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PICES Science in 2023 — Notes from the Science Board Chair

Sukyung Kang

2023 was a year marked by record-high temperatures, and October 2023 was the warmest October on record. PICES-2023 was held from October 23-27, 2023, in Seattle, a seaport city on the West coast of the United States. Hosted by the US National Oceanic and Atmospheric Administration (NOAA) in coordination with the PICES Secretariat, this meeting assessed PICES' progress to date, and set a path for the rest of the United Nations Decade of Ocean Science for Sustainable Development. I am sure that all of you who had the opportunity to attend PICES-2023 in person or virtually would agree that it was a truly memorable meeting. What becomes evident to me is that our PICES scientific community is very vibrant: we have strong friendships and collaborations among scientists, and our science is dynamic, cutting-edge, and well-recognized.

PICES-2023 was the largest Annual Meeting ever. In total, we welcomed 672 attendees, including 76 virtual participants. These attendees included 244 Early Career Ocean Professional (ECOP) in-person participants, and observers from 20 international and regional organizations and programs. There were 19 Science Board/topic/paper sessions, 11 workshops, and 22 business meetings. Participants were encouraged to use the Whova app to access the updated schedules, communicate with each other, and review organizer announcements. 70% of participants used the Whova app. (PICES-2023 awards,

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PICES Science Board meeting 2023. Front Row L-R: Akash Sastri (BIO Chair), Sung Yong Kim (MONITOR Chair), Sukyung Kang (SB Chair), Sanae Chiba (PICES Deputy Executive Secretary). Back Row L-R: Jackie King (FIS Chair), Hannah Lachance (ECOP), Jeanette Gann (SB-Vice-Chair, TCODE Chair), Andrew Ross (MEQ Vice-Chair), Mitsutaku Makino (HD Chair), Hanna Na (FUTURE-SSC Co-Chair), Steven Bograd (FUTURE-SSC Co-Chair).

sessions, workshops, and statistics are detailed in this issue). At the Opening ceremony, we took a moment to recognize individuals who have contributed significantly to our organization. The PICES Chair Award was given to Dr. Robin Brown (Canada) for his sustained dedication to scientific activity and administration of PICES. The Wooster Award was presented to Dr. Steven J. Bograd (USA) for his long-term and ongoing excellence in research and teaching of North Pacific marine science. The PICES Ocean Monitoring Service Award (POMA) was given to the Chinese Harmful Algae Bloom monitoring and research programs. It started as the nationwide coastal red tide monitoring in 2004, contributed to disaster reduction and protection of the marine ecological environment, and expanded the monitoring efforts through 3 GEOHAB programs. Finally, the Zhu-Peterson Early Career Scientist Award was presented to Professor Minkyoung Kim (Korea), a co-chair of the Advisory Panel on Early Career Ocean Professionals (AP-ECOP), who makes valuable contributions to PICES science through her work on marine biogeochemistry and paleoceanography researches. The participants at the Opening Session were in a celebratory mood, praising the achievements of these individuals and one group with long-lasting applause (More details of the award recipients are presented in the awards article that follows).

Highlights of the Annual Meeting

PICES-2023 covered a broad range of timely and relevant marine science issues under the theme *"Connecting Science and Communities for Sustainable Seas."* Eric Quaempts, the Director of the Department of Natural Resources Confederated Tribes of the Umatilla Indian Reservation, gave a keynote presentation and introduced the approach to inspire learning and progressive, ecological work on First Foods in the interest of the Umatilla Tribes. Many presentations were fully or partly related to the UN Decade of Ocean Science (UNDOS). Dr. Matthew Savoca, one of the Science Board Symposium invited speakers, presented an inspirational talk entitled "*Across the Boundary: Internationally Coordinated Science and Action is required to Tackle Chemical Pollution in Marine Ecosystems*" He introduced the Global Plastic Ingestion Bioindicators (GPIB) project, which is hosted by the Ocean Decade Programme *Sustainability of Marine Ecosystems through Global Knowledge Networks* (SmartNet). Dr. Vivitskaia Tulloch, the first winner of the FUTURE ECOP award, applied a Social–Ecological–Environmental System (SEES) Framework to address and manage future climate change impacts on threatened killer whales and their Pacific salmon prey. Professor Shoshiro Minobe emphasized

the importance of advancing our capacity for marine biological forecasting for the success of the UN Decade of Ocean Science, for which one of seven desired outcomes is *"A Predicted Ocean."* Lastly, Professor Nianzhi Jiao introduced the interdisciplinary global Ocean Negative Carbon Emissions (ONCE) program of the Ocean Decade.

This year's other topic sessions focused on deep learning, extreme weather and climatic events, small pelagic fish to extreme events, anticipated and realized effects of climate change, non-indigenous species, emerging pollutants, seamount diversity, and more. Also, a special session was held to celebrate 100 years of science-based fishery management of the International Pacific Halibut Commission (IPHC). All session participants listened and contributed to discussions covering the scientific issues associated with *Connecting Science and Communities for Sustainable Seas*. I extend my sincere thanks to all the speakers and conveners.

One of the impressive activities at PICES-2023 was the

mentoring program, organized by AP-ECOP. A total of 26 mentor-mentee pairs were developed based on their background information and preferences. This program was completed with great success, was beneficial to both mentors and mentees, and will boost PICES' engagement opportunities for ECOPs. The AP-ECOP members agreed to continue this scheme as one of the top priorities for 2024. They discussed the need for guidelines and follow-up communication with the 26 pairs so that they can decide whether and/or how they can continue the mentorship sessions after the Annual Meeting.

Science communication is a crucial aspect of modern society. It helps bridge the gap between scientific disciplines, research, and the general public, making scientific knowledge more accessible and understandable to everyone. To bolster science communication skills within PICES, workshop 1 was held as part of a continued series of workshops hosted by the Advisory Panel on Science Communications (AP-SciCom). Entitled *"Creating Concise and Compelling Fact Sheets to Amplify your PICES Work,"* the workshop provided an excellent opportunity to analyze the goals and objectives of PICES expert groups and to describe their achievements concisely and clearly. I recommend that all expert groups review the AP-SciCom workshop report, to help groups create their own fact sheets and share their PICES Science.

PICES engagement with the UN Decade of Ocean Science for Sustainable Development

PICES has two science programs (FUTURE and SmartNet). FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) is the flagship science program of PICES, and SmartNet is a joint UNDOS-endorsed program sponsored by ICES and PICES. The FUTURE Scientific Steering Committee (SSC) is preparing a product matrix paper to evaluate the success of FUTURE in addressing the PICES Science Plan. The tentative title of the paper is *"Climate Variability and Ecosystem Resilience in the North Pacific; Lessons Learned from the PICES FUTURE Program."* Since a critical component of Phase III of FUTURE is engagement with the UN Ocean Decade, identified gaps and lessons in scientific advancement derived from the paper will help to set a path for the rest of the Ocean Decade.

The UN Decade is a valuable opportunity to build upon the existing collaborations, networks, and infrastructure of ICES and PICES, so SmartNet has a focus on several cross-cutting themes that the program wants to invest its efforts in and promote to advance marine science and sustainability: Promote ECOP activities, Enhance Science Communication, Involve Indigenous Community, Small Islands DevelopingStates, Empower Women in ocean science and Innovate for greener ocean science. SmartNet has 5 task teams (writing, survey, outreach, network, and capacity-sharing teams) to achieve its program goals. It should be noted that a 'global survey' led by the survey team will provide us with information about the public perceptions of the Ocean Decade.

Upcoming PICES activities

At PICES-2023, PICES Governing Council (GC) agreed to support one new working group WG-DATA. This group was built upon the recommendations of the Study Group on Encouraging Data Awareness and Increased Transmission and Accessibility (SG-DATA) and will address the need for an enhanced data, metadata, and information management and data sharing plan within PICES.

At the conclusion of PICES-2023, Profs. Xianshi Jin (FIS, China), Guangshui Na (MEQ, China), and Dr. Andrew Ross (MEQ Acting Chair, Canada) completed their term as Committee Chairs and Acting Chair. I sincerely acknowledge their valuable contributions to committees and Science Board activities. From the conclusion of the 2023 Annual Meeting, Drs. Jackie King (FIS, Canada) and Thomas Therriault (MEQ, Canada) started their terms. We want to welcome them to PICES Science Board and welcome their leadership.

PICES is expected to play a leading role in the Ocean Decade. Looking ahead to 2024, we have several exciting PICES-organized or sponsored events planned, including ICES-PICES 7th International Zooplankton Production Symposium, which will be held in Hobart, Australia, 17-22 March 2024, and the Marine Socio-Ecological Systems (MSEAS) Symposium, which will take place in Yokohama, Japan, June 3-7, 2024. MSEAS will bring scientists together to discuss the study and management of marine ecosystems, especially the human dimension aspect. Both symposia are endorsed as official UN Decade of Ocean Science activities.

