Summary of Scientific Sessions and Workshops At PICES 2022

Sustainability of Marine Ecosystems through global knowledge networks during the UN Decade of Ocean Science

Convenors:
Vera L. Trainer (SB), Steven Bograd (FUTURE), Jeanette C. Gann (TCODE), Xianshi Jin (FIS), Sukyung Kang (FUTURE), Sung Yong Kim (MONITOR), Emanuele Di Lorenzo (POC), Mitsutaku Makino (HD), Guangshui Na (MEQ), Akash Sastri (BIO), Igor Shevchenko (Russia)

Background
In 2015, the United Nations (UN) General Assembly adopted the 2030 Agenda for sustainable development recognizing the peril humanity faces. The Intergovernmental Oceanographic Commission (IOC) of UNESCO announced the launch of the UN Decade of Ocean Science for sustainable development (hereafter, the Ocean-Decade) to support the 2030 Agenda for 2021-2030. The first batch of endorsed programs and contributions for the Ocean-Decade has been set in place in 2021 and will be followed by more Decade actions. It is about time to evaluate whether we have a good arsenal in line with the Ocean-Decade to transform ecosystems in the North Pacific. While some areas of scientific knowledge are advancing well, certain aspects need to be enhanced to fulfill the transformative nature of the Ocean-Decade. For example, more extensive involvement of stakeholders and early career researchers/professionals. Also, inclusive action networks formed by all the stakeholders involved are crucial in harnessing the ocean knowledge to transform the ocean. In this meeting, we will review the major efforts in the PICES regions to meet with the Ocean-Decade objectives and challenges and steer the future directions by identifying gaps and setting the priorities.

List of papers

Oral presentation

1. **The intersection of UN Ocean Decade and PICES FUTURE in the North Pacific.** Fangli Qiao
2. **Increasing Capacity and Incentives for Data Sharing within the UN Decade, and Strategies to Incorporate PICES Research and Data into Broader International Platforms,** Kate Wing, Jeanette Gann
3. **Identifying the Ocean Decade challenges: A common framework for Small Island Developing States.** Naya Sena and Mitsutaku Makino
4. **Co-Designing Climate Solutions under the U.N. Ocean Decade.** Manu Di Lorenzo
5. **Shall We Repeat Plastics Research,** Gennady Kantakov
6. **SmartNet: The ICES-PICES Joint Program of the UN Decade of Ocean Science for Sustainable Development.** Steven J. Bograd and Sanae Chiba
7. **Possible abiotic causes of catastrophic ecosystem event in Avachinskiy Bay of Kamchatka in 2020.** Vyacheslav Lobanov, Aleksandr Sergeev, Pavel Semkin, Petr Tishchenko and Pavel Tishchenko
8. **Mapping widespread hypoxia off the Pacific Northwest during the 2021 summer upwelling season: A necessary ingredient to informing sustainable use of the ocean.** John A. Barth, Stephen D. Pierce, Brendan Carter2 Anatoli Erofeev, Jennifer Fisher, Richard Feely, Kym Jacobson, Aimee Keller, Cheryl A. Morgan, John Pohl, Leif Rasmuson4 and Victor Simon
9. **Lifting the voices of Indigenous students to empower the next generation of ocean leaders.** Misty B. Peacock

Poster presentation

1. **The Alaska Ocean Observing System: Critical Research Infrastructure for a Rapidly Changing Arctic.** Sheyna Wisdom, Carol Janzen, Molly McCammon, Jill Prewitt, Darcy Dugan, Thomas Farrugia and Holly Kent Alaska Ocean Observing System, Anchorage, Alaska, USA.
2. **Consistent seabird migration route across years and populations reveals key areas for marine conservation in the North-western Pacific.** Jean-Baptiste Thiebot1, Akinori Takahashi, Ui Shimabukuro, Jumpei Okado, Nobuo Kokubun and Yutaka Watanuki
3. **How fisheries/marine science looks like in the past, present and future: from an ECOP's perspective in 2022.** Aoi Sugimoto
   Development of the maximum specific rate of photosynthesis algorithm: a case study for the
4. **Atlantic Ocean.** Aleksandra **Malysheva** and Polina Lobanova

Marine Ecosystem Services – Connecting Science to Decision Making

Convenors:
Sarah Dudas (Canada), Jingmei Liu (China)

Background
Marine Ecosystem Services provide a conceptual framework to understand and communicate the value our coastal and marine ecosystems have from ecological, economic, and socio-cultural perspectives. All species and habitats provide ecosystem functions and produce 'services'. This session seeks to bring together natural scientists (ecologists, biologists, oceanographers, etc.) studying species and habitats that provide these services with the social scientists (economists, anthropologists, sociologists, etc.), policy makers, managers, and others that use the concept of MES to affect decision making. The session will include discussions on ecological, economic, and socio-cultural metrics to identify synergies between them. An objective of this session will be to help bridge the gaps in communication and understanding about ecosystem services between natural and social scientists in PICES nations and to illustrate the range of applications studying marine ecosystem services.

List of papers

Invited Talk
1. **Integrating human wellbeing indicators in Puget Sound ecosystem restoration.** Kelly Biedenweg
2. **Implementing the marine ecosystem service concept.** Michael Townsend, Andrew M. Lohrer, Vera Rullens, Fabrice Stephenson, Conrad A. Pilditch, Judi E. Hewitt and Simon F. Thrush

Oral presentation
1. **Toward the inter-regional cooperation for high seas resource conservation: Implications from the Asia-Pacific region.** Iwao Fujii, Yumi Okochi, Hajime Kawamura and Mitsutaku Makino
2. **Floating marine debris in Shiretoko, Japan: Relationship between debris density, type and local human activities.** Monica Ogawa and Yoko Mitani
3. **Evaluation of ecosystem services provided by Pacific oyster, *Crassostrea gigas,* farms in Hansan bay, South Korea.** Jongyoon Baek and Sukgeun Jung
4. **Climate attribution time series to support decision making by fisheries stakeholders.** Michael Litzow, Brendan Connors, Erin Fedewa1 Trond Kristiansen, and Michael Malick.
5. **Blue carbon in South Korea: Knowledge gaps, critical issues, and novel approaches.** Yeajin Jung

Poster presentation
No presentation

Session 3: POC/TCODE/FUTURE Topic Session

Realizing scalable artificial intelligence in marine science

Convenors:
Pramod Thupaki (Canada), Thomas Y. Chen (USA), Hernan Eduardo Garcia (USA), Igor Shevchenko (Russia), Di Wan (Canada)

Background
Exploratory projects in applications of artificial intelligence (AI) to marine science issues have been advancing rapidly in recent years, and these projects so far have been limited in scope and not been made scalable. This session brings together the scientists, developers, and leaders who are interested in advancing scalable AI applications. We will discuss the knowledge gaps, priorities, infrastructure requirements, feasibilities in realizing scalable AI in marine science. More importantly, we will welcome innovative, future oriented and actionable solutions. We invite a wide range of submissions, including but not limited to real-time and delayed-mode QC and anomaly detection using AI and data infrastructure that allows scalable operations. Other information: This session is a contribution to 2 of the PICES Strategic goals. Goal 4: Advance methods and tools. Machine learning and AI are new tools with enormous potential that should be explored in the PICES context. Goal 6: Engage with early career scientists to sustain a vibrant and cutting edge PICES scientific community. Big data and AI represent the cutting edge of the process to convert data into information in the modern world, therefore encouraging the development and application of these new tools is one way to attract early career scientists to PICES.

List of papers

Oral presentation

1. **Artificial neural network for ocean surface current prediction around the Korean peninsula using transfer learning.** Jeong-Yeob Chae, Young-Taeg Kim and Jae-Hun Park
2. **Impacts of seasonal and interannual variabilities of sea surface temperature on its short- term deep-learning prediction model around the southern coast of Korea.** Ho-Jeong Ju1, Jeong-Yeob Chae, Eun-Joo Lee, Young-Taeg Kim and Jae-Hun Park
3. **Reconstruction of Long-Term Gaps of Sea Level Using Neural Network Operator.** Eun-Joo Lee and Jae-Hun Park
4. **Bayesian inference for extracting information from abundance and catch at age time series.** Igor I. Shevchenko
5. **AIS data-driven automatic machine learning model for predicting suitable fishing vessel operating areas in Northwest Pacific.** Yang Liu, Yuanzhe Qin and Hao Tian
6. **The Problem of Learning to Make Statistical Decisions for Small Samples for Remote Monitoring Marine Ecosystems.** Ferdenant Mkrtchyan
7. **Using Machine Learning to evaluate ecosystem connectivity and biodiversity in marine ecosystems.** Annalisa Bracco and Ljuba Novi
8. **Machine learning approaches for processing large datasets from the Prawler and Oculus glider autonomous platforms.** Emily P. Lemagie, Shaun Bell, Jens M. Nielsen, Noel Pelland, Phyllis Stabeno, Peggy Sullivan and Jordan T. Watson
9. **Identifying changes of research focuses and potential collaborations in PICES toward the UN Decade of Ocean Science for Sustainable Development (UNDOS)**. Shion Takemura , Karen Hunter and Mitsutaku Makino

Poster presentation

1. **Analysis of water quality fluctuations in Estuary using a Random forest.** Sangyeob Kim, Koji Seto, Kenji Minami, Shohei Hayashi and Yasushi Seike

2. **Seasonal to multiannual marine ecosystem prediction: Deep learning approaches.** Ji-Sook Park, Jong-Yeon Park, Jeong-Hwan Kim and Yoo-Geun Ham

Application and best practice of imaging technologies for plankton and ecosystem monitoring

Convenors:
Hongsheng Bi (USA), Julie Keister (USA), David G. Kimmel (USA), Akash Sastri (Canada)

Background
Traditional plankton monitoring programs often involve field sampling and sample processing techniques that are high cost, time consuming, and labor intensive. These limitations restrict the potential to use planktonic communities as indicators of environmental change. However, recent developments in plankton imaging systems and machine algorithms provide a unique opportunity to move plankton monitoring programs from net-based techniques to either fully imaging-based or a hybrid of net-based and imaging-based plankton monitoring approaches. It is important to understand the strength and limitations of imaging systems and a need to develop broadly applicable taxonomic identification algorithms. This session focuses on plankton imaging systems and image processing methods. Our session seeks contributions that provide examples of imaging systems are applied to plankton monitoring and discuss how captured images are processed using automated recognition and enumeration methods. Our goal is to share state-of-the-art science that serves to facilitate the deployment and use of imaging systems for plankton monitoring worldwide.

List of papers

Invited talk

1. **Advances in imaging technology and image analysis – applications in coastal systems.** Robert K. Cowen, Moritz S. Schmid, Su Sponaugle, Kelsey Swieca

Oral presentation

1. **The Prince William Sound Plankton Camera: a profiling *in situ* observatory of plankton and particulates.** Robert W. Campbell, Paul L. Roberts and Jules Jaffee
2. **A novel end-to-end deep learning system for marine biological and environmental images.** Hongsheng Bi, Yunhao Cheng, Xuemin Cheng, Mark Benfield, David Kimmel, Haiyong Zheng, Bri Groves and Kezhen Ying
3. **A new portable tow-yo imaging system for marine snow and plankton using image recognition and tracking technique.** Ingibjorg Bjorgvinsdottir, Kristinn Throstur Sigurdarson, Takeyoshi Nagai, Gloria Silvana Duran Gomez, Miku Okawa
4. **A dual mode imaging method for phytoplankton: a combination of shadowgraph imaging and fluorescence imaging.** Gaoge Chen, Hongsheng Bi, Xiaojin Cui and Xuemin Cheng
5. **Increase depth of field for underwater microscopic imager.** Xiaojin Cui, Hongsheng Bi, Gaoge Chen and Xuemin Cheng
6. **Copepoda in Yellow Sea coastal areas: influence factors for the distribution of density and size structure.** Dai Liu, Huichao Jiang, Jianlong He, Zhonghua Cai, Kezhen Ying, Hongsheng Bi
7. **Planktonic trophodynamics in the Northern California Current - multiyear in-situ observations derived from underwater imaging.** Moritz S. Schmid, Su Sponaugle and Robert K. Cowen
8. **Differential response of coastal plankton to tidal and diurnal variations.** Junting Song, Hongsheng Bi, Zhonghua Cai and Kezhen Ying·

9. **Zooplankton community and size structure from surface to deep-sea for the various neighboring waters of Japan: Analysis by ZooScan.** <u>Kunito Yamamae,</u> Yasuhide Nakamura, Kohei Matsuno, and Atsushi **Yamaguchi**[1]

10. **Influence of freshwater on zooplankton distribution in Laizhou Bay.** <u>Yi Zhu</u>, Huichao Jiang, Jianlong He, Zhonghua Cai, Kezhen Ying and Hongsheng Bi

11. **Automation of rapid zooplankton assessment for use in ecosystem based fisheries management.** <u>David G. Kimmel</u>, Deana C. Crouser, Paweł Kaźmierczak, Barbara Kłopotowska, Mirosław Ciupiński and Hongsheng Bi

Poster presentation
> No presentation

Session 5: FIS Topic Session

Environmental variability and small pelagic fishes in the North Pacific: exploring mechanistic and pragmatic methods for integrating ecosystem considerations into assessment and management

Convenors:

Chris Rooper (Canada), Toshihide Kitakado (Japan), Vladimir Kulik (Russia), Bai Li (USA)

Co-sponsor:
NPFC

Background

Small pelagic fish species are a key component of North Pacific ecosystems. They are a prey species for large bodied fishes, marine mammals and birds and an important predator of zooplankton and phytoplankton production. In addition, there are substantial commercial fisheries that exploit small pelagic species. Small pelagics are often short-lived and respond strongly to environmental changes. This makes these species particularly difficult to manage, as changes in productivity caused by environmental changes can precede management responses. This also creates an opportunity, in that environmental changes can have impacts on the species distribution and abundance over shortened time scales that are relatively easily detected. For example, Pacific Saury is a species with a 2-year life cycle, with distribution and abundance known to be strongly correlated to temperature and ocean conditions. Abundance and productivity are likely to change over very short time scales. The species also supports a large multi-national commercial fishery in international waters. However, the linkages to environmental conditions are not parameterized in the existing stock assessment or management strategy. This proposed session will focus on methods to incorporate the environment into stock assessment and management of small pelagics. We will solicit contributions under three broad categories, 1) contributions that hypothesize and apply mechanistic approaches to relating growth, recruitment and productivity to environmental changes in the North Pacific Ocean, 2) methods for monitoring and predicting ocean conditions that have implications for population status and can assist in projecting future changes in the abundance of small pelagic fishes and 3) examination of environmental relationships that can contribute to understanding the implications for management measures such as biological reference points and harvest control rules.

