Summary of Scientific Sessions and Workshops At PICES-2024

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Topic Session 2	Innovation in using integrated approaches to detect and manage for the effects of climate change tipping points and critical thresholds in marine ecosystems
Topic Session 3	Advanced tools to monitor, observe, and assess small pelagic fish populations in support of ecosystems based fisheries management and maintaining ecosystem services
Topic Session 4	Observational frontier and new studies for understanding of ocean and ecosystem
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Workshop 3	Exploring human network to power sustainability in North Pacific Ocean
Workshop 4	Contrasting the occurrence of toxic *Alexandrium* bloom in the eastern and western North Pacific
Workshop 5	Exploring international knowledge co-production: Lessons learned from international marine science organizations at the science-policy interface
Workshop 6	Co-creating a shared framework for ocean data management: Finding common ground on terminology
Workshop 7	Integrating biological research, fisheries science and management of flatfish species in the North Pacific Ocean in the face of climate and environmental variability
Workshop 8	"Science Jam" – Bringing the gap between science and social media to communicate PICES accomplishments wit the world.
Workshop 9	Puffin diet samples and indicators of forage nekton availability and community structure in the North Pacific
BECI Special Workshop	Bringing together models for fisheries management under climate change – Multiple model ensembles and inference to guide decision-making

FUTURE Symposium

This report is modified from the articles in the PICES Press 2025 Winter Issue

The FUTURE of PICES: Science for Sustainability in 2030

Convenors:
Hanna Na (Korea), Steven Bograd (USA), FUTURE SSC.

The theme of the PICES-2024 Annual Meeting was 'The FUTURE of PICES: Science for Sustainability in 2030'. Since 2009, the 'Forecasting and Understanding Trends, Uncertainty, and Responses of North Pacific Marine Ecosystems', or FUTURE, has been the PICES flagship Science Program. A key objective of the Annual Meeting was for the PICES community to take a step back and evaluate the status of PICES science, and to embark on a new scientific path to better fulfill our goal of understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services, and marine-dependent social systems. The theme of PICES-2024 was inspired, in part, by the ongoing UN Decade of Ocean Science for Sustainable Development (Ocean Decade), for which PICES plays a leadership role through its SmartNet Program, and its mission to develop 'the science we need or the ocean we want'. The theme is also well aligned with recently completed PICES External Review Panel Report.

To introduce the theme of the Meeting, PICES-2024 opened with the full-day, plenary FUTURE Symposium. This Symposium comes a full decade after the first FUTURE Open Science Meeting, also held in Hawaii (Kona, April 2014), that launched FUTURE's new vision to investigate and understand the climate and anthropogenic impacts on North Pacific marine ecosystems with an emphasis on the synergy of social, ecological, and environmental systems (SEES) and processes. **Steven Bograd** and **Hanna Na** kicked off the Symposium with introductory remarks (Figure 1), noting that, 10 years after the initial FUTURE Open Science Meeting, we are here to: (1) celebrate what FUTURE has brought to the PICES and North Pacific marine science communities; (2) assess the strengths and weaknesses, as well as accomplishments and gaps, of the Program; and (3) take our lessons learned from FUTURE to pave the path forward for PICES science. It was noted that FUTURE has accomplished a lot during its tenure as flagship Science Program:

- Facilitated Trans-disciplinary Science Collaborations
- Implemented a Social-Ecological-Environmental-Systems Approach to PICES Activities
- Expanded Human Dimensions into PICES Activities
- Provided Assessment of Key Organizational Strengths and Gaps

The first set of Symposium speakers provided details on many of these accomplishments. **Shin-ichi Ito** (see Figure 2 for Symposium speakers) provided a history of PICES science, describing the motivations and process of transitioning from the first Science Program, '*Climate Change and Carrying Capacity*' (CCCC; 1995-2009) to FUTURE. This was followed by two presentations that reviewed the evolution of the scientific enterprise within FUTURE. **Hanna Na**, in collaboration with **Jennifer Boldt**, presented the FUTURE Product Matrix, which provides an evaluation of the scientific products developed during the FUTURE period and links these products to each of the key FUTURE scientific questions. The Product Matrix thus provides a summary of which fundamental scientific questions were best or least addressed, allowing for an assessment of Program achievements and gaps. Continuing with this theme, **Shion Takemura** described a study he led that uses keywords from the historical PICES abstract archive to demonstrate the evolution of PICES science from CCCC (disciplinary scientific processes) to FUTURE (inter-disciplinary research and inclusion of human dimensions). Finally, **Mitsutaku Makino**, current Chair of the Human Dimensions Committee, presented on the renewed emphasis, and critical importance, of integrating human dimensions throughout the PICES scientific enterprise.

Speakers following lunchbreak provided overviews of a few key scientific advances made during the FUTURE period. **Mary Hunsicker** reviewed the work of the FUTURE-sponsored Working Group 36 on '*Common Ecosystem Reference Points across PICES Member Countries*', which analyzed ecosystem reference points within regional PICES-area ecosystems. **Helen Killeen** and **Hiroki Wakamatsu** provided an overview of the work being conducted

in the FUTURE-sponsored Working Group 49 on '*Climate Extremes and Coastal Impacts*'. Following these science presentations, we celebrated the critical role that Early Career Ocean Professionals (ECOPs) have played in advancing science and collaborations with FUTURE and PICES more generally. The current Chairs of the Advisory Panel on ECOPs (AP-ECOP), **Minkyoung Kim**, **Hannah Lachance**, **Hana Matsubara** and **Raphael Roman**, gave a fantastic review of the great work they have accomplished, including new strategies to recruit, welcome and retain ECOPs into the PICES community. We were then treated to the invited presentation from this year's FUTURE SEES ECOP award winner, **Rachel Seary**, who summarized her work on incorporating the SEES approach into her research on supporting ocean sustainability. We then had a presentation from **Nakayama Natsuko** who described the work of the Advisory Panel on Science Communications (AP-SciComm), which has been an active area of emphasis within PICES in recent years.

Following this wonderful set of speakers, we conducted a Panel Discussion on the progress, challenges and lessons learned from FUTURE. **Steven Bograd** led the discussion with several distinguished panelists who represented each PICES member country and the Secretariat: **Sanae Chiba** (Secretariat), **Jennifer Boldt** (Canada), **Fangli Qiao** (China), **Shin-ichi Ito** (Japan), **Sinjae Yoo** (Korea), **Vladimir Radchenko** (Russia) and **Ryan Rykaczewski** (USA). The Panel engaged in a lively discussion around a few leading questions (below) and took questions from the audience:

1. What do you think is the **most significant contribution** FUTURE has made to the PICES and North Pacific marine science communities?
2. What were the **biggest barriers** in achieving FUTURE's scientific objectives?
3. How should PICES science be **transformed** in the future?

The panelists agreed that one of the most significant accomplishments of FUTURE was its facilitation of inter-disciplinary work across PICES, including the implementation of the SEES approach. The panelists also recognized that the FUTURE Science Plan was overly ambitious, which limited the ability to accomplish some key objectives. For example, questions on ecosystem resilience and vulnerability would be difficult to answer within the life cycle of FUTURE.

Finally, **Cisco Werner** (Figure 3), U.S. Governing Council member and one of the original developers of the FUTURE Program, closed the Symposium with some personal remarks on the accomplishments and lessons learned from FUTURE. He also primed the audience to review the PICES External Review Panel Report and to think about what should come next for PICES science, echoing the theme of PICES-2024. His remarks resonated with the audience, which engaged in a long and lively discussion until we were compelled to break for the Welcome Reception. We thank all of the Symposium speakers and panelists, as well as the highly engaged PICES community, for a very successful FUTURE Symposium!

Figure 1: FUTURE SSC Co-Chairs Hanna Na and Steven Bograd kicking off the FUTURE Symposium at PICES-2024.

Figure 2: Speakers at the FUTURE Symposium: (top, from left) Shin-ichi Ito and Shion Takemura; (middle, from left) Mitsutaku Makino, the AP-ECOP Co-Chairs (Hana Matsubara, Minkyoung Kim, Hannah Lachance and Raphael Roman), and Mary Hunsicker; (bottom, from left) Nakayama Natsuko, and Rachel Seary (this year's winner of the FUTURE SEES ECOP Award).

Figure 3: Cisco Werner closing out the FUTURE Symposium at PICES-2024.

Session 1: FUTURE/HD/POC Topic Session

Climate Extremes and Coastal Impacts in the Pacific

Convenors
Antonietta Capotondi, *Corresponding* (USA), Chan Joo Jang, *Corresponding* (Korea), Charles Hannah (Canada) Helen Killeen (USA)

Co-sponsor: CLIVAR

Description

Over the past several decades, extreme climate events (ECEs) have generally become more frequent and intense, resulting in devastating, long-lasting ecological and socio-economic impacts on both global and regional scales. ECEs include both rapid or intermittent physical events (e.g., marine heatwaves, tropical cyclones, and storm surges) and imbalances initiated by biogeochemical responses to climate change (e.g., ocean acidification, deoxygenation, HABs, bleaching). These events affect marine ecosystems at all trophic levels mainly through shifts in habitat distribution, biodiversity, and communities, resulting in the destruction of coastal biogenic habitats.

There is a clear need to better understand and predict these events in different Pacific regions. Advances needed include an updated statistical characterization of ECEs (e.g., in terms of intensity, frequency, duration, and three-dimensional evolution), identification of their driving mechanisms, a refined assessment of their ecological impacts, and improvements in our ability to predict and project future changes in extremes. Improved characterization and understanding of compound events, i.e., the co-occurrence of different types of physical and/or biogeochemical extremes, is also needed.

This session provides a platform to compare physical and biogeochemical processes and the statistics of ECEs in different regions by inviting case studies in the Pacific.

In this session, we welcome contributions on ECEs and related compound events on the following topics: 1) the physical and biogeochemical processes of extremes, 2) the ecological and socio-economic consequences, and 3) the prediction or projection of extremes.

List of papers

Oral presentation

1. **(Invited)** (ECOP) Physical Drivers of Global Marine Heatwaves. Ce **Bian**, Zhao Jing, and Lixin Wu
2. **(Invited)** Impacts of marine heatwaves on tropical western and central Pacific Island nations and their communities. Neil J. **Holbrook**, Vanessa Hernaman, Shirley Koshiba, Jimaima Lako, Jules B. Kajtar, Patila Amosa and Awnesh Singh
3. Modeling decisions in Hawaii's deep-set longline fishery: fishing under spatial closures and climate variability**.** Kristy **Wallmo**, Hing Ling Chan, Lisa Pfieffer, and Paul Carvalho3
4. (ECOP) Relationship between subtropical Indian Ocean Dipole and phytoplankton blooms. Seongsik **Park** and Kyunghoi Kim
5. (ECOP) Disturbance in benthic sediment and primary production in tidal flat by extreme meteorological events (typhoons Maysak and Haishen) in 2020**.** Seong Woon **Jeong** and Ho Kyung Ha
6. (ECOP) Impact of ocean heat changes induced by the Pacific Decadal Oscillation (PDO) on typhoon intensification in the Philippine sea**.** Kiduk **Kim**, Jeong-Yeob Chae, Hajin Song, Eun-Joo Lee and Jae-Hun Park
7. (ECOP) A transition at twilight: the declining diel vertical migrators in a warming shelf sea. Lingyun **Nie**, Jianchao Li *, Yang Liu , Peng Sun , Zhenjiang Ye , Honghai Zhang , Liyan Zhu, Shuyang Ma , Wenchao Zhang ,3 and Yongjun Tian

8. (ECOP) Spatial variability in multivariate climate vulnerability produces mosaic of risks and tradeoffs for four California Current shellfish species. Esther G. **Kennedy**, Sara L. Hamilton, Ben Walker, Meghan Zulian, , Kristy Kroeker, Eric Sanford, , Brian Gaylord, and Tessa M. Hill
9. Marine Heatwaves and Pyrosome Blooms: Are these the new normal for the Northern California Current? Richard D. **Brodeur**, Kelly R. Sutherland, Kim S. Bernard, Dylan G.E. Gomes, Laura E. Lilly, Elizabeth A. Daly, Samantha M. Zeman, Moira Galbraith, R. Ian Perry, Douglas L. Draper, James J. Ruzicka7, Eric P. Bjorkstedt8, and Roxanne R. Robertson
10. (ECOP) Interannual variability of the marine heat waves in the Western North Pacific Ocean and its marginal seas. Hyung-Ju **Park** and Hanna Na
11. (ECOP) A dipole pattern bias in marine heatwave intensity in the Kuroshio Extension simulated by the CMIP6 models. Wonkeun **Choi**, Heeseok Jung1 , Zhenya Song,4 and Chan Joo Jang
12. Tropical and North Pacific decadal variability promotes the occurrence of Northeast Pacific marine heatwaves. Antonietta **Capotondi**, Tongtong Xu, Matthew Newman2 and Emanuele Di Lorenzo
13. (ECOP) Pan-basin warming now overshadows robust Pacific Decadal Oscillation**.** Allison A. **Cluett**, Steven J. Bograd, Michael G. Jacox, Mercedes Pozo-Buil,3 and Elliott L. Hazen
14. Improved ocean-related forecasting ability has been paving the way for providing decision-making actionable information. Fangli **Qiao**
15. **S**tructure of Marine Heatwaves in the Southern Java and Karimata Strait, Indonesia. Young-Gyu **Park**, Mochamad Riza Iskandar2 and Ahmad Bayhaqi
16. (ECOP) Variation of commercial pelagic species under ENSO and Climate Change in the Northern South China Sea. Po-Yuan **Hsiao**, William W.L. Cheung2 and Kuo-Wei Lan
17. Unraveling the formation mechanism of Marine Heatwaves in the Northeast Pacific. Fei **Chai**, Yuntao Wang2 and Huan-Huan Chen

Poster presentation

1. Regional variations of water transparency in the Yellow Sea using MODIS data. Young Baek **Son**, Sun Kyeong Choi1 and Don-Hyug Kang
2. (ECOP) Impact of super typhoon on subtropical Ulva green tides in Korean coast. Sun Kyeong **Choi**, Seul Yi and Young Baek Son
3. Long-lasting marine heatwaves in the East Korea Bay, East/Japan Sea: Characteristics and mechanisms**.** Chan Joo **Jang**, Subi Lee, Wonkeun Choi, Minkyoung Bang1 and Heeseok Jung
4. (ECOP) Observations on the delayed genesis of Marine Heatwaves on the East coast of the Korean Peninsula by near-inertial waves after the passage of typhoon Hinnamnor. Saranya. J. S, Panini **Dasgupta** and SungHyun Nam
5. (ECOP) Representing annual marine heatwave characteristics using the monthly sea surface temperature datasets. Gyundo **Pak**
6. (ECOP) Sensitivity of extreme events detection to satellite data resolution in coral reef habitats. Jessica N. **Perelman**, Hui Shi, Ryan R. Rykaczewski, and Justin J. Suca
7. Identification and delineation of key control area of storm surge disaster in Zhoushan City based on loss perspective. Yang **Luo**, Ziyan Guo, Jianwei Wu, Jinlong Jiang and Quanyi Xiang
8. (ECOP) Multiproxy analysis for understanding ecosystem shifts in coastal Louisiana under environmental and climatic stressors**.** Junghyung **Ryu**, Kam-biu Liu, Terrence A. McCloskey, and Jeogyun Kim
9. (ECOP) Basin-scale events to coastal impacts (BECI) project. Kathryn **Berry**, Vivitskaia Tulloch, Devon Wawara, and Sonia Batten

Session 2: FUTURE/BIO/FIS/HD/POC Topic Session

S-CCME/SICCME Session on innovation in using integrated approaches to detect and manage for the effects of climate change tipping points and critical thresholds in marine ecosystems

Convenors:
Kirstin Holsman (USA), Elliott Hazen (USA), Kathy Mills (USA), Xiujuan Shan (China)

Co-sponsor: ICES

Description

Climate change and extreme events are rapidly altering marine ecosystems worldwide, impacting ecosystem productivity, structure, and stability and the livelihoods and wellbeing of people that rely on sustainable marine resources. Understanding if and when climate-driven changes will push systems and species past tipping points (critical points where a small change in a pressure or driver can induce a disproportionate change in system dynamics) has profound implications for management decisions and climate adaptation planning and response. The goal of this session is to follow on findings from our ECCWO5 workshop on tipping points and threshold analyses and to integrate across PICES and ICES working group efforts to synthesize findings and outputs from recent integrated modeling projects across the globe. In particular, the session will include presentations that (1) explore methods for detecting tipping points in marine ecosystems, (2) provide evidence and case studies for historical and future physical, biological, and social-economic tipping points and thresholds in marine systems, and (3) review progress towards inclusion of such information in actionable advice to support climate-informed Ecosystem Based Management.

List of papers

Oral presentation

1. **(Invited)** Approaches to detect tipping point and estimate the resilience of marine populations and communities. Camilla **Sguotti**
2. Revisiting bias correction of earth system models for climate-informed ecosystem based management. Kelly A. **Kearney** and Jennifer Bigman
3. Preliminary study on the Artificial Intelligence-based climate change and marine environmental predictions. Guimei **Liu**
4. Projected climate change and variability of krill population in California Current. Jerome **Fiechter**, Megan Cimino, Monique Messié, Michael Jacox, Mercedes Pozo Buil,2 and Jarrod A. Santora
5. (ECOP) Red-shifted temperature variability in Alaskan marine ecosystems: implications for climate tipping points. Emily R. **Ryznar** and Michael A. Litzow
6. Interacting impacts of prey availability and climate warming on future California sea lion reproductive success in the California Current System. Barbara A. **Muhling**, Stefan Koenigstein, H. William Fennie, Rachel Seary, Steven J. Bograd, Megan A. Cimino, Alexandra Curtis, John Field, Elliott L. Hazen, Pierre-Yves Hernvann, Charles Hinchliffe, Michael G. Jacox, Isaac Kaplan, Elizabeth A. McHuron, Mercedes Pozo Buil, Sharon Melin, Jarrod A. Santora, Julie A. Thayer1, Desiree Tommasi and Andrew R. Thompson
7. Marine heatwaves disrupt ecosystem structure and function via altered food webs and energy flux. David D. **Huff** , Dylan G. E. Gomes , James J. Ruzicka , Lisa G. Crozier , Richard D. Brodeur, and Joshua D. Stewart
8. An updated end-to-end ecosystem model of the Northern California Current reflecting ecosystem changes due to recent marine heatwaves. Jim **Ruzicka**, Dylan Gomes, Lisa Crozier, David Huff, Elizabeth Phillips, Pierre-Yves Hernvann, Cheryl Morgan7, Richard Brodeur, Jen Zamon8, Elizabeth Daly, Joseph Bizzarro, Jennifer Fisher and Toby Auth

9. (ECOP) Data integration improves model performance in a changing climate. Nima **Farchadi**, Camrin D. Braun, Martin C. Arostegui, Elliott L. Hazen, Barbara A. Muhling, Andrew Allyn, Kiva Oken and Rebecca L. Lewison
10. Environmental drivers of species shift in Dokdo coastal waters. Seokjin **Yoon**, Youngsun Song, Eunho Kim and Jung Hwa Choi
11. Evaluating climate-robust management strategies for environmentally-driven recruitment in transboundary fisheries: avoiding tipping points for Pacific Hake. Kristin N. **Marshall**, Aaron Berger, Kelli Johnson, Eric J. Ward, Nick Tolimieri, Mary Hunsicker, Michael Jacox4 and Mercedes Pozo-Buil
12. (ECOP) Exploring the impacts of warming timescales on top predator distributions in the California Current. Meghan L. **Kaschner**, Nerea Lezama-Ochoa, Steven J. Bograd, Heather Welch, Michael Jacox, Allison Cluett, Andrew D. Barton, C. Anela Choy, Joshua A. Cullen1 and Elliott L. Hazen

Poster presentation

1. (ECOP) Ecosystem observations and evolving technology in Central & Northern California. Alex R. **Harper**, Henry Ruhl, Amy West and Jason Adelaars
2. (ECOP) Relevance of international trends in EBFM to Japanese fisheries management systems. Hitomi **Oyaizu**
3. Widespread marine predator culls will not recover salmon populations. Lisa G. **Crozier,** Dylan G.E. Gomes, James J. Ruzicka, David D. Huff and Joshua D. Stewart
4. (ECOP) The ecological responses of tunas to Marine Heatwaves based on explainable artificial intelligence. Peng **Lian**, Wenbo Yang, Jing Zhao and Xiong Zhang
5. (ECOP) North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME) to inform fisheries management under climate change. Vivitskaia **Tulloch**, Kathryn Berry, Julia Blanchard, Cheryl Harrison, Kelly Ortegas-Cisneros and Robin Brown

Session 3: FUTURE/FIS/HD/MONITOR Topic Session

Advanced tools to monitor, observe, and assess small pelagic fish populations in support of ecosystem based fisheries management and maintaining ecosystem services

Convenors:
Jennifer Boldt (Canada), Rebecca Asch (USA), Matt Baker (USA), Chris Rooper (Canada), Dongwha Sohn (Korea), Kresimir Williams (USA)

Description

Small pelagic fish are important components of fisheries and marine ecosystems worldwide. Yet for many species, there is limited information on the consequences of climate change and multiple stressors. Information on pelagic fish distribution, habitat use, and the pressures that affect them is required for sustainable and ecosystem based approaches to fisheries management. Recent advances in technologies, empirical analytical tools, and models can lead to better observations and improved understanding of pelagic fish. In this session, we invite presentations that elucidate the effects of climate change and other pressures on the distribution and productivity of small pelagic fish through advanced technologies in sampling and observational tools (e.g., optics, eDNA, modified trawls, autonomous vehicles), analytical tools (e.g., automated image and acoustics analyses, advances in processing remotely collected data, using diet analyses to develop indices of abundance and distribution), and modeling techniques (e.g., artificial intelligence, spatio-temporal and other statistical methods, incorporating the environment into ecosystem models and ecosystem considerations into stock assessments). Advances in tools used for monitoring, observing, and assessing will improve our ability to predict and manage small pelagic fish populations, which is critical for both ecosystem-based fisheries management and communities that rely on marine resources. This will address the United Nations Decade of Ocean Science's mission of developing the "science we need for the ocean we want".