Finally, our next Annual Meeting (PICES-2024) will take place in Honolulu, USA, with the theme *"The FUTURE of PICES: Science for Sustainability in 2030"*. I look forward to seeing you in Honolulu and other venues of PICES-hosted events in 2024.

Sukyung Kang
Science Board Chair


PICES-2023
PICES
Oct 23–27 • SEATTLE, USA

Congratulations to PICES-2023 Award Recipients

About the PICES Chair Award

The PICES Chair Award was established in 2016. It is given for sustained contributions to the development of the Organization that have allowed it to meet the purpose as set out in the PICES Convention: to promote and coordinate marine scientific research in order to advance scientific knowledge of the area concerned and of its living resources, and to promote the collection and exchange of information and data related to marine scientific research.

PICES-2023 Chair Awardee: Robin Brown

The winner of the PICES-2023 Chair Award is Mr. Robin Brown. For those who have joined the PICES community in relatively recent years, Robin may be most recognized as the former Executive Secretary of PICES. However, he has contributed to PICES for three decades. Since its dawning period he took the role ("persuaded" in his words) of the first Chair of the Technical Committee on Data Exchange (TCODE) in 1995, where he helped establish the foundation of current TCODE functions. As the committee Chair post means his membership of the Science Board (SB), he also served as a SB member till 2001. During the development of the new PICES flagship program FUTURE from 2009 to 2012, he chaired one of the Advisory Panels for FUTURE - Status, Outlooks, Forecasts, and Engagement (SOFI). He also served as a Finance and Administration Committee (F&A) member and Canadian advisor and alternate delegate to the Governing Council (GC). Lastly, he served as PICES Executive Secretary from 2015 to 2020.

The years when Robin led the PICES Secretariat coincided with the first-ever UN Ocean conference with the Sustainable Development Goal 14 *"Life Below Water,"* followed by the emergence of the UN Decade of Ocean Science. Working with international partners, Robin put his efforts into the promotion of PICES in the global community and set the direction of PICES's role in the new era of Ocean Science. Even now in retirement, his role as a liaison to various partner organizations and projects is crucial to PICES Science.

"PICES is a stronger, more engaged and networked, and a more relevant scientific organization because of Robins' efforts over the past thirty-one years"

~Andrew Thomson, Canadian National Delegate

Robin appreciates and is proud of the cultural diversity of our community as the "fun" part of the PICES tradition which may be the driving force for generating genuine international collaboration. Robin attended the first PICES meeting in 1992 and has rarely missed one since, including PICES-2023 in Seattle. Congratulations Robin! Thank you for your dedication to the PICES community in the past , present, and future, too!

About the PICES Wooster Award

In 2000, PICES Governing Council approved the Wooster Award, named in honour of Professor Warren S. Wooster – a principal founder and the first Chairman of PICES, and a world renowned researcher and statesman in the area of climate variability and fisheries production. The Award selection criteria are: sustained excellence in research, teaching, administration or a combination of the three in the area of North Pacific marine science. Special consideration is given to individuals who have worked in integrating the disciplines of marine science, and preference is given to individuals who were or are currently actively involved in PICES activities.

PICES-2023 Wooster Awardee: Dr. Steven Bograd

The winner of the PICES-2023 Wooster Award is Dr. Steven Bograd, a senior oceanographer at the NOAA Southwest Fisheries Science Center in Monterey, CA, who also teaches budding oceanographers as an Adjunct Professor at the University of California, Santa Cruz.

Steven was born and grew up in Mississippi, USA, but has spent most of his adult life on the West Coast. After receiving his PhD in physical oceanography from the University of British Columbia, Steven did a post-doc at Scripps Institute of Oceanography before joining NOAA in 2001. Steven's research interests encompass climate impacts on marine ecosystems, with a focus on eastern boundary upwelling systems. He has led many projects collaborating with biological oceanographers, including the decade-long *Tagging of Pacific Predators* project (https://gtopp.org), through which his interdisciplinary efforts have been widely appreciated. Steven has won 3 NOAA bronze medals during his career.

Steven has been part of the PICES community his entire career for 30 years, since attending the first PICES Annual Meeting in Victoria, BC, in 1992. Everyone in the PICES community knows and is amazed at his tireless dedication to PICES activities. Steven has contributed to the development of the PICES flagship science program, FUTURE, in the early 2010s, and served as its Co-Chair from its launch in 2014. This also means that he has served on the PICES Science Board since then. He also Co-Chairs the Advisory Panel on the UN Decade of Ocean Science for Sustainable Development (AP-UNDOS) and co-leads two United Nations Decade of Ocean Science Programmes (SmartNet and SUPREME).

Some readers may not be familiar with the traditional selection protocol for PICES Awards. All PICES Awardees are selected in a fully confidential manner, with only the selection committee members, Secretariat, and the nominators of the awardee knowing the selection outcome, which is kept a secret from the awardees and any others until the very moment of the Annual Meeting Opening Ceremony award presentations. This keeps the awards a surprise, and explains why most awardees arrive at the stage to accept their awards in very casual outfits. The announcement of the Wooster Award is the main event among all awards, for which Secretariat and the nominators of the awardee team up to prepare a memorable presentation to show at the ceremony. This year, the gang who joyfully took part in the mission are: Elliott Hazen, Matthew Savoca, Barbara Muhling, Erin Satterthwaite, and Emanuele Di Lorenzo, under the secret code name "Operation Lima Bean" (see next page for the back story). Steven's wife, Xuhua and daughter, Zoya also joined the team.

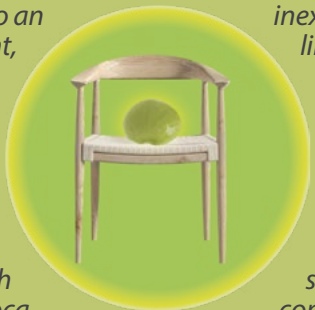
Upon the announcement of Steven's name at the ceremony, Matt and Erin ran up the podium to send back to back congratulatory messages along with slides full of Steven's photos that the gang secretly collected from his friends and family. Matt and Erin are the Zhu-Peterson Awardees of PICES 2021 and 2022, and represent many early career ocean scientists inspired by Steven's passion for science. Steven has been enthusiastic about mentoring budding scientists, and they appreciated Steven's mentorship for their successful career development. The presentation was followed by heart-warming video messages from his friends, from long-lasting research mates to early careers who respect him as the "guru" of oceanography.

Steven gave characteristically humble acceptance remarks, excited but in his usual shy way of speaking with a smile, as we expected. The criteria of the Wooster Award says scientific excellence, promotion of young scientists, and contribution to the PICES science. However, looking at every past winner, another important criterion may be – though not written anywhere – how much they are respected and loved by the PICES community.

Congratulations Steven! May the seeds you have sown bloom across the world's ocean!

😊 "Operation Lima Bean" - the backstory 😊 *(by Elliot Hazen)*

"It's a funny story from Ocean Sciences in Portland, Oregon in 2018. About 20 of us went as a lab to an Ethopian restaurant. It was a very festive night, dark and misty outside but warm and jovial inside the restaurant. During the din of the evening meal, something tickled Steven's nose and he let out a gigantic sneeze in the direction of Matt Savoca who was sitting directly to his left. In the hushed aftermath of Steven's explosive sneeze, the air in the Ethiopian restaurant seemed to thicken with an unspoken cosmic significance. Matt Savoca, rattled by the sudden burst, excused himself with a mysterious urgency, leaving behind a room cloaked in uncertainty. As the door swung closed behind him, the atmosphere inside shifted, the warmth of the celebration replaced by an enigmatic chill.



In the void left by Matt's departure, Steven discovered an inexplicable anomaly on the vacated seat – a lone lima bean, untouched and perfectly formed. The restaurant's patrons exchanged puzzled glances, their laughter now tempered by an unspoken realization that something beyond the realm of ordinary understanding had transpired. "Operation Lima Bean" was quietly initiated, with Steven's investigative venture into the origins of this cosmic legume: its presence suggesting a connection to forces beyond the comprehension of Ocean Sciences. Little did they know, this seemingly innocuous incident would unfurl a tapestry of mysteries that reached far beyond that misty night, weaving together threads of laughter, fear, and an inexplicable cosmic dance that defied the boundaries of their scientific understanding."