List of papers

Invited talk

1. **Options for including environmental variability into management of California Current fish species.** <u>Isaac C. Kaplan</u>

2. **Evaluating the spatiotemporal dynamics of Pacific saury in the Northwestern Pacific Ocean by using a geostatistical modelling approach.** Jhen Hsu, Yi-Jay Chang, Toshihide Kitakado, Mikihiko Kai, Bai Li, Midori Hashimoto, Chih-hao Hsieh, Vladimir Kulik, Kyum Joon Park

Oral presentation

1. **Explaining variability in the Pacific saury fishery with the help of Lagrangian characteristics in the western North Pacific.** Vladimir V. Kulik, Sergey V. Prants, Michael Yu. Uleysky and Maxim V. (Cancelled)
2. **Assessment of multiscale nutrient supply processes on biological productivity in the Tokara Strait along the Kuroshio.** Gloria S. Duran Gomez, Takeyoshi Nagai, Toru Kobari, Hirohiko Nakamura, Kristinn Þröstur Sigurdarson and Ingibjorg Bjorgvinsdottir
3. **Effects of the Kuroshio nutrient stream intrusion into the north of Yaku Island and Osumi Strait south of Kyushu.** Takeyoshi Nagaiand Gloria Silvana Durán Gómez
4. **Recruitment variability of chub mackerel (*Scomber japonicus*) with respect to varying water temperatures.** Seonggil Go and Sukgeun Jung
5. **Effect of climate change on the Korea chub mackerel stock in stock assessment via an age-structured model.** Jinwoo Gim, Saang-Yoon Hyun, and Heejoong Kang
6. **Evaluation of model specification and parameter identifiability in state-space stock assessment models with an application to the Korea chub mackerel (*Scomber japonicus*) stock.** Kyuhan Kim, Nokuthaba Sibanda, Richard Arnold, and Teresa A'mar
7. **Responses to Phytoplankton Size and Community Composition by Calanus and Pseudocalanus During Late Summer in the Southeast Bering Sea: potential implications for age-0 pollock recruitment.** Jeanette C. Gann, Sarah L. Mincks, Franz J. Mueter, Wesley W. Strasburger, David Kimmel, Lisa B. Eisner
8. **Calibration of Multiple Fishing Vessels by Using Secondary Reflection from Sea Bottom.** Yanhui Zhu1, Kenji Minami, Yoshihiro Nishiyama, Akinori Kasai, Tsutomu Tokeshi, Mitsuhiro Matsuura and Kazushi Miyashita
9. **Evaluation of modeling methods for assessing and comparing the abundance of two size classes of eulachon in British Columbia.** Christopher N. Rooper, Madeline Lavery, Sarah Hawkshaw, Linnea Flostrand
10. **Future changes in the distributions of chub mackerel (*Scomber japonicus*) in the seas around Korea using a Maximum Entropy Model based on CMIP6: Importance of seasonal variation.** Minkyoung Bang, Sukyung Kang, Dongwha Sohn, Won Keun Choi, Heeseok Jung, Jung Jin Kim, Chan Joo Jang
11. **Shifting distribution and abundance of sand lance in the Arctic in response to the physical environment.** Matthew Baker, Alex De Robertis, Robert Levine, Daniel Cooper and Edward Farley

Poster presentation

1. **Effects of spring-neap tides on the sea surface chlorophyll-a in relation to the Kuroshio path modulation during 2006-2021.** Iára Torres, Silvana Duran, Takeyoshi Nagai and Luis Icochea
2. **Assessment for effect of climate regime shifts and extreme events on the spatial distribution of sardine, mackerels and saury in the Northwestern Pacific.** Elena Ustinova

Using eDNA to assess and manage Non-indigenous species in the North Pacific

Convenors:
Thomas Therriault (Canada), Keun-Hyung Choi (Korea), Satoshi Nagai (Japan)

Co-sponsors:
NOWPAP, KIOST

Background
Non-indigenous species (NIS) cause ecological and/or economic harm and are a threat to biodiversity. The spread of aquatic NIS has increased in the last decade due to globalization and other related human activities and preventing all introductions is not possible. Thus, early detection is the most valuable cost-effective control and eradication option, yet many species are difficult to detect using traditional survey techniques, especially over large spatial areas. The use of environmental DNA (eDNA) as a new and rapidly growing tool to detect, monitor, and quantify species for biodiversity and conservation management is of considerable interest. In comparison to traditional methods, eDNA sampling is more sensitive, less harmful to the environment, cost-effective, safer for both species and field staff, and more targeted for identifying species of interest. Therefore, eDNA is a promising tool for early detection of NIS. However, the effectiveness for this technique across many NIS taxonomic groups and habitat types is unexplored and could have important management implications. This topic session will explore the use of eDNA to detect and assess NIS status in the North Pacific. The goal is to evaluate the landscape of how eDNA monitoring is being applied in the NIS community globally and to share information relevant to management and policy. Since different environments and species will require different sampling standards, there are potential opportunities for lessons learned and shared methodologies for data collection, analyses, and comparison.

List of papers

Invited talk

1. **ANEMONE: an eDNA-based biodiversity monitoring network.** Michio Kondoh

Oral presentation

1. **Attempts to predict occurrences of plankton species by AI technologies in Mombetsu, Hokkaido, Japan.** Satoshi Nagai, Satoshi Tazawa, Noriko Nishi, Sirje Sildever, Hiromi Kasai, Junya Hirai, Akihiro Shiomoto, Taisei Kikuchi, Seiji Katakura, and Fumito Maruyama
2. **Effects of antifoulants on the formation of marine biofouling communities monitored in Jangmok using environmental DNA metabarcoding approach.** Sang-Eun Nam, Sung-Ah Kim, Jee-Hyun Jung, Min Chul Jang and Jae-Sung Rhee
3. **Assess Non-indigenous species in East China sea using traditional methods and eDNA.** Shouhai Liu 1 and Jinhui Wang
4. **Marine invasive species biosurveillance in the northeast Pacific by eDNA metabarcoding.** Kristen Westfall, Thomas Therriault and Cathryn Abbott
5. **Metazoan diversity and seasonality through eDNA approaches: Surveillance of non- indigenous species in Jinhae Bay.** Kyu-Yung Shim, Kyu-Hyung Kim, Heesang Shin, In-Cheol Yeo and Chang-Bum Jeong
6. **Detection and quantification of four main harmful algal species in the East China Sea (Yangtze river estuary) via quantitative real-time PCR.** Jiarong Hu, Ruoyu Guo, Xinfeng Dai, Douding Lu, and Pengbin Wang
7. **An eDNA-based approach to investigate species diversity and exotic species in fish.** Wooseok Gwak
8. **Assessing winter Gulf of Alaska biodiversity and non-indigenous species using eDNA surveys.** Svetlana Esenkulova and Christoph M. Deeg
9. **eDNA metabarcoding reveals high microalgae diversity in the East China Sea near Jeju Island and marine environments of Korea.** Jang-Seu Ki, Taehee Kim and Jaeyeong Park

Poster presentation

1. **Invasion Success of *Ascidiella aspersa* (Chordata: Tunicata): A Population Genetic Approach predicts the Genetic Diversity of Populations Introduced in Korea.** <u>Soyeon Kwon</u>, Jeounghee Lee, Michael Dadole Ubagan, Taekjun Leeand Sook Shin
2. **Variation in genetics, morphology, and recruitment in the invasive barnacle *Amphibalanus eburneus* (Gould, 1841) in Korea.** <u>Jeongho Kim1</u>, Michael Ubagan, Soyeon Kwon, Il-Hoi Kim and Sook Shin

Session 7: BIO/FIS/POC/FUTURE/HD Topic Session

Forecasting and projecting climate variability and change on northern hemisphere marine ecosystems using coupled next generation biophysical model

Convenors:
Kirstin Holsman (USA), Elliott Hazen (USA), Shin-ichi Ito (Japan), Sukyung Kang (Korea), Kathy Mills (USA), Xiujuan Shan (China)

Background
The completion of the Intergovernmental Panel on Climate Change Sixth Assessment Reports in 2021 and 2022 provides a global update on past, current and future implications of climate change on marine ecosystems. In preparation for, and in response to, these global assessments of climate impacts and adaptation, scientists throughout the northern hemisphere have utilized coupled models to assess the implications of changing climate on marine ecosystems and fishery-dependent communities. This session seeks contributions on innovative new methods for ocean model simulations, improvements in seasonal to decadal forecasting skill, biogeochemical model enhancements, impacts and risk assessments, and evaluations of fishery adaptation strategies to short-term and long-term climate change within contrasting ocean management systems. The session will provide a forum for the exchange of emerging science, advanced methods and synthesis of climate change impacts and adaptation approaches throughout the northern hemisphere.

List of papers

Oral presentation

1. **ENSO prediction modulated by interactive phytoplankton feedback.** <u>Woo-Jin Jeon</u> and Jong-Yeon Park
2. **Attribution and predictability of climate-driven variability in global ocean color.** <u>Hyung-Gyu Lim1</u>, John P. Dunne, Charles A. Stock, Colleen M. Petrik, Sang-Ki Lee, and Minho Kwon
3. **Sources of uncertainty in global projections of oceanic fish biomass under climate change.** <u>Daniele Bianchi</u>, Keith B. Rodgers, Jerome Guiet, Ryohei Yamaguchi
4. **Ecosystem impacts of marine heat waves in the Northeast Pacific.** <u>Abigale Wyatt</u> 1, Laure Resplandy and Adrian Marchetti
5. **Future projections of fish biomass to 2300: uncertainty over global and regional scales.** <u>Keith B. Rodgers</u>, Daniele Bianchi3, Ryohei Yamaguchi4, Olivier Aumont, Ji-Eun Kim, and Jerome Guiet
6. **Mechanistic modeling of dynamics and blooms of jellyfish in light of climate change in the northern Gulf of Mexico.** Chengxue Li and <u>Hui Liu</u>
7. **The collapse of eastern Bering Sea snow crab.** <u>Cody Szuwalski</u>

Poster presentation

1. **Oceanic and Atmospheric Drivers of Post-El-Niño Chlorophyll Rebound in the Equatorial Pacific.** <u>Hyung-Gyu Lim</u>, John P. Dunne, Charles A. Stock, Paul Ginoux, Jasmin G. John and John Krasting

2. **Arctic sea ice concentration retrieval based on FY3 series MWRI sensors.** Suhui Wu, Bin Zhou, and Lijian Shi
3. **The role of stratification variability on biogeochemical properties across British Columbia's Queen Charlotte Sound shelf system.** Khushboo Jhugroo, Jennifer Jackson, Stephanie Waterman, Jody Klymak, Tetjana Rossand Charles Hannah
4. **Seasonal and interannual variability of the longwave radiation flux in the northwestern Pacific Ocean according to ERA5 reanalysis data.** D.M. Lozhkin and G.V. Shevchenko,
5. **IPCC AR6 simulates the impact of climate change under different scenarios on the marine environment and cephalopods in the southern Eastern China Sea.** Yu-Jhen Yang, Muhamad Naimullah, Kuo-Wei Lan and Po-Yuan Hsiao
6. **Predictability of Metabolic index in an Earth System model.** Hwa-Jin Choi, Jong-Yeon Park, and Charles Stock
7. **Environmental impacts on fish catch in the Arctic/Subarctic EEZ assessed with reconstructed ocean biogeochemistry.** Eun-Young Kim and Jong-Yeon Park

<div style="background:gray">**Session 8: BIO Topic Session**</div>

Recognizing the importance of zooplankton to fisheries research

Convenors:
Karyn Suchy (Canada), Hui Liu (USA), Toru Kobari (Japan), Lidia Yebra (Spain)

Background
Zooplankton play a key role in the transfer of energy from primary producers to higher trophic levels and are thus highly relevant to fisheries dynamics and to the overall function of ocean ecosystems. Despite their key role, routine estimates of zooplankton production remain rare, resulting in a knowledge gap with respect to how variations in zooplankton may impact the growth and survival of larval and juvenile fishes. Further, the current development of ecosystem based management of fisheries may benefit from the incorporation of zooplankton data. Built upon the recent effort of PICES WG37, the main goal of this session is to bring diverse researchers together on topics ranging from zooplankton to fisheries management in order to better understand the knowledge gap of the critical link between secondary producers and fisheries dynamics in light of climate change. Studies linking zooplankton productivity to fish larvae and recruitment dynamics are especially encouraged. Contributions from experimental, observational, and modeling approaches are welcomed.