List of papers

Oral presentation

1. **(Invited)** A deep learning-based method to identify and count small pelagic and mesopelagic fishes from trawl camera images. Vaneeda **Allken**, Shale Rosen, Nils Olav Handegard and Ketil Malde
2. **(**ECOP) Projecting future seasonal distribution of small pelagic fishes under continued ocean warming in Korean waters. Minkyoung **Bang**, Dongwha Sohn, Jung Jin Kim, Wonkeun Choi, Elliott Lee Hazen, Sukyung Kang, and Chan Joo Jang
3. The role of upwelling fronts in structuring trophic dynamics and ecosystem function. Brian K. **Wells**, Jarrod A. Santora, David Huff, Meredith Everett, and Jack Barth
4. (ECOP) Random forest regression models in ecology: accounting for messy biological data and producing predictions with uncertainty. Caitlin **Allen Akselrud**
5. Automated stereocameras to assess movement in a pelagic forage fish. Matthew R **Baker**, TS Smeltz, Kresimir Williams, Casey Greufe, Megan Ewing, Jonathan Chapman, Julia Glassy, Eva Hasegawa, Kathleen Cieri, Sofia Matson, Rick Towler
6. (ECOP) Length estimation of curved fish using zero shot learning. Yuka **Iwahara**, Yasutoki Shibata, Masahiro Manano, Tomoya Nishino2 and Hiroki Yaemori
7. (ECOP) Distribution of Fish Communities Around Japan: Insights from eDNA Methods. Yuan **Lin**, Zeshu Yu, Sk Istiaque Ahmed, Xueding Wang, Tomihiko Higuchi, Itsuka Yabe, Sachihiko Ito, Eisuke Tsutsumi, Hiroaki, Saito, Kosei Komatsu, Atsushi Tsuda, Yusuke Kawaguchi, Eitarou Oka, Kyoko Okino, Hajime Obata, Yuki Minegishi, Hideki Fukuda, Marty Kwok-Shing Wong, Jun Inoue, Susumu Hyodo1 and Shin-Ichi, ITO

8. (ECOP) Applications of Computer Vision in Underwater Ecology: A Case Study from the Northeast Pacific. Talen K.L. **Rimmer**, Declan Mcintosh, Colin R. Bates, Tom Zhang, Alexandra Branzan Albu, and Francis Juanes
9. Estimation of length composition by species from images of catches obtained using a fish image analysis system using deep learning (FIAS-Deep). Yasutoki **Shibata**, Yuka Iwahara, Masahiro Manano, Daiki, Suzuki, Tomoya Nishino, Yuka Murayama4 and Toru Kitamura
10. (ECOP) Biogeographic patterns of two typical mesopelagic fishes in the Cosmonaut Sea through a combination of environmental DNA and trawl survey. Yehui **Wang**, Chunlin Liu, Mi Duan, Peilong Ju, Wenchao Zhang, Shuyang Ma, Jianchao Li, Jianfeng He3 and Yongjun Tian
11. Assessment of pelagic fish density using a stereo camera. Kresimir **Williams**, Christopher Rooper, and Matthew Phillips1
12. Ecosystem models to evaluate the role of trophic vertical exchange processes on forage and predator productivity within oceanic ecosystems. Jim **Ruzicka**, Stacy Calhoun-Grosch, Jesse Van Der Grient, Jacob Snyder4 and Réka Domokos
13. (ECOP) Automatic detection and measurement of otolith using zero-shot learning. Masahiro Manano, Yuko Hiraoka, Yasutoki Shibata, Yuka Iwahara1 and Daisaku Masuda
14. (ECOP) Eye lens isotopes reveal different migration ecology of European sardine and anchovy. Tatsuya **Sakamoto**,2 and Susana Garrido
15. (ECOP) Using lower trophic levels to identify habitat for small pelagics in the Bering Sea, 2002-2023. Jens **Nielsen**, Margaret Siple, Alex Andrews, Cheryl Barnes, Lewis Barnett, Lisa Eisner, Jeanette Gann, Jeremy Harris, David Kimmel, Calvin Mordy, Jodi Pirtle, Lauren Rogers, Sean Rohan, Elizabeth Siddon, Genoa Sullaway and Ellen Yasumiishi
16. Coupling small pelagic fish distribution models to complex ecosystem models: tools and choices to support ecosystem-based fishery management and climate assessment. Isaac C. **Kaplan**, Elliott L. Hazen, Stefan Koenigstein, Nerea Lezama Ochoa, Mariana Hill Cruz, Pierre-Yves Hernvann, Owen R Liu, Dylan G.E. Gomes,Sebastian I. Vásquez,7, Criscely Lujan8 Stephanie Green, Matthew R. Baker, Ricardo Oliveros-Ramos, Alberto Rovellini, Rebecca G. Asch, and Barbara Muhling
17. Predicting of future changes in the distribution of Spanish mackerel habitat in the waters surrounding Korea**.** Dongwha **Sohn**, Minkyoung Bang, Jung Jin Kim, Chan Joo Jang2 and Sangil Kim

Poster presentation

1. Ocean forecast for fishermen: Information technology for exploring fishery grounds of natural juveniles for yellowtail farming using ocean big data. Toru **Kobari**, Eisuke Tsutsumi, Gen Kume, Ayako Nishina, Hirohiko Nakamura, Hirofumi Sumoto, Hikaru Endo, Masafumi Kodama, Yuji Sakuno, Shin-Ichiro Kako3 and Toru Yamashiro
2. Passive acoustic monitoring of Pacific herring (*Clupea pallasii*) spawning aggregations. Frances **Juanes**, Philina A. English, William Halliday, Dana Haggarty, Sarah Dudas, Jennifer Boldt, Jaclyn Cleary, Darienne Lancaster,2 and Stephanie K. Archer
3. Using eDNA to study Longfin Smelt in the Nooksack River Estuary, WA. **Steffan Michael Francis Kinley**, **Na'ta'ne Morning-Song Miles**, **Justice Marie Black-Williams**, Andrés Lopez, Megan Schulz, Kira Walters1 and John Rombold
4. (ECOP) The pelagic species trait database, an open data resource to support trait-based ocean research. Miram R. **Gleiber**, Natasha A. Hardy, Caitlin J. Morganson, Catherine F. Nickels, Barbara A.Muhling, Elan J. **Portner**, Pierre-Yves Hernvann, Brian K. Wells,7, Richard D. Brodeur8, Toby D. Auth9, Jarrod A. Santora, Sarah M. Glaser, Daniel J. Madigan, Elliott L. Hazen, Michael G. Jacox, Steven J. Bograd, Zachary Roote, Alana Krug-Macleod, Zackary Tandy, Iris George, Cindy Matuch, Cole B. Brookson, Elizabeth A Daly, C. Anela Choy, Larry B. Crowder and Stephanie J. Green

5. Species composition and assemblages of ichthyoplankton of small pelagic fishes around the Korean waters using DNA barcodes. Hwansung **Ji**, Hyojae Yu and Sukyung Kang
6. Trends in the reproductive phenology and thermal sensitivity of thirteen populations of small pelagic fishes across North American waters. Rebecca G. **Asch**, Katherine Dale, Sarah Weisberg, Toby D. Auth, Gerardo Aceves-Medina, Richard D. Brodeur, Rubén Esteban García Gómez, Sylvia P.A. Jiménez-Rosenberg, Hannah Murphy, Neil McNeill7 and R. Ian Perry

NOTE: The session report below is modified from the articles in the PICES Press 2025 Winter Issue

Background:
Small pelagic fish are important components of fisheries and marine ecosystems worldwide, comprising greater than 30% of worldwide capture fisheries. Yet for many species, there is limited information on the consequences of climate change and multiple stressors on these populations. Information on pelagic fish distribution, habitat use, and the environmental and anthropogenic pressures that affect them is required for sustainable and ecosystem-based approaches to fisheries management. Recent advances in technologies, empirical analytical tools, and models can lead to better observations and improved understanding of the pelagic forage community (including fish and squid). This session focused on studies that elucidate the effects of climate change and other pressures on the distribution and productivity of small pelagic fish and squid through advanced sampling technologies and analytical and modeling tools to improve our ability to predict and sustainably manage these populations.

During the 1-day topic session, there were 16 oral presentations (including two invited talks) and 6 poster presentations (see listing below). Of these, half (8) of the oral presentations and 1 of the poster presentations were by Early Career Ocean Professionals (ECOPs). At the beginning of the session the conveners provided an introduction to the session, as well as an overview of the newly formed Joint ICES-PICES Working Group on Sustainable Pelagic Forage Communities (WG53). This introduction was followed by an invited talk presented by Vaneeda Allken that described her work to use deep-learning techniques to automatically detect, identify and measure small pelagic fishes photographed by a camera system mounted inside a trawl net. Vaneeda and co-authors found good agreement in identification, enumeration and size distribution between the camera system and trawl catches. Vaneeda detailed many of the challenges confronted in developing her Artificial Intelligence (AI) algorithm and provided constructive suggestions on how others can overcome similar challenges. This presentation was followed by 5 additional talks that integrated camera images and AI to improve our ability to automatically measure items ranging from curved fish to otoliths.

Following this set of presentations on AI and optics, the next set of presentations examined the distribution of small pelagic fish species using a number of novel methods. New techniques, such as eDNA and novel applications of oceanographic equipment such as gliders, provided insights into the distribution of small pelagic fish. A second invited talk by Minkyoung Bang began the afternoon session; her work included climate projections and species distribution models for small pelagic fish and squid. Minkyoung used an ensemble modeling approach to project future seasonal changes that could considerably affect distribution and spawn timing of small pelagic species under climate change scenarios. Other session talks that employed species distribution modeling in combination with advanced technologies and model outputs to project the current and future distributions (and projection uncertainty) of small pelagic fish followed the invited speaker. The final two oral presentations used ecosystem models in novel ways (e.g., vertically and horizontally integrated models) with applications to improve ecosystem management.

The poster presentations highlighted additional applications of image-based sampling and artificial intelligence, eDNA, passive acoustic monitoring, species distribution modeling, trait-based models and phenology studies, all of which incorporated advanced technologies.

Invited speakers, Vaneeda Allken, Institute of Marine Research, Bergen, Norway (left), and Minkyoung Bang, Korea Institute of Ocean Science and Technology, Busan, Korea (right)

Session topics and main takeaway messages from S3 presentations include:

1. Improvements in monitoring and data synthesis of forage species:
   a. The use of stereo-cameras and artificial intelligence is allowing better monitoring of small pelagic fish species.
      i. The time required to conduct fish identification and counting has been a major hurdle to widespread implementation of image-based techniques.
      ii. Image-based techniques are applicable to more than just counting and measuring fish.
   b. Advances in eDNA and other molecular techniques can improve our ability to monitor small pelagic fish quickly and efficiently:
      i. eDNA data can be used to complement traditional survey data sources.
      ii. Naturally occurring isotopic composition can provide insights into patterns such as migration that have typically been relegated to tags. This is important given that the small size of many forage fish makes satellite and acoustic tagging challenging.
2. Describing changes in small pelagic species (fish and squid) distributions and communities:
   a. Advanced technologies (such as eDNA, passive acoustic monitoring) can be integrated into species distribution models to provide better estimates of small pelagic fish distributions.
   b. Advances in species distribution modeling allow both better projections of future species distributions and also allows us to measure the variance of these projections.
   c. Trait-based analyses, phenology trends, climate change models, ecosystem models and ocean observations using advanced technologies can improve our ability to predict future changes.

Other speakers in Session 3: top row, from left to right: Matt Baker, Talen Rimmer, Masahiro Manano, Yasutoki Shibata, Yuka Iwahara, Yuan Lin, Brian Wells; bottom row, from left to right: Dongwha Sohn, Yehui Wang, Jens Nielsen, Caitlin Akselrud, Tatsuya Sakamoto, Isaac Kaplan, Jim Ruzicka.

Session 4: FUTURE/BIO/MONITOR/TCODE Topic Session

Observational frontier and new studies for understanding of ocean and ecosystem

Convenors:
Sung Yong Kim (Korea), Jack Barth (USA), Kiyoshi Tanaka (Japan), Akash Sastri (Canada)

Description

Advanced technology has helped our sampling efforts and increased our understanding of oceanography and ecosystem processes over the last two decades. Various sampling sensors, platforms, and ways of sensor fabrication have been developed, such as physics, biology, biogeochemistry, underwater communication, bioacoustics, bio-optics, and autonomous vehicles. These observational frontiers and new studies can be combined with building a seamless data integration and sharing system, which can relay information to artificial intelligence technology. We invite contributions on recent ocean observational approaches to obtain primary ocean variables and unprecedented measurements for physical, biological, and biogeochemical ocean properties and integrated efforts using different platforms. We also welcome contributions of low-cost ocean observations and new approaches by citizen scientists using new and existing sensors and platforms. These advanced technology and accessible approaches will support our goal of understanding the ocean sustainably.

List of papers

Oral presentation

1. (**Invited**) Novel approaches to monitor zooplankton in the large marine ecosystems of Alaska. David G. **Kimmel**
2. (**Invited**) Marine Biodiversity Observation Network in the Northern California Current: technological integration, ecosystem science, and management applications. Maria T. **Kavanaugh**, Jennifer L. Fisher, Su Sponaugle, Robert Cowen, Nicolaus Adams, Jan Newton, Stephanie Moore, Laurie Juranek, Jenny Waddell, Kym Jacobsen, Anna Bolm, Kelly George1 and Samantha Zeman
3. (ECOP) Long-term changes in demersal community structure of an urban bay: Transition from bottom-heavy to top-heavy pyramids. Shujuan **Xia**, Takashi Yamakawa, Mari Kuroki, Toshihiro Horiguchi, Keita Kodama, Hiroaki Shiraishi, Makoto Shimizu, Jun'ya Takakura, Kiyoshi Takahashi
4. (ECOP) Genomic signatures of natural selection in *Calanus marshallae* in response to geographic variation in oxygen and temperature. Kristofer K. **Bauer,** Sam Zeman, Jennifer Fisher, John Nelson, Moira Galbraith, Colleen Kellogg, Jesse Lamb5 and Felipe Barreto
5. Ten years of PSF Citizen Science Oceanography monitoring in the Strait of Georgia, Canada. Svetlana **Esenkulova**, Nicole Frederickson, Rich Pawlowicz, Deniz Coskuner, Brian Hunt, Andrew Ross, and Isobel Pearsall
6. (ECOP) Impact of the mining process on the near seabed environment of a polymetallic nodule area**.** Bowen **Li**, Yonggang Jia, Zhihan Fan, Kai Li3 and Xuefa Shi
7. (ECOP) Diapycnal mixing and isopycnal stirring in the Kurohsio Extension front and Izu ridge. Yuki **Ikeda** and Takeyoshio Nagai
8. (ECOP) Toward discerning Submesoscale Coherent Vortices originating from Tokara Strait in the Upstream Kuroshio. Gloria Silvana **Duran Gomez** and Takeyoshi Nagai
9. (ECOP) Consequences of physical and biogeochemical processes for ecosystem: preliminary results from in-situ environmental and acoustic measurements. Hikaru **Homma**, Daisuke Hasegawa, Takahiro Tanaka, Yuji Okazaki and Takeshi Okunishi
10. Attitude and heading measurements with inertial measurement unit for tow-yo type observation system. Terubumi **Saito**, Hikaru Homma, Takahiro Tanaka, Daisuke Hasegawa and Takeshi Okunishi

11. Using passive and active acoustics from an underwater glider over the Pacific Northwest continental shelf. John A. **Barth**, Anatoli Erofeev, Steve Pierce, Otavio Mendes, Brian Wells, and David D. Huff
12. Resolving submesoscale and microscale mixing processes using a tow-yo microstructure profiler. Takeyoshi **Nagai**, Gloria Silvana Duran Gomez1 and Miku Okawa2
13. (ECOP) Leveraging 4-dimensionally mapped ocean biogeochemistry data products to inform species distribution modelling. Mary Margaret **Stoll**, Andrea Fassbender, Barbara Muhling, Paige Lavin, Mar Arroyo, Steve Bograd, Hartmut Frenzel6 and Jon Sharp
14. (ECOP) Resource partitioning among pelagic predators in the southern California Current remains stable despite temporal variability in diet composition. Barbara A. Muhling, Elan J. **Portner**, Antonella Preti, Owyn Snodgrass, Travis Richards, Catherine F. Nickels, Heidi Dewar, Elliott L. Hazen, and C. Anela Choy
15. Integration of novel ocean observing technologies to advance NOAA EcoFOCI's monitoring of Alaska marine ecosystems. Heather M. **Tabisola,** Julie E. Keister, Phyllis J. Stabeno, Calvin Mordy**,** Zach Gold, Natalie Monacci, and Catherine Berchok
16. Backyard Buoys: meeting coastal Indigenous community needs for wave data through co-design and co-production. Jan **Newton**, Sheyna Wisdom, Melissa Iwamoto, Roxanne Carini, Jordan Watson, Sebastien Boulay, Duncan Mactavish, Jennifer Hagen, Joe Schumacker7, Dua Rudolph8, Dolores Kattil-Debrum8, Pua Tuaua9, Eric Brown9, John Hopson Jr10, and Jenny Evans
17. (Pre-recorded) Combining advanced technologies to monitor and assess forage fish temporal distribution and abundance. Chris **Rooper**, Jennifer Boldt, Stéphane Gauthier, Xiamao Wang3 and Kresimir Williams

Poster presentation

1. Seasonal turbulent characteristics in physical and spectral domains obtained from multiple Lagrangian surface drifters. Sung Yong **Kim**, Changhoon Ko, and Jinwhan Kim
2. Comparison of carbon storage capacity and physiological activity of 8 halophytes in the West Sea of Korea. Sunwoo **Park** and Eun Ju Jeong
3. (ECOP) Artificial Intelligence (AI) literacy for ocean professionals is needed for a sustainable future. Erin **Satterthwaite**1 and Matthew Robbins
4. (ECOP) Combined effect of polystyrene microplastics and dibutyl phthalate on the microalgae *Chlorella pyrenoidosa.* Zhaochuan **Li**1 and Xianliang Yi
5. (ECOP) Implementing the UN Ocean Decade: Climate change response through research on marine ecosystem and marine toxins in Korean coastal waters. Eunyoung **Yoon**, Jaeyeon Park, Jungrae Rho 2 and Wonho Yih
6. Temporal dynamics of nearshore zooplankton communities in the Strait of Georgia: implications for ecosystem health. Deniz **Coskuner**, Svetlana Esenkulova, Isobel Pearsall and Brian Hunt
7. Comparison of environmental DNA and imaging methods for monitoring deep-sea fishes on a seamount. Akira **Iguchi**, Miyuki Nishijima, Eri Ikeuchi, Hiroyuki Yokooka, Hideki Sugishima, Kazumasa Ikeda, Ryuichi Miwa, Yoshiro Sekido, Nozomu Iwasaki, Masahiro Suzumura, Ayumi Tsukasaki, Yuichiro Tanaka, Shogo Kato, Jumpei Minatoya, Nobuyuki Okamoto, Taiga Kunishima, Yuji Ise and Atsushi Suzuki
8. (ECOP) Spatial distribution of deep-sea megabenthos around cobalt-rich ferromanganese crusts on seamounts in the northwestern Pacific. Hiroki **Kise**, Akira Iguchi, Shogo Kato, Hideki Sugishima, Shota Mitsui, Jumpei Minatoya, Ryuichi Miwa, Nozomu Iwasaki, Masahiro Suzumura, Ayumi Tsukasaki, Yuichiro Tanaka, Keigo Yanagita, Shohei Kikuta, Hiroko Kamoshida and Atsushi Suzuki
9. Detailed observations of the Kuroshio Extension Front. Daisuke **Hasegawa**, Takahiro Tanaka and Okunishi Takeshi
10. (ECOP) Study on the difference characteristics of spring and autumn in Tie Bay ecosystem. Minbo **Luo**, Tianxiang Li, Yunlong Wang and Mei Jiang

11. An overview of SynObs UN Decade Project and preprimary results of its flagship observing system experiments. Shoichiro **Kido**, Yosuke Fujii, Ichiro Ishikawa, Yasumasa Miyazawa, Elisabeth Remy, Drew Peterson, and Jennifer Waters
12. (ECOP) Anomalous Edge Warming and High Biomass in High-Latitude Oceanic Eddies Driven by Submesoscale Ageostrophic Motions. Huizi **Dong,** Meng Zhou, Roshin Raj, etc
13. (E-Poster) (ECOP) Limited Genetic Connectivity of Precious Corals on Fisheries Impacted Seamounts of the North Pacific. Amy R. **Baco-Taylor**, Nicole B. Morgan, and E. Brendan Roark, Peter Beerli and Tara Khodaei
14. High-rate, near-surface foraging of Rhinoceros Auklets revealed by depth and video data loggers. Jean-Baptiste **Thiebot**, Mindaugas Mitkus, Kozue Shiomi, , Jumpei Okado, Ui Shimabukuro, Yutaka Watanuki5 and Akinori Takahashi
15. Consistent seabird habitat use across years and populations reveals key areas for marine conservation in the North-western Pacific. Jean-Baptiste **Thiebot**, Ui Shimabukuro, Jumpei Okado, Nobuo Kokubun, Yutaka Watanuki and Akinori Takahashi
16. Seasonal resilience of temperate estuarine fish in response to climate change. Zhaopeng **Zhang,** Yuanchao Wang, Cui Liang, Lei Zheng and Weiwei Xian
17. An overview of the US Biogoechemical Argo program in the North Pacific. Yuichiro **Takeshita**, Kenneth S. Johnson, Andrea Fassbender, Alison Gray, Todd Martz, David Nicholson, Sarah Purkey, Stephen Riser, Lynne Talley and Susan Wijffels

Session 5: POC/TCODE Topic Session

Ocean negative carbon emissions: Blue technology innovation for promoting global sustainable development (Cancelled)

Convenors:
Nianzhi Jiao (China), Louis Legendre (France), Carol Robinson (UK), Douglas Wallace (Canada)

Co-sponsors: ICES, Global ONCE

Description

The continual emission of greenhouse gases into the atmosphere is the main driver of global climate change, posing a serious threat to the sustainable development of human society. The PICES/ICES joint Working Group 46 promoted interdisciplinary collaboration across different research communities by bringing together professionals from science (biological, biogeochemical, chemical, and physical oceanography) and engineering.

The Working Group initiated the creation of the international network Global ONCE, which has been approved by the IOC of UNESCO in 2023. In order to continue to consolidate and deepen the achievement of WG46 and to continue to contribute to the scientific objectives of PICES (in particular the FUTURE program), this session seeks to explore and showcase innovative technologies, methodologies, and best practices that leverage the potential of the world's oceans to sequester carbon and mitigate climate change effects. By uniting experts, researchers, policymakers, industry leaders, and environmental advocates, the event strives to accelerate the development and deployment of cutting-edge blue technologies, while also fostering a deeper understanding of the role oceans play in promoting global sustainable development.

By addressing these objectives, this session strives to fully demonstrate Global ONCE's latest progress and future development to the PICES community, as well as to build a bridge between Global ONCE and PICES FUTURE to discuss mechanisms for possible cooperation and coaction.

Session 6: FUTURE/MONITOR/TCODE Topic Session

Past, Present and Future of CREAMS program: 30 years of international research in North East Asian Marginal Seas

Convenors:
Vyacheslav Lobanov (Russia), SungHyun Nam (Korea), Fei Yu (China), Jing Zhang (Japan)

Description

International program on Circulation Research of East Asian Marginal Seas (CREAMS) started in August of 1993. It was the first international program in this area and it significantly promoted collaboration between marine scientists of bordering countries as well as their colleagues from other parts of the world. North East Asian Marginal Seas are one of the most affected areas in the global ocean by climate changes and anthropogenic impacts. There have been considerable advances in exploring these seas over the 30 years. Being initially focused on research of water circulation and ventilation, the CREAMS program evolved into biogeochemical and ecosystem research and now is seeking a way to be a more socio-economic oriented program. This session would summarize and share the knowledge and experience in water dynamics, biogeochemistry, ecosystem and their variability at multi-scales, and discuss the future directions of research in the area moving toward a multidisciplinary science. It is especially important to identify links between marine sciences and socio-economic requirements in the area to develop an integrative program for future research in this region to correspond to the UN Decade targets. Participation of ECS is especially welcomed to involve them into the CREAMS activity. The session outcome should clarify a vision of international comprehensive marine research in the North East Asian region that meets the current needs of society.

Oral presentation

1. (Invited) (ECOP) Estimation of vertical eddy diffusivity over the southwestern East/Japan Sea. Seongbong **Seo** and Young-Gyu Park
2. (Pre-recorded) The Tsushima Warm Current and its connection to sea surface temperature and winter rainfall along Japan. Shinichiro **Kida**, Cocoro Yokomatsu, and Hiromi Matsuura
3. (ECOP) Long-term sediment trap study in the Northwest Pacific (Ulleung Basin): Insights from organic and inorganic tracers**.** Minkyoung **Kim**, Young-Il Kim, Sun A Lee, Ho Jung Kim, Otosaka Shigeyoshi, Michael Bollen, Patrick Blaser, Samuel L. Jaccard, Negar Haghipour, Timothy I. Eglinton
4. (ECOP) Feasible sketch of the nitrogen cycling process and N_2O production pathways using bacterial biomarker genes in the East Sea. Hyo-Ryeon **Kim**, Seo-Young Kim, Hae-Kun Jung, Ju-Hyoung Kim, and Il-Nam Kim
5. Coincidental increase in the primary productivity and sardine catch in the East Sea in response to the warming after 2014. Sinjae **Yoo**, and Sukgeun Jung
6. Learning outcomes from the CREAMS 30th-anniversary workshop. SungHyun **Nam**
7. Intraseasonal variability of the Deep Scattering Layer observed by subsurface mooring deployed east of Taiwan Island. Fei **Yu**, Bei Wang, Ran Wang ,Zhencheng Tao, Qiang Ren , Xingchuan Liu , Zifei Chen1 and Feng Nan
8. Study on the Yellow Sea warm current and Yellow Sea cold water mass in spring. Xinyuan **Diao**, Fei Yu and Guangcheng Si
9. (ECOP) Unravelling Phytoplankton bloom in the subarctic western North Pacific Marginal Seas. Yi **Xu**, Xinyuan Diao, Yansong Liu, Jianzhong Ge and Fei Yu

Poster presentation

1. (ECOP) Role of the Yellow Sea Cold Water Mass in Modulating Winter Sea Surface Temperature. Xingchuan **Liu** and Fei Yu

Session 7: BIO/HD Topic Session

Social, economic and ecological implications of recoveries, range expansions and shifting distributions of marine birds, mammals and fish

Convenors:
Andrew Trites (Canada), Elliott Hazen (USA), Kaoru Hattori (Japan), Rolf Ream (USA)

Description

Reports of fish, seabirds, and marine mammals occurring in regions of the North Pacific where they infrequently or were not known to previously occur are on the rise. In some cases, the arrival of newcomer-species may reflect re-establishments of historic ranges following protection from over-exploitation. In other cases, range expansions and shifting distributions of the newcomer-species may be responses to bottom-up processes related to changing ocean conditions or may reflect top-down behavioral responses to predation.