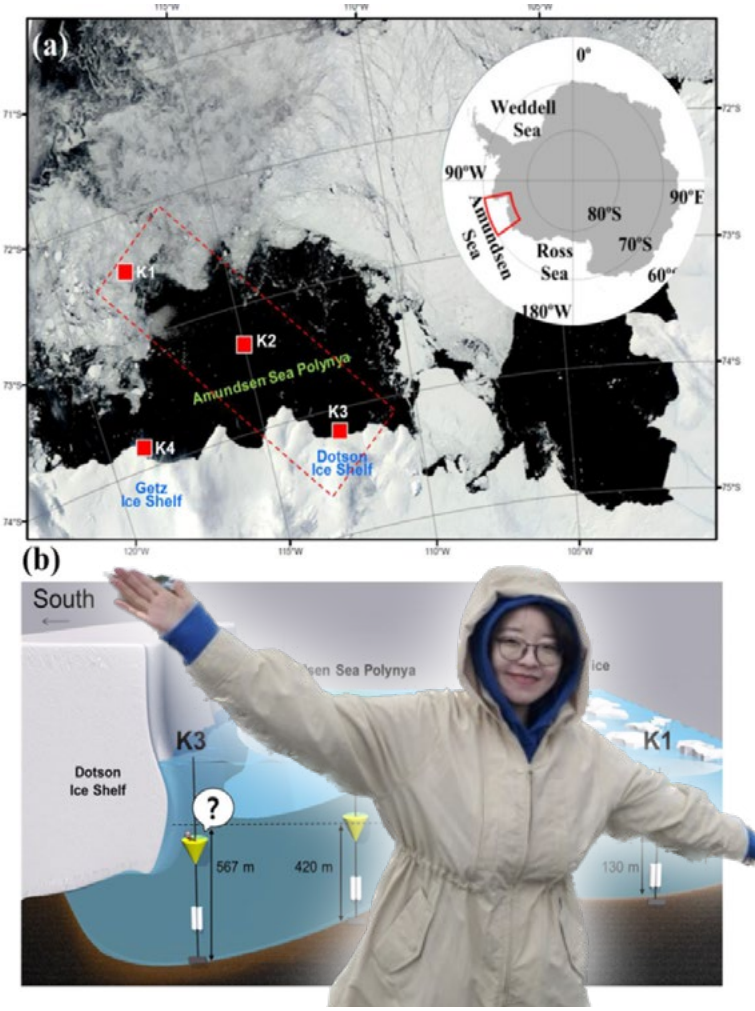
About the PICES Zhu-Peterson Award

The Zhu-Peterson Award was established in 2019, and is named in honor of the late Professor Minguan Zhu, (above, left), formerly of the First Institute of Oceanography, State Oceanic Administration (now Ministry of Natural Resources), China, and the late Dr. William Peterson, (above, right), formerly of the Northwest Fisheries Science Center of NOAA, USA. Professor Zhu and Dr. Peterson were strong advocates for encouraging early career marine scientists to become engaged in PICES activities. This Award is given annually to an early career scientist who has performed innovative research at the frontier of science relevant to the PICES mission, as set out in the PICES Convention. Professor Zhu trained many graduate students and early career scientists, who carry on his legacy of honest enthusiasm for cooperative approaches to marine science research. Dr. Peterson was cherished by his students, technicians, and PICES early careers who regarded him as a *"great teacher, and a fun, humble and inspiring mentor."* Zhu and Peterson passed away far too early in their prime, while still actively engaged in their scientific interests. PICES honours the memories of their contributions with this Award.

PICES-2023 Zhu-Peterson Awardee: Dr. Minkyong Kim

Dr. MInkyoung Kim, Assistant Professor of Kyungpook National University, won the PICES-2023 Zhu-Peterson Award. She received her PhD from Seoul National University in 2019, with which she won the best PhD dissertation award from the Korean Society of Oceanography. She finished her postdoctoral activity at ETH Zurich, Switzerland, and Seoul National University in April 2021, and worked as a senior researcher at KIOST(Korea Institute of Ocean Science and Technology) by August 2021, before starting her career at Kyungpook National University.

Minkyoung is a chemical oceanographer who has studied the biogeochemical cycle, particularly mechanisms of particulate carbon transport using sediment trap samples. She is an active ocean-goer who has participated in many observation cruises in PICES regions, and the Arctic and Antarctic Oceans. She has already published 17 peer-reviewed journal papers and has given presentations at more than 40 scientific conferences (as of March 2023).



In the PICES Community, she is one of the Co-Chairs of AP-ECOP and leads its Mentor Task Team. She is known for her enthusiasm not only for scientific research but also promotion of early career scientists and women in science. This has made her the recipient of more than 15 awards including Korea's LOREAL-UNESCO for Women in Science Awards, (Korea, 2023); King-Munmu's Ocean Awards-Early Career Scientists, (Korea, 2022), and the first prize of Ministry of Maritime Affairs and Fisheries (Korea, 2021).

Congratulations Minkyoung!
May your future career continue to shine and flourish!

About the PICES Ocean Monitoring Service Award (POMA):

PICES created the Ocean Monitoring Service Award (POMA) in 2007 aiming to recognize organizations, groups and outstanding individuals that have contributed significantly to the advancement of marine science in the North Pacific through long-term ocean monitoring, data management and sharing, and innovative advances in ocean monitoring. Monitoring programs are often taken for granted or even targeted for budget cuts when organizations experience financial constraints. With this in mind, the POMA award strives to enlighten the PICES community on the importance of those activities as fundamental to understanding marine environmental and ecosystem change. The Award promotes the collection and exchange of information and data related to marine scientific research in the North Pacific.

PICES-2023 Ocean Monitoring Service Awardee: HAB monitoring and research programmes in China

PICES-2023 POMA was bestowed upon the *"Harmful Algae Bloom (HAB) monitoring and research programmes in China,"* marking the first time that a Chinese-based monitoring program has been recognized with this award since the establishment of POMA.

The programme was motivated by the occurrence of a massive dinoflagellate bloom and its impacts on the coastal environment in tens of thousands of square kilometres off the Yangtze River estuary in the early 2000s. In 2004, the Ministry of Natural Resources set up nationwide coastal red tide monitoring areas (Figure) to monitor harmful algae species and toxins caused by those species. The project contributed to disaster reduction and protection of the marine ecological environment from HAB.

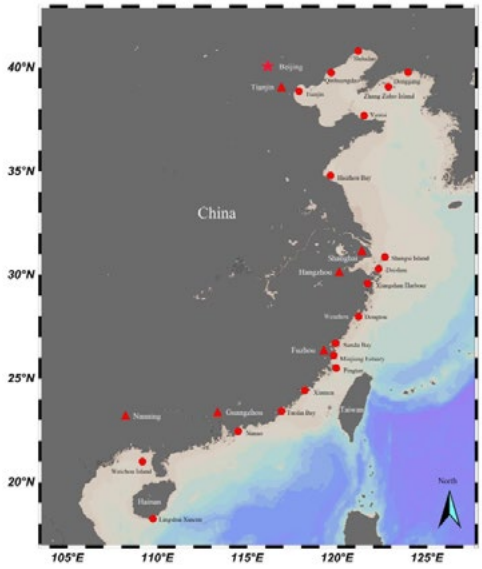


Figure 1. Distribution of 19 HAB (microalgae) monitoring areas in China's coastal waters. Each area has at least 6 monitoring stations.

With the support of the Ministry of Science and Technology and the National Natural Science Foundation of China, a number of national research projects have been initiated, such as the National Key Research Basic Development Program *"Ecology, Oceanographic Mechanism, Forecast and Prevention of the Occurrence of Hazardous Red Tides in China Offshore (2002~2006),"* *"Evolution mechanism and ecological security of recent algal blooms in China (2010~2014),"* and *"Formation mechanism, monitoring and prediction, evaluation and control techniques of disaster-causing red tides in China's coastal waters (2017~2021")*. These were endorsed by the SCOR/IOC Global Ecology and Oceanography of Harmful Algae Blooms (GEOHAB) as the Chinese GEOHAB (CEOHAB 1, 2 and 3, respectively).