List of papers
Invited talk

1. **Linking zooplankton to fish: integrated ecosystem monitoring can inform ecosystem approaches to fisheries management.** Jennifer L. Boldt, Hannah Murphy, Chris Rooper, Jaclyn Cleary, Jackie King, Stéphane Gauthier

Oral presentation

1. **Linking zooplankton to fisheries stock assessment and management in changing ecosystems: challenges and opportunities.** Hui Liu and Yong Chen
2. **The food source of anguilliform leptocephali in the Satsunan area, southern Japan.** Akinori Minagawa, Toru Kobari, Junya Hirai, Satoru Jinno, Kazuhiro Shiozaki, Mutsuo Ichinomiya, Tomohiro Komorita and Gen Kume
3. **Spatiotemporal trophic dynamics of four zooplankton taxa in the East/ Japan Sea revealed by stable isotopes and fatty acid composition.** Jieun Kim, Hee Young Yun, Hyuntae Choi, Seok-Hyun Youn, Kyung-Hoon Shin
4. **Evidence of the importance of zooplankton to salmon success in the southern Salish Sea, US**. Julie E. Keister

5. **Spatiotemporal variability of micronekton at two fronts in the central North Pacific.** Réka Domokos
6. **Unexpected mass-occurrence of walleye pollock *Gadus chalcogrammus* in the epi-pelagic layer at the edge of the ocean basin: the benefit from copepod bloom.** Orio Yamamura, Kohei Matsuno and Yoshihiko Kamei
7. **How to adapt larval growth of widely appearing fish to food availability in the Kuroshio?** Tomoko Kusano, Gen Kume, Takafumi Azuma and Toru Kobari
8. **Metabarcoding analysis on prey of fish larvae appearing in the Kuroshio and its neighboring waters.** Hirata Manami, Gakuto Murata, Gen Kume, Akimasa Habano, Takafumi Azuma and Toru Kobari
9. **Seasonal influence of intrusion from the Kuroshio Current on microplankton biomass and community structure in the northern Satsunan area, western Japan.** Mutsuo Ichinomiya, Takehito Nomiya, Tomohiro Komorita, Toru Kobari, Gen Kume, Akimasa Habano, Yoichi Arita and Fumihiro Makino
10. **Temporal changes of micoplankton community after the inflow of the Kuroshio branch current in the Northern Satsunan region, southern Japan during mixing period.** Tomohiro Komorita, Mutsuo Ichinomiya, Toru Kobari, Gen Kume, Shin'ichro Kako, Akimasa Habano, Yoichi Aritaand Fumihiro Makino2
11. **Molecular identification of the zooplanktonic diet of *Sardina pilchardus* larvae in the SW Mediterranean Sea.** Lidia Yebra, Alma Hernández de Rojas, Nerea Valcárcel-Pérez, Candela García-Gómez, M. Carmen Castro, Raúl Laiz-Carrión, Francisco Gómez-Jakobsen, Amaya Uriarte, José-María Quintanilla and Jesús M. Mercado
12. **Model-based zooplankton productivity and trophic transfer efficiency in the Strait of Georgia, Canada.** Karyn D. Suchy, Raisha Lovindeer, Elise M. Olson, and Susan. E.
13. **Promoting cooperation of monitoring, control, and surveillance for IUU fishing in the Asia- Pacific.** Iwao Fujii1, Yumi Okochi, and Hajime Kawamura

Poster presentation

1. **Copepod community determined with metabarcoding analysis represents advection of with coastal waters to the Kuroshio.** Gakuto Murata, Gen Kume, Hirohiko Nakamura, Ayako Nishina and Toru Kobari
2. **Distribution and feeding habits of skinnycheek lanternfish *Benthosema pterotum* larvae and juveniles in Kagoshima Bay, southern Japan.** Shinsaku Kato, Toru Kobari and Gen Kume
3. **Growth and food requirement of chub mackerel *Scomber japonicus* larvae in the northern Satsunan area, southern Japan.** Hiroki Oba, Toru Kobari, Taichi Shigemura, Kazuhiro Shiozaki, Mutsuo Ichinomiya, Tomohiro Komorita and Gen Kume
4. **Protein synthetases activity of fish larvae appearing in the Kuroshio and its neighboring waters.** Yusuke Manako, Toru Kobari, Mutsuo Ichinomiya, Tomohiro Komorita, Akimasa Habano, Takafumi Azuma and Gen Kume
5. **A field-based intercomparison of biochemical methods for measuring zooplankton secondary production off the coast of Vancouver Island.** Liam D. Hubbert, Akash R. Sastri, and John F. Dower

Session 9: BIO/MEQ Topic Session

The effects of ocean acidification and climate change stressors on the ecophysiology and toxicity of harmful algal species

Co-sponsors:
GlobalHAB, IOC UNESCO, ISSHA

Convenors:
William Cochlan (USA), Pengbin Wang (China), Mark L. Wells (USA)

Background

The responses of Harmful Algal Bloom (HAB) species to climate-change induced environmental factors (stressors) is largely unknown. This is particularly true for phytoplankton responses to ocean acidification and the concomitant changes in temperature, vertical stability and light availability, and biologically available chemical species. The primary environmental stressor – the decline in pH resulting from increased partial pressure of CO_2 (pCO2) in surface waters – leads to greater carbon availability for plankton photosynthesis, less need for metabolically costly carbon concentrating mechanisms, and changes other aspects of cellular physiology – all changes that may alter the competitive interactions among species of harmful and non-harmful phytoplankton. In addition to altering the growth rates, decreasing pH may influence the cellular toxicity of some HAB species, including both diatoms (*Pseudo-nitzschia* spp.), and dinoflagellates (*Alexandrium* spp.), and alter the swimming abilities of others, such as the fish-killing raphidophyte Heterosigma akashiwo, as well as other physiological responses such as rates of photosynthesis and nutrient uptake - all of which have the potential to substantially influence HAB impacts. There have been significant advances over the past few years in understanding how ocean acidification influences various aspects of phytoplankton physiology and growth responses, however, there is considerable variation in how HAB species respond to pH change, challenging the ability to project how ocean acidification may influence the frequency or intensity of HABs. The recent PICES Special Publication on Ocean Acidification and Deoxygenation in the North Pacific Ocean provides a framework for identifying regions and times where ocean acidification stress is dynamic and increasing, and the newly established Global Ocean Acidification Observation Network (GOA-ON) is now beginning to incorporate co-observations of biological parameters that include HAB events and indicators. The confluence of these research resources provides new opportunities to study the mechanistic basis for, and outcomes of, ocean acidification-HAB species interactions. This Topic Session welcomes papers that address all aspects of how climate change affects HAB species, in particular the understudied consequences of ocean acidification on the cellular physiology and toxin production of HAB species in both laboratory and field-based studies.

List of papers

Invited talk

1. **Acclimation of various US *Dinophysis* isolates to changing light intensity: effects on growth, photosynthetic efficiency and toxin production.** Nour Ayache, Vera L. Trainer, Brian D. Bill, Lisa Campbell, James M. Fiorendino, Michael L. Brosnahan, David M. Kulis, Christopher J. Gobler, Juliette L. Smith

Oral presentation

1. **Effect of marine heatwaves on the bloom of harmful dinoflagellate *Cochlodinium polykrikoides* in Korean coastal waters: Field and laboratory approaches.** Young Kyun Lim, Bum Soo Park, Jin Ho Kim, Sang-Soo Baek and Seung Ho Baek
2. **Correlations between ocean temperature and the concentrations of harmful algal biotoxins measured in British Columbia coastal waters.** Andrew R.S. Ross, Blair Surridge, Harry Hartmann, Mackenzie Mueller, Melissa Hennekes, Ovi Haque, Nicole Frederickson, Svetlana Esenkulova, Stewart Johnson, Lenora Turcotte and Andrea Locke
3. **Linkages among harmful algae, marine biotoxins in shellfish, and oceanographic conditions in the Strait of Georgia, Canada.** Svetlana Esenkulova, Nicole Frederickson and Isobel Pearsall
4. **Using the Continuous Plankton Recorder to detect and monitor the spread of Harmful Algal Blooms from the Pacific into the Arctic Ocean.** Clare Ostle1, Sonia Batten, Martina Brunetta, Jon Fisher, Melissa Hennekes, David Johns, Francesca Loro, Humfrey Melling, John Nelson, Akash Sastri, Rowena Stern and Marianne Wootton.
5. **Climate Change and the Growth and Toxicity of *Pseudo-nitzschia multiseries* from the California Current Upwelling System: Effects of Ocean Acidification and Temperature.** William P. Cochlan1, Christopher E. Ikeda, Lindsey Metz, Brian Bill, and Vera L. Trainer

Poster presentation

Coastal HABs driven by kleptoplastidy and bi-species interaction along the *Teleaulax-Msodinium-Dinophysis* prey chain. Jong Woo Park, <u>Wonho Yih</u>, , Hyung Seop Kim and Yeong Du Yoo

BIO Contributed Paper Session

Convenors:
Akash Sastri (Canada), Wongyu Park (Korea)

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

List of papers

Oral presentation

1. **Fiddlers on the tidal flat: fiddler crabs change their tunes depending on the contexts.** <u>Minju Kim</u>, Seojeong Park, Hyemin Lee and Taewon Kim
2. **Don't tread on my tidal flats: assessment of human trampling effects on the endangered fiddler crab for coastal management.** <u>Seojeong Park</u>, Minju Kim and Tae Won Kim
3. **Characterization of the organic matter of biodeposits derived from marine aquaculture bivalves: a meta-analysis approach.** <u>Tomohiro Komorita</u>
4. **Multiple genetic sources for the golden tide *Sargassum* patches in northwestern Pacific: temporal variation in their genetic makeup.** <u>Seo Yeon Byeon</u>, Sangil Kim, Sun Kyeong Choi, Sang Rul Park and Hyuk Je Lee
5. **Mating systems and sexual patterns of red-belted anthias *Pseudanthias rubrizonatusis* in different-sized groups in Kagoshima, Japan.** <u>Emma Hinako Moritoshi1</u>, Midori Matsuoka, Gen Kume, Shinichi Dewa and Tomoki Sunobe
6. **Changes in pinniped prey consumption along the west coast of North America following protection from hunting and culling.** <u>Kate M. Colson</u> and Andrew W. Trites
7. **Nitrogen isotope baseline isoscape using amino acid nitrogen isotope of copepod *Calanus*.** <u>Hyuntae Choi</u>, Bohyung Choi, Jee-Hoon Kim, Nayeon Park, Haemin Won, Eun Jin Yang, Min-Seob Kim, Yeonjung Lee, and Kyung-Hoon Shin
8. **Prey consumption by marine mammal in the North Pacific Ocean.** <u>Andrew W. Trites</u>, Kate M. Colson, and Tsutomu Tamura
9. **Potential shift in mesozooplankton community structure in response to climate-driven changes during summer in the Ulleung basin.** <u>Minju Kim</u>, Chan Joo Jang, Wonkeun Choi and Jung-Hoon Kang
10. **Diversity and Biogeography of Dinoflagellates in the Kuroshio Region.** Yubei Wu, Siyu Jiang, Junya Hirai, Fanyu Zhou, Jun Inoue, Susumu Hyodo, and <u>Hiroaki Saito</u>
11. **Role of sea ice retreat in formation of spring phytoplankton bloom in the Bering Sea.** <u>Kirill Kivva</u> and Alexandra Sumkina

Poster presentation

1. **Helminths in the schoolmaster gonate squid *Berryteuthis magister* (Berry, 1913) off the northern Kuril Islands.** <u>Mikhail A. Zuev</u> and Zoya I. Motora
Attached bacterial community dynamics with changes in core phytoplankton species based on the phycosphere concept. <u>Hyun-Jung Kim1</u>, JunSu Kang2, Yu-Jin Kim1, Taek-Kyun Lee1, Joon Sang Park and Seung Won Jung1

2. **Spatial, vertical, size, and taxonomic variations in stable isotopes (δ13C and δ15N) of zooplankton and other pelagic organisms in the western North Pacific.** Dongwoo Kim1, Sota Komeda1,4, Koki Tokuhiro1,5, Maki Noguchi Aita2, Fujio Hyodo3 and Atsushi Yamaguchi1
3. **Macrozoobenthos of river estuaries of Sakhalin Island.** Egor S. **Korneev** and Vjacheslav S. Labay
Ecological characteristics of Zooplankton community in the Shengsi Sea Area of the East China Sea. Minbo Luo and Jieqing Yang
4. **Coastal reservoir utilization and estuarine restoration in Korea: recent cases and lessons.** Nam-Il Won

FIS Contributed Paper Session

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

Background
This session invites 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).

List of papers

Oral presentation
1. **Climate-driven changes in size-dependent overwintering success in age-0 Pacific cod (*Gadus macrocephalus*).** Benjamin J. Laurel, Mary Beth Rew Hicks, Steve Barbeaux and Louise A. Copeman
2. **Age, growth and reproductive biology of areolate grouper *Epinephelus areolatus*, southern Japan.** Kosuke Oyama, Kenshiro Hikichi, Emma Moritoshi1 and Gen Kume
3. **Thermal effects on early life stages of Gulf of Alaska Pacific Cod: shifts in reproductive phenology, size, and growth.** Jessica A. Miller, L. Zoe Almeida, Hillary Thalmann, Lauren Rogers, Taylor Brooks, Rebecca Forney, Ben Laurel
4. **WANTED: Searching for Longfin Smelt in the Nooksack River and Bellingham Bay.** Rachael Mallon, Brandi Cron Kamermans, J. Andrés López, Mickki Garrity, Sandra James, Devin Flawd, Jeffrey Solomon, Melissa Peacock and Rachel Arnold
5. **Gastric evacuation rate and maintenance ration of pointhead flounder: Why do they feed at pelagic?** Sango Nishio and Orio Yamamura
6. **Emergence of thiamine deficiency in salmon in the California Current** Rachel Johnson, Nate Mantua, John Field, Tommy Williams, Steve Lindley, Anne Todgham, Nann Fangue, Carson Jeffres, Heather Bell, Dennis Cocherell, Dale Honeyfield, Jacques Rinchard, Donald Tillitt, Bruce Finney, Taylor Lipscomb, Scott Foott, Kevin Kwak, Mark Adkison, Brett Kormos, Steve Litvin, and Illiana Ruiz-Cooley
7. **Association between Far East pink salmon catches and variations of heat content in the upper 100 m of the North Pacific during the wintering seasons, 1978-2021.** Andrey S. Krovnin, and George P. Moury
Application of multiple satellite datasets to sustainable use of salmon resource under changing climate. Sei-Ichi Saitoh, Yasuyuki Miyakoshi, Takafumi Hirata 1, Irene D. Alabia 1 and Fumihiro Takahashi
8. **Exploration of the variation in the northwest Pacific fishing ground using improved ocean color Chlorophyll-a data.** Chuanyang Huang, Yang Liu, Yanping Luo and Yongjun Tian
9. **Pacific water propagation in the Sea of Okhotsk and walleye pollock fishery.** Maksim Budyansky, Vladimir Kulik, Kirill **Kivva**, Mikhail Uleysky and Sergey Prants
10. **A comparison study for behavior of Japanese and Chinese neon flying squid vessel in the North Pacific using Automatic Identification System.** Shintaro Ohno, Hiroto Abe, Hiromichi Igarashi and Sei-ichi Saitoh

Poster presentation

1. **Biomass of commercial bottom ichthyofauna in the northwestern part of the Japan/East Sea.**
   Nadezhda L. Aseeva, Vera N. Izmyatinskaya and Denis V. **Izmyatinsky**

HD-MEQ Joint Contributed Paper Session

Convenors:
Mitsutaku Makino (Japan), Karen Hunter (Canada), Guangshui Na (China), Andrew RS Ross (Canada)

Background
This session invites 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. We invite abstract submissions on any of these topics (HD).
Papers are 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 presentation

1. **Economic valuation of fisheries monitoring programs: A case of the international fisheries observer program of Korea.** Yeon-gyeong Kim and Sangchoul Yi
2. **Comparative and historical study of international guideline and policy documents of Japan relevant to gender equality in fisheries.** Hana Matsubara and Mitsutaku Makino
3. **Importance of terrestrial input on marine microplastics as traces recorded in sediments from rivers through estuaries to open seas.** Seung-Kyu Kim, Ji-Su Kim, Nan-Seon Song and Yong-Woo Lee
4. **Ciguatera Research Strategic Planning to build local warning networks for the detection and human dimension of ciguatera fish poisoning in Indonesia.** Suhendar I Sachoemar, Mitsutaku Makino, Alexander Bychkov, Mark L. Wells, Shion Takemura, Naoki Tojo, Arief Rachman and Shinta Leonita
5. **Potential threats of harmful algal blooms and ciguatera fish poisoning in the marine tourism park of Gili Matra islands, Indonesia.** Arief Rachman, Riani Widiarti, Hanny Meirinawati, Suhendar I. Sachoemar, Diswandi, Ratu Siti Aliah, Mark Wells and Mitsutaku Makino

Poster presentation

Fisheries in the time of pandemic: toward the sustainable future of seafood system. Aoi Sugimoto

POC Contributed Paper Session

Convenors:
Emanuele Di Lorenzo (USA), Jennifer M. Jackson (Canada)

Background
Papers are 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).