Documenting and understanding the drivers of new appearances of species is needed to assess the ecosystem impacts, including consequences that increasing numbers of new arrivals may have on other species. Similarly, assessments are needed to evaluate the social, economic and ecological benefits and threats that such newcomer-species pose. This type of information is needed to help guide future social and fisheries policies.

This topic session invites papers that address 1) decadal changes in the distributions of marine birds, mammals and fish—and their implications and underlying causes, 2) direct and indirect effects that the changes in species distributions are having on other species and community compositions, 3) social and economic consequences that changing distributions and ranges of species have on coastal communities, 4) unique observations of newcomer-species as a result of extreme-events, and 5) how newcomer-species can help inform ecosystem status reports and other management needs.

This session contributes to FUTURE, BIO, S-CCME and MBM goals to document ecosystem response to climate-driven (and other) changes. Presenters will be encouraged to link their work to other PICES expert groups. If there is enough interest, we will plan a special issue of such examples of newcomer-species and rapid-range shifts that interested presenters could participate in.

List of papers

Oral presentation

1. (ECOP) Understanding jellyfish proliferations and their implications for coastal fisheries: insights from Cameroon. Gisèle Flodore Youbouni **Ghepdeu**, Durane Chougong Tchatchouang, Andre Carrara Morandini, Felix Meutchieye, Anselme Crépin Mama, Emmanuel Henock Kwambe Dicka, Ulrich Joël Felicien Bilounga and François Tchoumbougnang
2. **(Invited)** Social-economic impacts of rewilding: the case of the pinniped population boom along the California coast. Harold **Levrel**
3. **(Invited)** New wintering ground for humpback whales that have appeared around Hachijojima Island (33°06'N, 139°47'E), Tokyo Metropolis, Japan since 2015: Their ecology and positive impact on the local tourism. Hiroto **Murase**, Taiki Katsumata, Gen Nakamura, Hidehiro Kato, Taro Kato, Shingo Tamura and Tadashi Yamakoshi
4. (Pre-recorded) Ecological and Social Dynamics of Shifting Marine Species Distributions and the Role of Non-State Initiatives in the Blue Economy**.** Isa Olalekan **Elegbede**
5. (ECOP) Evaluating marine fish migratory strategies and subsequent effects on distribution and ontogenetic process using an individual based model developed for Pacific chub mackerel (*Scomber japonicus*). Ziqin **Wang** and Shin-ichi Ito
6. Temporal changes in distribution and prey species of common minke whales in Sendai Bay off the Pacific coast of Japan. Tsutomu **Tamura**, Kenji Konishi, Tatsuya Isoda, Hidehiro Kato, Mitsuhiro Saeki3 and Kazushi Miyashita

7. Multi-decade northward shift of loggerhead sea turtle pelagic habitat as the eastern North Pacific Transition zone becomes more oligotrophic. Dana K. **Briscoe**, Larry B. Crowder, George H. Balazs, Jeffrey A. Seminoff, Alberto Abreu, Masanori Kurita, Masanori Mori, Denise M. Parker7, Marc R. Rice8, Tomomi Saito9, Bianca S. Santos, Calandra N. Turner Tomaszewicz, Noah Yamaguchi and Jeffrey J. Polovina
8. Drivers of variability in the Transition Zone Chlorophyll Front and its linkage to the Hawaii shallow-set longline fishery. Hui Shi, Ryan **Rykaczewski**, Justin Suca, Johanna Wren, Réka Domokos, Joseph O'Malley1 and Phoebe Woodworth-Jefcoats
9. (ECOP) Inter-decadal assembly processes shaping fish community in the Eastern Bering Sea. Irene D. **Alabia**, Jorge García Molinos, Takafumi Hirata, Hiromichi Ueno, and Sei-Ichi Saitoh
10. (ECOP) Eastern Pacific fish spawning patterns demonstrate mixed spatiotemporal tradeoffs in response to environmental changes. Katherine **Dale,** Lorenzo Ciannelli, Jerome Fiechter, Mercedes Pozo Buil, Rubén Esteban García Gómez, Sylvia P. A. Jiménez-Rosenberg, Gerardo Aceves-Medina, Andrew Thompson, John C. Field, Toby Auth, R. Ian Perry, Lauren Rogers, Rebecca Howard and Rebecca Asch
11. (ECOP) Evaluating the uneven impacts of ENSO events on pacific tunas**.** Hongyu **Lin** and Fan Zhang
12. (ECOP) Can Dynamic Ocean Management tools prove useful for a fishery set to disappear? Rachel **Seary**, Elliott Hazen, Steven Bograd, Helen Bailey Olde, Rebecca Lewison, Austin Sell, Emily Nazario, Dan Lawson and Amber Rhodes
13. Multiple scales for multiple whales: management-inspired ecological models. Elliott L. **Hazen**, Nerea Lezama Ochoa, Stephanie Brodie, Michael Jacox, Steven Bograd, and Heather Welch
14. (ECOP) Biological hotspots under threat: Quantifying climate impacts to sentinel features in the California Current. Danial G. **Palance**, Nerea Lezama-Ochoa, Stephanie Brodie, Heather M. Welch, Jarrod A. Santora, Barbara A. Muhling, Briana Abrahms, Elizabeth A. Becker, Scott Benson, Megan A. Cimino, Karin A. Forney, Michael G. Jacox, Mercedes Pozo-Buil, Steven J. Bograd, Conner M. Hale, Z. Premo, Gemma Carroll, Kristy J. Kroeker, Roxanne S. Beltran and Elliott L. Hazen
15. (ECOP) Impacts of whale population recovery on pelagic ecosystems of the subarctic Pacific. Szymon **Surma**, Evgeny A. Pakhomov, Brian P.V. Hunt, Andrew W. Trites, and Kerim Y. Aydin4
16. (ECOP) Climate change impacts on the distribution of seabirds within National Marine Sanctuaries and offshore wind areas in the California Current Ecosystem. Ryan P. **Gasbarro**, Nerea Lezama-Ochoa, Adena Schonfeld, John Field, Jarrod A. Santora, Megan Cimino, Elliott L. Hazen, Steven Bograd, Kelly S. Andrews and Heather Welch
17. Arctic Ecosystem Update: a 20-year Synthesis. Elizabeth **Logerwell**, Silvana Gonzalez, Jens Nielsen, David Kimmel, Adam Spear, Ellen Yasumiishi, Dan Cooper, Katrin Iken, Lewis Barnett, Jackie Grebmeier, Lee Cooper, and James Thorson1
18. (ECOP) Oceanographic partitioning of catch and by-catch rates in Hawai'i's longline fisheries. Justin J. **Suca,** Johanna L.K. Wren, Ryan R. Rykaczewski, Robert Ahrens, Donald Kobayashi, Phoebe A. Woodworth-Jefcoats, Heather Welch and Elliott Hazen4
19. Recent changes in larval, juvenile, and adult Pacific sardines in the northern California Current. Elizabeth A. **Daly**, Toby D. Auth, Kym C. Jacobson, Cheryl A. Morgan, Brian J. Burke4 , Miram R. Gleiber, Barbara Muhling ,7, Catherine Nickels , and Antonella Preti
20. (ECOP) Balancing Marine Mammal Protection and Fisheries Sustainability: Social Indicators in California's Dungeness Crab Fishery. Alexis **Hadinger**, Steven Bograd, Elliott Hazen, and Rachel Seary
21. (ECOP) Quantifying the socioeconomic risk of Alaskan fishing communities to climatic-driven changes in Pacific cod spatial distributions**.** Sarah **Stone**, Lorenzo Ciannelli, Sarah Wise, Michael Harte, and Kirstin Holsman

Poster presentation

1. (ECOP) The climatic impacts of Marine Heatwaves on tropical tuna resources. Yurong **Mu**, Yuxiang Qiao, Peng Lian, Xiong Zhang and Zelin Chen
2. (ECOP) Deep-sea fish fauna in the Sea of Japan off Niigata Prefecture. Akinori **Teramura**, Atsushi Suzuki, Hiroki Kise, Shusaku Goto, Masahiro Suzumura, Akira Iguchi
3. (ECOP) Assessment of the habitat characteristics of salmon predation locations of southern resident Killer Whales. Sophia **Hemsi**, Jennifer Tennessen, Marla Holt, Bradley Hanson, Candice Emmons and Deborah

Session 8: BIO/POC Topic Session

Changing ocean carbon cycle and its consequences for the ocean environment: Detection, prediction and mitigation

Convenors:
Tsuneo Ono (Japan), Alexander Kozyr (USA)

Description

Ocean carbon cycles have been perturbed critically by human activities, with consequences for the ocean environment as well as the world's climate already emerging both at regional and global scales. Prompt detection of such perturbations and accurate projection of future consequences are essential for adequate social planning and implementation of countermeasures. However, our skills require further development to support society's needs for timely, accurate information on ocean conditions. Especially in coastal areas, anthropogenic signals are often masked by large, complex natural perturbations, and our ability to accurately predict future natural variation is also limited. Interaction of coastal and open ocean ecosystems and biogeochemical cycles are also important, but many processes and interactions require further investigation.

In addition to these advances needed for understanding changing ocean carbon cycles, marine carbon dioxide removal (CDR) is emerging as a rapidly expanding issue in ocean sciences and industries. The 6th IPCC assessment report clearly stated that implementation of negative emission technologies is unavoidable to limit warming to less than 2 °C by the end of this century, and ocean CDR is one such option. However, estimation of the efficiency of each CDR technique still has large uncertainties, and understanding of potential side effects of each technique on marine ecosystems and global biogeochemical cycles is limited.

Capacities required to fill critical knowledge gaps on ocean CDR overlap with those needed for prompt detection of natural/anthropogenic perturbations and accurate projection of their future consequences. This session aims to showcase our current knowledge, and knowledge gaps, regarding detection of natural and anthropogenic perturbations of the carbon cycle including ocean CDR, and accurate projection of their future consequences. We welcome submissions across all disciplines that address these issues in both open and coastal ocean.

List of papers

Oral presentation

1. (ECOP) Global Dynamics of Fossil-Derived Brown Carbon in Wet Atmospheric Deposition. Min-Young **Lee** and Tae-Hoon Kim
2. (ECOP) Alkalinity pumping by coastal macroalgal forests. Chnag-Ho Lee, Kitack **Lee**, Miok Kim, Ju-Hyoung Kim, Yong Woo Choi and Jin Woo Kang
3. Standardization of Ocean Negative Carbon Emission Technologies and Carbon Neutrality. Yanli **Lei**
4. A negative emission application based on floating integrated system. Fengjun **Duan**
5. (ECOP) Dissolved organic carbon cycle in the Yellow Sea and the East China Sea: Insights from radiocarbon analysis. Yeongjin **Ryu**, Heejun Han, Taehee Na, Guebuem Kim1 and Jeomshik Hwang
6. (ECOP) Amplified subsurface signals of ocean acidification and the implications for interior ocean ecosystems. Andrea J. **Fassbender**, Brendan R. Carter, Jonathan D. Sharp, Yibin Huang, Mar C. Arroyo,1 and Hartmut Frenzel
7. (ECOP) Investigation of concentrations and fluxes of potent greenhouse gases (N2O, CH, andCO2) in the port and harbor seawaters of Jeju Island (Korea). Seo-Young **Kim**, Hyo-Ryeon Kim, Ju-Hyoung Kim and Il-Nam Kim
8. (ECOP) Ocean acidification and compound extreme events in the northern California Current System during 1993–2023: A modeling study. Yifan **Zhu**, Samantha Siedlecki, Felipe Soares, Dipti Hingmire, Parker MacCready, Simone R. Alin, Richard R. Feely, Craig M. Risien5 and Jeannette Waddell

9. (ECOP) Seasonal forecasts of bottom water pH conditions for the Bering Sea shelf. Darren J. **Pilcher**, Natalie Monacci, Kelly Kearney, Albert Hermann, Wei Cheng, Linquan Mu, Jessica N. Cross, and Elizabeth Siddon4

Poster presentation

1. Observing marine carbon dioxide in Alaska's coastal oceans. Natalie M. **Monacci**, Simone Alin, Roman Battisti, Randy Bott, Jessica Cross, Wiley Evans, Stacy Maenner-Jones, Linquan Mu, Sylvia Musielewicz, John Osborne, Darren Pilcher, Phyllis Stabeno, Adrienne Sutton, and Hongjie Wang
2. (ECOP) Studies on the use of locally available (Coxs Bazar and Saint Martin) renewable seaweed wastes as compost organic fertilizer resources. Durlave **Roy**

Session 9: MEQ Topic Session

Recent advances in plastic pollution research in the North Pacific

Convenors:
Matthew Savoca (USA), Chengjun Sun (China)

Description

The North Pacific and its marginal seas are heavily polluted with meso- and microplastics. The science to understand and tackle this problem is moving quickly. This session will highlight recent advances in plastic pollution science in the North Pacific and its marginal seas, covering issues such as how we are monitoring plastic pollution in the ecosystem, harmonization of methodologies and how this standardization is driving novel insights, trends in plastic pollution in the abiotic and biotic components of the ecosystem, and how science is informing risk assessments and mitigation of this mounting global threat. We are also interested in how science in the PICES region aligns with global coordination of plastic pollution research. Along this theme, there is also interest in how researchers in the PICES community are interfacing with scientists, managers, and policymakers from other regions. These interactions with members of the global community are supported by the UN Decade of Ocean Science for Sustainable Development and will be increasingly necessary to empower science-guided decision-making for plastic usage and litter management, as well as assessing threats to environmental and human health.

List of papers

Oral presentation

1. (**Invited**) Occurrence and migration rules of seawater microplastics in the Pacific sector of the Arctic Ocean. Jinfeng **Ding**, Chengjun Sun, Wei Cao, Jingxi Li and Fenghua Jiang
2. Estimating the biological removal timescale of microplastics in the North Pacific. Haodong **Xu**, Yoshimasa Matsumura, Hideyuki Nakano, Kazutaka Takahashi, Kentaro Miyazono2 and Shin-ichi Ito
3. (ECOP) Recent advances in macroplastic risk assessments. Erin **Murphy**, Britta Baechler, George Leonard, Nicholas Mallos, and Chelsea Rochman
4. The alteration of toxicity in marine organisms by micro and nanoplastics, co-existing with typical organic chemicals. Ying **Wang**, Mingxing Zhang, Fei Jin, Fuwei Yu and Juying Wang
5. Benthic marine litter in the Hawaiian Archipelago: evidence from a citizen science initiative. Pierpaolo **Consoli**, Gaia Grasso, Valentina Costa, Valentina Sciutteri, Danilo Malara, Fabio Figurella, Ian Campbell, Emily Deery and Franco Andaloro
6. (ECOP) Thirteen years of sea turtle plastic ingestion monitoring in the Central Pacific. Rachel M. Nakamoto, Katherine R. Shaw, Raquel N. Corniuk, Melissa R. Jung, George H. Balazs, T. Todd Jones, Thierry M. Work, Summer Martin and Jennifer M. Lynch
7. (ECOP) The role and impact of salp blooms on the removal of floating small microplastics in the Kuroshio, south of Japan. Kengo **Egami**, Kentaro Miyazono, Rei Yamashita, Gajahin Gamage Nadeeka Thushari, Akinori Takasuka, Mikio Watai, Tohya Yasuda, Taketoshi Kodama and Kazutaka Takahashi
8. An overview of marine debris removal, sourcing, and recycling in the Hawaiian archipelago. Jennifer M. **Lynch,** Mafalda de Freitas, Katherine A. Stevens, Cara Megill, Mandy Brinkmann, Paige White, Eric Kingma, Eileen Nalley and Darren Lerner
9. (ECOP) Big fish, little plastics: investigating microplastic accumulation and trophic transfer in salmon sharks. Maddie **English**, Alexandra McInturf, Bonnie Hamilton, Olivia Boisen, Reilly Boyt, Matthew Savoca, Susanne Brander and Taylor Chapple

10. Unraveling the effects of climate change and microfibers from textiles on coastal food webs via a critical prey species. Lauren M. **Kashiwabara**, Patrick Reece, Clarissa B. Raguso, Lisa Hildebrand, Leigh Torres and Susanne M. Brander
11. Abundance and vertical distribution of microplastics in the epipelagic waters of the Kuroshio region. Yuichiro **Nishibe**, Lingfeng Guan and Rei Yamashita
12. Modelling seafloor deposition of heavy microplastics in the North Pacific over the past 65 years. Haodong Xu, Yoshimasa Matsumura, Rei Yamashita, Hideyuki Nakano3 and Shin-ichi **Ito**
13. Long-term changes in the abundance, size, and morphotype of marine plastics in North Pacific. Kazutaka **Takahashi**, Kentaro Miyazono, Kazuaki Tadokoro, Gagame G. N. Thushari, Hiroomi Miyamoto, Akinori Takasuka, Mikio Watai, Tohya Yasuda, Takuya Sato, Rei Yamashita6 and Taketoshi Kodama

Poster presentation

1. (E-poster) (ECOP) Development of analytical procedures to investigate the environmental occurrence of micro to nano-sized plastics in Asian urban cities. Tamaki **Morioka**, Shuhei Tanaka, Akiko Kohama-Inoue, and Ibukun Oluwoye
2. Insights into diversity and plastic substrate specificity of potential pathogenic bacteria. Hyun-Jung **Kim**, Sang-Hen Lee and Seung Won Jung
3. (ECOP) Investigating the spatial and temporal patterns of microplastics in the Fraser River and Burrard Inlet (British Columbia, Canada)**.** Nicole **McHugh**, Roger Francois, Maureen Soon and Maite T. Maldonado
4. Effect of different sampling methods on microplastic abundance and composition in marine surface waters. Rei **Yamashita** and Yuichiro Nishibe
5. (ECOP) Effect of Harmful microalga *Heterosigma akahiwo* on Aggregation and Sinking of Microplastics in Marine Environments**.** Young Kyun **Lim**, Chung Hyeon Lee, Kyun-Woo Lee, Sang Hee Hong and Seung Ho Baek
6. (ECOP) Fate and mass budget of microplastic in the Beibu Gulf, the Northern South China Sea. Zuhao **Zhu**, Kazi Belayet Hossain, Huihua Wei, Jie Chen, Renming Jia , Xiaofeng Gao, Haiyan Jin and Minggang Cai

Session 10: MEQ Topic Session

East meets West and West meets East: Past, current and future implications of Non-Indigenous Species (NIS) in the North Pacific

Convenors:
Thomas Therriault (Canada), *corresponding*
Joseph Krieger (USA)
Aibin Zhan (China)

Co-sponsor: National Invasive Species Council

Description

PICES will provide leadership to the United Nations Decade of Ocean Science for Sustainable Development and its mission of developing "the science we need for the ocean we want" through its science programs. The current FUTURE scientific program promotes investigations of North Pacific ecosystems with an emphasis on the synergy of social, ecological, and environmental systems and processes. Within this framework, PICES is focused on developing a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems and services, and their marine-dependent social systems. Globally, non-indigenous species (NIS) are recognized as major ecosystem stressors which can cause ecological and economic damage to marine ecosystems and are a threat to biodiversity, ecosystem services, and the livelihood of coastal communities around the North Pacific. The spread of marine NIS has increased in the last decade due to globalization and other related human activities such as climate change. An increased awareness about the threats NIS pose has resulted in a recognition for better management and policy in order to achieve sustainability goals. From aquaculture imports to commercial shipping to the catastrophic consequences of the Great East Japan Tsunami, there are many examples of NIS movements between the eastern and western Pacific and between the Pacific and all world oceans. In order to mitigate the risks posed by NIS to achieve greater sustainability of North Pacific ecosystems we must first learn from the past and present in order to make informed decisions about the future. The goal of this session is to share experiences around understanding, forecasting, assessing, and mitigating NIS that will inform future priorities on NIS for PICES member countries.
List of papers

Oral presentation

1. (**Invited**) An overview of *Chondria tumulosa* in Papahānaumokuākea Marine National Monument and the development of preliminary biosecurity protocols. Brian B. **Hauk**1; Heather L. Spalding2; Taylor M. Williams and Randall K. Kosaki Non-linear
2. (**Invited**) New connections across marine ecosystems facilitated by spread and accumulation of floating anthropogenic debris. Nikolai A. **Maximenko**, Clara Benadon, James T. Carlton, Luca Centurioni, Fiona Chong, Mary Crowley, Jan Hafner, Linsey E. Haram, Rebecca R. Helm, Verena Hormann, Cathryn C. Murray, Andrey Shcherbina, Cynthia Wright, Gregory M. Ruiz and Chela J. Zabin
3. (**Invited**) Coordination of invasive species at various scales: Experiences of the U.S. National Invasive Species Council. Stanley W. **Burgiel**
4. (**Invited**) Marine invasive species in Hawai'i: pathways, pests, and policies. Christy **Martin**
5. (ECOP) Reef fish community changes along a gradient of invasive macroalgae cover in Papahānaumokuākea Marine National Monument. Chelsie W. W. **Counsell**1 and Heather Ylitalo-Ward
6. (ECOP) NOAA's response to novel and emerging marine invasive species threats. Joseph R. **Krieger**
7. Fine-scale larval dispersal dynamics in an expanding invasive crab population. Carolyn **Tepolt**, Weifeng (Gordon) Zhang, Jiabi Du, Rayna Hamilton, Sara Shapiro, Yan Jia, Emily Grason and P. Sean McDonald

8. Monitoring and seasonal succession of invasive ascidians and predicting their distribution shifts under climate change scenarios in South Korean waters**.** Seongjun Bae and Keun-Hyung **Cho**

Poster presentation

1. Development of Biological Risk Assessment Protocols for Evaluating the Risks of In-Water Cleaning of Hull-Fouling Organisms. Bonggil Hyun, Pung-Guk Jang, Min-Chul Jang, Jin-Young Seo, Woo-Jin Lee and Kyoungsoon **Shin**

Session 11: FIS Topic Session

Impacts of warming-induced changes in body sizes on marine fish ecology and their consequences for ecosystems and associated fisheries

Convenors:
Shinichi Ito (Japan), Chenying Guo (China, ECOP), Christine C. Stawitz (USA), Paul Spencer (USA)

Co-sponsor: ICES

Description

As sea temperatures keep rising, warming impacts on marine fisheries have become increasingly prevalent. For example, temperature-induced changes in fish distribution and movement across management boundaries impact management of multi-jurisdictional fisheries. Additionally, changes in phenology can lead to mismatch between larva abundances and plankton blooms, thereby affecting recruitment and fish stocks productivity. In contrast, warming-induced changes in fish body sizes have been increasingly documented but their potential impacts have received comparatively less attention.

Changes in body size can impact other life history traits such as maturity, fecundity, diet, habitat preferences, and predator-prey interactions; all of which can alter the functioning of size-structured ecosystems and commercial fisheries. While research has thus far mainly focused on understanding how warming seas affect fish growth, the magnitude of the consequences of changes in body size and what it could mean for ecology, fisheries and ecosystems is yet to be explored.