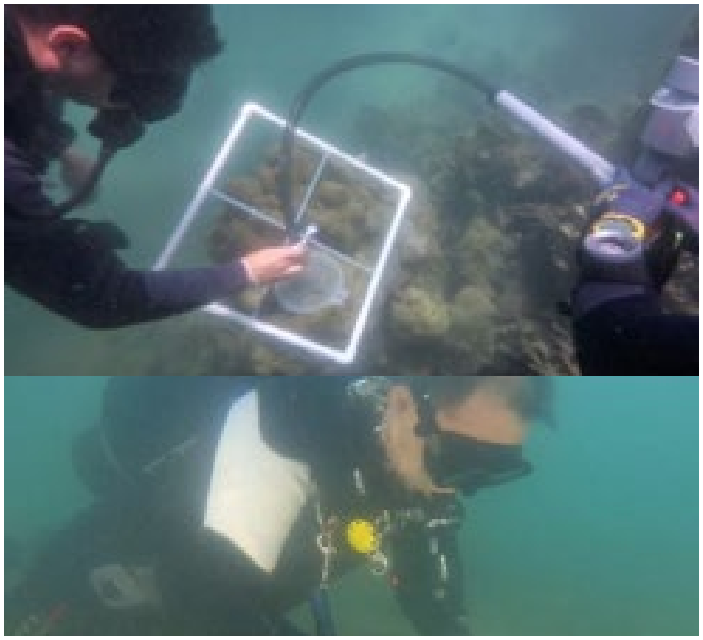


Figure 2. Benthic dinoflagellate samples collection in the southern coastal areas of China.

Over 300 scientists and 500 graduate students were involved in these monitoring and research projects in the past 20 years. The China HAB programme has made significant contributions to the progress of HAB science not only in China but also in the Northeast Pacific and globally. Additionally, it has trained a large number of HAB researchers, who are present on the international stage. Participant Research Organizations include: The First, Second, Third, and Fourth Institutes of Oceanography of the Ministry of Natural Resources and the National Marine Environmental Monitoring Center, Marine Science Institute, Chinese Academy of Sciences, the South China Sea Marine Research Institute, Jinan University, China Ocean University, Xiamen University, City University of Hong Kong, China Institute of the East China Sea Fisheries Research.

Congratulations to all scientists of HAB monitoring and research programmes in China. May your programmes be continuously successful and productive!

About the FUTURE ECOP SEES Award:

To further increase the capacity of the PICES community to understand and communicate the mechanisms that link climate processes and human activities to multi-scale ecosystem responses, a Social-Ecological-Environmental Systems (SEES) framework was developed (Bograd et al., 2019). The FUTURE ECOP SEES Award was established in 2019 to encourage Early Career Ocean Professionals (ECOP) to employ the SEES approach in their research. The FUTURE-SSC provides some travel support to an ECOP to attend a PICES Annual Meeting where the awardee presents their research highlighting the application of the SEES approach at the Science Board (or other plenary) Symposium.

FUTURE ECOP SEES Awardee: Dr. Vivitskaia J.D. Tulloch

The first-ever recipient of the FUTURE ECOP SEES Award is Dr. Vivitskaia J. D. Tulloch. She is a conservation decision scientist based at the University of British Columbia (UBC), Canada, where she studies innovative solutions for managing, conserving, and protecting marine species and natural resources, with a special interest in cetaceans. She presented her invited talk *"Application of a Social–Ecological–Environmental System Framework to address and manage future climate change impacts on threatened killer whales and their Pacific salmon prey"* during the Science Board Symposium on October 26. (See *FUTURE ECOP SEES Award* article in this issue for more information).

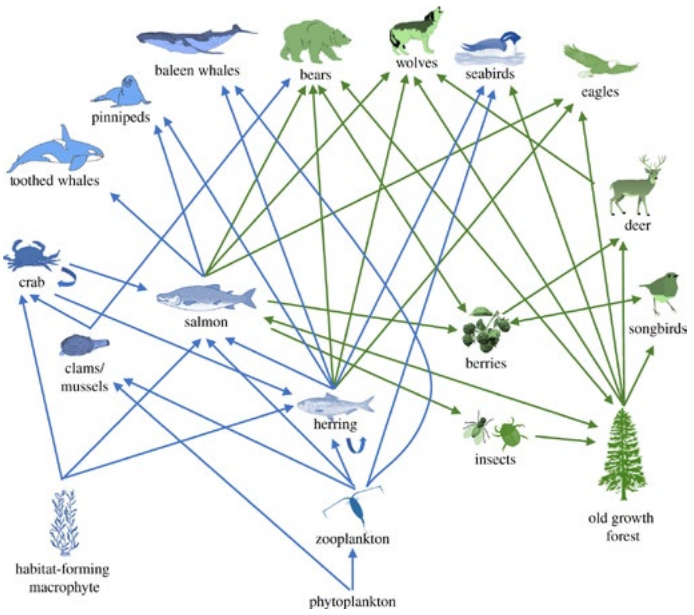


Figure 1. Conceptual risk pathways (food and biogenic habitat) for all the trophic groups of the ecosystem components considered, with land ecosystem components and pathways in green, and marine ecosystem components and pathways [29] identified by in blue. Pathways directionality is shown as one-way or two-way interaction arrows. From Tulloch, V. J., Adams, M. S., Martin, T. G., Tulloch, A. I., Martone, R., Avery-Gomm, S., & Murray, C. C. (2022). Accounting for direct and indirect cumulative effects of anthropogenic pressures on salmon-and herring-linked land and ocean ecosystems. Philosophical Transactions of the Royal Society B, 377(1854), 20210130.

Viv completed her Ph.D in Quantitative Decision Science and Ecological Modelling at the ARC Centre of Excellence for Environmental Decisions, University of Queensland, Australia, where she researched the impacts of multiple disturbances including climate change on coastal and pelagic systems. She has worked on a diverse range of problems globally, from inclusive regional cumulative effects assessment for salmon-linked ecosystems of British Columbia; to ridge-to-reef MPA planning across the Coral Triangle; finding cost-effective mitigation cetacean bycatch around Australia; and understanding the impacts of whaling and climate change on whales and krill across Southern oceans. Viv is a member of the IWC Ecosystem Modelling and Climate Change Subcommittees; and the Committee on the Status of Endangered Wildlife in Canada Marine Mammals Subcommittee. Viv is currently a Banting Postdoctoral Fellow at the University of British Columbia, where she is developing multi-species models to understand the effects of anthropogenic change on salmon and endangered killer whales.

Congratulations Viv on your award, and best of luck for a generative and fulfilling career!

PICES Early Career Ocean Professionals (ECOP) Best Presentation Awards

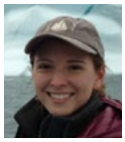
At PICES annual meetings, Early Career Ocean Professionals (ECOPs) are particularly encouraged to submit abstracts to present their work. These presentations offer an excellent opportunity for ECOPS to share their science, and also make these presenters eligible for the Best Oral/Poster Presentation Awards, chosen by PICES Scientific Committees.

Science Board

- **Best Oral: Yunzhou Li:** *How will China's stressed marine fisheries respond to climate change impacts? A social-ecological analysis of vulnerability and risk.* (Science Board Symposium: Connecting Science and Communities for Sustainable Seas).

- **Best Poster: Kyungsik Jo:** *Presuming the pathways of sea turtles by using δ18O values from commensal barnacle shell.* (Science Board Symposium: Connecting Science and Communities for Sustainable Seas).

FUTURE Science Program



- **Best Oral: Jessica Randall:** *Using otoliths to understand how marine heatwaves affect fish growth.* (Session 4: The Oceanographic, Ecological and Societal Impacts Arising from Extreme Weather and Climatic Events in Coastal Regions).

Biological Oceanography Committee

- **Best Oral: Anna K. McLaskey:** *Inter-specific differences outweigh seasonal variability in zooplankton trophic markers, revealing distinct roles within a complex food web.* (BIO-Paper Session).

- **Best Poster: H. William Fennie:** *Increased temperature decreases starvation resiliency in first feeding Sablefish (Anoplopoma fimbria).* (S11: Anticipated and realized effects of climate change on predatory fish, birds, and mammals of the North Pacific).

Fishery Science Committee

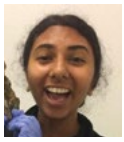
- **Best Oral: Andrea N. Odell:** *Spatiotemporal trends in weight and its potential implications for stock assessments* (S9: Understanding the implications of body size change for stock productivity and fisheries management).

- **Best Poster: Luke A. Bobay:** *Predicting larval northern anchovy (Engraulis mordax) abundance across space and time.* (S3: Responses of Small Pelagic Fish to Extreme Events in Pacific Ecosystems).

Human Dimensions Committee

- **Best Oral: Patrick Farnole:** *Framework for regional downscaling of climate modelling based on a co-designed traditional seasonal calendar, with the community of Ulukhaktok.* (HD-Paper Session).

Marine Environmental Quality Committee



- **Best Oral: Yaamini R. Venkataraman:** *Investigating the basis of thermal tolerance of a rapidly spreading crab.* (S6: The complex reality of managing Non-indigenous Species (NIS) in the North Pacific).

- **Best Poster: Olivia Boisen:** *Assessing potential drivers for microplastic ingestion by myctophids caught near the Columbia River mouth.* (S8: Session on the Occurrence and Ecological Impact of Emerging Pollutants in the Coastal Marine Environment).