List of papers

Oral presentation

1. **Characteristics and mechanisms of marine heatwaves in the East Asian Marginal Seas: regional and seasonal differences**. Wonkeun Choi, Minkyoung Bang, Youngji Joh, Yoo-Geun Ham, Namyoung Kang and Chan Joo Jang
2. **Why are the marine heatwaves long-lasting in the East Korea Bay in the East Sea?** Subi Lee, Wonkeun Choi, Minkyoung Bang, Gyundo Park and Chan Joo Jang
3. **Tracking the pumice rafts from the recent eruption of the submarine volcano Fukutoku- Okanoba, Japan: a perspective from Satellites and Lagrangian Particles tracking.** Mochamad Riza Iskandar, Young-Gyu Park, Kwangseok Kim, Hyunkeun Jin and Seongbong Seo
4. **Fate of river-derived microplastics from the South China Sea.** Yusuke Uchiyama1, Kosei Matsushita, Naru Takaura and Taichi Kosako
5. **Interannual variability of barotropic sea level difference across the Korea/Tsushima Strait and its relationship to upper-ocean currents variability in the western North Pacific.** Jihwan Kim and Hanna Na
6. **Stronger decadal variability of the Kuroshio Extension under simulated future climate change** Youngji Joh, Thomas L. Delworth, Andrew T. Wittenberg, William F. Cooke, Anthony J. Rosati, and Liping Zhang,
7. **Destination of New Guinea Coastal Undercurrent in the western tropical Pacific: variability and linkages.** Fuad Azminuddin, Chan Joo Jang, and Dongchull Jeon
8. **Seasonal variability of deep western boundary current in the Philippine Basin from observation and numerical simulation.** Hajin Song, Xiao-Hua Zhu, Jeong-Yeob Chae, Dong Guk Kim, Hong Sik Min, Jae Hak Lee, and Jae-Hun Park
9. **Seasonal Variation of the Surface Kuroshio Intrusion into the South China Sea Evidenced by Satellite Geostrophic Streamlines.** Yisen Zhong, Meng Zhou, Joanna J. Waniek, Lei Zhou and Zhaoru Zhang
10. **Identification of a Seasonal Subsurface Oxygen Minimum in Rivers Inlet, British Columbia, Canada.** Jennifer M. Jackson, Sophia Johannessen, Justin Del Bel Belluz, Brian P.V. Hunt and Charles G. Hannah
11. **Seasonal and interannual variations in major shelf-scale currents off the west coast of Canada.** Guoqi Han and Nicolas Lambert
12. **Bi-directional energy cascades in the Pacific Ocean from Equator to Subarctic Gyre.** Bo Qiu, Toshiya Nakano, Shuiming Chen and Patrice Klein
13. **Barotropic Rossby waves induced by tropical instability waves in the Northeastern Pacific Ocean from observation and simulation.** Kang-Nyeong Lee1, Chanhyung Jeon, YoungHo Seung, Hong-Ryeol Shin, Seung-Kyu Son and Jae-Hun Park
14. **Peripheral upwelling induced by the merging of low-density water into a warm eddy and its effects on the biological and physical environment.** Dong-Kyu Lee and Sok Kuh Kang

Poster presentation

1. **The causes of the sea level rise in the East Asian marginal seas since 1993.** Hyeonsoo Cha, Jae-Hong Moon, Taekyun Kim and Y. Tony Song
1. **Characteristics and types of evolution of marine heatwaves in the East Sea (Japan Sea).** J. S. Saranya and S. H. Nam
2. **Modulation of Kuroshio intensity in the East China Sea on interannual time scales.** Seonghyun Jo, Jae-Hong Moon, Taekyun Kim, Yuhe Tony Song and Hyeonsoo Cha
3. **Observations on enhanced mixing over the steep continental slopes in the southwestern East Sea (Japan Sea).** Yeong Seok Jeong and SungHyun Nam
4. **Spatial Patterns of Long-term (1995-2021) Changing Surface and Subsurface Temperature and Salinity around the Korean Peninsula.** Day Hong Kim1 and SungHyun Nam
5. **Evaluation of Thermocline Depth Bias in the Seychelles-Chagos Thermocline Ridge (SCTR) simulated by the CMIP6 models.** Saat Mubarrok, and Chan Joo Jang,

6. **Assessment of future changes in the sea surface temperature in the Northwest Pacific projected by CMIP6 models.** Heeseok Jung, Chan Joo Jang and Yong Sun Kim
7. **Submesoscale mapping of kinematic and physical ocean properties obtained from unmanned surface vehicles and Lagrangian surface drifters.** Sung Yong Kim and Jinwhan Kim

NOTE: workshop reports are modified from the articles on PICES Press 2023 Winter Issue.

W1: BIO Workshop

Distributions of pelagic, demersal, and benthic species associated with seamounts in the North Pacific Ocean and factors influencing their distributions

Convenors

Janelle Curtis, Mai Miyamoto, Akash Sastri, Chris Rooper, and Samuel Georgian

PICES' Working Group on Ecology of Seamounts (WG47) convened a 2-day workshop from 24-25 September 2022 to explore questions around biodiversity associated with seamounts in the North Pacific Ocean and factors influencing their distributions. There are tens of thousands of seamounts worldwide and their abundance is greatest in the North Pacific Ocean. Few seamounts have been extensively studied due to their occurrence at deep depths of remote regions of the oceans and the resulting difficulty in accessing these habitats. Thus, the ecology of most seamounts is poorly understood in terms of the pelagic, demersal, and benthic species that they support. The primary aims of the workshop were to:

- Identify and understanding factors influencing the diversity and distributions of species associated with seamounts in the North Pacific Ocean.
- Build capacity to develop predictive habitat models for seamount species.
- Consider how seamount species distributions are likely to respond to natural and anthropogenic forcing, including climate change.

Over the course of two days, we had participants from Canada, Japan, Korea, Portugal, and the USA join us in person, and another six participants from Canada and the USA join us remotely to present and discuss their work on seamount ecology. It was fortunate that the PICES Secretariat and the Korean Institute of Ocean Science and Technology (KIOST) were able to assist us in conducting this hybrid workshop as one of our co-conveners and three speakers were not able to join us in person. We were also grateful to Dr. Samuel Georgian for leading much of our discussion as an unofficial co-convenor.

The workshop was divided into three main topics: a series of oral and poster presentations on seamount ecology, case studies of particular topics on predictive modeling of seamount taxa and discussions of emerging issues that were inspired by the presentations and case studies. Our workshop began with an informative presentation by our invited expert, **Telmo Morato**, from the Okeanos Research Institute of the University of the Azores in Portugal: *Improved deep-sea biodiversity assessments inform sustainable management of seamount and other geomorphologic features in a changing planet: Lessons learned from the North Atlantic.* A number of speakers and participants have an interest in the identification of vulnerable marine ecosystems (VMEs), which often comprise populations of corals, sponges, and other benthic taxa. Telmo contributed significantly to our discussions and has undoubtedly inspired colleagues to explore seamounts and the intersect between seamount research and policy. Telmo's influential talk was followed by nine oral presentations:

1. *Oceanographic influences on biological production and energy transfer in seamount ecosystems.* **John Dower**
2. *Investigating seamount effects on zooplankton in the Northeast Pacific.* **Daniel Labbé**
3. *Seamount effects on micronekton at a subtropical central Pacific seamount.* **Réka Domokos**

4. *Can Gulf of Alaska seamounts be a spawning ground for sablefish recruiting to inshore nursery habitats?* **Georgina Gibson**
5. *Biology and fisheries of North Pacific armorhead and splendid alfonsino in the SE-NHR area.* **Kota Sawada**
6. Species Distribution Modeling to Identify and Protect Vulnerable Marine Ecosystems: Case Studies from the South Pacific Ocean. **Samuel Georgian**
7. Using species distribution modeling to predict deep-sea coral and *sponge communities, hotspots, diversity and indicators.* **Chris Rooper**
8. *Composition of cold-water corals and other deep-sea benthos in the Emperor Seamounts.* **Mai Miyamoto**
9. *Using predictive habitat models and visual surveys to identify vulnerable marine ecosystems (VMEs) on seamounts in the North Pacific Fisheries Commission's Convention Area.* **Janelle Curtis**

Three posters were also presented as part of this workshop:

1. *Features of spatial distribution of dominant groundfish species on the Koko Seamount (Emperor Seamounts) in 2019.* **Alexey Somov, Albina Kanzeparova, Svetlana Orlova, Denis Kurnosov, Vladimir Belyaev, and Alexei Orlov**
2. *Distribution of giant grenadier (Albatrossia pectoralis) at different stages of ontogenesis in the Bering Sea.* **Andrey Alferov**
3. *Genetic resources of deep-sea corals from seamounts in West Pacific by de novo RNA sequencing.* **Yejon, Sung-jin Hwang, and Seonock Woo**

Three oral presentations examined zooplankton productivity around seamounts in offshore regions. The work by Dr. John Dower showed that much of the productivity in seamount benthic systems arises in the pelagic zone through overwintering zooplankton in deep waters. Dr. Réka Domokos showed that micronekton communities (an important food source for tuna) can be more abundant near seamounts using acoustic surveys. Interestingly, her work also documented both horizontal and vertical migrations of micronekton around the seamount flanks, potentially exposing them to predation by fishes at the tops of seamounts. Both of these studies documented the ways in which seamount zooplankton productivity can be aggregated at seamounts. Dr. Daniel Labbé added to the theme of seamounts as productive features of the ocean floor by showing that for three seamounts off the coast of Canada the assemblages of zooplankton can differ, both in species composition and in the relative abundance of each species. In part this may be influenced by how close the seamounts are to the continental shelf.

The fish fauna of seamounts was also explored through a series of presentations and posters. The potential for large scale oceanographic patterns to influence seamount fish fauna was shown by Dr. Kota Sawada who demonstrated that basin-scale oceanography had a weak but significant effect on recruitment patterns for North Pacific Armorhead. However, recruitment for this species is difficult to predict and measure given the strange life history of the species where it essentially stops growing upon settlement to benthic habitat on seamounts. Dr. Georgina Gibson used models of large scale circulation patterns to demonstrate the potential for connectivity between sablefish populations on the coastal shelf and those at seamounts. Her work also demonstrated that in years of high sablefish recruitment (e.g. 2016) the circulation patterns were much different than in years with average or low recruitment. Two poster presentations also examined the fish fauna of seamounts, with a description of the biology of giant grenadier in the Bering Sea (an important component of seamount fish fauna, Alferov et al.) and an examination of the fish fauna from Koko seamount using bottom trawl survey data (Somov et al.).

The final topic addressed by presentations was the distribution and abundance of vulnerable marine ecosystems (VMEs) on seamounts in the North Pacific Ocean. Managing VMEs is an important topic in seamount ecology due to the risks to VMEs imposed by fishing and climate change, as well as the interaction of these two pressures. Two presentations (Georgian et al. and Rooper et al.) focused on methods for modeling the distribution and abundance of VMEs using environmental covariates. A presentation by Dr. Mai Miyamoto examined the species composition of deep sea corals and sponges in the Emperor Seamounts in the northwest Pacific Ocean, by examining fisheries bycatch and underwater images. Dr. Miyamoto found that the most important (measured by abundance) species in the Emperor seamounts tended to be Alcyonacean corals, while sponges were generally not as important in these areas. This was in contrast to the presentations on the northeast Pacific Ocean seamounts which tended to have fauna dominated by sponges. A poster presentation by Dr. Ye Jin Jo also demonstrated the potential for identifying and

measuring biodiversity of corals using a combination of ROV collected specimens and DNA sequencing of function genes in deep-sea corals. Dr. Janelle Curtis finished up the oral presentations by demonstrating a method to identify VMEs using data on species presence or absence and its relationship to biodiversity. This is an important advance, as it allows for a quantitative definition of what a VME is, rather than using simply the presence of a VME indicator taxa.

Following the presentations, the workshop moved to discussing key topics related to predicting the distribution of taxa associated with seamounts. We began with a discussion of environmental factors that influence the ecology of seamounts. Dr. Samuel Georgian then presented **a case study** of predicting the distribution of corals in the northeast Pacific Ocean as a first step to identifying VMEs.

Key environmental factors that were highlighted as being important for both species distribution models (SDMs) and for spatial management based on those SDMs included bathymetry data and geomorphological structures. Participants also discussed the value of including surface variables, such as chlorophyll *a*, as predictors in SDMs and considering how these variables may be important for different taxa. Many surface variables, including temperature, salinity, oxygen, phosphate, silicate, and nitrate, are available from the World Ocean Atlas and from PICES' Working Group on the Biodiversity of Biogenic Habitats (WG32).

Discussions of spatial scale of both modeling and species distributions were a highlight of the workshop. It was noted during the discussions that productivity variables, such as chlorophyll a do not vary on the small spatial scales at which many seamount taxa, including corals are distributed, so this raised questions about the importance of including these variables in SDMs of seamount taxa. Participants noted that we are not usually observing the environment or developing predictive models at a scale that is relevant to animals: what we can observe and what we predict are at different spatial scales. Over finer scales, multibeam bathymetry data could be coupled with interpolated World Ocean Atlas data to model the distributions of suitable habitat for species. Participants also noted that scale matters both horizontally and vertically (as evidenced by the presentation from Dr. Réka Domokos); some predictor variables do not vary considerably at the 100 km scale, but what might be very important for benthic species is what the environment is within 10 m of the seafloor. This disconnect may be more important when modeling climate change to identify refugia for benthic species, habitats and ecosystems.

Participants discussed the importance of flow patterns, including Taylor cones, around seamounts and their effects on deep scattering layers and the availability of food, including overwintering copepods. Food availability is an important variable for predicting the distribution of corals, so including variables related to turbulence, current stability and speed, and POC flux would improve SDMs of corals. Oceanography has an important role in driving species distributions on seamounts; even though water column variables may be similar over large spatial scales, turbulence at the seafloor is where most seamount species live. Participants discussed the potential value of sediment traps to measure POC and export flux on seamounts.