As global warming is likely to lead to further changes in fish body sizes there is a need to assess the possible consequences facing marine ecosystems and fisheries in order to understand the challenges that lie ahead. This session aims at assessing the future consequences of changing fish body sizes occurring in warming seas. We are seeking contributions on (but not limited to) the following topics:

1. Interrelations between fish growth and other life history traits
2. Impacts of fish body sizes on species mobility, use of habitat, and migrations/distributions
3. Evidence of changes in fish body sizes affecting predator-prey interactions and their consequences on size-structured food webs.
4. Impacts on commercial fisheries, including changes in yield, fishery practices, and management measures
5. Examples accounting for changes in fish body sizes in fish stocks assessment and management
6. Impacts on markets and fish sales, changes in nutritional value, and implications for food security

List of papers

Oral presentation (Day 1)

1. (**Invited**) (ECOP) Incorporating distribution shifts and spatio-temporal variation when estimating weight-at-age for stock assessments: A case study involving the Bering Sea pollock (*Gadus chalcogrammus*). Julia **Indivero**, Timothy E Essington, James N Ianelli and James T Thorson
2. (ECOP) Impacts of Hypoxia and Warming on Petrale Sole (*Eopsetta jordani*) Growth: Introspection of a 24-Year Time Series. Savannah **Clax**, Jessica A. Miller, Jenny Waddell
3. (ECOP) Climate, fishing, and size structure in an ever-changing marine food web. Cheryl L. **Barnes**, Jonathan C.P. Reum , Carey R. McGilliard , Meaghan D. Bryan , Martin W. Dorn and André E. Punt3
4. Environmental impact on growth in Barents Sea capelin, cod and haddock. Edda **Johannesen**, Johanna Fall and Georg Skaret
5. Temperature-dependence assumptions regarding fish growth drive projected responses of diverse size-based food webs to warming**.** Jonathan. C. P. **Reum**, Phoebe Woodworth-Jefcoats, Camilia. Novaglio, R. Forestier, Asta Audzijonyte, Anna Gårdmark, Max Lindmark and Julia. L. Blanchard

6. (ECOP) Can the temperature size rule help predict fisheries productivity in a changing climate? Jennifer **Bigman,** Lewis Barnett, Kelly Kearney, Darren Pilcher, Wei Cheng, Al Hermann, Krista Oke, and Lauren Rogers
7. A new approach to integrate multiple environmental covariates into state-space stock assessments. Juliette **Champagnat,** James Thorson**,** Cole Monnahan**,** Kalei Shotwell**,** Jane Sullivan and Andre Punt
8. (ECOP) Dynamics of growth autocorrelation in Japanese anchovy larvae: Influence of sea temperature and feeding conditions. Shota **Tanaka**, Shizuna Togoshi, Naotaka Yasue, Masahiro Nakamura, Corinne M. Burns, Dominique Robert and Akinori Takasuka
9. Analysis of California Current groundfish growth using a state-space autoregressive length-at-age (sarla) model. Christine C. **Stawitz**, Sean Anderson, Melissa A. Haltuch, Paul D. Spencer, Timothy J. Miller, Timothy E. Essington and Alan Baudron
10. Spatial distribution of Pacific Cod in the Gulf of Alaska across life history stages to identify stock structure. Claire **Rosemond**, Lorenzo Ciannelli, Lauren Rogers, Pete Hulson, Kally Spalinger, Albert Hermann, and Ingrid Spies
11. (ECOP) Spatial distribution of Pacific Cod in the Gulf of Alaska across life history stages to identify stock structure. Claire **Rosemond**, Lorenzo Ciannelli, Lauren Rogers, Pete Hulson, Kally Spalinger, Albert Hermann, and Ingrid Spies
12. (ECOP) Ecological and ontogenetic responses of groundfish species to climate-induced changes in the Northern California Current Ecosystem. Sajna **Hussain**, Lorenzo Ciannelli, Mary Hunsicker, Owen Liu, Jameal Samhouri and Eric Ward
13. (ECOP) Incorporation of the effect of climate change into management strategy evaluation: illustration with chub mackerel (*Scomber japonicus*) in Korean waters**.** Soyeon **Nam**, Jinwoo Gim, Sukyung Kang and Saang-Yoon Hyun
14. Body condition as a shared response to environmental conditions in a demersal fish assemblage. Philina A. **English**, Sean C. Anderson, and Robyn E. Forrest
15. Fish weight reduction in response to intra-and interspecies competition under climate change. Zhen Lin and Shin-ichi **Ito**
16. (ECOP) Strong density-dependent decline of condition factor of Japanese sardine (Sardinops melanostictus) linked to enhanced top-down effect on Neocalanus plumchrus under summer warming conditions off eastern Hokkaido, Japan. Daichi **Arima**, Hiroshi Shimada, Hiroki Ubukata and Hiroshi Yamaguchi
17. (ECOP) Deep learning techniques for evaluating the ecological impacts on the spatio-temporal varitions of tuna in the eastern Pacific Ocean. Peng **Lian** and Le Gao
18. (ECOP) Seasonal differences of Pacific herring larval and embryo metrics are small and proteomic analysis holds promise for uncovering subtle changes in physiology and environmental resilience. Ariel **Shiley**, Brooke Love, Emmanuel Keene, Lilia Vivaldo, Nic Benmam and Sabina Guzek

Poster presentation

1. Rapid melting of ice leads to the surge of primary productivity and its impact on the redistribution of fishery resources in the Arctic and surrounding areas. Changan **Xu** and Zongyong Gao
2. (ECOP) Delayed impacts of ENSO on fish size classes in the tropical Pacific**.** Hyung-Gyu **Lim** and Colleen M. Petrik
3. Declines in body size of Fraser River sockeye salmon and impacts on age-at-maturity, fecundity, and run timing. Dejan **Brkic**, Eric Taylor, Angela Phung, Stephen Latham

4. (ECOP) Alterations of pelagic food web structure in the marginal seas of western North Pacific under changing climate. Eun-Ji **Won**, Ji-Eun Kim, Hee Young Yun, Ha-Eun Cho, Seok-Hyeon Youn, Sae-Yun Kwon and Kyung-Hoon Shin
5. Impacts on fecundity and fisheries of declining body size in Fraser River pink salmon. Stephen **Latham**, Dejan Brkic and Angela Phung

Session 12: MEQ Topic Session

The Changes in Distribution of Harmful Algal Blooms (HABs) in the North Pacific Region

Convenors:
Mark L. Wells (USA), William Cochlan (Canada), Natsuko Nakayama (Japan), Yoichi Miyake (Japan)

Description

Higher latitude regions are experiencing the fastest rates of climate change, impacting marine biodiversity and plankton diversity, but significant changes are also occurring across mid-latitude coastal zones. These changes in physical and chemical conditions are affecting the biodiversity of plankton communities, creating new ecological spaces, resulting in local appearances of new HAB species and the blooming of endemic HAB species that previously had not been problematic. For example, recent observations show the appearance of paralytic shellfish toxin-containing plankton far north of the Arctic Circle. This condition would not have been possible with the very short planktonic growing season only two decades earlier. Indeed, northward-moving Pacific warm waters are shown to now carry Alexandrium blooms as far north as the Chukchi Sea. Similarly, Gambierdiscus species, the causative agents for ciguatera fish poisoning, historically found in tropical regions, have now been isolated in Japanese coastal regions. The importance of latitudinal shifts in biodiversity related to future HABs is highlighted in published proceedings from at least two international meetings co-sponsored by PICES. Yet, information on these changes in PICES nations must be more present. This session invites PICES and non-PICES experts from several countries to present their findings on how HAB species' distribution, prevalence, and emergence have changed over the last decades in the North Pacific region and elsewhere. Time will be set aside to discuss these changes and the steps needed to understand their mechanistic drivers better. Combined, these presentations will provide an overview of how changing ocean conditions have altered contemporary HAB events, provide insights into the trajectory of HAB risks, and consider if the HAB events are transitory or represent stable trophic shifts as climate change accelerates.

List of papers

Oral presentation

1. Physical drivers of *Noctiluca scintillans* (Dinophyceae) blooms outbreak in the northern Taiwan Strait: A numerical study. Zhonghao Lin, Peng Zhan, Jianping Li, Jun Sasaki, Chun Chen, Shuangyan Zou, Xiaotong Yang and Haifeng **Gu**
2. A study on the diversity of sand-dwelling dinoflagellates at Pyoseon Beach on Jeju Island, Korea from spring to winter 2023. Su-Min **Kang**, Joon-Baek Lee and Jin Ho Kim
3. Harmful algae dynamics in the Strait of Georgia, Canada. Svetlana **Esenkulova** and Isobel Pearsall
4. Multi-decadal trends in blooms of harmful algae Chattonella spp. in Japan**.** Yoichi **Miyake** and Goh Onitsuka
5. Observational evidence for arrival and evolution of Karenia spp. in the Pacific waters off southeast Hokkaido, Japan in 2021. Yukiko Taniuchi, Hiroshi Kuroda, Akira Kuwata, Tsuyoshi Watanabe, Takuya Ohshini, Hiromi Kasai, Tomonori Azumaya and Takuya **Nakanowatari**l
6. (ECOP) Water temperature changes blooming pattern and saxitoxins (STXs) synthesis in toxic dinoflagellates *Alexandrium catenella* and *A. pacificum***.** Han-Sol **Kim**, Quynh Thi Nhu Bui, and Jang-Seu Ki
7. (ECOP) The *in-situ* release of algal bloom populations and the role of prokaryotic communities in their establishment and growth**.** Xiao **Ma**

8. (ECOP) Competitive interaction between the dinoflagellates Karenia selliformis and Karenia mikimotoi co-occurred in Autumn of 2021 off the Pacific coast of Hokkaido, Japan**.** Ryoko **Yano**, Saho Kitatsuji, Yuki Takai, Yohei Shimasaki, Yasuhiro Yamasaki and Tomoyuki Shikata
9. (ECOP) Using autonomously collected eDNA to assess phytoplankton community composition and the presence of harmful algal species. Max **Taylor**, Nicolaus Adams and Stephanie Moore

Poster presentation

1. Physicochemical impact of green algae bloom in coastal area of Jeju, Korea. Taehee **Lee**, Kihwan Lee and Young Baek Son
2. Co-occurrence patterns and temporal changes of dinoflagellate communities in a semi-enclosed bay: Intensive monitoring of predominant key species. Yu Jin Kim, Hyun-Jung Kim, Kang Eun Kim, JunSu Kang and Seung Won **Jung**
3. First description of occurrence and distributions of the epibenthic dinoflagellate *Coolia palmyrensis* from Jeju coastal waters in Korea**.**Jun-Ho **Hyung**, Jaeyeon Park, Seung Joo Moon, Hangy Lee, Suk Yeon Lee and Yeong Du Yoo
4. The isolation of toxic compounds from the marine dinoflagellate Prorocentrum lima and the variation of the compound amounts over time as the culture grows**.** Sangbum Lee, Yeong Kwang Ji, Yeong Du Yoo and Jung-Rae **Rho**
5. (ECOP) Unveiling saxitoxins (STXs) synthesis potential of dinoflagellate Alexandrium through STXs synthesis genes (sxt) analysis**.** Han-Sol **Kim**, Quynh Thi Nhu Bui, Jeongmin Shin, Taehee Kim, and Jang-Seu Ki
6. Drifting seaweed may be an ideal carrier for the transport pathway of harmful algae. Chunjiang Guan, Yanlong Chen, Lu Yang and Jingfang Zhang
7. Northward expansion and large-scale outbreaks of harmful algae along the coasts of Japan reported since the 21st century**.** Setsuko **Sakamoto**

Session 13: BIO Topic Session

Rapid plankton assessment for ecosystem assessment

Convenors:
Hongsheng Bi (USA), David Kimmel (USA), Satoshi Kitajima (Japan)

Description

The objective of this session is to explore the importance of rapid plankton assessment in comprehending and managing the ocean carbon cycle, highlighting the crucial role of plankton in ecosystem management. We will concentrate on underwater imaging techniques and leverage deep learning technologies for efficient plankton assessment and subsequent application of this information to address ecosystem management in the face of a changing claimte. This session aims to unite experts in underwater imaging and deep learning systems, focusing on the applications of these techniques to facilitate rapid plankton assessment. Our aspiration is that this session will drive progress in plankton assessment methodologies, allowing us to develop a framework that integrates real-time or near real time plankton data with information from other sensors. This integration will be instrumental in examining and forecasting ecosystem status.

List of papers

Oral presentation

1. **(Invited)** Are plankton nets a thing of the past? How we can use AI for rapid plankton and ecosystem assessments. Sophie G. **Pitois**
2. Typhoon-Induced variations in zooplankton populations on the central Guangdong coasts: real time data from the PlanktonScope Imaging System. Jialin Zhang, Hongsheng **Bi**, Jian Zhao, Hui Liu and Zhonghua Cai
3. (ECOP) Plume Dynamics and Species Interactions in the Northern California Current. Kylie **Cherneskie,** Dong Liang, Katie Lankowicz, Hongsheng Bi, Brian Wells and Richard Brodeur
4. Rapid assessment of keystone species through in situ imaging along the Seward Line, Northern Gulf of Alaska. Russell R. **Hopcroft**, Hannah E. Kepner and Thomas B. Kelly
5. Rapidly analyzing in-situ plankton images by using metadata to enhance unsupervised clustering. Jeffrey S. **Ellen** and Jared W. Wilson

Poster presentation

1. (ECOP) Regional and vertical changes in body sizes of two copepod taxa: their effects on size spectra of the whole zooplankton community of 0–3000 m at five stations in the western North Pacific. Dongwoo Kim, Shintaro **Yoshida**, Sota Komeda, Kohei Matsuno and Atsushi Yamaguchi

BIO Contributed Paper Session (Poster only)

Convenors:
Akash Sastri (Canada), Toru Kobari (Japan)

Description

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

Poster presentation

1. (ECOP) Phytoplankton comparison and dynamics in the ocean off the coast. Raimot Titilade **Akanmu**, Aderonke Omolara Lawal-Are and Ikenna Charles Onyema
2. Genetic Connectivity of Seamounts in the West Pacific region for management of benthic ecosystem. Seonock **Woo**, Nayoung Lee and Yejin Jo
3. Growth, mortality, and predatory impact on mesozooplankton of Scomber spp. larvae in the northern Satsunan area, southern Japan**.** Gen **Kume**, Hiroki Oba, Masafumi Kodama, Taichi Shigemura, Kazuhiro Shiozaki, Mutsuo Ichinomiya, Tomohiro Komorita, Takafumi Azuma1and Toru Kobari
4. (ECOP) Unveiling the million-dollar loss in commercially cultivated red macroalga *Pyropia haitanensis* farms: The hidden impact of microalgal stress. Vishal **Patil**, Lin Sun, Vitthal Mohite, Junrong Liang, Dazhi Wang, Yahui Gao and Changping Chen
5. (ECOP) Modeling the transport and connectivity of the parasite *Toxoplasma gondii* to improve marine mammal conservation. Jennifer A.T.K. **Wong-Ala**, Johanna L.K. Wren, Stacie J. Robinson, Michelle Barbieri, Ryan R. Rykaczewski, Donald R. Kobayashi and Lorenzo Ciannelli
6. Cool ocean temperatures fail to buffer the negative impacts of heat exposure during low tide on the keystone predator *Pisaster ochraceus* (Ochre sea star)**.** Lydia N. **Walton**, Viola R. Watts, Jasmin M. Schuster and Amanda E. Bates
7. Comparison of microzooplankton grazing rate and phytoplankton growth rate in two different sites in Korean coastal waters. Jaeyeon **Park**, Seung Joo Moon, Jun-Ho Hyung, Hangy Lee and Eun Young Yoon
8. (ECOP) Comparison of trophic sources and pathways of mesozooplankton and ichthyoplankton in the Kuroshio and its neighboring waters. Ayane **Taniguchi**, Toru Kobari, Gen Kume, Mutsuo Ichinomiya, Tomohiro Komorita2 and Junya Hirai
9. (ECOP) Fatty acid composition of zooplankton composition in the Kuroshio and neighboring waters. Nao **Kominato**, Reo Ishimaru, Masafumi Kodama, Gen Kume2 and Toru Kobari
10. (ECOP) Impacts of advected coastal community on zooplankton standing stocks, productivity and taxonomic composition in the Kuroshio**.** Masahiro **Kodama**, Gen Kume, Masafumi Kodama, Hirohiko Nakamura, Ayako Nishina, and Toru Kobari
11. (ECOP) Modelling visitor nitrogen waste in coral reef habitats and implications for the future of sanitation management. Mitra L. **Nikoo**1 and Amanda E. Bates
12. Feeding by the marine chlorophytes on the unicellular cyanobacterium Synechococcus. Suk Yeon Lee, Eun Sook Hwang, Chul Ho Kim, Jung Rae Rho and Yeong Du **Yoo**
13. Ecological interruption on food web dynamics by eutrophic water discharge from the world's longest dike at Saemangeum, Yellow Sea. Inog **Lee**, Hosang Kim, Inha Kwon, Bong-Oh Kwon, Jae-Sung Kim, Junghyun Lee , Junsung Noh 5 and Jong Seong Khim

14. K-Blue Carbon Project: Estimating blue carbon sequestration potential of *Magallana gigas* in Korean aquaculture farms. Hyeong-Gi **Kim**, Du-young Jung, Bong-Oh Kwon, Tae-Lim Kim, Seohee Lim, Julie A. Kopplin, and Jong Seong Khim
15. Bloom formation of colony-forming harmful diatom *Thalassiosira diporocyclus* in the Kagoshima Bay and its significance as prey for some copepods. Mutsuo **Ichinomiya**, Tomohiro Komorita, Gen Kume and Toru Kobari
16. Long-term trend of Baird's beaked abundance in the Pacific coast off Japan. Hiroko **Sasaki** and Yu Kanaji
17. Estimating species-and population-specific life history parameters of two small cetacean species, particularly important for population dynamics modelling. Hikari **Maeda** and Yu Kanaji
18. (ECOP) Global boiling and adaptive green-living shoreline project with blue carbon, South Korea**.** Junsung **Noh**, In Ok Lee and Moo Joon Lee
19. Life cycle analysis of the dominant planktonic copepod *Metridia okhotensis* based on samples collected by deep-ocean water pumping at Rausu in the southern Okhotsk Sea. Atsushi **Yamaguchi**, Kazuki Maeda, Daichi Arima, Takahiro Nobetsu, and Hideki Yamaishi
20. Springtime upwelling conditions drive thiamin-associated microbiomes in the California Current Ecosystem (CCE). Kelly C. **Shannon**, Gillian St. John, Robin Gould, Christopher Hartzell, Hailey Matthews, Elizabeth J. Brennan, Luis M. Bolaños, Steven T. Lindley, John C. Field, Nate Mantua, Rachel Johnson, Carson Jeffres, Frederick S. Colwell and Christopher P. Suffridge
21. (ECOP) Importance of mixotrophic oligotrich ciliates in the subarctic and subtropical western North Pacific. Chiho **Funaki**, Taketoshi Kodama, Mitsunori Iwataki and Kazutaka Takahash
22. (ECOP) Local-scale recovery of the red-listed sunflower sea star (*Pycnopodia helianthoides*) is associated with kelp in Barkley Sound, BC. Valesca **de Groot**, Jasmin M. Schuster, Mara Bohm, Tomas Bird and Amanda E. Bates
23. Response mechanism of meiofaunal communities to multi-type of artificial reef habitats from the perspective of high-throughput sequencing technology. Zhaoyang **Jiang**, Zhenlin **Liang**, Minpeng Song, Jiahao Wang, Yuxin Wang, Renge Hu, Lu Wang and Zhansheng Guo
24. (ECOP) Importance of Accurately Identifying Trophic Position in Pollution Assessment Studies. Eun-Ji **Won**, Dokyun Kim, Ha-Eun Cho, Jangho Lee, Sae-Yun Kwon and Kyung-Hoon Shin
25. (ECOP) K-Blue Carbon Project: Estimating blue carbon sequestration potential based on shell growth of *Argopecten irradians* in Korean aquaculture farm. Tae-Lim **Kim**, Hyeong-Gi Kim, Du-young Jung, Bong-Oh Kwon, Seohee Lim, Julie A. Kopplin1 and Jong Seong Khim
26. (ECOP) The intra-and inter-specific overlaps of foraging sites and diet in sympatric seabirds breed on the colonies in the Tsugaru strait, Japan. Hikari **Ozawa**, Teru Kanaida, Shunsuke Nibe, Tatsuki Kojima and Motohiro Ito
27. Synchronized birthdates and lay dates: ocean-climate modulated phenology of rockfish and seabirds within the California Current Ecosystem. John C. **Field**, Tanya L. Rogers,Jarrod A. Santora, Jaime Jahnke, Pete Warzybok, Mike Johns Steven J. Bograd and Isaac D. Schroeder
28. Microbial food web dynamics in the North Bering and Chukchi Seas assessed using linear inverse modelling. Jens M. **Nielsen**, Thomas B. Kelly, Silvana Gonzalez, Michael W. Lomas, Lisa B. Eisner, Calvin Mordy, Andrew McDonnell, Stephanie O'Daly, Russ Hopcroft, Dean Stockwell, Seth Danielson, Laurie Juranek, Haley Cynar, Jeff Krause, David Kimmel, Adam Spear, Astrid Schnetzer, Miranda Hart, Remi Pages, Claudine Hauri, Tyler Hennon and Laura Whitmore
29. (ECOP) Blood stable isotope ratio of adults of a diving piscivore seabird shows variation in trophic niche across years and colonies. Tatsuki **Kojima,** Hikari Ozawa, Jumpei Okado, Yutaka Watanuki, Kotaro Shirai, Yasuaki Niizuma, Tomohiro Kuwae, Kenta Watanabe, Kazuya Matsumoto and Motohiro Ito
30. (ECOP) Hidden underlying mechanisms for changes in mesozooplankton communities: Transport and eddy driven changes. Minju **Kim**, Wonkeun Choi, Chan Joo Jang and Jung-HoonKang

31. (ECOP) Seasonal resilience of fish biogeography in the temperate estuary under climate change. Cui **Liang**, Zhaopeng Zhang, Yuanchao Wang,Lei Zheng and Weiwei Xian
32. (ECOP) Seabird mechanisms of response to changing ocean stratification. Helen **Killeen**, William J. Sydeman, Sarah Ann Thompson, Trond Kristiansen, Brian Hoover, Gammon Koval and Marisol García-Reyes
33. Threat of microplastic ingestion and chemical accumulation to cetaceans in the Republic of Korea. Taewon **Kim**, Byeongyong Park, Seungho Kim, Soobin Joo and Kyungsik Jo
34. (ECOP) Testing the validity of environmental DNA analyses on the benthic fauna of pelagic seamounts. Satoi **Arai**, Motoomi Yamaguchi, Kota Sawada, Yumiko Osawa, Mai Miyamoto, Christopher Gardner Ayer and Bungo Nishizawa

FIS Contributed Paper Session (Poster only)

Convenors:
Jackie King (Canada), Naoki Tojo (Japan)

Description

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

Poster presentation

1. Status and interannual variability of the Bering Sea and Chukchi Sea pollock stocks. Mikhail A. Stepanenko and Elena V. Gritsay
2. Biological and reproductive parameters of yellow striped butterfish Labracoglossa argentiventris around the Izu Islands: a step toward application of egg production method. Junichi **Iijima** and Akinori Takasuka
3. (ECOP) Distribution and growth rate of flathead grey mullet and longspine snipefish larvae and juveniles in the Kuroshio Current region in winter. Taro **Taniguchi**, Shigetaka Usui, Shijie Ma, Kazunari Higashiguchi, Mikio Watai, Junji Kinoshita, Chiyuki Sassa, Hiroshi Kuroda, Takeshi Okunishi, Tohya Yasuda and Akinori Takasuka
4. Growth and diet of juvenile yellowtail (*Seriola quinqueradiata*) in the Satsunan area, southern Japan. Shin-nosuke **Goto**, Toru Kobari, Masafumi Kodama, Hayato Nakatani, Shuhei Tsuda, Akimasa Habano, Fumihiro Makino, Takafumi Azuma and Gen Kume
5. Feeding habits of Japanese glass-eels, *Anguilla japonica*, in the Sendai River, southern Japan. Hiroki Takahira, Toru Kobari, Masafumi Kodama, Kazuhiko Anraku, Tomonari Kotani and Gen Kume
6. Modeling the impacts of ocean conditions to Japanese chum salmon abundance. Sei-Ichi **Saitoh**, Irene D. Alabia, Takafumi Hirata, Yasuyuki Miyakoshi, Fumihiro Takahashi, and Masahide Kaeriyama
7. (ECOP) Development of individual identification of the Japanese sea cucumber Apostichopus japonicus based on deep metric learning. Hiroya **Kito** and Hirokazu Matsuda
8. (ECOP) Long-term changes in fish assemblage structure in the Yellow Sea from 1968 to 2019 in relation to climate change. Seonggil **Go**, Sunkyu Park, Sun Kyeong Choi, Sukgeun Jung and Young Baek Son
9. (ECOP) Establishing baselines, risks, and mechanisms of thiamine deficiency in British Columbia Chinook salmon. Anna K. **McLaskey**, Jacob E. Lerner and Brian P.V. Hunt
10. (ECOP) Relationship between mesoscale eddies and habitat distribution of a pelagic squid in the Northwest Pacific Ocean. Wei **Yu**, Yuchen Zhang and Xinjun Chen
11. Comparing large-scale environmental indices used as covariates in Pacific salmon models. Gottfried **Pestal** and Tatiana Tunon
12. (ECOP) Investigating habitat use and trophic overlap among North Pacific predators and their implications for Pacific salmon. Genyffer C. **Troina**, Philip Riekenberg, Marcel T.J. van der Meer, Evgeny Pakhomov and Brian P.V. Hunt
13. (ECOP) Early life history of juvenile sablefish using eye lens stable isotopes and trophic discrimination factors: An experimental lab study. Mariela **Brooks**, Matthew Rogers, Fletcher Sewall, Jacek Maselko, and Wil Licht
14. (ECOP) A study design analyzing the contribution of Pacific lamprey (*Entosphenus tridentatus)* to levels of thiamine in Battle Creek, Central Valley, California**.** Sebastian **Vassas**, RJ Bottaro, and Patricia Bratcher

15. (ECOP) Spawning responses of Peruvian anchovy and Pacific sardine to environmental variability in the northern Humboldt Current system. Mingkun **Li**, Patricia Ayón and Akinori Takasuka
16. Comprehensive evaluation of tropical reef fishes and habitats using geographic information system and length-based evaluation approach in data-poor situation in Mauritius. Naoki **Tojo**, Vinesh Emrith, and Nadeem Nazurally
17. (ECOP) A tropical sardine in a temperate environment: understanding the biology of *Sardinella lemuru* in the northern waters of Japan. Alexanra **Bagarinao-Regalado** and Shin-ichi Ito
18. (ECOP) Projected Decline in Commercially Important Fish Catches in the Arctic and Subarctic Assessed Using a Reconstructed Ocean Biogeochemical Model. Eun-Young **Kim** and Jong-Yeon Park, Hyung-Gyu Lim
19. (ECOP) Dungeness crab larval recruitment patterns in the Salish Sea and linkages to the coastal ocean. Heather **Gordon** and Evgeny Pakhomov
20. 2010: A breakpoint for salmon productivity in the Northern California Current? Brian **Beckman**, Meredith Journey, Cheryl Morgan3 and Brian Burke
21. Does the Zhenbei seamount in the South China Sea harbor distinctive biodiversity? A primary study based on eDNA metabarcoding. Hui **Zhang1** Xiaofei Chen and Hui Jia
22. Collaborating with longline fishers to improve the post-release survival of mobula rays**.** Jennifer **Stahl**, Melanie Hutchinson, Chelsey Young, Joshua Tucker, Forest O'Neil and Emily Crigler
23. Impact of warming on the distribution pattern of the sardine *Sardinops melanosticta* (Temminck et Schlegel, 1846) in the northwestern Pacific Ocean. Dmitriy **Antonenko**, Yuriy Novikov and Evgeniy Basyuk

HD Contributed Paper Session (Poster only)

Convenors:
Mitsutaku Makino (Japan), Karen Hunter (Canada)

Description

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).