Physical Oceanography and Climate Committee

- **Best Oral: Hikaru Homma:** *Distribution of acoustically detected marine organisms across Kuroshio Extension front associated with physical and biogeochemical environments* (S5: Multi-scale ocean processes and their impacts on marine ecosystems).

- **Best Poster: Wonkeun Choi:** *Evaluation of marine heatwave biases in the North Pacific Ocean simulated by the CMIP6 model.* (POC-Paper Session).

Technical Committee on Monitoring

- **Best Oral: Tatsuya Sakamoto:** *Consideration of the population dynamics of sardines in the western and eastern North Pacific on the basis of isotope chronologies.* (S10: Improved detection and understanding of factors affecting changes in North Pacific forage communities and implications to ecosystems).

- **Best Poster: Kelia E. Axler:** *Shifts in the distribution, size structure, and feeding of Arctic cod early life stages in a changing Pacific Arctic.* (S10: Improved detection and understanding of factors affecting changes in North Pacific forage communities and implications to ecosystems).

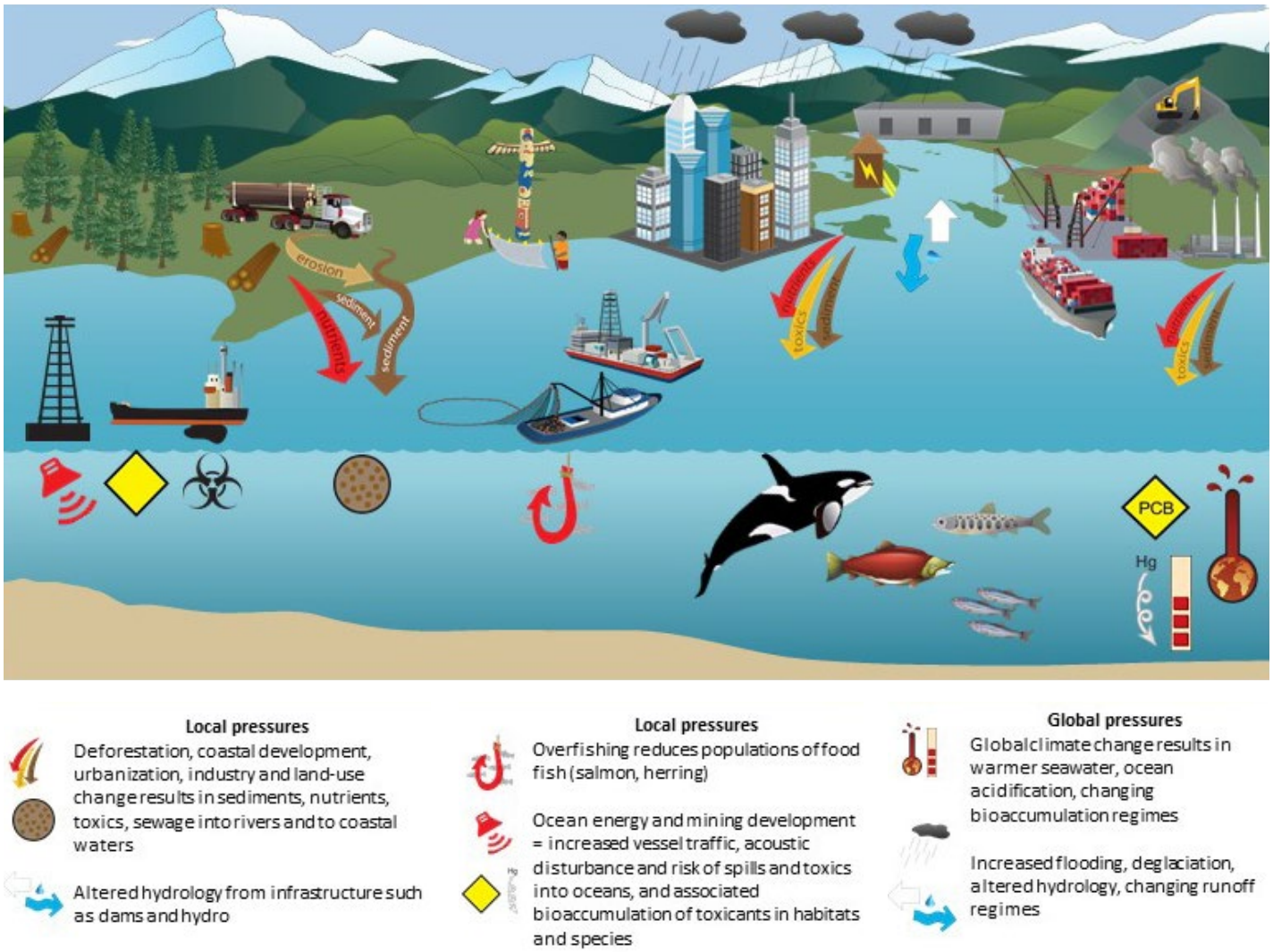
Technical Committee on Data Exchange

- **Best Oral: Hannah E. Kepner:** *Fine-scale spatial patterns of gelatinous zooplankton in the Northern Gulf of Alaska.* (S2: Applications of Deep Learning Systems in Marine Science).

- **Best Poster: Karlee E. Zammit:** *Automating the acoustic detection of Arctic ringed seal vocalizations using deep learning.* (S2: Applications of Deep Learning Systems in Marine Science).

Note from the FUTURE ECOP SEES Awardee

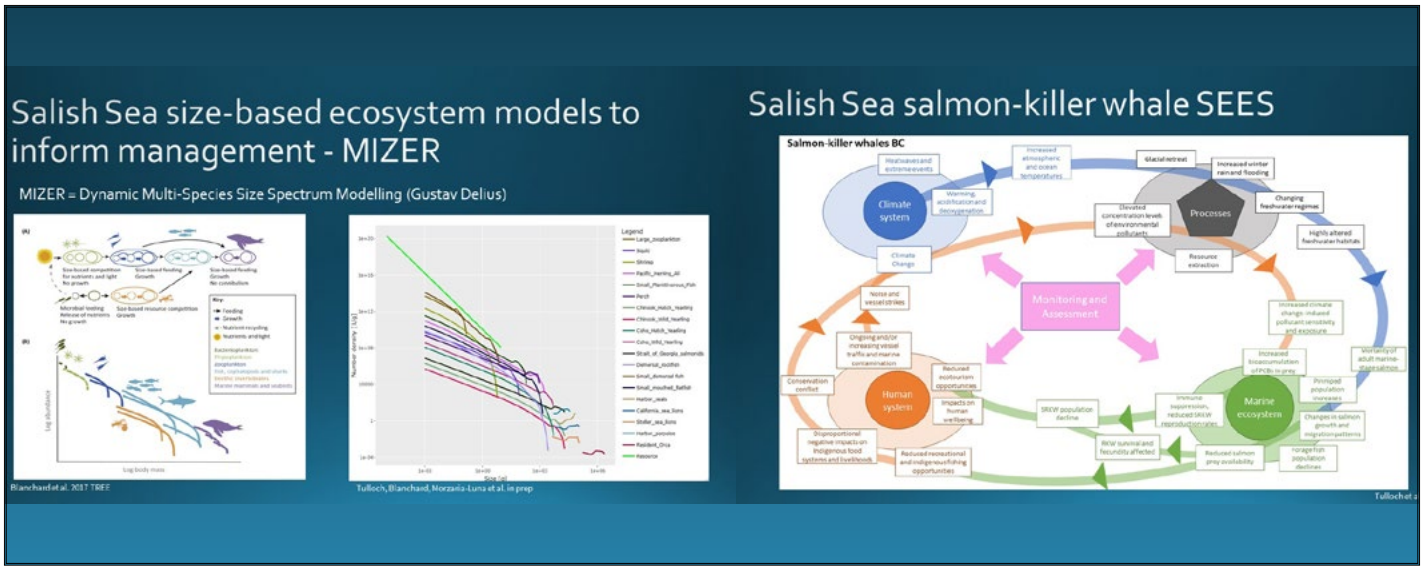
Vivitskaia J.D. Tulloch



I recently attended the Annual Meeting of PICES: North Pacific Marine Science Organisation in Seattle (PICES-2023) that ran from 22 to 27 October at the Westin Hotel Conference Centre. PICES is an intergovernmental science organization that promotes and coordinate marine research in the North Pacific and its adjacent seas. Its present members are Canada, Japan, China, Korea, Russia, and the USA. The theme of the conference was to connect science and communities for sustainable seas.

