatsuki Toda and Shinji Shimode

### **Individual growth rate (IGR) measurements negatively correlate with aminoacyl-tRNA synthetases (AARS) activity in North Pacific krill, *Euphausia pacifica***

Anna K. McLaskey and Julie E. [Keister](#)

## **BIO Workshop (W7)**

### **Diets, consumption, and abundance of marine birds and mammals in the North Pacific**

Convenors: *Andrew Trites (Canada), Tsutomu Tamura (Japan), Yutaka Watanuki (Japan), Robert Suryan (USA)*

Invited Speaker:

*Andrew Trites (The University of British Columbia (UBC), Vancouver, Canada)*

### Background

The Section on Marine Birds and Mammals, under the BIO Committee, is midway through a 5-year program to update the 2000 PICES Scientific Report on Predation by Marine Birds and Mammals in the Subarctic North Pacific Ocean. To date, we have held a successful workshop (2016) to frame the program and agree on general modelling approaches, spatial boundaries, time scales and other considerations (see PICES Workshop (W6) [summary](#) on “Consumption of North Pacific forage species by marine birds and mammals”). Since the 2016 workshop, S-MBM initiated the agreed upon databases to estimate prey consumption, and continued to add and verify data in anticipation of this workshop, when invited experts reviewed the compiled information. Obtaining this expert consensus on model input parameters through the proposed workshop process is a necessary and critical next step to ensure the success of our program to estimate the amounts of prey consumed by seabirds and marine mammals in the North Pacific. The workshop participants contributed to the finalization of the databases of diets, abundances, distributions, and energy requirements of 135 species of seabirds, and all 47 species of marine mammals in the 12 PICES eco-regions. During the workshop, the invited holders of data and knowledge on the feeding ecology of seabirds and marine mammals in the North Pacific 1) reviewed the data summaries compiled by S-MBM members, 2) identified data gaps and sources of missing information, and 3) assisted in framing appropriate educated guesses on possible values for missing data. The

workshop was structured with two breakout groups (birds and mammals), where data were presented by individual species and consensus was obtained on their accuracy and completeness. This process resulted in near-complete databases of diets, abundances, and energy requirements of marine birds and mammals in the North Pacific.

### List of papers

#### *Oral presentations*

#### **Reconstructed and actual weight of stomach contents of the Steller sea lion to estimate their food consumption during wintering in Japan**

Yoko Goto

#### **Spatial estimation of prey consumption by Bryde's whales in the western North Pacific during the summers of 2008 – 2009: Density surface model approach**

Hiroko Sasaki, Tsutomu Tamura, Takashi Hakamada, Koji Matsuoka, Hiroto Murase and Toshihide Kitakado

#### **Summer prey consumption by three species of seabirds breeding in Japan**

Yutaka Watanuki, Jumpei Okado, Heya Na, Maki Yamamoto

#### **Preliminary estimates of prey consumption by seals and sea lions in the North Pacific (Invited)**

Andrew W. Trites

#### **Estimation of prey consumption by marine mammals in the PICES regions - Update to Hunt *et al.* (2000)**

Tsutomu Tamura, Kenji Konishi, Koji Matsuoka and Takashi Hakamada and Andrew W. Trites

### **HD Workshop (W8)**

#### **Taking stock of Marine Ecosystem Services in the North Pacific - Exploring examples and examining methods**

Convenors: *Shang Chen (China), Daniel K. Lew (USA)*

### Background

The purpose of this workshop was to advance understanding of the character and value of marine ecosystem services under the aegis of the Working Group on *Marine Ecosystem Services* (WG 41/WG-MES). Participation by local scientists was encouraged. The main tasks of this workshop included: (1) reviewing MES studies from the North Pacific region; (2) identifying gaps in understanding the status and trends of MES in North Pacific region; (3) developing a draft typology of marine ecosystem services and various approaches and methods for assessing those services and their value.

### Summary of presentations

On Saturday, October 27, 2018, The Working Group on *Marine Ecosystem Services* (WG 41) convened a workshop (W8) on “Taking stock of marine ecosystem services in the North Pacific–Exploring examples and examining methods.” The workshop was a half-day in length and included presentations and an extended discussion. The workshop was co-convened by Dr. Dan Lew (USA) and Dr. Shang Chen (China) and was sponsored by the HD committee. Dr. Chen was unable to attend the workshop in person, so it was chaired by Dr. Lew, who provided an introduction that included a statement of the workshop goals, history and purpose of the WG, and some additional background material on marine ecosystem services. There were 12 attendees, including four presenters and five WG 41 members (Lew, Wallmo, Li, Sugimoto, and Dudas).

## Session Summaries – 2018

Originally, six presentations were scheduled, but two were cancelled at the last minute. The remaining four presentations included presentations by the following:

Yousuke Fujii presented on the effects of changes in kelp farming practices in the Fukushima region of Japan. Prof. Jingmei Li presented a study to assess the recreational and ecological damages from green algae tides in Jiaozhou Bay in China. Dr. Kristy Wallmo presented a survey of researchers, managers, and policy analysts and other staff working on topics related to marine ecosystem services who work within entities involved in fishery management in the U.S. (*e.g.*, NOAA Fisheries and Regional Fishery Council staff). Dr. Dan Lew presented an evaluation of the stated preference valuation literature valuing marine ecosystem services

Following the presentations, the speakers and participants engaged in a discussion about challenges related to ecosystem service valuation (ESV), principally scale (small region, state, nation, *etc.*), double counting of values across ESV, and what ESVs should be valued (final outcomes *vs.* intermediate ones). Challenges to the validity of MES value information resulting from non-market valuation methods were discussed, as was the literature to develop best practices for minimizing biases associated with the methods. Events like the Deepwater Horizon oil spill were discussed as events that had driven general research and science on MES valuation, but the difficulty of industry-sponsored research as an unbiased source of MES information was also acknowledged.

### List of papers

#### *Oral presentations*

##### **Labor situation of kelp farmers and the change in farming practice**

Yousuke [Fujii](#)

##### **Ecological damage assessment of green tide blooms based on double-bounded dichotomous bias correction model**

Jingmei [Li](#), Jingzhu Dan

##### **Challenges and opportunities for using ecosystem service values in NOAA Fisheries**

Kristy [Wallmo](#) and Daniel K. Lew

##### **Marine ecosystem service values and valuation in the U.S.: An assessment of the literature through the lens of recent best practice guidelines**

Daniel K. [Lew](#), Leif Anderson, Doug Lipton, Tammy Murphy, and Kristy Wallmo

#### *Poster presentations*

##### **Economic value of ecosystem services and utility of coastal fisheries in Indramayu, Indonesia**

Takaaki [Mori](#), Ayumi Kanaya, Naoki Tojo, Mitsutaku Makino, Mark Wells, Vladimir Kulik, Joon-Soo Lee, Shion Takemura, Charles Trick, Chang-an Xu, Suhendar Sachoemar