List of papers

Poster presentation

1. Spatial and Temporal Differentiation of the Coordination and Interaction among the Three Fishery Industries in China from the Value Chain Perspective. Meng **Su**, Jintian Gao and Kai Cheng
2. Marine ecological damage compensation: Monetary compensation or ecological restoration? Jingzhu **Shan** and Jingmei Li
3. Socioeconomic implications due to climate change in the Pacific Islands fisheries. Hing Ling **Chan**
4. (ECOP) The impact of communication as a tool for the sustainable resource use. Takato **Ishikawa**, Shintaro Arakane and Naoki Tojo
5. (ECOP) Synergies between Gender Equality and Sustainability in Coastal Fisheries Resource Use: Case Studies in Japan. Hana **Matsubara** and Mitsutaku Makino
6. (ECOP) Pathway study on how Marine Spatial Planning can contribute to ocean carbon negative emissions. Yuting **Hou** and Dahai Liu
7. The Arabian Gulf and Climate Change: On the imperative of regenerative ecology and partnerships building. Saif M. **AlGhais**
8. Value chain analysis of low-priced small pelagic fisheries on the Western coast of Sri Lanka amid data and information scarcity. Naoki **Tojo**, Don Wasalathanthri, Lasami Upsala De Silva and Waradana Nilantha De Silva
9. (ECOP) A bioeconomic analysis on the effectiveness of TAC in South Korea. Min-Je **Choi**, Young Il Seo, Sang Chul Yoon and Heejoong Kang
10. Towards a Transformative Ocean Science for climate change adaptation using FishGIS. Mitsutaku **Makino**
11. (ECOP) Information, Altruism, and the Value of Traceability in Seafood**.** Mina **Fukagawa**, Nobuyuki Yagi and Yutaro Sakai
12. Exploring potential strategy for highly exploited multispecies fisheries management. Peng **Sun**, Runlong Sun, Guankui Liu, Yongjun Tian and Yanli Tang

MEQ Contributed Paper Session (Poster only)

Convenors:
Thomas W. Therriault (Canada), Takafumi Yoshida (Japan)

Description

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

Poster presentation

1. Bio-monitoring system for early detection of toxic dinoflagellate *Alexandrium pacificum* using the shell valve movements of bivalve. Seok Jin **Oh**, Soo Yong Jeong and Chang Geun Choi
2. (ECOP) Contrasting seasonal behavior of dissolved rare earth elements and anthropogenic gadolinium in the estuary dam system, Korea**.** Jumi **Kim**, Ijin Lim, Jiwoo Kim, Hunsub Sim, Taejin Kim, Hojong Seo and Guebuem Kim
3. (ECOP) Contribution of an estuarine dam to controlling the temporal variability of biological productivity in the Yeongsan River Estuary, South Korea. Yujeong **Lee**, Hyung-Mi Cho, Yong-Woo Lee2 and Tae-Hoon Kim
4. (ECOP) Nature-based Solutions for Ocean Resilience and Sustainability. Pengbin **Wang**, Dorsa Sheikholeslami, Naomie Kayitesi, Mikhael De Souza and Charles Karangwa

POC Contributed Paper Session

Convenors:
Lei Zhou (China), Jennifer M. Jackson (Canada)

Description

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

Poster presentation

1. Emulation of MOM6-based downscaling results in the Northeast Pacific using Machine Learning methods. Albert J. **Hermann**, Wei Cheng, Vivek Seelanki, and Phyllis J. Stabeno
2. Submesoscale Seasonal Dynamics of Phytoplankton Production in Eastern Boundary Upwelling Systems and Their Susceptibility to ENSO Events and Climate Change. Diego Andre **Otero Huaman** and Takeyoshi Nagai
3. Impact of anticyclonic eddy on fish distribution in Kuroshio-Oyashio transition area. Ryo Dobashi, Hiromichi **Ueno**, Riku Kato, Naizheng Yan, Tohru Mukai, Hiroki Yasuma, Daiki Nomura, Sachihiko Itoh and Akihide Kasai
4. Introduction to Quality Management of Observation Data from the Ieodo Ocean Research Station (Ieodo-ORS) and Its Registration in International Observation Networks. Kwang-Young **Jeong**, Gwang Ho Seo, Hyun-Sik Ham, Jinyong Jeong, Yongchim Min, Hee Yoon Park, Seok Jae Kwon and Hyun-Ju Oh
5. Coastal disaster risk assessment based on climate change scenarios along the Korea coasts**.** Gwang Ho **Seo**, Kwang-Young Jeong, Hwa Young Lee, Hyun Ju Oh, Myung Won Kim and Tae Soon Kang
6. The Kuroshio intrusion into the East China Sea revealed by a new mixed layer water mass analysis. Yisen **Zhong** and Shuangzhao Li
7. Linking northeastern North Pacific oxygen changes to upstream surface outcrop variations**.** Sabine **Mecking** and Kyla Drushka
8. Sources and sinks of N2O in the subtropical Jiulong River Estuary, Southeast China**.** Yang **Luo**, Yuhong Li, Jian Liu, Wangwang Ye, Jiexia Zhan, and Liyang Zhan
9. (ECOP) Long-term transport of Fukushima originated-137Cs based on a Lagrangian particle tracking model. Haejin **Kim**, Kyeong Ok Kim and Seongbong Seo
10. (ECOP) Frontogenesis elevates the maximum chlorophyll a concentration at the subsurface near the Kuroshio during well-stratified seasons. Daiki **Ito**, Taketoshi Kodama, Yugo Shimizu, Takashi Setou, Kiyotaka Hidaka, Daisuke Ambe1 and Sayaka Sogawa
11. Summertime hypoxic water in the bottom of Funka Bay, Japan**.** Hiroto **Abe**, Chihiro Miki, Hiroji Onishi, Atsushi Ooki and Tetsuya Takatsu
12. (ECOP) Predictability and prediction skill of summertime East/Japan Sea surface temperature events. Youngji **Joh**, SeonJu Lee, Young-Gyu Park, Thomas L. Delworth, Gyun-do Pak, Liwei Jia, William F. Cooke, Colleen McHugh, Young-Ho Kim6 and Hyung-Gyu Lim
13. MOM6-NEP simulated connectivity pathways between the Northeast Pacific LMEs: from the Gulf of Alaska to the Chukchi Sea. Wei **Cheng**, Albert J. Hermann, Vivek Seelanki and Phyllis Stabeno
14. (ECOP) Factors affecting the local variability of the Kuroshio: The Changjiang diluted water effect**.** Eun-Seo **Jeong** and Jae-Hyoung Park

15. (ECOP) Pairwise surface drifter separation by eddies in the Western Pacific, Kuroshio Extension, and Bering Sea. Seongbong **Seo**, Jun Myoung Choi, Dong Guk Kim, Kyeong Ok Kim and Young-Gyu Park
16. Meso, submeso and microscale structures in and around a cyclonic eddy. Sachihiko **Itoh**, Eisuke Tsutsumi, Ryuichiro Inoue, Takeyoshi Nagai, Yusuke Sasaki, Anne Takahashi, Shin-ichi Ito and Ichiro Yasuda
17. (ECOP) Seasonally contrasting wind-driven submesoscale dynamics contributes to chlorophyll-a patchiness in the Northern Gulf of Alaska. Isaac **Reister**, Seth Danielson, Tyler Hennon, Thilo Klenz and Ana Aguilar-Islas
18. Intrusion of Coastal Oyashio water to southwest Hokkaido Island, Japan, occasionally disturbed by Kuroshio-originating warm core ring**.** Hiroto **Abe**, Yuta Yahiro, Takuya Hasegawa, , Toru Hirawake, Hiroji Onishi, Atsushi Ooki, Tetsuya Takatsu, Ken'ichi Sasaki, Masahide Wakita, Hitoshi Kaneko, Shuichi Watanabe, Takahiro Tanaka, Takeshi Okunishi, Shintaro Ohno and Satoru Hashizume
19. (ECOP) Variability in the Alaskan Stream and the Subarctic Gyre in the NE Pacific. Emily P. Lemagie, Hristina Hristova and Phyllis Stabeno
20. Observed multi-decadal increase in the surface ocean's thermal inertia. Hajoon **Song**, Chaehyeong Lee, Yeonju Choi, Ajin Cho1 and John Marshall
21. Dissolved oxygen depletion in the intermediate layer in the Kuril region of the northwestern Pacific Ocean. A.S. **Kurnosova** and E.Yu. Malygin

Special Panel

PICES Science in the next decade

Upon completion of the Review Panel Report and Recommendations in August 2024, a half-day special panel was organised. The objective of the external report was to ensure that PICES is evolving in line with global marine science priorities and to get input on what changes could be made to make PICES more relevant, as it has been 30 years since much of our infrastructure was put in place. The report was released to the PICES scientists last summer. During the panel, the chair of the external review committee, Prof. Eileen E. Hofmann, presented summary recommendations and identified five high-priority areas (role, organizational structure, integrative science program, administration, and capacity development)that are considered essential to PICES future. After that, Dr. Erin Satterthwaite shared the workshop results on PICES knowledge co-production at the science-policy interface followed by Prof. Hanna Na delivering the FUTURE symposium outcomes. Prof. Enrique Curchitser, PICES Chair, discussed the next steps in PICES looking forward. Finally, Dr. Ian Perry moderated a panel discussion featuring members of the PICES community and representatives from external stakeholder groups. This was a very important and spirited discussion on the future of PICES which provided a positive atmosphere to end the week. The newly formed Study Group on External Review Report Response under the Governing Council and Science Board will revisit and discuss this further. (*this text was extracted and modified from PICES Press Vol. 33(1) article by Science Board Chair, Dr. Sukyung Kang*).

Session one (talks)

1. Review Panel Report and Recommendations Overview. **Eileen Hofmann** (External Review Panel Chair)
2. PICES knowledge coproduction and the science-policy interface overview. **Erin Satterthwaite** (AP-ECOP Representative)
3. FUTURE symposium outcomes. **Hanna Na** (FUTURE Co-chair)
4. Next steps in the PICES forward-look. **Enrique Curchitser**, PICES Chair)

Session two (panel discussion)

Moderator: **Ian Perry** (University of British Columbia)

Panellists: **Hanna Matsubara** (AP-ECOP Co-chair), **Steven Bograd** (FUTURE and AP-UNDOS Co-chair), **Se-Jong Ju** (GC member), **Eric Kingma** (Hawaii Longline Association), **Matthew Ramsey** (Conservation International), **Jo Foden** (ICES).

W1:FUTURE/BIO/MONITOR/TCODE Topic Workshop

North Pacific plankton time series data analyses and synthesis

Convenors:
Akash Sastri (Canada), Julie Keister (USA), Kazuaki Tadokoro (Japan), Samantha Zeman (USA), Xuelei Zhang (China)

Invited Speakers:
David Kimmel (NOAA Fisheries, USA)
Hiroomi Miyamoto (Japan Fisheries Research and Education Agency (FRA), Japan)

Description
Plankton monitoring is a key component of observational programs in the North Pacific. Many of these programs contribute to mature and relatively short plankton time series which provide early and rapid biological indicators of response to climate-ocean variability and extreme events (e.g. marine heatwaves) occurring with increasing frequency. A major goal of this workshop is to bring PICES-region plankton monitoring groups together and develop a common understanding of differences and similarities in sampling methods (gear, timing, coverage) and analytical methods. Discussion and presentation of non-standard but complementary sampling (biochemical, imagery, etc.,) methods and time series analyses of plankton are also important to this goal. Against this background, our objective is to begin a comparison of regional phyto- and zooplankton time series with the goal of identifying common metrics and methods useful at broader scales relevant to the North Pacific. An additional motivation for this workshop is to census the appetite for continued group discussion and regular updates on regional plankton time series.

NOTE: workshop report below is modified from the articles in the PICES Press 2025 Winter Issue

This workshop was proposed and supported through the PICES Advisory Panel on North Pacific Coastal Ocean Observing Systems (AP-NPCOOS). The workshop was originally motivated by a successful collaboration to address broad-scale synchrony of North American coastal zooplankton response to the extreme 2015/2016 marine heat wave. This effort involved synthesis of ten zooplankton time series along the west coast of North America (northern Gulf of Alaska to northern California) by Jennifer Fisher (OSU) and others (2020; PICES Press Vol. 28, No. 1). The workshop convened at this year's annual meeting aimed to build on this initial effort and expand the spatial coverage to include both the eastern and western subarctic Pacific.

We invited PICES-region plankton monitoring groups to develop a common understanding of the practical and analytical similarities and differences of our respective plankton time series. In keeping with this goal, we solicited presentation and discussion of non-standard but complementary sampling methods (biochemical, imagery, acoustics etc.,) in addition to more conventional, net tow-based time-series of zooplankton diversity and biomass. The half-day workshop activities were mostly based on presentations with discussion centering on planning of future collaborative activities. The two invited speakers represented long-term observational programs in the western/central and eastern subarctic Pacific regions. The six submitted presentations addressed: region-specific responses to extreme warm (and cold) years/events; statistical treatment of zooplankton time-series; recognizing and reconciling challenges of long time series; and exploring the sensitivity of finely resolved time series to environmental perturbation. Finally, we had a short but productive discussion centered on writing a follow-up workshop proposal and addressing the appetite for a PICES expert group focused on North Pacific zooplankton time series.

Presentation summaries:

Hiroomi Miyamato (Japan) presented an invited talk, *Zooplankton community change in the transition and subarctic regions of the North Pacific Ocean from 2004 to 2023.* This presentation focused on broadscale monitoring of zooplankton sampled in early summer in an area extending north from the subarctic/subtropical transition zone between in the western/central subarctic North Pacific (~145E to ~150W; 4500 km). Patterns of diversity, presence/absence, and abundance were analyzed to highlight variability of community composition north

and sound of the subarctic boundary. Communities north and south of the boundary were associated with cool and warm temperatures, respectively. Whereas distinction of assemblages within northern or southern groupings were more associated with phytoplankton biomass. Recent warm years, 2019, 2020, 2022, and 2024, were associated with large salp blooms in the transition zone and were associated with dominance of amphipods (*Themisto* sp.) instead of the large calanoid copepod, *Neocalanus plumchrus* in diets of Pacific Saury. The southern boundary of *N. plumchrus* in the region was displaced to the north in warm years and described by a negative correlation with PDO. Moreover, the zone of highest *N. plumchrus* density has moved northward continuously and by 3° over the course of the time series. Analysis of the broader zooplankton community indicates a progressive 'subtropicalization' of the transition zone and its sensitivity as an indicator of long-term climate change.

David Kimmel (USA) presented an invited talk, *Development and application of zooplankton time-series for use in ecosystem based management in Alaska.* This presentation walked workshop participants through the NOAA Alaska Fisheries Science Center (AFSC) zooplankton program, its relevance to ecosystem based fisheries management and lessons learned as the program has evolved. The geographical scope of AFSC plankton monitoring is vast (much of the Alaska EEZ, 3.77 million km^2) with ichthyoplankton time series starting in 1981. David introduced the team of experts (and expertise) responsible for maintaining the historical Bering Sea monitoring program started in the 1990's and focused attention on paths to: i) establishing rapid enumeration and timely reporting of useful zooplankton metrics for fisheries managers ii) standardization for gear changes; iii) establishing robust time series from spatially variable sampling; and iv) development of plankton imaging and molecular techniques for monitoring. This presentation amply covered the workshop objectives and provided valuable examples and practical insight toward the goal of comparing and reporting on North Pacific plankton time series.

Shinataro Yoshida (Japan) presented a talk titled, *Spatial changes in zooplankton communities within the western Subarctic Pacific during summers 2000-2020: Comparison between warm and cold years and with data from the eastern Subarctic Pacific.* This presentation analyzed spatial and interannual trends from a long-term (2001-2020) set of continuous plankton recorder (CPR) tows during the summer in the western subarctic Pacific. This time series was also compared to a similar time series in the eastern subarctic Pacific, yielding an east- west comparison. The focus of analyses was on spatial differences of diversity and abundance between cold and warm years as defined by the Pacific Decadal Oscillation. In the western subarctic Pacific, spatial heterogeneity of diversity (number of statistical groupings) was greater during cool periods and attributed in part to mesoscale eddies. Whereas during warm phases, especially within wide warm areas, diversity was limited and more homogenous. Warm phases were dominated by warm-water indicator species and were hypothesized to 'mask' eddy effects. CPR time series differ from traditional ship-based monitoring because sampling is limited to the near surface. However, they are key to plankton monitoring in the North Pacific because they capture larger patterns of spatial variability (40°N to 54°N) not often approached by ship based methods.

Julie Keister (USA) presented, *Differential response of zooplankton to warm events in the Salish Sea, Northern Gulf of Alaska, and Bering Sea.* The talk presented comparisons of zooplankton time series from the northern (Gulf of Alaska, northern Bering Sea, southeast Bering Sea), and southern (Strait of Juan de Fuca and Puget Sound) NE subarctic Pacific. These time series all support fisheries science and management, however, they vary in length, sampling frequency, and sampling methods. Interannual patterns of temperature across this broad space are similar and provide for exploring broad-scale coherence of zooplankton sensitivity to climate variability. Julie presented annualized abundance time series for a variety of indicator groupings standardized with Z-scores. Total copepod abundance anomalies for northern time series varied with time and temperature regime whereas patterns for southern time series was less clear. Differential responses to warm and cool temporal stanzas for copepod species (*Calanus marshallae, C. pacificus,* and *Acartia longiremis*) with 'northern' and 'southern' geographic affinities were also more closely tied to regional response. Efforts to resolve broad scale coherence of zooplankton to climate may be limited when considering temperature alone.

Russell Hopcroft (USA) presented a talk titled, *A quarter century of observations along the Seward Line: the good, the bad, and the ugly of long time-series.* He provided an overview of the ecological insights and lessons learned from regional oceanographic time series in the NE subarctic Pacific. Long-term zooplankton sampling along the Seward line, northern Gulf of Alaska, started in 1997 and takes place each May and late summer/fall. Seasonality in this region is strong, with cooler years favoring spring blooms of large phytoplankton supportive of zooplankton production; whereas, phytoplankton blooms in warm years occur later and are composed of smaller, poor quality prey for crustacean zooplankton. Some challenges of long time-series include recognition that sampling effort,

consistency, and data quality varies with time and that long time-series were not necessarily designed for current applications. Problems may not be recognized until new analytical approaches are applied. For instance, multivariate analyses are particularly sensitive to incorrect weight conversions, inconsistencies in species identification, and/or naming conventions; requiring alignment to the lowest common level. An ability to recognize and remedy time-series issues requires regular assessment for biases and anomalies and careful curation of the original collections.

Atsushi Yamaguchi (Japan) presented a talk titled, *Interannual changes of zooplankton assemblages in the western subarctic Pacific based on Continuous Plankton Recorder during 2001-2020: Analysis by GDM and future prediction*. This presentation explored seasonal patterns of zooplankton community composition as measured with Continuous Plankton Recorder (CPR) across a broad portion of the western subarctic Pacific during the 2001-2020 period. Regime shifts were identified for environmental data sets, sea surface temperature (SST), sea level anomaly (SLA), and chlorophyll *a*. The large zooplankton dataset was partitioned into seven community types and three zooplankton taxonomic groups. The seven community types were clearly distinguished and aligned with space, time and sea surface properties. Long-term shifts of SST, regime change, were most clearly associated with summer and fall community composition, and tied to changes in the abundance of *Neocalanus plumchrus*. This study used General Dissimilarity Modeling to identify SST and SLA as environmental factors exerting the strongest influence on community composition. Finally, twenty year forward predictions using the general dissimilarity models suggest a significant reorganization of zooplankton community spatial patterns with season and a 1°C and 0.04 m increase in SST and SLA, respectively.

Hongsheng Bi (USA) presented, *Unveiling the impact of winter storms on the dynamics of zooplankton populations in shallow estuaries.* This study introduced the workshop participants to a copepod time series captured with a moored plankton imaging instrument, the PlanktonScope. This shadowgraph imaging instrument was moored from a research pier at the mouth of the Patuxent River, Maryland. The abundance and sizes of the copepod, *Eurytemora* spp. (key for striped Bass recruitment) were followed on a high frequency, real-time basis starting in February 21, 2023. Sampling at this frequency is not feasible with traditional nets and was used to detect fine-scale variation of abundance associated with episodic winter storm events during late winter and early spring. This time series was sufficiently dense for assessing the performance of a deep-learning, zero-shot for time-series forecasting application. A successful validation of the forecast against recent observations using copepod density, temperature and salinity anomalies demonstrated the utility of relatively short, but finely resolved time series not feasible with traditional methods.

Akash Sastri (Canada) presented a talk titled, *Seasonal and monthly scale plankton sampling along the southwestern coast of Vancouver Island, British Columbia, Canada.* This talk wrapped up the submitted presentations for the workshop. The presentation focused on both a long (1979-present) and a short (2022-present) zooplankton time series located along the west coast of Vancouver Island (WCVI) in the NE subarctic Pacific. This region lies in the transitional zone between the equatorward flowing California Current and the poleward flowing Alaska Current. Zooplankton composition and biomass in this area are subject to variation in the position of the transitional streamline and strong seasonality in timing and intensity of upwelling and downwelling. The long-term southern Vancouver Island (SVI) shelf/slope time series represents a sensitive biological indicator of climate-ocean variability because of placement in a transition zone. The biomass composition (lipid rich vs. poor) and peak biomass timing continue to reflect warm and cool conditions associated with changes in broad-scale circulation. The short time series, located east of the SVI in Barkley Sound is a new euphausiid-centric time series focused on characterizing variation of a key prey item for juvenile Coho and Chinook salmon populations. Monthly sampling provides local information on prey availability/timing for early marine phase salmon not resolved with the SVI seasonal scale surveys.