I am a conservation decision scientist researching innovative solutions for managing, conserving, and protecting marine species and natural resources, with a special interest in cetaceans. I completed my Ph.D in Quantitative Decision Science and Ecological Modelling at the ARC Centre of Excellence for Environmental Decisions, University of Queensland, Australia, researching the impacts of multiple disturbances including climate change on coastal and pelagic systems (see above). I've worked on a diverse range of problems globally, from inclusive regional cumulative effects assessment for salmon-linked ecosystems of British Columbia; to ridge-to-reef MPA planning across the Coral Triangle; finding cost-effective mitigation cetacean bycatch around Australia; and understanding the impacts of whaling and climate change on whales and krill across Southern oceans. I am currently a Banting Postdoctoral Fellow at the University of British Columbia, where I am developing multi-species models to understand the effects of anthropogenic change on threatened species of the Salish Sea.

I was invited to talk in the PICES-2023 Opening Plenary session of the Science Board, as the winner of the first Early Career Ocean Professional Award, on my recent predictive modelling research in the Salish Sea. My talk was titled *"Application of a Social–Ecological–Environmental System*



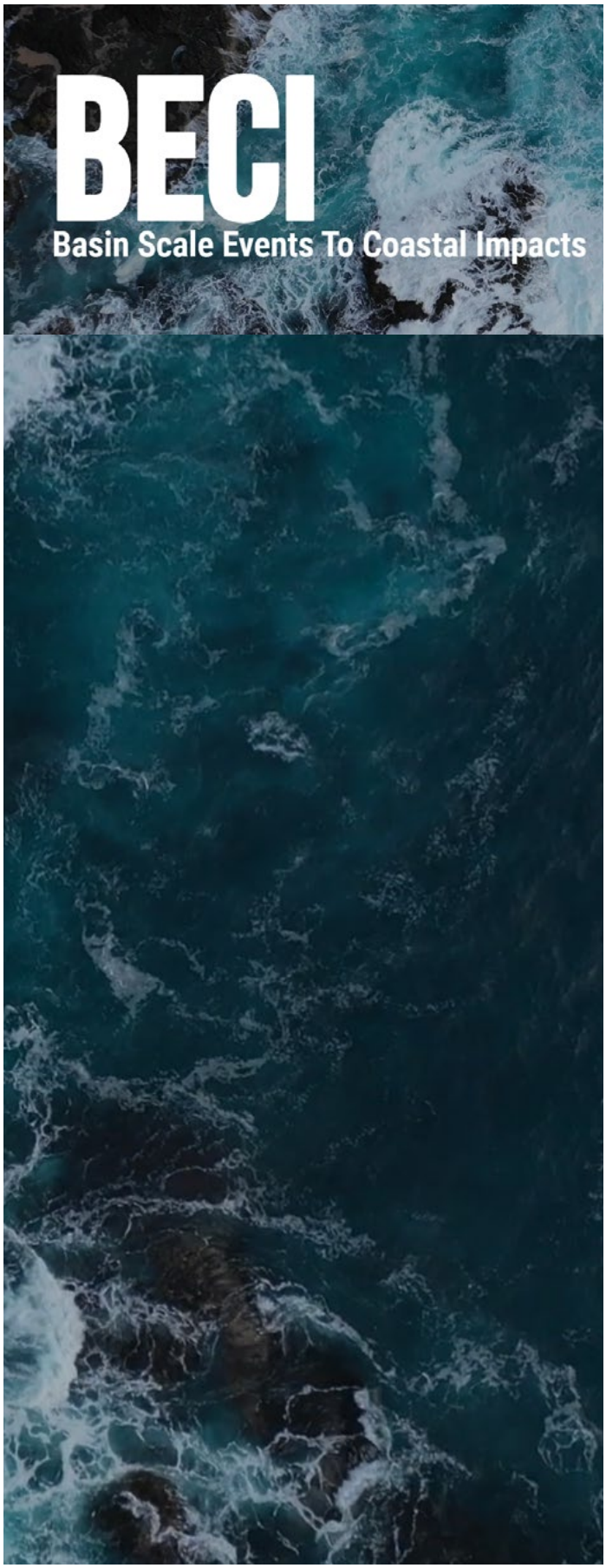
Framework to address and manage future climate change impacts on threatened killer whales and their Pacific salmon prey in the Salish Sea." The Salish Sea is one of the world's largest and most biologically-rich inland seas, encompassing Puget Sound, the San Juan Islands, Vancouver island, BC, and includes the large cities of Seattle and Vancouver. The name recognizes the Coast Salish peoples who were the sea's first stewards and who have lived here since time immemorial. More than 8 million people live in the highly urbanized region, which is experiencing high economic growth. By the year 2025, the population is expected to be over nine million. The region is home to iconic and culturally-important species with declining populations, resident killer whales (*Orcinus orca*), and Pacific salmon (*Oncorhynchus* spp.), supporting Indigenous and non-Indigenous food systems and livelihoods through sports fishing and whale watching. Southern Resident Killer Whales (SRKW) are directly affected by human activities in the form of pollution, noise, direct and indirect mortality from vessel traffic and marine contamination, and declines in salmon prey availability. The Salish Sea region is facing some important decisions right now about how climate change and increasing human population moving to the region, with increased pressure and reliance on land and ocean resources, which affect the animals and habitats on which we rely.

PICES recently conceptualized a social–ecological environmental–systems (SEES) framework. This was recently described by Bograd et al., in 2019. SEES was designed to identify and understand the linkages between climate forcing, oceanic processes, marine ecosystem responses (at multiple trophic levels and spatial scales), and the human system. At the PICES meeting, I presented a SEES for SRKW and salmon of the Salish Sea. In this framework I teased apart the feedbacks between the climate system, biological and chemical processes across land and sea environments, marine food web and human system, including both Indigenous and non-Indigenous components. I discussed linkages between winter and spring warming associated with climate change and projected negative impacts on ecosystem components, including salmon and SRKW.

My SEES framework highlights disproportional negative impacts on indigenous communities due to their dependence upon and close relationship with environment and resources. For many BC Indigenous communities salmon is the primary source of protein. When it is absent, it is replaced with cheap, unhealthy sources of protein, resulting in negative outcomes for health and livelihoods.

My presentation highlighted the need for more effective climate-informed management strategies that transcend jurisdictional and disciplinary boundaries, and improved compliance and enforcement of legally-binding guidelines to improve resiliency of killer whales, Pacific salmon, and dependent human communities to future change. I also presented preliminary findings from a quantitative size-based ecosystem model (MIZER) for the Salish Sea, that will be used to run scenarios and inform the SEES framework and management.

There were over 600 attendees from around the world at the meeting, and I was very grateful to be able to attend and present in the first session of the meeting. I especially enjoyed the presentations focused on solving pressing climate change issues facing fisheries and marine species in the North Pacific region. Stemming from my presentation, I had some successful side meetings with delegates from Fisheries and Oceans Canada (DFO), the National Oceanic and Atmospheric Administration (NOAA, USA) and the Northwest Fisheries Science Center USA. Discussions focused on building existing and new collaborations with scientists to further salmon and killer whale ecosystem modelling research. I look forward to the meeting in Hawaii!



Building BECI — Basin-Scale Events to Coastal Impacts

In 2017, the United Nations declared an urgent need to address alarming conclusions about the decline of ocean health, launching the United Nations Decade of Ocean Science and Sustainable Development (the "Ocean Decade" or "UNDOS"). The Ocean Decade (2021 – 2030) will address 10 Ocean Challenges and 7 Ocean Outcomes to deliver the *"Science We Need for the Ocean We Want."* The Ocean Decade will act as a convening framework for ocean stakeholders across the globe to advance ocean science, technology, research, and policy and management frameworks.

The Ocean Decade is being implemented through Ocean Decade Actions – comprised of programmes, projects, contributions, and activities. In 2021, the North Pacific Anadromous Fish Commission (NPAFC), and the North Pacific Marine Science Organization (PICES) submitted a request for the endorsement of the BECI (Basin-Scale Events to Coastal Impacts) Project, which was approved and formally endorsed in July 2021. As 2023 comes to a close, the BECI Project is pleased to announce $1.1M in funding from the British Columbia Salmon Restoration and Innovation Fund (BCSRIF).

The objective of the BECI project is to develop an international ocean intelligence system for the North Pacific Ocean that uses enhanced observations, numerical modeling, and data analytics infrastructure to provide timely and targeted information on the impacts of current and future climate events on ocean ecosystem. BECI will link increasingly extreme basin-scale climate events (such as marine heatwaves) to their impacts on North Pacific socio-ecological and coastal systems.