The implications of bentho-pelagic coupling and species interactions for SDMs were discussed at length. Plankton can be included in SDMs for benthic taxa. All of the presentations on zooplankton at seamounts demonstrated the linkages between pelagic productivity and the benthos. Participants noted that it is important to include ecological interactions among species such as predation and competition when developing predictive models. The consequence of not including these interactions is that their omission may lead to models that predict species occurrence in sub-optimal habitat where they may be outcompeted by other species.

Participants discussed the importance of clearly communicating the uncertainty associated with model predictions, especially given the broader scale of explanatory variables that are often used to predict the distributions of species that are distributed over smaller scales. One of the challenges noted was that SDMs developed for seamount taxa are often modelled at high levels of taxonomic resolution (e.g. orders of corals). Species that are grouped at higher levels of taxonomic resolution vary in their niche space, which can potentially increase the uncertainty associated with corresponding model predictions and lead to overpredictions where the suitable habitat of a taxonomic group is likely to be found. Moreover, the remote location of most seamounts means that only a few have been sampled, and most have not been randomly sampled. Participants discussed the construction and use of relatively cheap drop camera systems that could be launched from small boats down to depths of 1000 m. Having such equipment on hand could improve our ability to collect visual data from remote seamounts and could improve our ability to use a design-based approach to surveying seamounts. Participants discussed the value of monitoring variability among seamounts by sampling across many seamounts and monitoring a few sites over time. Although surveys are costly, seamounts are remote and subject to seasonal, interannual, and climate change, moorings and a small fleet of autonomous underwater vehicles could help monitor changes in chlorophyll a, temperature, microscale turbulence and other variables during the course of one or more years.

The impacts of climate change on zooplankton and the seamount communities is generally unknown, however workshop participants were able to draw some broad conclusions regarding potential impacts in the future. Long-lived species, such as many corals, may be affected by climate change over short time scales. The capacity of corals to adapt to change is slow and the most important variable is POC flux or availability of food. Some climate models predict changes to the size structure and lipid content of zooplankton as well as to their production and ontogentic migration, which will in turn affect predators. There is also some evidence of increasing productivity on seamounts in the North Atlantic Ocean. Corals with more food may be able to cope with sub-optimal conditions, but if food availability is lower, they are less likely to adapt. The oxygen minimum zone is more anoxic and the upper layer is shoaling. As this zone continues to shoal, species that live on seamounts will begin to run out of space to interact with other species and persist. Uncertainty in climate projections is important to include and models differ in their degree of optimism. Species adaptation, acclimation, or dispersal of species is often ignored when projecting changes in response to climate change. Physiological studies can help build an archetype that can predict what is anticipated to happen to a group of species. It can also be helpful to publish a range of projected scenarios that can then be communicated to managers and the public.

Finally, we considered next steps for PICES' Working Group on Ecology of Seamounts (WG47). A key next step for WG47 was to compile more data on variables that are important for predicting the distribution of seamount taxa and existing data on areas where those taxa are present or absent. Indeed, participants acknowledged the importance of validating model predictions with visual observations collected with remotely operated vehicles (ROVs), drop cameras, or other camera systems. And ideally, we would be in a position to collect data that allowed us to understand mechanisms that influence species distributions instead of relying on predictive models.
(photo: convenors with invited speakers)

Integrated Ecosystem Assessment (IEA) to understand the present and future of the Central Arctic Ocean (CAO) and Northern Bering and Chukchi Seas (NBS-CS)

Convenors

Sei-Ichi Saitoh, Hyoung-Chul Shin, Libby Logerwell and Yury Zuenko

The target LMEs of WG 39 and WG 44 are the Central Arctic Ocean (CAO) and the Northern Bering Sea-Chukchi Sea (NBS-CS), that are geographically and dynamically connected. CAO is in rapid transition, driven by North Pacific environmental changes in significant part, has become accessible to a range of activities. Rapid loss of sea ice cover has opened up the CAO for potential fishing opportunities. In this context, the agreement to Prevent Unregulated High Seas Fisheries in the CAO has been signed and entered into force, which will necessitate joint research and monitoring. NBS-CS is also experiencing unprecedented warming and loss of sea ice as a result of climate change. Declines of seasonal sea ice and rising temperatures have been more prominent in the northern Bering and Chukchi seas as in most portions of the Arctic. Chronic and sudden changes in climate conditions in this Arctic gateway are clearly reshaping the system and its food-webs, and enlarging opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts. An integrated ecosystem assessment (IEA) is a useful and pertinent approach in this circumstance, particularly with substantial science and policy challenges emerging in the Arctic, and this renders a coordinated IEA of the CAO and NBS-CS a priority task.

The main objectives for the workshop were to describe and discuss present ecosystem processes (sources, signals,

significance) in the CAO and the NBS-CS based on achievements from existing and future research programs such as MOSAiC and SAS, numerous NBS-CS programs, and Indigenous Knowledge. In addition, it is of particular significance to developing future approaches for The United Nations Decade of Ocean Science for Sustainable Development in these oceans, where science for resilience and sustainability is more important than anywhere else and the relevant, regional UN program is yet to be properly initiated. There were about 30 attendants at this one day in-person workshop on September 25 (Sun), 9:00-18:00 (Busan, Republic of Korea), 2022 **(photo left)**. Two invited, 8 oral and one poster presentations were made at W2. PICES members from four countries and ICES member from Norway contributed the presentations. The workshop started with a brief introduction by Prof. Sei-Ichi Saitoh, outlining the background of CAO and NBS-CS issues and objective of this workshop.

In the morning session, Dr. Lis Lindal Jørgensen, one of the co-chairs of WGICA, gave the first invited talk titled "Activities of the ICES-PICES-PAME working group on Integrated Ecosystem Assessment for the Central Arctic Ocean (WGICA)" **(photo right)**. She noted that the main results from the ongoing reporting of the main human activities (global sources, shipping, military and tourism), pressures (contaminants, garbage, noise, non-indigenous species (NIS), disturbance, ship traffics etc.) and the work on describing the vulnerability of the ecosystem. Dr. Ferdenant Mkrtchyan gave a recorded talk titled "About remote monitoring of water surface and ice cover of the Arctic". He described the physical foundations of water and

ice characteristics based on micro wave remote sensing data. Dr. Dong-Gyun Han gave a presentation titled "Passive acoustic monitoring in the Arctic Ocean for Integrated Ecosystem Assessment". He collected underwater acoustic data using an autonomous passive acoustic recorder in the East Siberian Sea from August 2017 to August 2018. The correlations between temporal variability of sound pressure levels and marine environmental data such as sea ice concentration, extent, drifting speed, wind speed, and ocean current were determined. Mr. Wuju Son gave a talk titled "Vertical behavior of key copepod species subsequent to the midnight sun period in the East Siberian continental margin, Arctic Ocean". He presented the vertical distribution of the key copepod species (*Calanus glacialis*, *Calanus hyperboreus*, and *Metridia longa*) subsequent to the midnight sun period in the Arctic Ocean. The findings could provide insight into monitoring and assessing the variation of the zooplankton distributions in the rapidly changing Arctic marine environment. Dr. Irene D. Alabia gave a talk titled "Arctic marine biodiversity and species co-occurrence patterns under recent climate". She pointed out that regional differences in the spatial patterns in species richness in the Arctic, despite the overall increasing trend in pan-Arctic during 2000-2019. Sea ice loss and rising temperatures have driven northward expansion of apex and mesopredators in major Arctic gateways. Dr. Jee-Hoon Kim gave a presentation titled "Inter-annual changes of the mesozooplankton community structure in the Central Arctic Ocean (CAO) and Northern Bering and Chukchi Seas (NBS-CS) during summers of 2016-2020". He described mesozooplankton distribution in the Arctic (CAO, NBS, CS) and composition of zooplankton and total abundance related to the water mass distribution from multi-year observations in the NBS & CS and suggested that these variable patterns of mesozooplankton communities fluctuate latitudinally from south to north as warming progresses on a regional and bathymetric scale. This could be used to infer the future status of mesozooplankton communities in the study area.

In the afternoon session, Dr. Lisa B Eisner gave the second invited talk titled "Recent ecosystem research in the Chukchi and north Bering seas". She provided an overview of recent ecosystem research in the north Bering and eastern Chukchi seas. Ecosystem level projects include Arctic Integrated Ecosystem Studies (IES) phase 1 (2012 and 2013) and 2 (2017, 2019) in August-September, and Arctic Shelf Growth Advection Respiration and Deposition (ASGARD, 2017 and 2018) in June. She also introduced a recently NPRB-funded synthesis proposal to evaluate pelagic–benthic coupling that will use data from these projects and other surveys (e.g., DBO) to model and predict the impact of a warming climate on pelagic and benthic ecosystems including trophic interactions and energy flow between these systems. Dr. Kirill Kivva gave a talk titled "Spatio-temporal variability of ice retreat in the Pacific Arctic". He investigated the spatiotemporal variability of the date of ice retreat (DOR) in the Bering Sea, the Chukchi Sea and the adjacent Arctic regions. He noted that the differences in sea ice retreat between regions are mostly associated to the wind forcing in the Bering Sea and variability of heat transport through the Bering Strait in the Chukchi Sea. He continued to give another talk titled "Distribution of water masses in the Chukchi Sea in August 2019 and their chemical characteristics". He used observation data from hydrographic surveys in the East Siberian Sea and found high temperature in Siberian coastal water (SCW) and differences in nutrient content and chemistry of different water masses. Dr. Fujio Ohnishi, a social scientist, gave a talk titled "The development of Japan's Arctic Policy and the citizens' awareness". He analyzed the interest of Japan's general public in relation to Arctic policy and emphasized the need to better disseminate the results from Arctic research to the general public.

In general discussion, Dr. Hyoung Chul Shin summarized the overall presentations and discussion at the workshop and noted 1) The workshop has presented updates on present studies/research in the CAO. Furthermore, how best to use the UNDOS-Arctic initiatives will need to be included in future works. Existing/emerging gaps in knowledge will need to be continually identified to guide future research. 2) WG 44 (NBS & CS) will continue to work on the following activities another year: pooling of existing datasets and comparative studies between Arctic gateways using such datasets and inclusion of community-based research in northern Canada. Finally, he led the discussion on the proposal of a new EG advisory panel (AP-ARC), to advance the work of WGs 39 and 44 in the Arctic Ocean context, and to bring more experts to this one-stop EG for Arctic issues. This was agreeable to both working groups and supported by the workshop participants. GC later agreed to establish a new study group, SG-ARC for one year until next PICES 2023. SG-ARC will consist both WG39 and WG44 members. Group photos were taken at the closure of the workshop, although the featured picture does not have all the participants unfortunately. **(photo below)**

SmartNet: Promoting PICES and ICES Leadership in the UN Decade of Ocean Science for Sustainable Development

Convenors

Steven Bograd, Sanae Chiba, Khush Jhugroo

On World Oceans Day, June 8th, 2021, the Intergovernmental Oceanographic Commission announced the first set of activities endorsed as part of the UN Decade of Ocean Science for Sustainable Development (UNDOS; 2021-2030). The program submitted jointly by PICES and ICES, Sustainability of MARine ecosystems Through knowledge NETworks (SmartNet), was endorsed as an UNDOS Program, ensuring that ICES and PICES will play a leading role in the development of UNDOS from its inception. The aim of SmartNet is to support and leverage ICES, PICES, and member countries' priorities and initiatives related to the UNDOS. This is being done by emphasizing areas of mutual research interest and policy needs, including climate change, fisheries and ecosystem-based management, social, ecological and environmental dynamics of marine systems, coastal communities and human dimensions, and communication and capacity development. SmartNet will also incorporate strategies to facilitate UNDOS cross-cutting inclusivity themes relating to gender equality, early career ocean professional engagement, and involvement of indigenous communities and developing nations in the planning and implementation of joint activities. At PICES-2022 in Busan, Korea, in September, SmartNet hosted a Workshop title 'SmartNet: Promoting PICES and ICES Leadership in the UN Decade of Ocean Science for Sustainable Development', to provide updates on SmartNet and other UNDOS activities and facilitate a broad discussion within the PICES community and amongst partners on methods and priorities for implementing SmartNet. Here we present a few highlights from the Workshop.

Following an overview of the UN Decade of Ocean Science for Sustainable Development and an introduction of SmartNet by Steven Bograd, we heard presentations from several UNDOS-endorsed Programs and Projects (**see Photos below**)

(Top Row) Steven Bograd and Sanae Chiba on SmartNet, Hannah Lachance on SUPREME, and Manu Di Lorenzo on GEOS (Bottom Row) Robin Brown on BECI and Leslie Smith on DOOS.

Hannah Lachance presented on the 'Sustainability, Predictability and Resilience of Marine Ecosystems' (SUPREME) Program. SUPREME aims to leverage efforts in the U.S. to globally implement an infrastructure to support robust climate- and ocean-related forecasts, predictions, and projections to guide marine ecosystem management and adaptation strategies that reduce risks and increase resilience of marine/coastal resources and the people who depend on them.

Manu Di Lorenzo presented on 'Global Ecosystem for Ocean Solutions' (GEOS) Program. GEOS aims to develop and deploy a series of equitable, durable, and scalable ocean-based solutions for addressing climate change and Ocean Decade's challenges.

Robin Brown presented on 'Basin-scale Events and Coastal Impacts' (BECI) Project. BECI aims to develop an international ocean intelligence system capable of assessing changes and predicting impacts on local ecosystems and communities, using salmon as an exemplar species.

Leslie Smith presented on 'Deep Ocean Observing Strategy' (DOOS) Program. DOOS represents an interconnected network of deep-ocean observing, mapping, exploration, and modelling programs working together for the coming decade to 1) characterize the physics, biogeochemistry and biology of the deep ocean in space and time, 2) establish a baseline required to understand changes to its habitats and services, and 3) provide the information needed to have a healthy, predicted, resilient and sustainably-managed (deep) ocean. Leslie also described the 'DOERs', a cohort of early career ocean professionals providing leadership for the Program.

Following the UNDOS Program and Project presentations, Mitsutaku Makino gave a presentation on a project being led by his group at the University of Tokyo and collaborators to implement a global survey on general public perceptions about the 7 outcomes of UNDOS. These survey results can contribute to a better formulation and prioritization of UNDOS challenges, as well as to guide PICES' international science collaborations and provide policy recommendations.

We then had an invited talk from Khush Jhugroo, an early career ocean professional from the University of British Columbia and the Hakai Institute, titled 'Early Career Ocean Professionals (ECOP) and Small Island Developing States (SIDS) engagement in the UN Decade of Ocean Science For Sustainable Development'. Khush reflected on the many challenges facing SIDS due to various anthropogenic and climate stressors, and as an example described the impacts of an oil spill in Mauritius, her home country. Khush also described some of the challenges faced by ECOPs. Importantly, Khush outlined some of the needs of both ECOPs and residents of SIDS, including inclusion and recognition; creation of a positive policy environment (with empowerment of women and ECOP engagement);

improved technical development and science communication to local communities; and financial support from external sources.