W2: FUTURE/HD/MONITOR Topic Workshop

Applying social-ecological frameworks to explore actionable solutions for climate extreme events across the North Pacific (Cancelled)

Convenors:
Karen Hunter (Canada), Helen Killeen (USA), Antonietta Capotondi (USA), Chan Joo Jang (Korea), Hiroki Wakamatsu (Japan)

Invited Speakers:
Hakase Hayashida (Application Laboratory, JAMSTEC, Japan)
Khush Jhugroo (Hakai Institute, Canada)

Co-sponsors: CLIVAR

Description
Climate extreme events (CEC) occur with regularity across the North Pacific. Physical ocean and atmospheric events cascade into ecological anomalies such as harmful algal blooms, marine species die offs, and changes in the distribution and abundance of species. These physical and ecological dynamics often have direct consequences for social systems requiring management such as through fishery closures or expansion, damage to infrastructure and property, and health problems. Currently, many resource management and policy frameworks do not yet handle the impacts of CECs efficiently. In this workshop, participants will explore CEC case studies in the North Pacific to outline drivers, and their ecological and societal impacts using the DSPIR (drivers, pressures, states, impacts, responses) framework. The DSPIR framework has been broadly applied to identify management and policy actions related to environmental problems. It draws out interactions between state changes and human impacts to identify where the system experiences shifts in ecosystem services and societal benefits and starts to identify suitable responses to control the adverse effects of the drivers and pressures. Participants will also link knowledge generated in the workshop to the PICES-specific SEES (social-ecological environmental system) framework. The SEES framework can help identify how PICES can streamline CEC science activities and solutions for the North Pacific. The workshop will aim to generate information for researchers and decision-makers to enable actionable solutions and build understanding of the similarities and differences in outcomes across different CECs.

Workshop Summary

W3: FUTURE/HD/TCODE Topic Workshop

Exploring human networks to power sustainability in North Pacific Ocean

Convenors:
Shion Takemura (Japan), Ling Cao (China), Karen Hunter (Canada), Moo Joon Lee (Korea)

Invited Speakers:
Raphaël Roman (IOC-UNESCO), Rachel Seary (NOAA Fisheries, USA)

Description

The Human Dimension Committee has been conducting analysis since 2020 to conduct a preliminary assessment of the PICES human network towards understanding how the organization may already be addressing a variety of UNDOS goals. The research team assembled and analyzed research products created within PICES since 1992 (Annual Meeting Books of Abstracts). WG51 on "Exploring Human Networks to Power Sustainability" aims to expand our initial work on the PICES organization by studying linkages among research activities and their social networks within PICES nations and other significant marine science organizations around the globe. The working group will update the database of PICES Abstract books until the proposed workshop. The practical workshop is for WG 51 members and other interested participants to (1) analyze case studies using updated version of the database by each PICES nations, (2) identify 100 keywords for each case studies for correspondence analysis and (3) create list of research institutions of each PICES member nation for network analysis and (4) establish the database for the final analysis in the following year (the final year of WG-51).

No Summary Report received (Feb 11, 2025)

W4: MEQ Topic Workshop

Contrasting the occurrence of toxic *Alexandrium* blooms in the eastern and western North Pacific

Convenors:
Mark L. Wells (USA),William Cochlan (USA),Vera Trainer (USA), Charles Trick (Canada), Pengbin Wang (China)

Invited speaker:
Satoshi Nagai (Japan Fisheries Research and Education Agency (FRA), Japan)

Description

There is clear evidence of contrasting occurrence and impacts of toxin-producing dinoflagellates of the genus Alexandrium between the western and eastern Pacific. All PICES nations have experienced *Alexandrium* blooms, and there is evidence that the seasonal window for these blooms is expanding with increasing ocean temperatures. However, there are significant differences in oceanographic conditions in the eastern and western margins of the Pacific. A better understanding of the similarities and differences in these bloom phenologies, magnitude, and character across this oceanographic framework would strengthen the foundation for forecasting how these toxic events may change in the future oceans, a key finding of PICES-funded international workshops on HABs and Climate Change. Indeed, while a recent global assessment of HABs finds little firm evidence of climate-induced changes in HABS, there are indications that regional trends may be obscured. This workshop is a continuation of our successful east-west Pacific HAB comparisons, which now will focus on *Alexandrium* species that historically have had massive economic and human health impacts in PICES member countries. The workshop foundation will be an extension of contemporary datasets in the PICES region back to the 1990s and earlier where available, with PICES participants pre-submitting available data on HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, water clarity, nutrients, wind, hydrologic intensification, and upwelling indices. Workshop participants will evaluate the trends and patterns in these data to develop hypotheses for development into outlook products on day 1 and develop a detailed outline for manuscript preparation on day , including writing assignments and submission deadlines. The manuscript will be prepared as a PICES Special Publication and/or an appropriate peer-reviewed journal.

No Summary Report received (Feb 11, 2025)

W5: FUTURE/SmartNet Topic Workshop

Exploring international knowledge co-production: Lessons learned from international marine science organizations at the science-policy interface

Convenors:
Erin Satterthwaite (USA), Steven Bograd (USA), Mitsutaku Makino (Japan), Hanna Na (Korea), Jörn Schmidt (Malaysia)

Co-sponsor: ICES

Invited Speakers:
Kentaro Ando (Japan Agency for Marine-Earth Science and Technology (JAMSTEC), UNESCO/IOC Sub-Commission for the Western Pacific (IOC/WESTPAC)
Kristin Kleisner (Environmental Defense Fund (EDF), USA)

Description

The vast and complex nature of the ocean necessitates large scale coordination of science and policy across local, national, and international institutions. We propose a workshop aimed at exploring the successful models of the North Pacific Marine Science Organization (PICES), the International Council for the Exploration of the Sea (ICES) and the UN Decade of Ocean Science for Sustainable Development (UNDOS) to inspire and guide institutions, scientists, and policymakers in fostering international marine science collaboration and knowledge co-production. The proposed workshop provides a unique opportunity to explore how ICES, PICES, and other organizations/programs are working to bridge the science-policy interface, offering valuable insights for the global scientific community. Experts from partner organizations and UNDOS Programs are strongly encouraged to participate in the discussion and we invite other examples/success stories/challenges to participate. We plan to produce a publication (e.g., PICES Press article or ICES IMS 'Food For Thought' article) detailing the outcomes of the workshop. By delving into the roles of institutions, interdisciplinary approaches, and the interface between research and application, participants can gain valuable insights to apply in their own regions and foster global science collaboration.

NOTE: The workshop report below is modified from the articles in the PICES Press 2025 Winter Issue

Rationale and Background
We are increasingly aware of the urgent need for solutions to address the complex challenges confronting society. The process of knowledge co-production has gained increasing attention for generating policy-relevant, solutions-oriented, and socially robust knowledge and is consistently discussed as one of the most effective strategies for mobilizing knowledge in the context of evidence-informed policy and practice.

There are many terms for this process (Figure 1), but most have similar goals of collaboration, sharing, bringing together diverse forms of knowledge and generating knowledge, action, and solutions (e.g., participatory and collaborative approaches like co-production, co-design, co-creation and mutual learning). Specifically, knowledge co-production for ocean sustainability is an interactive, participatory process that brings together diverse actors to collectively generate, integrate, and apply knowledge to address complex sustainability challenges.

There is growing recognition of the need for collaborative approaches to knowledge generation and use internationally, including within UN and other intergovernmental processes and increasingly within PICES. This workshop idea was born out of a UN workshop aboard the Statsraad Lehmkuhl (PICES Press 2024) and evolved throughout discussions with the PICES community over the course of the past year.

The questions we wanted to answer with this FUTURE and SmartNet-sponsored workshop were:

- *What does knowledge co-production look like in international organizations?*
- *How could this be applied within the context of PICES?*

Figure 1 (left) *A teardrop displaying some of the many terms related to participatory and collaborative approaches.*
Figure 2 (right) *A spiral of workshop participant names.*

Introduction
The workshop, "Exploring international knowledge co-production: Lessons learned from international marine science organizations at the science-policy interface", brought together 27 diverse participants across countries, knowledge producers and users, career stages, and organization types who engaged in invited presentations, a panel, interactive activities, and group discussions (Figure 2).

The goals of the workshop were to: 1) Understand how other international organizations conceptualize the process of working at the science-policy interface, 2) Identify effective strategies and practices for knowledge co-production in international organizations, 3) Evaluate the current use of PICES information and explore opportunities for enhancing its application.

Challenges of knowledge co-production in international organizations
The journey toward effective knowledge co-production may present challenges and may not always be the best approach for a given context. Some of the main challenges identified were limited resources, limited data or knowledge sharing, a lack of incentives to engage or goals being misaligned, a reluctance to engage due to lack of interest or training, or the unavailability of venues or structures for building relationships and sharing across sectors or communities.

Strategies for knowledge co-production in international organizations
We also identified effective strategies for knowledge co-production and mutual learning in international organizations that align with previously published strategies (Satterthwaite et al. 2024). Through the invited presentations and interactive activity, we identified some key summarized points:

Build and maintain relationships. The importance of building and maintaining relationships – which takes time– and ensuring that we have repeated and sustained interactions to build trust was highlighted. Trust is important because it can foster openness, transparency, and effective communication. The PICES annual meeting, this workshop and other workshops have been a great step in this process. Additionally, diverse venues and groups to discuss information needs, establish shared interest, and assess gaps and broaden engagement in a "big tent" style approach was identified as particularly important.

Assess who should be included and broaden engagement. Related to this, defining who should be included is important. Our North Pacific community is a broad range of actors interested in, engaged with, and or affected by

activities in the North Pacific. This can include those who have a stake, share, right, or interest. This requires working within and among a diversity of perspectives, across career stages, generations, disciplines, regions, and cultures. It also includes a range of people including science, policy, industry, education, local and traditional knowledge, and boundary-spanning organizations.

Contextualize engagement and establish clear expectations for engagement. Next, the importance of understanding the context of engagement and scoping resources and knowledge available was highlighted. Then setting clear goals, roles, and communication strategies, clear expectations of contributions, and establishing clear agreed upon guidelines for the process and how the knowledge will be produced and used.

Collaborate, adapt, and learn. Finally, in enacting the process the workshop participants thought it was important to ensure there is co-ownership of knowledge through collaboration, that the information is relevant, timely, and can be practically applied, and that the process is adaptable, and iterative through mutual learning.

Current state of PICES at the science-policy interface

The PICES Secretariat (Sanae Chiba) and a panel of representatives from partner organizations that included regional fishery management organizations, national representatives, and science and funding organizations shared their perspectives on where PICES is in this voyage focused on the science-policy interface. PICES influence on decision making is indirect and mostly happens through scientific outputs of PICES Expert Groups and Special Projects related to country and regional management, and commitments to international treaties. There was a call for establishment of clear protocol and organizational structure for effective community engagement that includes knowledge users, such as to align the scientific outputs with the needs of resources managers.

Needs identified by PICES users

The panel of PICES users was selected to address uses and needs of PICES information at the climate-fisheries nexus. The panelists included: Matt Baker, North Pacific Research Board (NPRB); Aleksandr Zavolokin, North Pacific Fisheries Commission (NPFC); Catherine Michielsnes, Pacific Salmon Commission (PSC); Mark Fitchett, Western Pacific Regional Fishery Management Council (WPFMC); Ryan Rykaczewski, NOAA Pacific Islands Fisheries Science Center and University of Hawaii, USA; and Sukyung Kang, National Institute of Fisheries Science, Korea.

The needs identified by the panel of PICES users were related to climate variability and change in relation to fisheries management, early warning and environmental indicators, emerging fisheries, equity, environmental justice and local/traditional knowledge, and climate-related displacement. The types of products that users needed were one pager, 2 slide summaries, factsheets, actionable tools, and data repository links.

Additionally, non-academic PICES users suggested that in some cases writing can be too technical, making it difficult to clearly communicate key findings and main points. Thus, a need for clearer communication practices was expressed. To address this, PICES could consider creating a communications style guide to help members write more effectively for non-technical audiences (e.g., plain language guidelines).

Future directions

Looking ahead, workshop participants emphasized the importance of strengthening existing relationships and partnerships, such as those outlined in established Memoranda of Understanding (MOUs), while also identifying and addressing any gaps in collaborations. They highlighted the need to create dedicated venues for dialogue, enabling input from a diverse North Pacific community to better understand preferred engagement methods and assess collective needs.

To foster inclusive collaboration, participants proposed developing a more structured approach to engagement within PICES. This could include refining the organizational structure, forming new expert groups, and organizing joint workshops and working groups to facilitate meaningful interaction. Additionally, they underscored the value of enhancing knowledge and capacity sharing, both within PICES and among partner organizations. Key strategies included improving systems for data and information sharing and offering training courses to support co-design efforts and build collaborative capacity.

We hope that this work serves as another steppingstone on the path toward cross-sector, transdisciplinary international science collaboration and look forward to seeing how this work evolves together in the coming decade.

Acknowledgements
We, the co-conveners, are grateful to the invited speakers (Kristin Kleisner, EDF**;** Alan Haynie, ICES**;** Jorn Schmidt, WorldFish**;** Kentaro Ando, WESTPAC; and Sanae Chiba, PICES), invited panelists (Matt Baker, North Pacific Research Board (NPRB); Aleksandr Zavolokin, North Pacific Fisheries Commission (NPFC); Catherine Michielsnes, Pacific Salmon Commission (PSC); Mark Fitchett, Western Pacific Regional Fishery Management Council (WPFMC); Ryan Rykaczewski, NOAA Pacific Islands Fisheries Science Center and University of Hawaii, USA; and Sukyung Kang, National Institute of Fisheries Science, Korea), and participants (Figure 2; Appendix 1). We are also grateful to the PICES Secretariat and PICES community for the thoughtful and stimulating discussions.

Workshop convenors and speakers.

Workshop participants.

Panel discussion.

W6: MONITOR/TCODE Topic Workshop

Co-creating a shared framework for ocean data management: Finding common ground on terminology

Convenors:
Erin Satterthwaite (USA), Naomi Boon (Canada), Jeanette Gann (USA)

Co-sponsors: Northeast Pacific DCC, ECOP Canada

Invited Speakers:
Steve Diggs (California Digital Library (CDL), USA)
Chunhua Han (National Marine Data and Information Service (NMDIS))

Description

In an era of burgeoning ocean data, this workshop will bring together ocean professionals interested in and working with ocean data across a range of experience levels (e.g., early career professionals, data managers, researchers) to establish a unified framework and shared language for effective ocean data management. With data's pivotal role across marine disciplines, cultivating a harmonized approach becomes imperative. Through interactive discussions, the workshop will collaboratively construct a common vocabulary of key ocean data concepts, and establish a comprehensive data framework – from collection to utilization. Additionally, the workshop will explore next steps, such as effective strategies to share the resulting terminology and framework and the potential development of a training. In doing so, the workshop aims to lay a foundation for improved data management practices within and across PICES, UN Ocean Decade actions, and the broader marine science community. By creating a common understanding of key data science terminology and data frameworks, the workshop seeks to enhance science collaboration, streamline processes, and elevate data utilization.

NOTE: The workshop report below is modified from the articles in the PICES Press 2025 Winter Issue

Background
The goal of the workshop, "Co-creating a shared framework for ocean data management: Finding common ground on terminology", was to develop a shared framework and language for effective ocean data management. In ocean science, the data framework and key terminology is often interpreted differently across, and even within, disciplines, meaning that often scientists are not "speaking the same language" when it comes to data processing, management, mobilization and best practices. To our knowledge, there is currently no consistent conceptual model or framework for the data lifecycle in ocean science. Through presentations and interactive discussions, the workshop was designed to collaboratively construct a common vocabulary and framework for ocean data concepts, which will serve to enhance science collaboration, streamline processes, and elevate data utilization.

Workshop overview
The workshop brought together about 25 ocean professionals, representing individuals from PICES member countries, from various disciplines (e.g. physical oceanography and fisheries scientists) and positions (policy analysts and research directors) within ocean science and management. (Appendix 1) During the context setting at the beginning of the workshop, the co-convenors shared a "basic shared framework" of 'stages' and 'outputs' (Diagram 1) to give the participants something to react to, and start thinking about the stages, outputs, and overall terminology used in their own subject areas. Metadata was not listed specifically in the shared framework but was brought up in group discussion that followed.

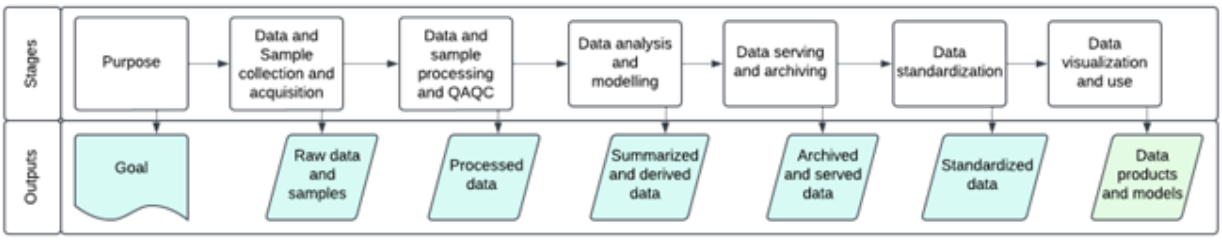

Diagram 1. Basic initial shared framework presented to workshop participants at the start. The conceptual diagram shows the stages (top row) and outputs (in teal, bottom row) from each stage, to be discussed among participants.

Following the context setting, two keynote speakers provided presentations on topics related to marine data lifecycle management.

Invited presentations

Steve Diggs (University of California Curation Center, California Digital Library, USA) presented an overview of climate-related data issues within and beyond the UC system, highlighting the importance of open data, and reviewing the various stages of the research data lifecycle, along with the importance of establishing clear terminology in order to enhance collaboration and transparency:

- Standardized language for sampling, processing, and validation enhances collaboration and reproducibility;
- Standardized terms for analysis and visualization helps make data products accessible across disciplines;
- A shared framework with unified technology can create a scalable, sustainable foundation for global climate and ocean data resilience."

Professor Chun-hua Han (National Marine Data and Information Service, China) shared insights into how they have developed infrastructure around marine data lifecycle management. Key aspects of their data management system include:

- The full data life cycle (from data aggregation to data value added services);
- Marine data governance
- Marine data asset management
- Marine data sharing and exchange management
- Marine data integrated management
- Marine data architecture management
- Marine data standardization management

Professor Han outlined four key prospects for the management of the marine data lifecycle; which included: 1) expanding marine data resources, 2) making full use of modern technologies such as big data and cloud computing, 3) improving marine big data technology, and 4) strengthening international cooperation on marine big data.

Ocean Data Lifecycle

After these insightful presentations, there was a series of interactive discussions around constructing a conceptual ocean research framework, defining what different stages and outputs fall within this workflow. Each stage was listed on a poster and hung up on the wall, and participants were encouraged to discuss among themselves what key terms, steps, important considerations and practices, and outputs are relevant within each stage, and whether they thought any stages were missing. The participants put their ideas and suggestions on sticky notes and onto the posters, before a discussion with the larger group where people shared their ideas, suggestions and feedback.

Overall, there was agreement on the terminology of the stages of the basic shared framework (Diagram 1), but there was considerable discussion on cross-cutting themes, the steps outlined within stages, and various outputs. This discussion led to a co-designed shared ocean data lifecycle by the end of the workshop (Diagram 2).

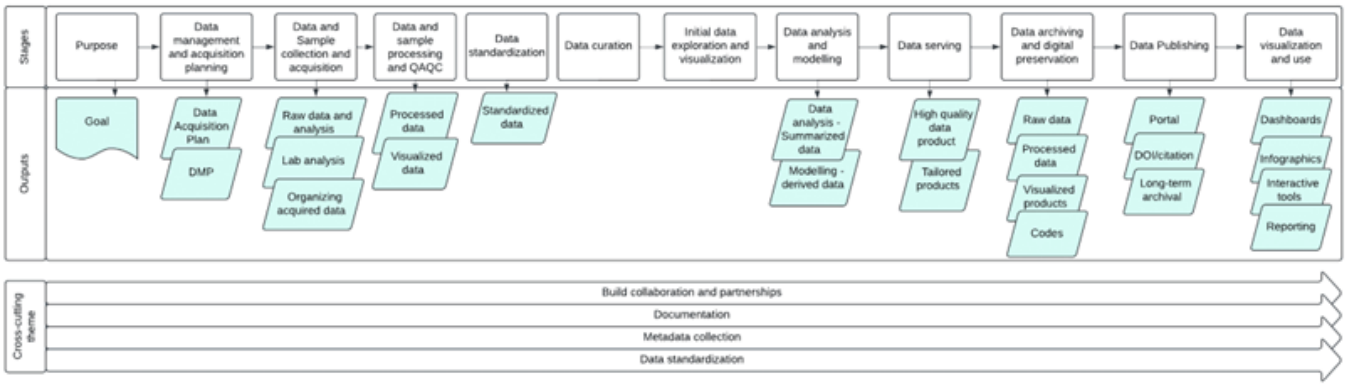

Diagram 2. Shared ocean data lifecycle framework following discuss2ions with workshop participants.

Cross cutting themes

The group identified several cross-cutting themes, outputs or areas of important consideration (Diagram 2) that were missing from the original basic framework, and which apply to multiple stages across the model, such as:

- Build collaboration and partnerships
  - To work with key partners to establish shared objectives, define the scope of data collection and promote multiple uses from one data collection. This may require MOUs, collaborative agreements and shared leadership, depending on the scope of the project.
- Documentation
  - Documentation is a cross-cutting output at all stages of the data framework and may be more exhaustive than metadata, for example documentation may include more of the historical background and explain how methods have changed over time.
- Metadata
  - Metadata was also defined as a cross-cutting output across many stages of the data framework to provide information about the data e.g. data owner, location, when the data was collected, geographic scope, data curator, data variables, and file size.
- Data standardization
  - While data standardization was also included as a separate stage, there was discussion as to whether it was a concept that was applicable to multiple stages of the workflow. Data needs to be standardized to a minimum level to ensure consistency, accuracy and compatibility. There's a need to be more purpose-driven in our standardization, rather than doing it ad hoc. Data standardization relies on ontologies, controlled vocabularies and existing best practices for each data type.

Stages

The group also described 12 stages of the ocean data lifecycle that included key terminology, outputs, and important considerations (Diagram 2). These stages included:

Purpose:

- In advance of data collection or acquisition, it is important to plan how the data will be collected, understand the context and scope of data collection, and to start working on a data management plan for the data. This can involve articulating a hypothesis, setting objectives and understanding the scope and extent of data collection.
- Articulate the research question and define the strategy for data collection, analysis, and representation.
- Understand the management needs and the purpose behind data collection (e.g., curiosity, answering specific questions).
- It is advantageous to consider how one data collection could lead to multiple uses of the data and to plan for this from the beginning of a project.

Data management and acquisition planning:

- Define the scope and extent of data collection, ensuring high-quality acquisition.
- Assemble best practices and identify key collaborators, partners, and schedules.
- Ensure proper prioritization and a solid data acquisition plan.

Data and sample collection and acquisition:

- Gather raw data/samples, ensuring that collection is standardized and includes photos for context.
- Field conditions should be documented to supplement numerical data.

Data and sample processing and QA/QC:

- Organize, process, and conduct quality assurance/quality control (QA/QC) checks at various levels (0, 1, 2).
- Ensure full documentation of data processes and use of flags for erroneous data.

Data standardization:

- Standardization involves creating practices based on a wide range of projects and datasets to ensure consistency and interoperability across various data sources.
- Standardize data for consistency, compatibility, and accuracy, ensuring it is not ad-hoc but purpose-built to meet specific needs.
- Utilize controlled vocabularies and ontologies to ensure consistency and cross-cutting compatibility in datasets.
- While maintaining minimum standardization is acceptable due to rapid advancements in technology, it should align with existing standards and best practices across data centers.

Data curation:

- Curate and store data in appropriate formats, making it accessible for long-term use and ensuring reversibility of processed data.
- Implement proper data curation systems (e.g., Ocean Info Hub) and establish clear distinctions between raw and processed data.
- Through proper data curation projects can become part of a sustainable and interoperable digital ecosystem

Initial data exploration and visualization (domain or technical users):

- Exploring and visualizing data can be used for different purposes (e.g., initial exploration or public presentation).
- It is important to define the purpose and anticipated audience of data exploration (products), e.g., whether it is to identify outliers, visualize data to the general public or the research team (if visualization is for a general/non-domain user then see *Data visualization/use (by non-domain users)* below).
- For example, initial data exploration and visualizations for domain users can be used to identify appropriate modelling or analysis approaches or to provide a more general summary before more detailed analysis and modeling.
- Provide atlases or dashboards to visualize data effectively for different audiences.