Building BECI

Designing BECI is no small task. As a first step, the BECI team started to develop a Science and Implementation Plan. In 2022, experts from across the Northern Hemisphere participated in four virtual workshops to assess our present capacity to assess climate effects on ocean processes, biological effects, and fisheries. These workshops considered appropriate climate change and fishery ecosystem models, approaches to monitoring and understanding biological production of the Northeast Pacific ecosystems, technologies and recent innovations to monitor and understand an environment the size and complexity of the North Pacific Ocean and its coastal ecosystems, and a special session on data management to apply to the BECI science plan. More information on the 2022 BECI Workshop Series can be found here.

In 2023, scientists from both sides of the Pacific Ocean convened at the Hakai Office in Victoria, B.C. for a hybrid workshop on developing the BECI Science Plan. Through consultation and discussion with experts and building off the 2022 BECI Workshop Series and lessons learned from the International Year of the Salmon (IYS) Initiative, five major components were identified as the basis of the BECI Project at this workshop. These five major components will be used to build out the BECI Science and Implementation Plan:

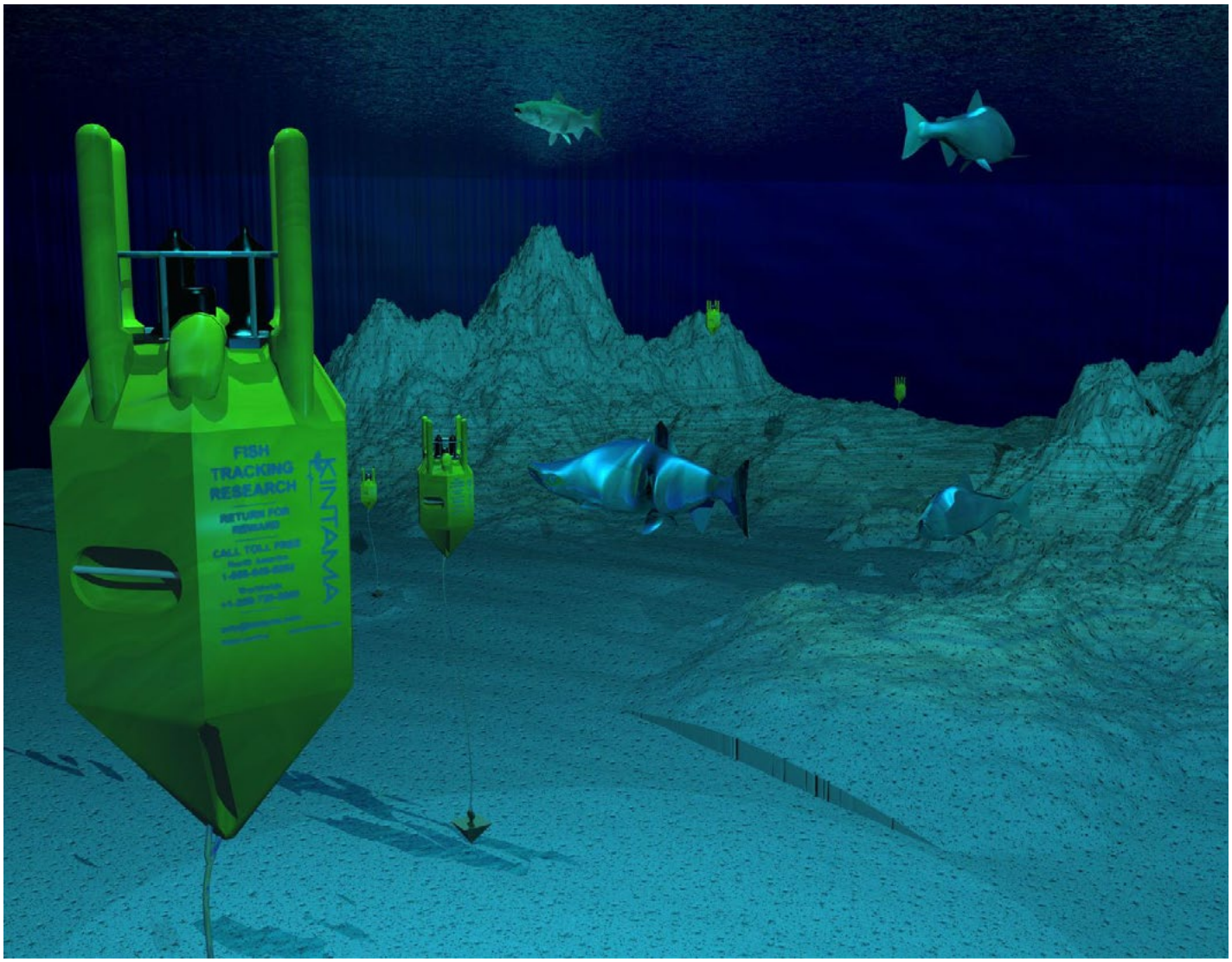
1. **Modeling:** Climate models are tools that help us better understand and predict changes to our climate. BECI hopes to focus on models with a seasonal to decadal (1 month to 10 years) timescale, which is both urgent and challenging.

2. **Data Mobilization:** The need to effectively mobilize existing data is crucial to the BECI Project. An effective and efficient system that enables access, integration and synthesis of old and new data will open doors to new understandings and applications for the ocean community.

3. **Observation and Monitoring:** Information from new observations for chemical, physical, and biological changes in the ocean is desperately needed to assist in current decision making. BECI will be utilizing newly available tools and technologies to connect ocean information to ocean resource understanding.

4. **Targeted at-Sea Research:** Experience gained from the IYS initiative is that at-sea research complemented with modern/emerging technologies can be highly productive. BECI will focus primarily on various forms of autonomous or opportunistic sampling or measurements and will work towards the most effective use of at-sea monitoring through careful analysis.

5. **Outreach, Communication, and Coordination:** Effective outreach, communication, collaboration, and coordination are crucial for a project encompassing the basin-scale and scope of BECI. Developing a communication and collaboration strategy for BECI will be a diverse and complex process but will create information networks that are accessible to a wide range of audiences, rightsholders, and stakeholders.



Looking Forward

At the 2023 NPAFC Annual Meeting, the NPAFC adopted their new five-year science plan (2023 – 2027) which will complement BECI research and collaboration. BECI will continue to build off the success of the International Year of the Salmon initiative, following up on the recent results meeting for the 2022 Pan-Pacific Winter High Seas Expedition – the largest pan-Pacific expedition to study the winter ecology of Pacific salmon in the North Pacific Ocean. BECI will continue to establish connections and collaborate with the ocean community to develop the BECI Science and Implementation Plan based off the five major components of the project.

The announcement of BCSRIF's $1.1M in funding for the BECI Project enables the establishment of a virtual project office and the recruitment of key personnel such as a BECI Science Director, communications lead, administrative coordinator, and postdoctoral students to complete the Science and Implementation Plan. For more information and updates on the BECI Project, visit https://beci.info

Happy Anniversary to PICES' Partner Organizations!

Sonia Batten

Three of PICES partner organizations celebrated significant anniversaries in 2023: the Korea Institute of Ocean Science and Technology (KIOST); the International Pacific Halibut Commission (IPHC); and the V.I. Il'ichev Pacific Oceanological Institute (VOI). We are grateful to their long-standing contributions to marine science in the North Pacific.

Korea Institute of Ocean Science and Technology

The year 2023 marks the 50th anniversary of the Korea Institute of Ocean Science and Technology (KIOST), since KIOST (at that time named the Korea Ocean Research and Development Institute (KORDI)) was founded on October 30, 1973, as the subsidiary of the Korea Institute of Science and Technology. It was originally established with government funding to lead, commercialize and disseminate Koreas' marine science research and development but education and training was also an initial priority, as well as collaborating with universities, research institutions and industries domestically and abroad. For the last 50 years, KIOST has expanded its research areas from terrestrial and coastal seas to global oceans covering the five oceans and polar waters. As a result, KIOST has become one of the top-class ocean science and technology research institutes. KIOST would like to thank the PICES Secretariat for its heartfelt congratulations on the 50th anniversary, and we will continue to actively participate in the development of ocean science and the resolution of global problems.