The final presentation was given by Raphael Roman, the UNDOS Regional ECOP Coordinator for Asia, on the engagement of ECOPs in PICES and UNDOS. Raphael reviewed a number of opportunities for ECOP engagement, including through mentorship and training opportunities, regional engagement under the UNDOS umbrella, and communication networks through social media. Raphael also gave a preview of the ECOP Workshop which was held immediately following the SmartNet Workshop (see ECOP Workshop report in this issue).

The SmartNet Workshop was very well attended, with lively discussions and a remarkable level of interest and curiosity about potential for engagement and collaborations by the participants. There were several outcomes from the Workshop, including:
1. Introduced SmartNet and PICES-related UNDOS programs to the PICES community;
2. Identified synergies for co-design of activities amongst UNDOS programs;
3. Strategized ECOP engagement in SmartNet and other UNDOS programs;
4. Developed list of activities and a SmartNet Action Plan for 2022-2023.

Participants of the workshop

Throughout the PICES-2022 meeting, workshop participants continued discussions on potential collaborations amongst UNDOS Programs and Projects, and within PICES more broadly. An idea that gained traction in post-Workshop conversations was the potential to co-design UNDOS activities around a common theme for which each Program or Project could provide unique expertise. An example that will be pursued is to integrate our efforts around the theme of marine spatial planning to support ecosystem sustainability. Future reports will describe the outcome of these efforts.

W4: FUTURE Workshop

Establishing a North Pacific ECOP node of the global ECOP program to increase inter-regional early career engagement and partnerships during the Ocean Decade

Convenors

Raphael Roman, Hannah Lachance, Minkyoung Kim, Hana Matsubara and AP-ECOP Members

Together with several AP-ECOP volunteers, Hannah Lachance (USA; AP-ECOP co-chair) and Raphael Roman (Canada; AP-ECOP co-chair) co-moderated the ECOP Workshop during the afternoon session on Sunday, September 25th, which naturally and conveniently followed the SmartNet workshop in the first half of the day. This was one of the more well attended workshops with more than 30 people in attendance (see *Fig. 1*), with strong

representation from the Republic of Korea. A master slide deck containing all of the presentations can be found here.

Hannah and Raphael started off with a warm welcome and walked participants through the session's agenda. Before moving into the "elevator pitches" prepared by each PICES Scientific Committee, Hannah provided a brief introduction of the PICES governance structure as well as the role, achievements and goals of the Advisory Panel on ECOPs (i.e. PICES and ECOP 101s), as several attendees might be new to both.

A lightning round followed, where invited speakers (i.e. co-chair(s) of all PICES Scientific Committees and Special Programs, mainly senior professionals and mentors) had around 5 minutes to introduce their Committee or Program and reflect on cross-pollination opportunities with ECOPs (including specific needs for better ECOP engagement within their own Expert Groups and initiatives). The list of speakers included:

1. Dr. Steven Bograd (NOAA, USA) talked about PICES's endorsed Decade Programme "SmartNet", its flagship science program called FUTURE ("Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems"), and a new working group (WG49) on climate extremes (see here). Steven has been a strong supporter of involving ECOPs into leadership positions within the PICES structure (e.g. as co-chairs of Expert Groups and scientific programs such as FUTURE). He also created a new early career scientist award that would cover the travel costs (CAD 3,000) of one or more ECOPs to present their research during the plenary session of PICES Annual Meetings. Due to the Covid pandemic, this award has yet to be granted. Its first awardee(s) will most likely be selected in 2023, when the next Annual Meeting is slated to happen in Seattle, USA.
2. Dr. Akash Sastri (DFO, Canada) introduced the Biological Oceanography Committee (BIO). Specifically, Akash emphasized the fact that one of the co-chairs of WG47 on "Ecology of Seamounts" is an ECOP, while the now disbanded WG37 on "Zooplankton Production Methodologies, Applications and Measurements in PICES Regions" actively involved ECOPs in the writing of the final report and other key deliverables.
3. Dr. Jackie King (DFO, Canada). Despite being physically present in Busan, Jackie was moderating another workshop that was happening in parallel. She kindly prepared a few slides introducing the Fishe ry Science Committee (FIS), which Raphael presented on her behalf (see slide deck for more information on FIS).
4. Prof. Mitsutaku Makino (University of Tokyo, Japan) provided an overview of the most recent Scientific Committee in PICES, named Human Dimensions (HD). Working groups under the HD Committee cover a variety of disciplines and interdisciplinary topics, from economics, human wellbeing, fisheries management and science communications to indigenous knowledge systems and transdisciplinary ocean sciences, among many others.
5. Dr. Andrew Ross (DFO, Canada) introduced the Marine Environmental Quality Committee (MEQ). Andrew highly encouraged interested ECOPs to contact the co-chairs of scientific committees directly, whether they have an idea for a new project or if they simply want to learn how they can participate and get further involved. The MEQ Committee has a special project in Indonesia (related to Ciguatera fish poisoning in Indonesian communities), which notably allowed young scientists from PICES member countries to connect and collaborate with Indonesian ECOPs, some of which attended and presented at the 2022 PICES Annual Meeting. Andrew also gave a special shoutout to all ECOP presenters joining sessions (co-)convened by MEQ.
6. Prof. Emanuele Di Lorenzo (Brown University, USA) and Dr. Jennifer Jackson (Hakai Institute, Canada) are the two co-chairs of the Physical Oceanography and Climate Committee (POC). They highlighted opportunities for ECOPs to participate in hands-on activities and in new Expert Groups focusing on artificial intelligence (AI) and machine learning, among other innovative and cutting-edge ocean topics. Similar to what Andrew said, they encouraged ECOPs to not be shy and reach out any time. ECOPs can propose new Expert Groups on their own if they have an idea they want to pursue. The POC Committee will be more than happy to support them in the process.
7. Prof. Sung Yong Kim (Korea Advanced Institute of Science and Technology, South Korea) introduced the Technical Committee on Monitoring (MONITOR). MONITOR identifies the principal monitoring needs of the PICES region, and develops recommendations to meet these needs, including through training and capacity building initiatives, such as Summer Schools for ECOPs. The latest example in date was during August 2022, when one of their Expert Groups organized a virtual summer school on "Ocean Big Data".
8. Ms. Jeanette Gann (NOAA, USA) was not able to participate in-person but she very kindly prepared slides on the role that the Technical Committee on Data Exchange (TCODE) plays within PICES, including an informative and timely summary of the outputs and recommendations that were derived from the TCODE

workshop two days earlier (W10). She reiterated the importance of actively involving ECOPs in changing the data culture within PICES (see slide deck for more information on TCODE).

A short coffee break allowed for organic networking between the workshop participants before starting the next series of presentations given by ECOP speakers. This second part of the workshop focused on international ECOP networks and engagement opportunities beyond the North Pacific. Invited representatives of these networks (i.e. ECOP Programme, ECOP Asia, ICES "Strategic Initiative on the Integration of Early Career Scientists" (SIIECS) and the Deep Ocean Early Career Researchers (DOERs), a program of the Deep Ocean Observing Strategy (DOOS)) were asked to introduce their ECOP community, what they have been accomplishing thus far, and to reflect on future synergies and areas of collaboration with the PICES ECOPs. ICES and DOOS are key partners of PICES, which organically led to meaningful encounters between their respective ECOP communities. This workshop aimed to sustain the momentum and cement these nascent but promising relationships between early career groups that span many geographies, disciplines and ocean layers.

ECOP

workshop attendees (top) and final brainstorming & networking session (left). Photos credit: Hannah Lachance and Raphael Roman

The list of invited ECOP speakers and their presentation focus were as follows:

A. Ms. Evgeniia Kostianaia (Global Coordinator of the ECOP Programme, Russia). Despite not being able to join us in person in Busan, Evgeniia kindly recorded her presentation, titled: "*ECOP Programme: Connecting with international ECOP networks".* She was an invited speaker at the 2022 PICES Annual Meeting (see here) and her talk provided a comprehensive overview of all the progress achieved since the endorsement of the ECOP Programme in early 2021. Notable updates included the regional expansion of the ECOP coordination team (who grew from 3 to 6 regional and national nodes, welcoming new coordinators from Central America, the USA and Japan) and the resounding success of its capacity development initiatives. The latter included funded trainings in Africa and the Caribbean, online webinars and financial support to attend conferences, workshops and other capacity building events.

B. Mr. Raphael Roman (Regional coordinator of the ECOP Programme in Asia and PICES AP-ECOP co-chair, Canada). As a natural follow-up to Evgeniia's presentation, Raphael provided a regional perspective of the work and outreach the ECOP Programme has been pursuing in Asia, which was especially relevant to the South Korean audience. His presentation was titled: "*UN Ocean Decade Endorsed Programme for ECOPs: Regional Node in Asia"*, with a special focus on PICES member countries in Asia. Raphael offered a brief overview of the current status of the ECOP network in Asia and the major activities that happened since its inception in the Spring of 2021. He happily shared the news about the recently launched National ECOP Node in Japan and his efforts to establish other ECOP hubs in the Republic of Korea and China. Raphael also presented key findings from the 2021 and 2022 ECOP Asia surveys, with a focus on East Asian countries (i.e. China, Japan and the Republic of Korea). He mentioned other key strategic pillars of the ECOP Asia node and reflected on his time as a regional coordinator, reminiscing about his in-person experience at the UN Ocean Conference in Lisbon, Portugal and the ICES/PICES Early Career Scientist Conference in Newfoundland, Canada, in addition to many stimulating and creative early career meetings he's had the privilege to attend online. Finally, Raphael invited members of the audience to join him in co-developing the ECOP Asia node and contributing to more inclusive ocean sciences in the North Pacific

(e.g. enhancing understanding of national nuances and scientific cultures, joining forces in translating English materials into several languages, co-designing webinars, trainings, etc.).

C. Ms. Hannah Lachance (PICES AP-ECOP co-chair and contractor at NOAA, USA) introduced the ICES Strategic Initiative on the Integration of Early Career Scientists (SIIECS) on behalf of their co-chairs, who prepared slides despite not able to join the workshop due to the ICES Annual Meeting running in parallel to the PICES one in Dublin, Ireland. Hannah has been shadowing the ICES ECOP group since the beginning by attending a few of their online meetings, which made her the perfect fit for introducing them during the workshop. Specifically, ICES SIIECS aims to engage ECOPs in the activities of ICES in a mutually beneficial way. They mainly consist of a volunteer core team of around 20 ECOPs, coordinating and engaging a much wider ECOP community within ICES (> 150 ECOPs). Some recent accomplishments include the creation of the "Rising Tides" article series in the ICES Journal of Marine Science (no submissions from the North Pacific community yet!), the allocation of more keynote speaking roles for Early Career Scientists, interdisciplinary publications and important Diversity, Equity and Inclusion (DEI) work, among other important contributions (their Terms of Reference can be accessed here).

D. Dr. Leslie Smith (DOOS Project Director, USA). The last presentation was given by the energetic and inspiring Leslie Smith, whose talk was titled: "*Fostering Future Leaders: The amazing things a program can achieve by simply showing young stars how bright they already are".* Leslie's presentation followed up on her intervention during the SmartNet workshop in the morning of the same day. This time she dove deeper into the DOERs program of the Deep Ocean Observing Strategy (DOOS), which can be defined as a collaborative early career mentoring program designed to bring together ECRs from across the global deep sea community. She introduced their current cohort of six multidisciplinary ECOPs, who received 1.5 months of funding each, with the goal being to lead working group efforts and create project deliverables. The DOERs community spans the entire globe, with 160 participants, but relatively low representation from Asia. They organize quarterly virtual professional development sessions (e.g. leading interdisciplinary cross-collaboration; FAIR data principles training; Communicating science to diverse audiences, etc.). Leslie then shared invaluable tips and insights on how to build an impactful Early Career Researchers (ECRs) Program, by trying to think differently, by focusing on:
- Assigning cool, high profile tasks to ECRs as a default,
- Spreading the workload across all team members for boring, menial tasks,
- Highlighting ECR successes to broad audiences, and
- Taking responsibility for program-wide failures and successes.

At DOOS, they strive to support their ECRs so they can lead. Leslie shared inspiring and heartfelt testimonials from the current members of their DOERs cohort. For instance, one of the testimonials reads: *"I feel very lucky to be an ECR in iDOOS. My previous experience as a named ECR was characterized principally by high pressure to complete major project deliverables. In contrast, within iDOOS ECRs are closely mentored in taking on meaningful leadership roles".* She also mentioned the need for someone to be their Champion, quoting Brene Brown in the process: "*A leader is anyone who takes responsibility for finding the potential in people and processes and who has the courage to develop that potential."*

With little remaining time before the end of the workshop, the conveners decided to blend the networking and brainstorming sessions together during the last hour. As a result, attendees would get sufficient time to interact and mingle with any of the ECOP and non-ECOP speakers they listened to during the workshop. Concurrently, the AP-ECOP team set up four different white boards with several markers at the back of the room (see *Fig.1*), with a different question on each board. Here are the 4 questions, alongside selected answers from participants:

01. What would you like the ECOP mentorship platform to look like ?
- *"Periodical events, e.g. every 3-4 months"*
- *"Ongoing communications about activities throughout the year (between meetings) to help ECOP navigate the programs and processes and to stay informed even if they choose the 'low commitment' track".*

02. What kind of ECOP activities would you like to see in PICES ?
- *"Networking events over beer"* 🍺
- *"Communication with mid-career researchers"*
- *"A regular newsletter about ongoing activities and opportunities"*

- *"Recruitment opportunities that have a low 'cost of entry' such as an all-virtual pre-meeting to go over travel support or to explain the virtual business meeting coupled maybe with an online discussion forum"*

03. What support do you need from PICES ?
- *"Airplane tickets"* ✈️
- *"English text check"* / *"Please speak slowly and clear English"*
- *"Training and workshops"* / *"Information sharing"*
- *"Help develop Topic Session and workshop proposals"*