Data analysis and modeling:

- Conduct data analysis before modeling, providing summaries and insights to guide further steps.
- Active feedback from colleagues enhances the sensemaking process, leading to more refined data.

Data serving:

- Data serving is crucial for ensuring the secure long-term archiving of information.
- Scientists should aim to serve up data through trusted sources, preferably with a user-friendly interface (depending on anticipated audience).
- Develop user-friendly interfaces for both technical and non-technical users.

Data archiving and digital preservation:

- Ensure data is securely archived and accessible
- Archive data in formats that support long-term preservation, including version control and metadata documentation.
- Provide accessible, well-documented data archives to ensure reproducibility.

Data publishing:

- Data publishing is vital for ensuring the long-term archival of data.
- Data publishing should result in making data more easily accessible and findable, for example by providing a unique digital object identifier (DOI) or citation for the work and be published in a long-term archive.
- Data published to repositories should be accessible through data portals.

Data visualization and use (by non-domain or non-technical users)

- Use charts, maps, and diverse visual formats to make complex data more understandable for various audiences.
- Provide clear, accessible tools like dashboards, infographics, factsheets, and interactive visualizations for easy data exploration and interaction.
- Consider language barriers and adjust presentations to ensure that data is effectively communicated to both technical and non-technical users.

Further important discussions on the stages & outputs of the ocean data lifecycle

Some issues that stood out included differences in viewing the QA/QC process, with some participants outlining an iterative process with multiple levels (0, 1, 2) of QA/QC. Additionally, the data analysis/modeling stage was viewed by some as two separate stages, while the order of other stages like data serving may be better situated before or after analysis/modeling depending on the user and the data type.

Data standardization is viewed differently depending on the data type involved, and standards for particular data types need to be considered. Regardless, themes of standardizing for consistency, compatibility, and accuracy were important. Some data types are more easily standardized than others (i.e. oceanographic data from instrumentation versus fisheries data, or eDNA data). Furthermore, some participants viewed data visualization as a step within the QA/QC portion of the workflow, while others saw it as part of the analysis/modeling and/or visualization and use.

Conclusions and Next Steps

Overall, given the range of backgrounds, cultures and familiarity with data management in ocean science, there were very productive conversations around the different stages and outputs that could be included in a conceptual framework, as well as discussions around key terminology, important considerations and practices, and cross-cutting themes that are applicable throughout the ocean data framework. Where our initial conceptual model included 7 stages (Diagram 1), our framework at the end of the workshop included 12 stages with insightful key terminology, outputs, and important considerations (Diagram 2).

Workshop participants.

This workshop was a step forward towards creating a shared framework for effective ocean data management, and agreeing upon general, shared terminology on the phrases that make up the framework. A future workshop (potentially at PICES 2025) will be built upon this, with the aim of refining the existing framework, and discussing effective strategies and important considerations for managing and mobilizing diverse data types in ocean science. The 2025 workshop will aim to: 1) review and enhance the conceptual diagram developed in 2024 and 2) explore effective strategies and practical steps across the data lifecycle, considering the unique data management, integration, and mobilization challenges of various ocean data types, as well as metadata handling. Overall, this work aims to lay a foundation for improved data practices within and across PICES, the UN Ocean Decade, and the broader international marine science community.

Appendix 1: Participants

Name	Affiliation	Country
Tim Van der Stap	Hakai Institute	Canada
Naomi Boon	Hakai Institute	Canada
Seong Woon Jeong	Inha University	Republic of Korea
Saranya Ji	Seoul National University	Republic of Korea
Catherine Michielsens	Pacific Salmon Commission	Canada
Talen Rimmer	University of Victoria	Canada
Vladimir Radchenko	Pacific Branch of VNIRO (TINRO)	Russia
Hui Tae Joo	National Institute of Fisheries	South Korea
Peng Lian	Chinese Academy of Fishery Science	China
Liqing Jiang	UMD & NOAA/NCEI	USA
Kathryn Sheps	BECI	Canada
Kathryn Berry	BECI	Canada
Noriko Shoji	NOAA	USA
Yutaka Michida	University of Tokyo (IOC)	Japan
Toru Suzuki	MIRC	Japan
Yon Li Lei	IOCAS	China
Vishal V. Patil	Xiamen University	China
Hannah Lachance	NOAA Fisheries	USA
Inae Lee	Seoul National University	Korea
Han Chun Hua	National Marine Data and Information Service	China
Wan Fangfang	National Marine Data and Information Service	China
Daisuke Hasegawa	Japan Fisheries Research & Education Agency	Japan
Erin Satterthwaite	CalCOFI & California Sea Grant, SIO, UCSD	USA
Jeanette Gann	NOAA Fisheries	USA
Steve Diggs	UCOP	USA

W7: FIS Topic Workshop

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

Convenors:
Josep Planas (USA), Mackenzie Mazur (Canada), Roman Novikov (Russia) ,Naoki Tojo (Japan),

Invited Speakers:
Shuyang Ma (Institute of Marine Research (IMR), Bergen, Norway)

Co-sponsors: IPHC

Description

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 flatfish species of great ecological, cultural and economic importance. Many of these species have wide distribution ranges and undergo significant ontogenetic and seasonal migrations, and, therefore, are particularly susceptible to climate and environmental variability. In order to address key issues related to flatfish species, from basic aspects of their biology to population management and conservation efforts at an international level, three FIS-sponsored PICES workshops have been organized at recent PICES Annual Meetings. The first workshop was co-sponsored by the International Pacific Halibut Commission (IPHC) at the 2019 PICES Annual Meeting (W2) and focused on important topics on 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 (featured in PICES Press, 2020, Vol. 28(1)). This workshop highlighted the need to apply integrative approaches to improve our understanding of the biology and management of widely distributed flatfish species in the North Pacific Ocean, requiring a high level of cooperation at the international level. One of the deliverables of this workshop was the publication of a Special Issue in the journal Fisheries Research that was edited by the convenors and that appeared in 2023. The second workshop took place at the 2022 PICES Annual Meeting (W5) and focused on addressing emerging issues in key flatfish species with broad distribution across the North Pacific Ocean related to their biology, environmental impacts on their distribution, and management (featured in PICES Press). This workshop will be followed by a third one at the 2023 PICES Annual Meeting (W7) with identical objectives and that has received considerable attention as shown by the full program (3 invited speakers and 10 oral communications). In order to capitalize on the gains of these three workshops, the convenors are proposing a fourth workshop during the 2024 PICES Annual Meeting that will aim at 1) devising strategies for data sharing on fishing efforts and management of flatfish species across the North Pacific Ocean, and 2) promoting 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.

NOTE: The workshop report below is modified from the articles in the PICES Press 2025 Winter Issue

Background

The North Pacific Ocean is a large and productive ecosystem that is characterized by strong interdecadal climate variability and that supports a number of fish species of great ecological, cultural and economic importance. To address important current topics related to the biology, ecology and management of flatfish species in the North Pacific Ocean, three FIS Workshops have taken place in previous PICES Annual Meetings (in 2019, 2022 and 2023) to bring together researchers, scientists and managers from countries that are invested in these resources. An important outcome of these three previous workshops 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 and others, 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 renewed MoU between the two organizations, a fourth flatfish Workshop took place at the 2024 PICES Annual Meeting (W7) to address emerging issues in key flatfish species with broad distribution across the entire North Pacific Ocean. The theme of this Workshop was aimed at 1) devising strategies for data sharing on fishing efforts and management of flatfish species across the North Pacific Ocean, and 2) promoting 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.

Summary

This half-day Workshop (W7) was held on October 26, 2024, and the session was opened by the corresponding convenor Dr. Josep Planas who welcomed the participants and provided a brief introduction to the Workshop. The session featured one invited presentation and four regular oral presentations. The various presentations covered topics related to climate impacts on productivity and recruitment relative to fish populations, including flatfish, (Ma, English), biomass and distribution data (e.g. fishery-independent surveys) inputs to fisheries management (Ciannelli, Pan), and importance of revised maturity schedules in stock assessment of a key flatfish species (Planas).

After the presentations, a brief discussion session took place among Workshop participants. The discussed topics included the importance of continued monitoring efforts in collecting environmental and fishery-independent (e.g., surveys) and fishery-dependent data to improve our current understanding of the impacts of climate change on flatfish populations and implications for fisheries management, and the need for establishing working international collaborations among North Pacific rim countries to improve available information on connectivity and distribution changes of flatfish species in the face of climate change. The discussion session ended with support from participants for the submitted proposal of a fifth Workshop to be held at the 2025 PICES Annual Meeting in Yokohama, Japan.

Agenda for Workshop 7

14:00-14:10 Welcome and Introduction to the Workshop

14:10-14:40 Invited Speaker: *How to explore climate-induced fish population dynamics? – conceptual frameworks and statistical advancements.* – Dr. Shuyang Ma, Institute of Marine Research, Bergen, Norway.

14:40–15:00 Oral Communication: *Can nearshore surveys improve management of flatfishes with coastal habitat dependencies?* – Dr. Lorenzo Ciannelli, Oregon State University, Corvallis, Oregon, USA (PRE-RECORDED).

15:00-15:20 Oral Communication: *How are environmental conditions influencing productivity of Petrale Sole in Canada?* **–** Dr. Philina English, Fisheries and Oceans Canada, Nanaimo, British Columbia, Canada.

15:20-15:40 Coffee Break

15:40–16:00 Oral Communication: *Non-Linear Catchability and Optimal Fisheries Management Target.* **–** Dr. Minling Pan, NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawaii, USA.

16:00-16:20 Oral Communication: *Spatial characterization of histology-based maturity estimates for female Pacific halibut in the Northeastern Pacific Ocean.* **–** Dr. Josep Planas, International Pacific Halibut Commission, Seattle, Washington, USA.

16:20-16:40 Discussion

W8: FUTURE/TCODE Topic Workshop

"Science Jam" - Bridging the gap between science and social media to communicate PICES accomplishments with the world

Convenors:
Natsuko Nakayama (Japan), Hannah Lachance (USA), Tammy Norgard (Canada), Raphael Roman (Canada), Vera L. Trainer (USA), Phoebe Woodworth-Jefcoats (USA)

Description

The proposed Science Jam builds upon the past two PICES science communication workshops that focused on video creation and fact sheet development. These previous 2 workshops taught PICES scientists how to develop tools to effectively and concisely communicate their science. At PICES 202, members completed a 2-day Science Communications workshop with the primary goal of developing videos that describe the accomplishments, needs, and future plans of PICES Expert Groups. In 202, PICES members will learn how to create Fact sheets that will be used to describe the accomplishments and future plans of PICES Expert Groups.

These communication products are now available for the public to view, but to date, only about 15 viewers have seen the 3 PICES videos developed in 2022 and shared on the PICES youtube channel. This clearly illustrates the need to bridge the gap between creating communication products and sharing them with the world. This proposed workshop for PICES 2024 aims to educate PICES members about effective social media tools to effectively communicate their science, such as Facebook, X/Twitter, Loomly and more, focusing on those tools that are viewable in all PICES member nations. In addition, time will be allocated to participants who would like to develop videos or factsheets by using the skills learned in the 2022 and 2023 AP-SciCom workshops.

NOTE: The workshop report below is modified from the articles in the PICES Press 2025 Winter Issue

Background
Scientists are more and more moving towards communicating their science beyond conference talks, poster sessions, and journal publications to reach interdisciplinary fields of science, as well as the wider public and non-scientists. However, few scientists have received formal training on how to create and present a memorable conference talk, let alone communicate effectively to wider audiences. Therefore, one of the goals of PICES Advisory Panel on Science Communications (AP-SciCom) is to provide PICES members with training related to science communication. Past science communication workshops organized by AP-SciCom for PICES Annual Meetings have focused on video creation (2021), using the "And, But, Therefore" approach to structure science storeis (2022), and fact sheet development (2023). To give PICES members further support on developing these methods, AP-SciCom held several mini workshops that revisit some of those topics as well as explored the world of social media in science.

Workshop Overview
W8 "Science Jam" was held over three 30 minute morning coffee breaks. Attendees were invited to the workshop room during break, along with their coffee/tea/snacks, to learn about a specific science communication topic each day. The topics covered include:

Oct.28 A presentation about the AP-SciCom in the Future session.
Oct 29 Science Communication overview
Oct.30 Fact sheets
Oct.31 Social media

Each session started with a short presentation, followed by a participant activity, and time for discussion at the end. There was an average of about 20 participants at each session. Participants asked questions actively at each session and contributed to the end discussion by sharing personal experiences, diving deeper into questions, and brainstorming ideas.

Science Communication Overview

In the first session, we started with an overview of past PICES science communication activities, before diving into a refresher on the powerful story telling structure called "And, But, Therefore (ABT)". The ABT storytelling structure was developed by a marine scientists turned filmmaker, Andy Olson, in his book "Huston, we have a narrative". It is an effective way to communicate in an engaging and compelling way, by drawing connections between different parts of information. Scientists tend to communicate by listing all the details, data, and results on top of each other. This turns into an "and, and, and" structure that our brains are less likely to engage with. Using this narrative structure can help scientists deliver their knowledge and research in a way that any audience; including the public, policy makers, and even other scientists; is more likely to understand, retain, and act on.

After the presentation, workshop organizers used their own research to provide examples of the ABT structure. Then participants had opportunity to create a narrative for their research. Workshop facilitators walked around to answer questions and participants were invited to share their ABT narrative with the group.

Fact sheets

The second session focused on using "fact sheets" as a science communication format. AP-SciCom organized a larger workshop on fact sheets at PICES-2023, where much more detailed information and training was provided (See workshop report in PICES Press Winter 2024 edition). The objective was to give PICES members a tool to advertise and share PICES science, with the goal of eventually having a fact sheet for each of PICES expert groups. This year's mini follow-up session provided PICES members another opportunity to learn more about them, ask questions, and get individual support from the PICES communication team.

The main purpose of the fact sheet is to communicate Expert Group key points in a consistent, clear, and concise format and connect the reader to find more information. They can be used to effectively communicate the work of Expert Groups to a variety of audiences, including the broader science community, policy makers, managers, and the public, and increase organizational recognition about the value and relevance of scientific work being conducted under PICES. They also provide a simple way to communicate PICES science to potential collaborators and aid them in identifying with which Expert Groups they are most closely aligned, while at the same time sparking interest and encouraging them to ask for more information.

The revised fact sheet template used in this year's workshop is available for all PICES members to use on the AP-SciCom page of the PICES website, under products. The current version is an Adobe fillable form, which simplifies the process and streamlines consistent formatting. As an example, AP-SciComm created a fact sheet for PICES as an organization (figure 1). The main sections include: 1) Introduction, 2) The Issues, 3) Current work. The "More Information" section is also important so the reader can easily learn more, find related resources, and know who to contact.

SCIENCE ORGANIZATION
PICES

North Pacific Marine Science Organization - PICES

An intergovernmental science organization to promote marine research in the North Pacific and its adjacent seas.

Participants of the 7th International Zooplankton Production Symposium

KEYWORDS

Scientific Knowledge

Intergovernmental

Collaboration

Diversity

Interdisciplinary

MORE INFORMATION

www.PICES.int

Introduction

PICES is an intergovernmental science organization established to promote and coordinate marine research in the North Pacific and its adjacent seas. Its members include Canada, Japan, People's Republic of China, Republic of Korea, Russian Federation, and USA. The PICES structure is designed to promote the collaboration and rapid exchange of scientific information through scientific committees, expert groups, advisory panels, and scientific programs with international participation. Jointly organized scientific sessions and workshops occur at PICES Annual Meetings.

The Issues

PICES coordinates international research on various issues that span the North Pacific Ocean, from the physical and biological foundations of marine systems, such as biogeochemistry and phytoplankton production, to the dynamics of the highest trophic levels, including fisheries and socioeconomic systems. International cooperation has led to dramatic advances in our understanding of the North Pacific's natural and socioeconomic systems providing tools and knowledge to inform solutions to current and future issues.

Current Work

- Partnerships for solutions during the United Nations Decade of Ocean Science for Sustainable Development.
- The integrative science program, FUTURE, seeks to understand how marine ecosystems in the North Pacific respond to climate change and human activities.
- Working Groups on diverse topics such as climate extremes, small fishes, and seamount ecology.
- Cross-cutting expert groups on Early Career Professionals and Science Communications.
- Scientific engagement in a climate conscious manner, considering environmental justice, equity, and diversity in planning meetings with the worldwide scientific community.

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Figure 1. Fact sheet for PICES that was provided as an example at the workshop and presented as a poster in the poster session.

After the overview presentation, participants were given fact sheet template handouts and time to start creating their own. There was also time for discussion and questions. Using fact sheets as a communication tool was well received by participants, especially when provided with a simple and structured template.

Social Media

The last session focused on using social media as a channel for science communication. Social media can be used, among many things, to spread your research more widely to have a greater impact; build collaborations with other scientists; or keep updated with current research. We looked at some of the research done on using social media as a platform for science, such as the impact it can have on spreading awareness. Social media research also looks at the dynamics and trends of different social media networks, which can be helpful in choosing which to share your research on.

We gave a short overview of some networks, starting with the ones PICES currently uses. This includes Youtube, X (formerly Twitter), Facebook, and Linkedin. Each of these differ in terms of their general audience and the format content is produced in (eg. Video content on YouTube versus short written text on X). While these platforms are available and used widely in North America, Raphael Roman described platforms that are more commonly used in Asia, including KakaoTalk, LINE, WhatsApp, WeChat and Weibo (figure 2). We noted that social media trends change rapidly and to focus on recent research and information that will best reflect the current state of social media. As an example, PICES started an account on Blue Sky shortly after this workshop.

After the presentation, participants had the opportunity to practice making their own social media post. Each participant was asked to choose a platform of their chose to post on and choose one of the two prompts provided to create a post about: Option 1 – “PICES members research highlights” (describe your own research in 3 sentences or less) or Option 2 – "PICES 2024 takeaways” (describe a key point you will take home from PICES 2024). Participants had the option to use their own existing social media accounts or have the facilitator post on their behalf via the PICES account. During the activity workshop organizers were available to answer questions and facilitate discussion.

To get a sense of what participants preferences are, we also had a Slido Poll displayed asking “What is your preferred Social Media Platform for following PICES”? We had responses from 13 participants, out of the 15 present, who could choose one or more from the list of platform options (figure 2). YouTube had the greatest number of votes, followed by X and Linkedin.

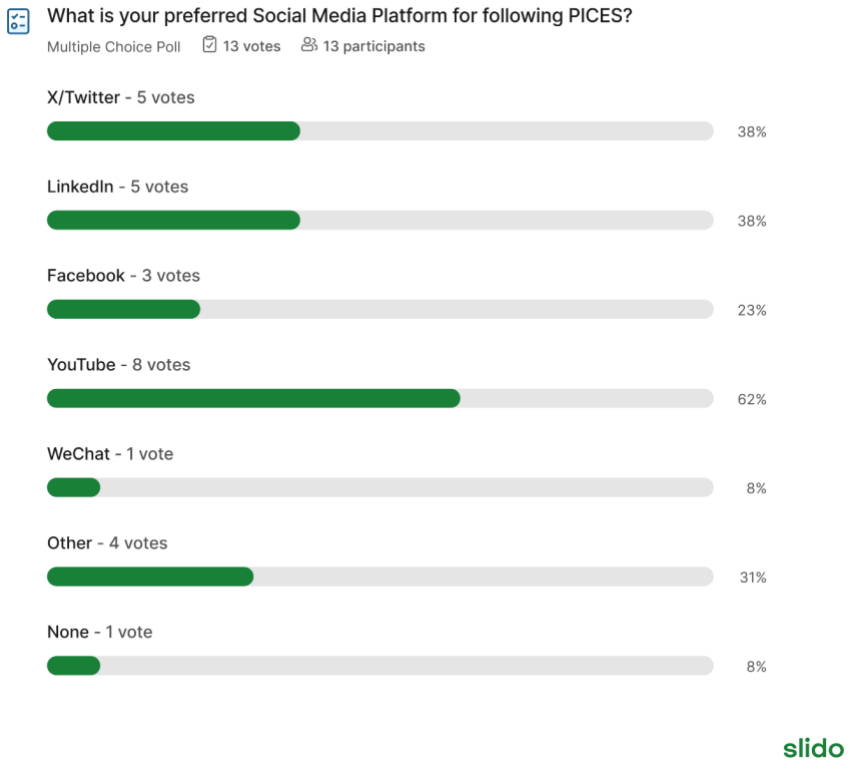

Figure 2. Results of a Social Media Survey of workshop Participants.

Conclusions

A recurring theme throughout PICES 2024 was the importance of science communication. Many workshop participants expressed a keen interest in building their science communication skill set and gave positive feedback about the workshop. AP-SciCom is here to continue providing the PICES community with science communication skills, tools, and resources needed.

W9: BIO Topic Workshop

Puffin diet samples as indicators of forage nekton availability and community structure in the North Pacific

Convenors:
William Sydeman (USA), Patrick O'Hara (Canada)

Invited Speakers:
Yutaka Watanuki (Japan)

Description

Marine predators have been put forth as samplers of poorly known forage nekton in remote coastal ecosystems. The Aleutian Archipelago is uniquely situated between sub-tropical and sub-arctic biomes in the Northcentral Pacific, and is a "hotspot" of biodiversity for upper level consumers. Longitudinal variation in water mass characteristics, as well as large-scale current and tidal transport of waters across the archipelago promotes high levels of primary and secondary productivity, but sampling of secondary production is lacking. Climatic events, including a long-lasting marine heat wave and apparent shifts in the PDO, also suggest substantial recent changes in key forage species, with lagged effects now appearing in the populations of some trophically-dependent predators. Fortunately, several long-term (1970-present) datasets on the diets of seabirds exist for the region, but these data have yet to be fully analyzed to understand variability and trends in meso- to epipelagic food webs through space and time. In this workshop, we will examine statistical and other approaches which could be used as indicators of forage availability, data available from coastally-foraging puffins (tufted, horned, and rhinoceros) from the Aleutian marine ecosystem. Puffins return "bill loads" of freshly caught fish and squid to colonies where they may be sampled for species, mass, size, and proximate composition. Sampling using puffins offers opportunities and challenges that must be examined in order to interpret dietary datasets properly, and use them in marine ecosystem ecology and management. We anticipate a report on analytical approaches for the use of puffin diet as indicators of forage nekton will result from this workshop.

No Summary Report received (Feb 11, 2025)

BECI Special Workshop

Bringing together models for fisheries management under climate change – Multiple model ensembles and inference to guide decision-making

Convenors:
Vivitskaia Tulloch (Canada), Kathryn Berry (Canada), Phoebe Woodworth-Jefcoats (USA)

Invited Speakers:
Kathy Mills (Gulf of Maine Research Institute, GMRI, USA)
Kalei Shotwell (Alaska Fisheries Science Center, NOAA, USA)

Description

The Basin-scale Events to Coastal Impacts (BECI) project is a UN Ocean Decade project led by the North Pacific Marine Science Organization (PICES) and North Pacific Anadromous Fish Commission (NPAFC), with goals of providing decision support to detect and predict ecosystem impacts and inform fisheries management under climate change.

The primary goal of this workshop is to enhance regional marine ecosystem modelling in a changing climate. We will bring together scientists with existing, proposed or work-in-progress ecosystem, biophysical and multispecies marine modelling approaches based in the North Pacific, which either already include, or have the capacity to include or couple to, climate and/or environmental drivers. We plan to focus on models that include target species of salmonids, groundfish, and/or small pelagic fish, but approaches with other focal components are welcome.

We will review the different approaches and assess their candidacy to contribute to a proposed North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME). The NOMEME builds upon work in development for the Southern Ocean, facilitated by the Fisheries and Marine Ecosystem Model Intercomparison Project (FishMIP) 2.0 protocol, and aims to reduce uncertainty and build confidence in regional marine ecosystem models (MEMs) as ecosystem-based management tools in a changing climate. Marine ecosystem model ensembles can assist policy and decision making by projecting future changes and allowing the evaluation and assessment of alternative management approaches.