04. What has been your experience with PICES so far?
- *"I met many lovely and respectable people from all over the Pacific, which stimulated me very much"*
- *"Great to meet diverse people with lots of positive energy - quite inspiring"*
- *"Lots of acronyms to remember"*
- *"Amazing people"* / *"Many hard working people!"* / *"Good people, good talks, wonderful coffees"* ☕
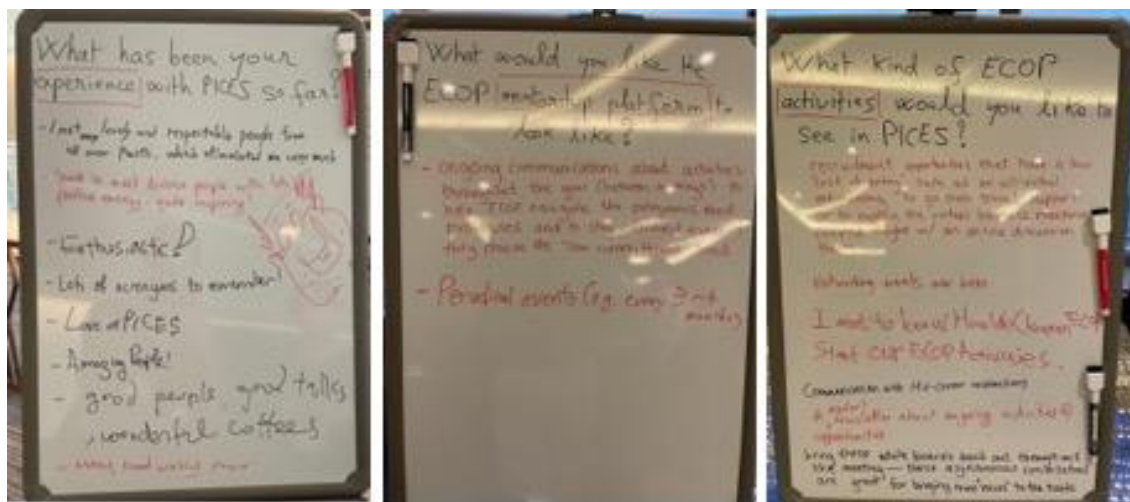
Figure 1. Brainstorming during the networking session. Photos credit: Raphael Roman

Despite the undeniable fatigue that was felt at the end of such a long day of workshops, several attendees remained actively engaged by answering the brainstorming questions (see *Fig. 1*) and by continuing to network with other fellow participants and guest speakers. Many fruitful discussions and exchanges of ideas were reported afterwards. The informative, inspiring and positive feedback we received will be truly instrumental in guiding future engagement initiatives and career development support for PICES ECOPs, including, inter alia, a mentorship platform, cross-cultural and inter-generational dialogues, networking and training opportunities, multilingual knowledge sharing, project leadership, informative sessions dedicated to ECOPs, and further lobbying towards greater financial assistance of ECOPs to attend conferences, high-level symposia, summer schools and other events. Additionally, we received word that a few ECOPs engaged in the opportunities highlighted by the PICES Scientific Committees during their presentations, with some ECOPs attending various business meetings and sessions throughout PICES 2022 to learn more about the working groups and to network and engage more deeply with experienced PICES members. All in all this workshop was a success and AP-ECOP looks forward to planning future opportunities for PICES ECOPs at upcoming meetings such as Effects of Climate Change on the World's Ocean (ECCWO) in Bergen, Norway and PICES 2023 in Seattle, USA

Integrating biological research, fisheries science and management of broadly distributed flatfish species across the North Pacific Ocean in the face of climate and environmental variability

Convenors

Josep Plana (USA), Chris Rooper (Canada), Naoki Tojo (Japan), Roman Novikov (Russia)

Invited Speakers:
Dr. Melissa Haltuch (Northwest Fisheries Science Center-NOAA, USA)
Dr. Patrick Thompson (Fisheries and Oceans Canada)
Dr. Takeshi Tomiyama (Hiroshima University, Japan)

Background
The North Pacific Ocean is a large and productive ecosystem that is characterized by strong interdecadal climate variability. This Ocean basin supports a number of fish species of great ecological, as well as economical, importance. A successful PICES FIS-Workshop, that was co-sponsored by the International Pacific Halibut Commission (IPHC) at the 2019 PICES Annual Meeting (W2), focused on important current topics related to the biology and fishery of Pacific halibut and interacting species by bringing together researchers, scientists and managers from countries that are invested in this resource. An important outcome of this workshop was the need to increase the application of integrative approaches to improve our understanding of the biology and management of widely-distributed species, such as Pacific halibut, in the North Pacific Ocean, requiring a high level of cooperation at the international level. Therefore, to achieve these goals and as a step forward in addressing key areas of cooperation between PICES and IPHC as described in the current MoU between the two organizations, a Workshop was organized to address emerging issues in key flatfish species with broad distribution across the entire North Pacific Ocean. The main objectives of this Workshop were to 1) improve the sharing of information on fishing efforts and management strategies across the North Pacific Ocean, and 2) promote international collaborative studies to improve our knowledge on movement of flatfish populations and potential distribution changes of flatfish and other interacting species in the face of climate variability. The Workshop consisted of several presentations on specific topics related to the biology of flatfish and interacting species as well as management and policy issues. The Workshop concluded with a discussion session.

Summary of Presentations
In this one-day Workshop held on September 25, 2022, the session was opened by Josep Planas who welcomed the participants and provided a brief introduction to the Workshop. The session featured 3 invited presentations and 4 regular oral presentations.

The first invited speaker, Dr. Melissa Haltuch of the Northwest Fisheries Science Center – NOAA, described the results of recent studies examining the oceanographic mechanisms that drive recruitment success of Petrale sole in the California current at different life stages. In addition, results on the modeled connectivity between deduced spawning areas and juvenile settlement areas in the context of particular oceanographic conditions (e.g. cyclonic eddies) were presented. The second invited speaker, Dr. Patrick Thompson of Fisheries and Oceans Canada, gave a live online presentation on the effects of changes in temperature and oxygen concentrations in waters off the West coast of the USA and Canada on distribution and abundance of a wide variety of groundfish species. Results on future projections of temperatures and oxygen content by depth and the expected changes in fish biodiversity were presented. The third and final invited speaker, Dr. Takeshi Tomiyama of Hiroshima University, Japan, provided an overview of the major Pleuronectidae species found in the Eastern (i.e. Hiroshima) and the Western (i.e. Fukushima) coasts of Japan and of key biological and ecological characteristics of these species at different life stages. Regular presentations included topics related to movement of Pacific halibut within the Bering Sea basin through the use of pop-up satellite tags (Mr. Austin

Flanigan), stress profiles and survival estimates of Pacific halibut discarded by the recreational fishery in Alaska (Mr. Claude Dykstra), the seasonal reproductive development of Pacific halibut females during an annual reproductive cycle (Dr. Josep Planas), and, lastly, the generation of a chromosome-level assembly of the Pacific halibut genome and its application to studies on population structure of Pacific halibut in the northeast Pacific Ocean (Dr. Josep Planas).

After the presentations, a discussion session took place among participants. The need to share analytical tools for fishery management among researchers from the various PICES regions was identified as important. In addition, it was suggested that the existence of international repositories of fishery and biological data would assist in efforts to foster international collaboration. Emphasis was made on the value of supporting Early Career Scientists and to promote mobility of researchers. Finally, the creation of a flatfish species list was suggested. The discussion session ended with support from participants for the submitted proposal of a third Workshop to be held at the 2023 PICES Annual Meeting in Seattle.

W6: FIS/HD Workshop

(Cancelled) Bridging Multiple Ways of Knowing within an Integrated Ecosystem Assessment to understand the social and ecological changes in the Northern Bering and Chukchi Seas

Convenors

Sarah Wise (USA), Mellisa Johnson (USA), Nadia Steiner (Canada), Yutaka Watanuki (Japan)

W7: BIO Workshop

Anthropogenic stressors, mechanisms and potential impacts on Marine Birds, Mammals, and Sea Turtles

Convenors

Patrick O'Hara (Canada), Miran Kim (Korea), Yutaka Watanuki (Japan)

Summary:
The workshop was divided into Eastern and Western Pacific region-based sessions with presentations and discussions focusing on key threats. There were two invited speakers, one from each region (Dr Jongmin Yoon, Korea; Dr Matthew Savoca, USA), who began each session. In total, there were 15 presentations (13 oral, 2 poster) with 8 presentations based in the Western and 7 presentations based in the Eastern Pacific PICES subregions. The workshop was held as a hybrid meeting and was fairly well attended with approximately 14 attendees participating online, and 12 attendees in person (Korea – 10, USA – 6, Canada – 5, Japan – 4, China – 1). Presentations were varied in their focus, with either a taxa specific approach to understanding impacts from various stressors (for e.g., conservation challenges for sea turtles in Jeju Korea), or stressor specific approaches (for e.g., microplastics and their impact on marine organisms). Our workshop began with a presentation by Dr Yoon, who described a very interesting indirect pathway of effect, with land reclamation near Incheon acting as an ecological trap, where colonizing breeding seabirds are exposed to elevated levels of predation from urban adapted predators. The real strength and potential outcome of this workshop lies in the comparison between the two PICES subregions (Western and Eastern Pacific), with the identification of important (and/or emerging) stressors, and how focal taxa interact with these stressors. We are currently drafting a more comprehensive report as a follow up discussion with workshop participants.

Science Communication Training Workshop 2022: How to Create Memorable PICES Science Stories

Convenors

Lori Waters, Vera Trainer and Tammy Norgaard

Ocean scientists, including PICES members, usually do amazing science, and often feel that their results speak for themselves. But many scientists are eager to learn new ways to communicate their work more effectively, in order to facilitate improved ocean health. PICES has been working towards finding ways to support its members in better and more broadly communicating their science. This short workshop report describes the "How to Create Memorable PICES Science Stories" two-day workshop held on September 23/24, during PICES-2022, by the Advisory Panel on Science communication (AP-SciCom).''In keeping with the *Terms of Reference* for AP-SciCom, the panel will facilitate regular workshops to assist PICES members to learn more effective ways of communicating their science. This builds on previous PICES Science Communication workshops and Science Communication Expert Group work (described in previous issues of PICES Press).[1]

This year's Science Communications workshop focused on the 'ABT (And, But, Therefore) method' of communicating science, as this proven communication framework developed by Dr. Randy Olsen (and elucidated in his books such as "The Narrative Gym" and "Don't be such a Scientist") is designed to take advantage of a human neurological tendency to be compelled by narrative. Participants learned to craft their science into narrative stories in such a way that their audiences would not only connect with and believe our science stories, but also remember them.

The ABT workshop featured invited expert speakers Julie Claussen (Director of Operations, Fisheries Conservation Foundation, attending virtually) , Brian Palermo <Lori – get link> (comedian, improv coach, and science communicator) and John Pohl (Oceanographer, NOAA) with assistance from AP-SciCom members Vera Trainer, Elliot Hazen, and Lori Waters.

Palermo's compelling introductory presentation focused on audience connection, by teaching science communicators not to focus so much on "did I say what I wanted," but rather "did the audience hear what I need them to hear." By first flipping the narrative from ourselves to our audience, science communicators are able to better engage with an audience, who will be better able to hear our compelling science story. And, Palermo points out that creating a narrative does not mean compiling a list of facts, as this traditional scientific "and, and, and" propensity serves not to compel audiences, but is more likely to send them to sleep. Instead, participants learned that the key to bringing their science stories to life is to set up agreement in the audiences mind, (this is the "And" portion of the story), introduce a problem, (the "But") and then to offer a solution (the "Therefore"). Agreement is key, as this engages the audience with your science. Introducing the problem then taps into the problem-solution dynamic so critical to storytelling, as it taps into human problem-solving propensities. Lastly, because our brains are activated by the tension between the agreement and

This is your brain on...

Non-narrative   Narrative

[1] "Communicating Science" https://meetings.pices.int/publications/pices-press/volume28/PPJan2020.pdf#page=14 and "PICES new Science Communication Study Group (SG-SciCom): Bringing our science to the world" https://meetings.pices.int/publications/pices-press/volume29/PPJan2021.pdf#page=51

the problem, offering a solution to relieve the tension, and this third piece – the "therefore" will help your audiences to remember (and ideally act upon) your key messages. The neurological impact of the ABT method has been tested, and shown to activate brain centers, as shown below.

Palermo describes the ABT method (Figure 1) in simple terms as:

And: this is the "heaven" – there are common threads.

For example: "We all love the ocean" and "We all want to protect the ocean" are "and" statements that would build agreement and the beginning of a narrative.

But: is the "hell" statement, and science communicators need to ensure that there is a great contrast between the heaven and hell. Using the ocean "and" statements above, the "hell" "but" statement could be something like: "But, plastic pollution is destroying our ocean ecosystems."

Therefore: The final statement is the solution, and the consequence, and should reflect a changed world and a narrative of hope, in order for audiences to relate and remember the message. Using the example above, the therefore could be something like: "So scientists have developed a way of removing plastic pollution from ocean ecosystems."

Using this method, PICES scientists can motivate their audiences by using the ABT method to:

- A- Remind audiences what they love (create agreement)
- B- Take away (or destroy) the thing that the audience loves (create tension)
- T – Give the audience hope. (create resolution, memory)
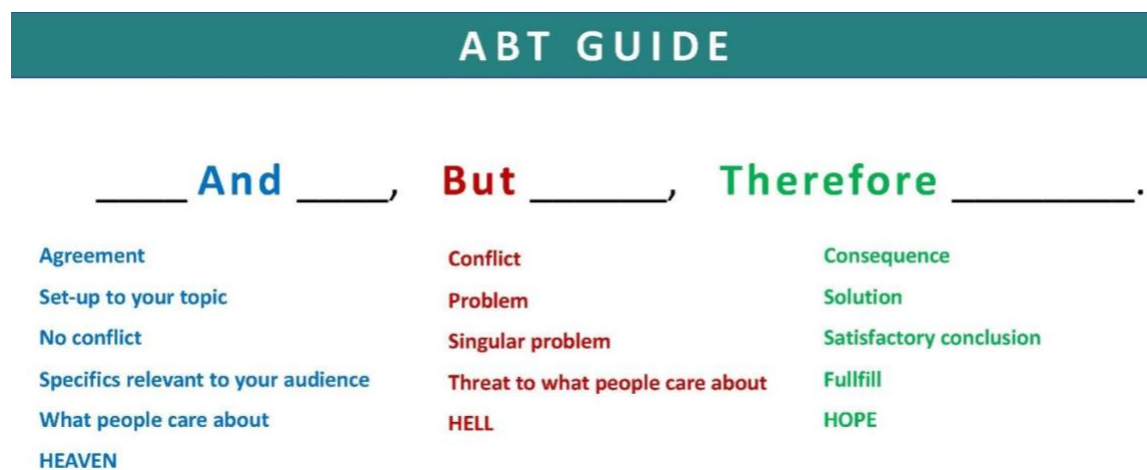
Figure 1. Simplified ABT guide, courtesy of Julie Claussen.

Palermo summarized that a statement using the method could be as simple as: "In the past, life was like this, AND all was well. BUT we had this problem, THEREFORE, in the future, we're going to do this to solve the problem."

However, while this seems simple, participants found that reducing the problem to one simple statement can be more difficult than it sounds. Palermo stressed the importance of defining <u>one</u> singular problem (Figure 2), because if a scientist isn't able to decide their singular problem, it is difficult or impossible for your audience to do so. Using a fisheries example, participants were asked to consider whether the problem is climate change, policy, invasive species, staffing compliance, etc.) If there is more than one problem, then your audience is not able to focus, and, worse, Palermo explained that if everything is important, then nothing is important.

Figure 2. Honing to a singular problem – courtesy of Julie Claussen

Further honing the methodology for creating and honing problem statements, Julie Claussen then gave a in-depth

presentation on the ABT narrative framework. During this presentation she supplied the above quick guide (figure X), answered questions from workshop participants about the process and expected results, and shared several instructional videos (linked below in this report). Importantly, Claussen differentiated between narrative and non-narrative, providing the following example of what is NOT a story, but that many scientists would normally likely interpret as a story. "*There is this thing, and it was important to the ecosystem and people valued this thing and this thing did this and it did that and you want to be sure to know about this and…and…and…*"

Dorothy lives in Kansas
We're not in Kansas anymore
Clicks her heels to go home

Rather, it is the narrative structure set out in the ABT method that builds the story, by setting up tension in the mind of the reader between the agreement and the problem, before offering a solution. The reason that this narrative structure works, Claussen explained, is because humans, as natural problem-solvers, have brains which seek solutions as soon as a problem is presented: "People are hard-wired to follow the '*Problem – Solution Dynamic*.' Providing several examples from well-known and popular films, she summarized the narrative arcs of these, and how they also fit into the ABT structure, with the creation of agreement ("heaven"), a problem ("hell"), and finally, provision of a solution, which satisfies our brains.

Our challenge as science communicators, she explained, is to better understand the narrative structure of stories so that we can better tap into a narrative dynamic, to better connect audiences with our science. Cautioning participants, she reminded the group that using the narrative framework, which seems deceptively simple, does not mean that undertaking the process of telling our science stories in this way is easy. Nor does the process mean that we need to dumb down our stories. Rather, in using the process well, we can create focused and concise stories that will be memorable for our audiences.

Claussen further differentiated for the group that while the ABT form supplies the narrative structure for our stories, the content is the information itself, which science communicators craft and hone. The information includes the "colour, depth, visuals, adjectives, humour, etc." Following on from Brian Palermo's introduction, the creation of this content also must balance what you – the scientist – wants to say, versus what the audience wants to hear. Messages need to be crafted for your chosen audiences, in order to connect with your audience so that they will understand your science.

Claussen's short videos detailed why scientists must tell their stories, the forces of narrative, defining audiences, and, a methodology video reminded participants that the less concise they are, the less compelling they are. Lastly, she introduced attendees to a storyboarding method as a means of honing their stories, and encouraged them to use the storyboarding template as a means of working through the ABT drafting process.

The group then focused, with Palermo's direction, on ways – especially in verbal narration of audio and videos - of intentionally and holistically employing all of our communication skills and aspects of our selves to tell our science stories, which may run counter the traditions of science, which set out an implicit expectation of "objective" (emotionless) communication, which can hinder effective communication. He encouraged participants to use all of their abilities to convey their messages and be more engaging, explaining that messages are not solely about content but also about delivery. Connecting with other humans in order to have them hear, understand, and remember our messages means connecting with them on many levels, including delivering our messages via both verbal and non-verbal communication. Important to non-verbal communication is eye contact, expression of some emotion through facial expressions, and using "paralanguage" such as vocal volume, inflection, intonation and rhythm to emphasize your message, in conjunction with body language gestures.

Participants were led through a series of "improv" exercises designed to heighten awareness and skills in paralanguage, which participants found very helpful and that organizers hope to feature to the broader PICES audience at PICES-2023. The goal of these exercises was to enhance the ways in which PICES scientists can connect with their audiences. Through a series of "safe to fail" experiments participants will listen to understand, rather than respond, and can enhance their agility in being able to deliver messages in such a way that audiences can relate and better understand them.

Though these may seem counter-intuitive to the perception that a 'rational' scientist must demonstrate their impartiality by describing their work in restrained, passionless, reserved, or controlled terms, this can impair audience's ability to relate to, understand, or remember scientific messages, because the lack of emotional content in a scientific message may give the perception that the message is unimportant, that the scientist is condescending or boring, or that they are unconcerned with the impacts of the issue they're studying.
Participants were reminded that the most important thing is not that which you are presenting to an audience – it is what the audience is perceiving that is most important. A recent cultural example of the importance of emotional content that can help demonstrate this point is that emojis so commonly used in conventional daily communication were developed to enhance the emotional meaning of messages, by adding emotional content. Palermo emphasized that we are humans, and by adding the full spectrum of emotional content, we can better engage in full-spectrum communication, and that by enhancing our emotional expression when we communicate our science messages, we enhance the ability of our audience to understand our science and our messages. In short – Palermo reminds us – "if we don't reveal it, they don't feel it." And, if they don't feel it, your audience is unlikely to engage in, or seek to better understand (or remember) your science.

The final instructional portion of the workshop then focused primarily on visuals. Participants reviewed ABT videos made earlier by group members; John Pohl from NOAA provided an overview of composition basics; and Brian Palermo provided a primer for participants on technical aspects of creating and framing quality videos. Pohl's background reminded communicators to consider their audience, and in preparation for creating science communication deliverables, to determine what is known about the target audience, and what result is sought from the communication piece – i.e. what would you like the audience to think, feel, or do. Referencing the work of Edward R. Tufte, Pohl reminds us that stories must also be revised depending on delivery media, but that regardless of media, visual elements are key to effective storytelling.

In addition to using words to tell our science stories, creation of effective visuals can enhance understanding of ideas, and provoke emotions to better engage our audience. Pohl reminds us that an image with a few words is much more effective than words alone. Covering the basics of compositional space, line, contrast, shape, tone, colour,

movement, Pohl also contrasted the impact of showing a series of graphs showing the impact of ghost nets and derelict fishing gear, versus a photograph of a dead pinniped in a net, which conveys much more directly the impact (Figure 3).

To finalize his presentation, Pohl provided several links below to imagery that science communicators can freely use when producing their work. Lori Waters in the Secretariat can also provide access to some images for PICES members, including PICES access to the Ocean Image bank during the UN Decade of Ocean Science for Sustainable Development (UNDOS).
pexels.com
thenounproject.com
unsplash.com
https://www.theoceanagency.org/ocean-image-bank

With this background, three groups of workshop participants set about to produce their own short (~1 minute) videos, using their new ABT skills: <upload videos and link to their text>
- Advisory Panel on Science Communications (AP-SciCom) members provided an overview of the ABT method workshop, and its importance to PICES.
- SmartNet Sustainability of Marine Ecosystems through global knowledge network) steering committee members provided an overview of the goals and importance of the SmartNet UNDOS program.
- Section on Harmful Algal Blooms (S-HAB) members provided an overview of current HAB work being conducted in Indonesia, a special project funded by the Japanese Ministry of Forestry and Fisheries that is responsive to increasing incidence of HABs.

The purpose of these videos in general is to provide audiences with a better understanding of PICES Expert Group work, provide scientific highlights in a user-friendly format. We also hope that they may spark collaboration and encourage further inquiry into PICES global work.

For PICES members wishing to use the ABT method, we hope that the resources contained in this report will be a good starting point. AP-SciCom members look forward to seeing your short videos and related work, which we hope you'll share. We look forward to the Science Communication workshop planned for PICES-2023 in Seattle, WA, which will focus on the development of compelling fact sheets to help PICES members better share their work.

W9: MEQ Workshop

(Cancelled) The Expansion of Harmful Algal Blooms (HABs) from lower to higher latitudes

Convenors

Natsuko Nakayama (Japan), Yoichi Miyake (Japan), Mark L. Wells (USA)

W10: HD/FUTURE Workshop

Openly Discoverable, Accessible, and Reusable Data and Information in the U.N. Decade

Convenors

Jeanette Gann (USA), Jill Prewitt (USA), Shelee Hamilton (Canada), Brett Johnson (Canada), Wan FangFang (China), Hernan Garcia (USA)

Ocean data in all forms contribute to understanding and informing management and sustainability of the world's oceans and its ecosystems. Open sharing of that data and information across international boundaries remains a

formidable challenge. The overarching motto of the U.N. Decade of Ocean Science is 'the science we need for the ocean we want'. To obtain this, we need to share data openly across all regions, continents, and countries. There are many efforts at regional, national, and international levels working towards this goal. Keeping apprised of UN Decade data activities is paramount for PICES data and information management. Encouraging the facilitation of data mobilization and sharing across international boundaries and private institutions will help to bring UN Decade data goals to fruition.

PICES is in a unique position to engage scientists and data managers from countries around the north Pacific to help facilitate discussions about open data sharing. Inviting a wide range of participants, we discussed histories, successes, and challenges of open data. This workshop helped to guide TCODE to an actionable role in facilitating data sharing between PICES member nations for the U.N. Ocean Decade. Additionally, it helped to form a new study group devoted to investigating data and information management within PICES that will identify gaps, mishandling, or roadblocks for data flow, among other issues.

Workshop goals included the following:
- Assess barriers to open data sharing and/or exchange (i.e. FAIR-compliant)
- Draw a PICES data flow diagram
- Identify incentives to open data sharing
- Identify appropriate UN Decade endorsed data platforms for PICES data and reports
- Assess the need for a study group to further increase PICES data management and sharing
- Update PICES data policy for submission to science board and general council
- Strategize ways in which TCODE can integrate with FUTURE and Smartnet, and include ECOPs into TCODE membership

Participation in the workshop included a hybrid format with invited speakers for our morning session (listed below), and an afternoon of discussion on a number of topics related to our goals for the workshop (above). Additionally, guest speakers (Drs Raphael Roman, and Steven Bograd) addressed the workshop regarding related PICES programs and ECOP initiatives where potential TCODE overlap/membership could occur.

Ms. Kate Wing, founder of the Intertidal Agency, and co-chair of the IOC Ocean Decade Data Coordination Group (DGC), gave a presentation entitled "*Data coordination across government, private industry, and non-profit entities: increasing access through the U.N. decade"*. Ms. Wing's presentation touched on a variety of topics regarding large scale data coordination efforts and included the introduction of the Ocean Data and Information System (ODIS) catalog that could improve communication of PICES data, information, and projects to a wider international audience.

Ms. Han Chunhua from the National Marine Data and Information Service (NMDIS), presented a talk on "*China's practice on marine big data management and sharing*". Her talk centered on China's largest ocean data and information system and included information on understanding, management, sharing, and prospects of big data. Additionally, she discussed specifics of how data is collected, QA/QCd, and ultimately managed from the outset of each project. And finally, the NMDS marine observation data sharing and service platform plans expansion to larger international data sharing.

Dr. Igor Shevchenko (PICES and TINRO Center) talked about "*Lessons learned from TCODE metadata federation activities"*. He discussed the many barriers to data sharing both on an individual level, and between various organizations and across international boundaries. His discussion points gave ideas on how PICES could benefit from better resources and focus on taking care of data and metadata, how PICES will need to add metadata into our data policy, and that UNDOS presents a good opportunity to increase data sharing and management in general.

Mr. Tim Van der Stap and Mr Brett Johnson, both ECOPs from Hakai Institute in Canada, presented "*Mobilizing international salmon data from open ocean to open access"*. Points made during this talk include how scientists often have limited funding and that using resources to manage and mobilize data for purposes of sharing tend to go to the bottom of the project list. He introduced the Basin Scale Events to Coastal Impacts project (BECI), which plans to mobilize data to increase its value, and utilize a data science team helpful for mobilization, coordination, data exchange, and standardization.

Dr. Yutaka Michida, and ex-officio member of TCODE, and a former co-chair of IODE, presented a talk on "*Oceanographic data and information sharing towards goals and outcomes of the UN Decade of Ocean Science"*. His presentation highlighted past conferences centered on data sharing, and encouraged PICES participation in future meetings like the 2nd International Ocean Data conference to be held the 20th-21st of March, 2023, and the IODE XXVII and Ocean Data Conference, to be held the 22nd-24th of March, 2023 both in Paris, France.

A summary of the findings from the workshop are as follows:

Barriers to data sharing:
- *3 categories:* 1) social/cultural   2) technical   3) legal constraints organizations
- Language barriers add to data sharing blockages
- Scientists not generally awarded for sharing their data (opposite)
- Lack of Financial/Specialist/Admin support for proper management of data/metadata!

Incentives to data sharing:
- Possibly create PICES (or other) award on data management/sharing/interoperability
- Incentives for some are different than for others (industry vs gov vs academic, etc.)
- Have data management strategy ready at beginning of projects instead of an 'afterthought'
-

Other findings:
- PICES Data flow diagram has gaps (needs focused discussion)
- Culture of dealing with data is lacking. UN Decade >> fuel new culture, better management, sharing, mobilization.
- ECOPs could be very helpful in changing this culture!
- Study group would be very helpful to further improvements of data culture in PICES

As a direct result of this workshop, a new study group was formed on encouraging Data Awareness and increased Transmission and Accessibility (SG-DATA). Anyone interested in joining SG-DATA is encouraged to contact the chair Dr. Hernan Garcia (Hernan.Garciea@noaa.gov).

SG-DATA Terms of Reference:
- To assess existing best practices, and complete a PICES data flow diagram
- To gather lessons learned from past, ongoing and planned projects, programs and initiatives;
- To identify solutions for known problems and bottlenecks regarding sharing of data within PICES and beyond;
- To facilitate harvesting of PICES metadata catalog records by UN Decade data platforms (like ODIS);
- To draft a checklist of questions to promote data sharing and the reproducibility of results for paper/report submissions;
- To consider what kind of infrastructure would be sufficient to enable those with "small" and "besides" science data who wished to contribute to a digital commons environment;
- To consider how to make FUTURE, IPOD organic parts of the future UNDOS digital ecosystem;
- To increase collaboration between TCODE and other PICES programs like Smartnet, in addition to external collaborations (ICES DIG).
- To identify a digital platform that is accessible by all PICES member nations/constituents for use in simultaneous document editing and updates that can be used by all committees and expert groups for more efficient and effective communications and work.
- Review the current PICES data management policy and forward any changes/edits to TCODE, SB, and GC for approval.

- end of the document -