The outcomes of this workshop will include progress towards a protocol for bringing together multiple models in an ensemble approach at a regional scale for the eastern region of the North Pacific and provide a foundation for these ensembles to be developed for other regions. We also hope to advance discussions about the role, utilization, and limitations of MEMs to fisheries decision-making. The workshop outcomes and next steps will be communicated in a post-workshop report.

We are hosting an online seminar on related topics, alongside Ocean Decade Programmes Blue Food Futures, FishScore, SmartNet and Supreme on September 30th, 2024. For more information visit:

NOTE: the report below is modified from the articles in the PICES Press 2025 Winter Issue

Introduction
Predicting marine ecosystem and species responses to climate change is not easy and presents significant methodological challenges. Current modeling approaches and the robustness of their predictions vary due to selection of climate models, future emissions scenarios, differences in climate information integration by ecological models, and structural differences in ecosystem model configurations. This uncertainty and variability is inherent within the estimation and prediction of climate change impacts, how they will be distributed, and how they will vary across species and fisheries, and constrains our ability to make robust decisions.

While still in the planning stages of its work, the BECI project convened a workshop on October 26, 2024, as part of the PICES annual meeting, to address some of the issues constraining our ability to understand and manage climate impacts in the North Pacific. The BECI workshop had four objectives:

1. **Community:** to bring together scientists with existing or work-in-progress related to ecosystem, biophysical and multi-species marine modelling approaches in the North Pacific which include, or have the capacity to include, fisheries and climate/environmental drivers;
2. **Knowledge:** to better understand existing efforts in the North Pacific to model regional marine ecosystems in a changing climate;
3. **Tools:** to review different models and assess their candidacy for inclusion in a proposed North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME), a key BECI initiative, and develop potential approaches for building out the NOMEME;
4. **Future:** to scope some of the challenges and opportunities associated with moving forward with ecosystem-scale research pertaining to climate change and fisheries management in the North Pacific.

Representatives from all six PICES member countries (Japan, China, Korea, Russia, USA. and Canada) attended the workshop, including representatives from Regional Fisheries Management Organisations (RFMOs) as well as oceanographic, marine ecosystem, and fisheries modelers (see table of attendees in *Appendix 1*). The workshop began with an introduction to the BECI project, followed by two invited speakers: Kirstin Holsman (Alaska Fisheries Science Center, NOAA) and Phoebe Woodworth-Jefcoats (Pacific Islands Fisheries Science Center, NOAA).

Setting the Context: Basin-Scale Events & Coastal Impacts (BECI)
The BECI project was co-developed by PICES and the North Pacific Anadromous Fish Commission (NPAFC) and is endorsed by the UN Decade of Ocean Science. PICES provides administrative hosting for the project, which is currently funded by the BC Salmon Restoration and Innovation Fund. As a project, BECI is focussed on better understanding the impacts of climate change, which is significantly impacting the world's oceans and marine resources, including exploitable fish stocks across the North Pacific. BECI's overarching goal is to support ocean and coastal management under increasing climate variability by providing future-focused decision support based on advanced transboundary ocean and climate change science. There is a need to coordinate international efforts across the North Pacific to assess biological impacts of climate-driven changes to future marine resources, particularly for transboundary species and common fishery resources. BECI will build on the existing international partnerships of PICES and NPAFC to bring people together to work as a collective. Because the North Pacific is so large, BECI is strategically focussed on areas of work based on fishes and regions of interest and hopes to launch coordinated working groups to enhance scientific progress and collaboration on issues that extend beyond areas of national jurisdiction.

BECI's first three initiatives are focussed on modelling and data integration:

1. The North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME) - the focus of the October 26th workshop;
2. Ensemble models of salmon scenarios to inform fisheries management and conservation of linked species of concern;
3. North Pacific Ocean Integrated Information System (NPOISS) a framework for a federated, integrated information system to bring together environmental, climate and fisheries data from across the North Pacific, including all six PICES member states.

All three initiatives aim to improve data sharing capacity and collaborative efforts, enhance the interoperability of diverse data sets, enable scientific synthesis, and make robust scientific predictions about the state of the North Pacific Ocean, and the critical fisheries species who call it home. The outputs of BECI will support a variety of ongoing projects, including enabling and supporting PICES annual ecosystem status reporting, as well as strengthen engagement with and collaboration between PICES scientists, projects, and working groups.

Setting the Context: North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME)
Viv Tulloch, BECI's Modelling lead, spoke about the NOMEME initiative, the need for greater certainty in the face of climate change, as well as some of the ways the BECI team is proposing to move forward with this work in the next few years. Multi-model or ensemble approaches can reduce uncertainty and improve reliability of predictions. The NOMEME that has been proposed will combine multiple disparate marine ecosystem models (MEMs) linked to climate drivers, to help support and guide fisheries management decisions under uncertainty. This builds on work currently underway by colleagues in the global Fisheries and Marine Ecosystem Model Intercomparison Project (Fish-MIP), and NOAA's Climate Ecosystems and Fisheries Initiative (CEFI), to reduce the uncertainty around

some climate-ready fisheries decision making. A stepwise approach was proposed for the NOMEME for bringing together the regional models across the North Pacific, increasing in complexity and capacity/resource needs.

Stage 1 – cross-regional comparison of existing regional models to inform common broad ecological indicators

Stage 2 - update/develop new models and ensembles addressing research needs and knowledge gaps; rigorous historical model calibration, standardised inputs, and model evaluation to address uncertainty (as per Fish-MIP, CEFI, the Alaska Climate Integrated Modeling Project (ACLIM), and the Gulf of Alaska Climate Integrated Modeling Project (GOA-CLIM)

Stage 3 - Management strategy evaluation/scenarios of alternative futures.

Tulloch explored the ways BECI proposes to help with decision-making in the North Pacific ecosystems and fisheries by following principles of decision science to reduce as much uncertainty as possible. One way to think about the work that BECI proposes is as a toolkit that addresses the needs, values, and concerns at regional scales, with relatively standardised approaches, so that a basin-scale understanding is possible. Starting from clear objectives articulated by collaborators, partners, and decision-makers, such as RFMOs in the region, we can help coordinate efforts and build a suite of tools to help answer key questions and provide information to help guide and support decision-making.

Setting the Context: Building on Other Collaborative Initiatives – CEFI and FishMIP

NOAA's Climate Ecosystems and Fisheries Initiative (CEFI)

Kirstin Holsman spoke next about NOAA's Climate Ecosystems and Fisheries Initiative (CEFI) a US-wide initiative to develop climate-ready ecosystems and fisheries advice. CEFI is comprised of four connected decision-support pillars: a suite of robust forecasts and projections of ocean conditions for use in developing climate-informed advice; the operational capacity to assess risks, evaluate options and provide advice on adaptation to changing conditions; increasing decisionmaker capacity to use climate-informed advice to reduce risks and increase resilience of marine resources and the communities that depends on them; and validation and innovation through continuous observations and research. Each of these pillars is focussed regionally, to provide culturally specific information and advice to those who need it most in a rapidly changing world.

NOAA's Alaska Fisheries Science Center leads the regional CEFI work in the North Pacific, specifically building on the work of ACLIM and GOACLIM (Gulf of Alaska Climate Integrated Modeling) projects, which aim to inform Alaskans about the risks of climate change, especially on fish and fisheries, and enable the evaluation of a range of adaptation strategies. The experience of the snow crab collapse was sudden and destabilizing in Alaskan communities and it is hoped that the increased funding for CEF provided via the Inflation Reduction Act will help provide necessary and timely climate-ready advice to help avoid similar losses in the future.

Community engagement has been a hallmark of this work in Alaska, so that communities, decision-makers, fishers, Alaska Native Tribes and other stakeholders had appropriate, culturally sensitive information to guide their decisions about marine ecosystem health and population abundance of key species that are relevant economically and culturally, and that climate advice is well-matched to the needs of the community. Multiple types of scenario planning are investigated, including quantitative, operational or event driven, goal-oriented or normative, and strategic management scenarios, allowing for specific advice to be developed from modelling. Of resonance to BECI's goals is the work happening to better understand the impacts of climate change on salmon and the communities that depend on the Yukon River. It incorporates both scientific and traditional ways of knowing about the Yukon River Drainage system to deliver culturally competent scientific advice and predictions.

Fisheries and Marine Ecosystem Model Intercomparison Project (Fish-MIP)

Phoebe Woodworth-Jefcoats was the final invited speaker and spoke to her work with FishMIP), an international collaboration of ecosystem modellers working to bring together diverse MEMs to help better understand and project the long-term impacts of climate change on fisheries and marine ecosystems. Phoebe summarized the work of the FishMIP project in the North Pacific. FishMIP utilizes an ensemble modelling approach to compare the results of multiple ecosystem models when those models are forced by a standard group of environmental and climate inputs and simple fishing scenarios. Marine ecosystem models can vary widely in what ecosystem components are represented and linked together. Comparing the results when those models are forced by standard drivers and scenarios can help elucidate differences, strengths and weaknesses of various models in specific scenarios and regions. Currently FishMIP is running simulation experiments to evaluate models for how well they detect past ecosystem and fisheries changes. FishMIP is part of the ISIMIP project, the Intersectoral Impact Model Intercomparison Project, which offers a framework for comparing how models from diverse sectors and scientific disciplines respond to standard climate forcing and scenarios. The environmental and climate forcing data that

FishMIP modellers use in their comparisons is freely available from the ISIMIP platform, as well as from FishMIP modellers directly. Additional collaborators and modellers are invited to join this effort, which has already demonstrated success in informing policy and management (Blanchard and Novaglio, 2024).

Figure 1. Workshop presenters and attendees

Discussion

Discussion during the workshop was open and free-flowing, allowing participants opportunities to share their knowledge and experience and learn from one another. Members of the BECI staff team took notes during these discussions and the following is a summary of some of the key themes that were discussed throughout the workshop.

Fisheries Species of Interest

Important fished species in the North Pacific mentioned by the participants included Pacific salmon (*Oncorhynchus* spp.), Pacific halibut (*Hippoglossus stenolepis*), Pacific hake (*Merluccius productus*), Pacific bluefin tuna (*Thunnus orientalis*), Japanese and Pacific sardine (*Sardinops spp.*), and Pacific saury (*Cololabis saira*). These species vary regionally in their importance (e.g. between the Northeast and Northwest Pacific), but all face transboundary issues and have at least some reliance on open ocean environments, making them good focal species for BECI.

Pacific salmon are significant species of interest in the North Pacific and have a complex, anadromous life history. Since salmon stock assessments are conducted for individual stocks, it was suggested by some participants that regional or basin-scale approaches may be too large in scale and that approaches to understanding salmon dynamics based on individual stocks, populations, or conservation/management units should be considered. Other participants noted a range of conservation and management actions that can be informed using ecosystem models, not simply stock assessments, and highlighted the need for ecosystem-scale research to adequately understand salmon ecology and approach an Ecosystem Approach to Fisheries Management (EAFM). Salmon are complex to research and to model appropriately, as they have both freshwater and saltwater components in their life histories and, while well studied in coastal ecosystems, much less is known about the fate of salmon in the open ocean beyond boundaries of national jurisdiction.

Participants agreed that sardines (*Sardinops* spp.) might also be an important fisheries group across the North Pacific. While Japanese sardine (*S. melanostictus*) is an important fished species in Japan and was also recently detected off the West Coast of the United States, Pacific sardine (*S. sagax*) is of interest to fisheries in Canada (British Columbia), the USA (especially California), and Mexico (Baja California). This might help to make further north-south and east-west connections among models, as well as increasing collaborations between modelling communities and decision-makers along the California Current and on either side of the Pacific. Pacific saury are also very important to fisheries in the Western Pacific, and they are known to occur offshore in the Eastern Pacific (e.g., the southern Gulf of Alaska), but much less is known about their fate in the Northeastern Pacific because they are not commercially valuable there. Participants suggested that surveying and modelling Pacific saury might provide key insights into forage fish populations and predator-prey dynamics across the Pacific.

Scale: Basin Scale and Regional Approaches

While individual stock assessments and models are mostly adequate for their purposes, there is little existing work to connect local/individual stock assessments and models into wider analyses at the scale at which many species are distributed, as well as the scales at which climate change is operating and affecting marine environments and species. Transboundary research, and work to fill the gaps between population-level assessments and connect individual ecosystem models, will increase in importance in the coming years. There is a need to better include, understand, and assess data for both stock assessment and environmental indicators beyond boundaries of national jurisdiction.

Transboundary Fish Populations

Participants acknowledged that there are real gaps in understanding the movement and population structure of transboundary fish populations, and in modelling them accurately, across the North Pacific Basin, and discussed some ways that BECI might be able to contribute to solving some of those issues. The complexity of salmon life history, combined with the siloed data repositories and non-standardized data and models across the North Pacific nations, means that while we know that salmon are moving across the boundaries of national jurisdictions, and into new niches they had not previously exploited, it is difficult to make decisions based on the patchwork of data and models that are available. There is a mismatch between the scales of climate change, the scales at which species are distributed and moving, the scales and scope of current modelling efforts, and the scales at which managers need information and are making decisions. This will require a concerted and collaborative effort across nations and management agencies to improve and resolve. Participants highlighted a clear need to connect relevant researchers along the eastern North Pacific to address these challenges.

For many species, coordination of regional modelling work would be critical to inform knowledge gaps and management questions. Several participants shared about the difficulties of collaborating internationally for several reasons, including present geopolitical situations, differences in management frameworks, international policies and a lack of data sharing. As a result, decisions are made to manage fisheries at a national level when only part of the story is known. Although ecosystem models are ideal for addressing these issues, it was suggested that even sharing or obtaining better biological data on species abundance and distribution between the Northwest and Northeast Pacific would be very useful for management, especially in the case of transboundary species such as halibut. Currently it is hoped that genomics work will help to better understand the size and extent of the halibut populations in the Western Pacific, but this information is a real gap in current management practices.

Time Scales of Interest

Representatives from RFMOs participating in the workshop were asked about the time scales that are relevant for their management decision processes. For halibut management, the actionable or tactical advice period would be useful in three-year horizons, while strategic advice is considered over a longer term - up to 100 years of prediction of halibut populations can be useful for management processes.

Pacific Salmon Treaty negotiations occur every nine years. Fisheries stocks and environmental conditions are changing faster than our management processes and both the US and Canada need to better understand the implications of changing environmental conditions. If the countries involved understood the future of fisheries in the North Pacific, then negotiations would be more meaningful. Without that clear picture of the future, countries are negotiating without really understanding what they are fighting for. In that sense, advice fit for long-term management strategy is useful as far out as can be accurately predicted.

Participants raised that the decadal scale might be useful to inform both fisheries management and to understand and predict regime shifts and tipping points. This is especially the case when understanding interactions with competitor, predator, or prey species for the target fishery populations. An example was given by a participant about the length of sardine booms – the length of time that the sardine population booms and then recedes in the North Pacific might be a helpful signal to predict as it may allow for better understanding or prediction of fish density and predator-prey dynamics. Further, participants agreed that predictions on the scale of the next 10-20 years are of particular interest: global predictions have long suggested a pause or change in the rate of warming in the North Pacific, but that has not been observed in all locations across the North Pacific. A better, more precise, understanding of the rates of change in the North Pacific Ocean would be helpful.

A participant shared that in their work engaging coastal communities, there is less interest in long-term predictions, which are more difficult for community groups to contemplate. Indigenous communities are wanting short-term advice and predictions about fisheries stocks, as well as hyper-local or downscaled advice – for these

audiences and end-users, basin-scale and long-term information and advice is helpful to understand, but less useful operationally.

Data Integration

There is a need for data integration across the North Pacific to make any modelling endeavor work. Currently data is a patchwork, especially beyond borders of national jurisdiction. If starting from an ensemble of regional models in the Northeast Pacific, there will be a real need to understand data availability to parameterize and force models in the Western Pacific, to ensure accuracy across the basin. Participants also discussed the lack of data standardization even across regions in the Northeast Pacific: Alaska is especially data rich, and NOAA makes all its data publicly accessible, but there may be differences across states and the US-Canadian border. Canadian First Nations, Alaska Native Tribes, and other Indigenous communities own their own data and may be willing to share some access to data for specific questions but may not be willing to make that data publicly accessible, or even accessible to managers and scientists within a federated framework. Participants agreed that there are methods that can be employed to solve some of these challenges, however.

Currently, RFMOs are managing transboundary fish species, making do with the data they have available. Accessing data from other countries and from beyond areas of national jurisdiction would be helpful, as currently only a patchwork of data from the open ocean is available. A participant described this as trying to explain the plot of a story while only reading alternate chapters. Another BECI initiative is to develop a framework for a North Pacific Ocean Integrated Information System, so BECI will hopefully be able to support data integration in the future. Participants agreed that if a project affiliated with PICES takes this on, it may have salutary benefits for the PICES community.

Modelling Approaches and Drivers

Participants discussed some of the attributes of different global climate models that can be used as drivers for the NOMEME model ensemble. The relevance, suitability, and utility of using global climate model outputs for the North Pacific versus waiting for downscaled high-resolution outputs (in development by CEFI) were discussed, as well as the need for standardised environmental inputs across ecosystem models to enable adequate comparison of outputs. One participant suggested that it might be less important to get the specific environmental drivers all matching correctly, and more important to get the ecosystem relationships and structure of the food web right. This is where ensemble methods will play a key role. Participants discussed some needs around better interconnection between different models, modelling communities and even breaking of silos among researchers. For complex salmon life cycles, there is a real need to connect estuarine and river models of salmon stocks and the marine models. Some participants thought that this might be useful, even for marine-only species (such as saury, halibut, and hake) because it might lead to better understanding of riverine and estuarine inputs into the coastal ocean and how these mediate open ocean signals. There is plenty of great estuarine and river modelling happening for salmon across the Northeast Pacific, but the models do not all "talk to each other" nor do the researchers working on them. Additionally, participants agreed that there were more models needed to predict and understand salmon dynamics in the open ocean basin, as opposed to in the coastal ocean, shelf and slope, which are better studied.

Collaboration

Discussions throughout the workshop concluded that there is a plethora of models to build a model ensemble from in the Northeast Pacific, and that this would be a good first step towards thinking about building a model ensemble for the whole of the North Pacific. It was also suggested that BECI's work in building a NOMEME can identify gaps where more specific models might be necessary or useful. The information gained from a well-executed model ensemble in the Northeast Pacific can also be utilized to determine where the next efforts should be made to improve data or models, or which knowledge gaps need to be better understood to improve future work. Participants agreed that the NOMEME should not attempt to reinvent the wheel, but rather to lean on existing networks and communities of researchers to join in a large-scale collaboration.

For BECI to succeed, the team will need to build effective working groups and collaborations to contribute to the end goals. Participants shared some ideas about how BECI might incentivize collaboration, including ensuring that collaborator's needs and time are respected, that the collaborators have opportunities to raise their own profiles, both within the collaboration, and in the wider scientific community and that the collaborators involved understand and agree to be accountable to each other. The urgency to understand climate change's impact on North Pacific fisheries may accelerate these collaborations. Participants agreed that climate change's significant effects on fish survival and marine resource-dependent communities provide strong motivation for this work. As one participant

stated, we have already seen the snow crab and Atlantic cod fisheries collapse, we are now past the 'nice to know' phase and into the 'need to know' phase.

BECI is continuing to engage with modelers, researchers, and practitioners working in the North Pacific on ecosystem-scale problems relating to fisheries and climate change. A virtual discussion group will be initiated in early 2025 bringing together these modelers, researchers, and practitioners to advance the BECI initiatives, including building out the NOMEME protocol for the Northeast Pacific, with eventual expansion to the Northwest Pacific.

Workshop outcomes and next steps

A key goal of the workshop was to bring together the community of ecosystem modellers in the North Pacific who were attending the PICES Annual Meeting. Workshop participants were encouraged to review and contribute to a working draft database that summarises recent ecosystem models across the North Pacific that include fisheries management and include, or have the capacity to include, climatic drivers. A map detailing the spread of these ecosystem models across the North Pacific Ocean was generated after the workshop, identifying some of the spatial overlap and gaps in ecosystem modelling efforts to date (Fig. 2).

This map and the models represented therein will be used to guide and inform next steps of the project, including choice of focal region and species for a pilot regional NOMEME protocol. We are continuing to engage with modelers, researchers and practitioners working in the North Pacific on ecosystem-scale problems relating to fisheries and climate change. A virtual discussion group will be initiated in early 2025 bringing together these modelers, researchers and practitioners to advance the BECI initiatives, including building out the NOMEME protocol for the east Pacific, with eventual expansion to the west Pacific region.

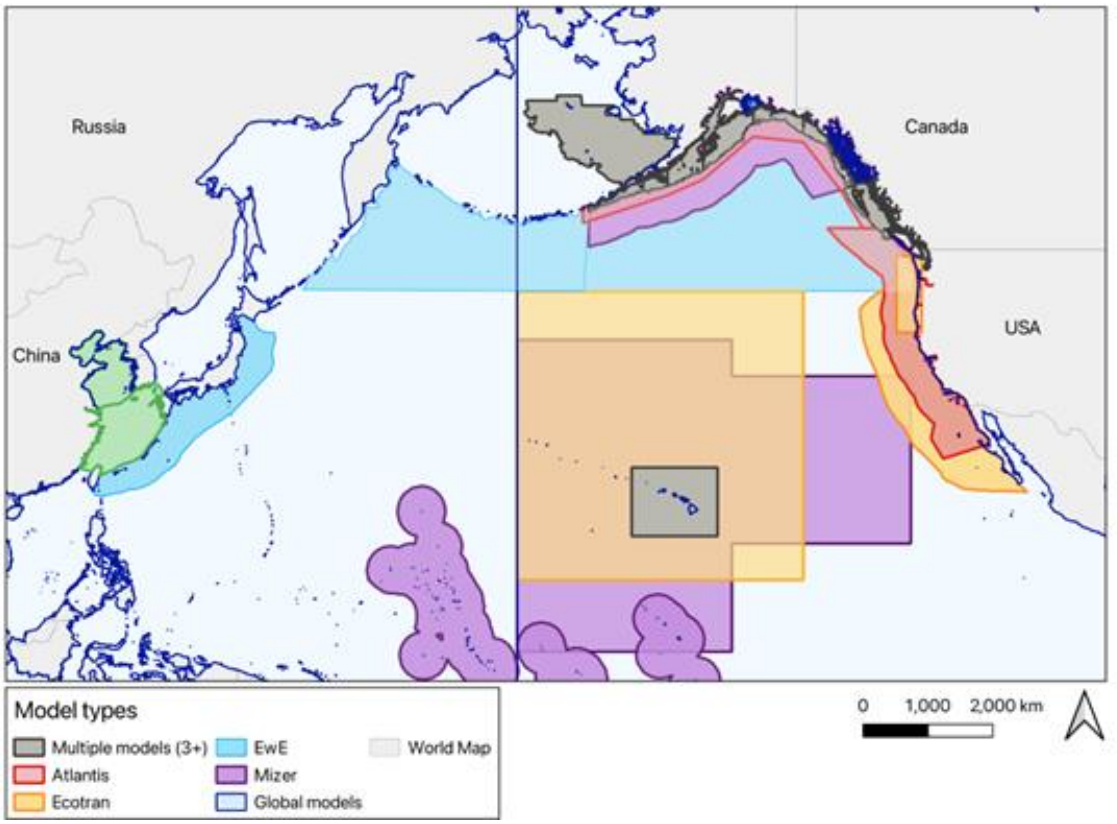

Figure 2. Known regional marine ecosystem models in the North Pacific suitable for inclusion in the proposed model ensembles (references for models included here are available by request and are not listed here due to space limitations).

Conclusion

The BECI project represents a critical collaborative effort to address the urgent challenges facing North Pacific marine ecosystems in the era of climate change. By bringing together scientists from all nations within PICES, the project is already helping to build a community focused on ecosystem-scale insights and solutions for fisheries management and conservation. The North Pacific Ocean Marine Ecosystem Model Ensemble (NOMEME) is not just a technical endeavor, but a strategic approach to understanding transboundary fish populations, reducing uncertainty in climate predictions, and supporting decision-makers across different regions and communities. As the project moves forward, its success will depend on continued collaboration, data integration, and a shared commitment to addressing the profound environmental changes transforming marine ecosystems. With the urgency underscored by recent fisheries collapses and rapid climate shifts, BECI's work transitions marine science from a "nice to know" to a "need to know" phase, offering hope for more informed and adaptive management of our precious marine resources.

References

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**NB – references for models included in Fig 2 are available by request and are not included here due to space limitations*.

Workshop participants

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