The International Pacific Halibut Commission

The International Pacific Halibut Commission celebrated its 100th anniversary in October 2023 as the world's first international agreement established for the joint management of a marine fishery. The IPHC is an international organization that has been managing the Pacific halibut fishery and conducting research on Pacific halibut population biology and its environment in the Convention waters of Canada and the United States for the last 100 years. A long-term partner organization for PICES, since 2000, the IPHC has regularly participated in PICES activities, recognizing the value of international cooperation to gain a more thorough understanding of environmental impacts on the biology, distribution and management of flatfish species across the North Pacific Ocean. Co-sponsored workshops and topic sessions at PICES annual meetings have provided venues for emerging and topical issues to be discussed amongst the researchers and managers with an interest in this resource. Furthermore, the environmental data that IPHC collects during the surveys that span much of the PICES Convention area are a valuable source of information that contributes to other PICES goals. At PICES-2023 a Special Session was held to mark the start of the IPHC centenary entitled "The International Pacific Halibut Commission: 100 years of science-based fishery management"

V.I. Il'ichev Pacific Oceanological Institute

The V.I. Il'ichev Pacific Oceanological Institute of the Russian Academy of Sciences (POI) is the largest oceanographic institute in the Russian Far East and the second largest in the country. It was established in 1973 and so celebrated its 50th anniversary in 2023. The academician Victor Il'ichev was the first director of POI, and participated in the intergovernmental meetings leading to the formation of PICES. He promoted the involvement of Russian marine scientists in PICES and POI scientists have been contributing to PICES activities since the very early days of PICES. In commemoration of the POI's anniversary, former POI director and long-term PICES member Dr. Vyacheslav Lobanov was awarded with the Sea Star Award for the achievement in the study of marine waters of the Primorye region.

PICES-2023 Reports

S9 - Understanding the implications of body size change for stock productivity and fisheries management (GRAFY; BIO/FIS)

Chenying Guo, Paul Spencer, John Morrongiello, Shin-ichi Ito

Presentation of Jessica Miller and chairing by a ECOP convenor Chenying Guo at S9

Everyone loves photos of the big fish that didn't get away. However, warming oceans often mean that young fish grow more quickly but reach smaller adult sizes. This equates to a loss of yield in commercial fisheries. Scientists are working together to assess the magnitude of the shrinking fish problem in different regions and determine what this means for sustainable fisheries management now and in the future. Warming seas can affect fish body sizes, with major implications for size-structured marine ecosystems, species interactions and fisheries productivity. Synchronous shifts toward smaller adult body sizes in marine fish have already been detected in several rapidly warming areas. Yet, the mechanisms underpinning the temperature size rule (TSR; higher temperatures result in smaller body sizes) remain debated and most fisheries models do not routinely account for the expected temperature-dependent trends in growth. Understanding the impacts of temperature-driven changes in body size on reproduction and maturity is critical if we want to predict shifts in stock productivity. Novel monitoring programs are needed to provide managers with the appropriate information to detect and quantify any body size change that is occurring. Fisheries management plans need to adequately account for the implications of shifting fish body sizes and ensure harvest strategies are flexible enough to ensure stock productivity in a rapidly changing world. S9 provided the opportunities to 1) synthesize ecological and empirical knowledge about trends in fish and other ectotherms' growth rates and body sizes, and how this can be incorporated into monitoring programs; 2) explore the utility of new assessment models that allow for time-varying and environmentally driven trait parameters; 3) assess the potential impacts of temperature-induced body size change on fisheries yields in the future ocean; and 4) discuss management options to addressing the impacts of rapid temperature-induced changes in stock productivity.

The session had 1 invited talk, 16 contributed oral talks and 1 poster from delegates spanning a wide range of career levels, starting from recent Masters graduates to prominent researchers. The session had 10 presentations by ECOPs (Early Career Ocean Professional) including the invited presentation of Dr. Max Lindmark and an ECOP, Dr. Chenying Guo, co-convened the session. This article reports the session itself in addition to Chenying's participation in the session, including her impressions. The session attracted over 100 attendees.

1) Synthesize ecological and empirical knowledge about trends in fish:

Max Lindmark proposed two important questions: "Physiological responses to warming are not linear?" and "Do responses to temperature differ among populations within species?." Max showed an example of the weight response of Eurasian perch monitored at 12 areas in the Black Sea, which include two areas artificially warmed by discharge from nuclear power plants. The unusually large temperature gradient demonstrated non-linear temperature effect on the weight: positive (negative) temperature effects on growth in the coldest (warmest) area. Deana Crouser reported the size decline of large copepods in the Bering Sea and hence biomass of them which potentially influence the fish production in the area. Andrea Odell investigated the effect of data sources on characteristics of weight-at-age variation using weight-at-age data of Pacific Hake and showed some inconsistency due to sampling biases, which indicates importance of modeling application to reduce the effects of the sampling biases. Zhen Lin demonstrated synchronized fish weight decline in the western North Pacific in 1980s and 2010s with a strong influence of density effects. Cody Szuwalski presented historical data reconstruction which were surveyed from the literature using over 1500 entries spanning 89 species. Sufficient data were available for 4 species and the analysis revealed increasing growth rates, smaller maximum sizes, and increases in natural mortality for the 50 years. These changes have resulted in increases in productivity as seen through yield per recruit for some stocks and decreases for others.

2) Explore the utility of new assessment models

Aleksey Somov applied Vector Autoregressive Spatio-Temporal package (VAST) to standardize and interpolate the data of salmon juveniles in the Western and Eastern Bering Sea and found out stronger impacts of temperature on salmon juveniles in the Eastern Bering Sea. Alberto Rovellini used a whole-of-ecosystem model ATLANTIS to investigate the potential mechanisms to weight change of forage and ground fishes in the Gulf of Alaska and suggested that the decreased plankton productivity is a

potential driver to decrease the fish weight reduction and ecosystem food web change. Josep Planas identified genes and proteins in skeletal muscle of halibuts responding to temperature-induced manipulation and developed molecular assays to measure the growth marker genes in skeletal muscle which can be applied to the wild fishes. Saang-Yoon Hyun applied a state-space length-based assessment model to chub mackerel as a framework to explore the effect of warming on yield-per recruitment and optimal fishing intensity. Richard Methot presented about the Stock Synthesis (SS3) assessment program which incorporated size-selective fishing effects. Richard reported that the SS3 approach is also able to estimate the correct average maximum size of fish in the population, while also estimating the realized average size after the effect of size-selective fishing. Cole Monnahan introduced the Woods Hole Assessment Model (WHAM) platform which expanded the applicability of state-space assessment models by including size-specific data and modeling mean size and weight-at-age. The WHAM is still in the development stage but it should be valuable for stocks where length data are a key source of information, variation in growth is an essential part of the dynamics of the assessed stock, or when linking climate variables to growth in hindcasts or forecasts is relevant. Paul Spencer compared how complex spatial growth patterns can be accounted for with either spatially-structured assessment models which internally estimate growth parameters, or simpler one-area models in which spatially-averaged estimates of size at age are estimated outside the model. The results suggest that complex interactions between spatial and temporal patterns may be better addressed with multi-area models.

3) Assess the potential impacts of temperature-induced body size change on fisheries yields

Hillary Thalmann showed the marine heatwaves (MHWs) influences on juvenile Pacific cod diets and growth. The fish were larger and older during MHWs and growth was moderately faster during MHWs which indicated additional drivers such as size-dependent selection in the nursery. Jessica Miller suggested greater size-selection during MHWs and importance of change in selection intensity as a potential mechanism contributing to changes in age and size associated with warming using the same dataset of Hillary. Jennifer Bigman investigated temperature and oxygen influences on weight-at-age of fished in the Gulf of Alaska and found consistent temperature and oxygen influences on species but complexity in the temperature size rule to predict fisheries productivity. Ziqin Wang introduced a bioenergetics – population dynamics coupled model to investigate impacts of environments on fish growth and population.

WG-GRAFY (Impacts of Warming on Growth Rates and Fisheries Yields) dinner at Seattle

4) Management options to addressing the impacts of rapid temperature-induced changes in stock productivity

Jan Ohlberger showed a case study on Chinook salmon and suggested the importance of accounting for demographic trends when estimating reference points to improve management performance and reduce conservation risks. Jan also suggested that conservation of population demographic structure may be critical for sustaining productive fish populations. Fan Zhang demonstrated effects of increased body growth and earlier maturation on MSY-based reference points (BMSY and FMSY), unexploited reference points (B0) and yield-per-recruit reference points (FMAX) using bigeye tuna as an example. This highlighted the importance to consider changing population vital rates and non-stationary population dynamics when implementing reference points in fisheries management.

Conclusions

A series of presentations providing evidence of the importance of temperature impacts on growth, body size, survival, food availability, maturity and reproduction, which are critical to predict shifts in stock productivity. The session also indicated importance of long-term novel monitoring to detect and quantify body size change which should be shared with managers. Facing global climate change, fisheries management plans need to adequately account for the implications of shifting fish body sizes. In addition, harvest strategies should be flexible enough to ensure stock productivity facing to increasing extreme events.

Impression of S9 J by Chenying Guo (a ECOP co-convenor)

It is not the first time I participate in PICES, but it was my first time serving as a convenor for an international science meeting. I co-convened the Session 9, which aimed to understand the implications of body size change for stock productivity and fisheries management. In this report, I will reflect on my first experience as a convenor, highlighting the main challenges, achievements, and lessons learned from the meeting.

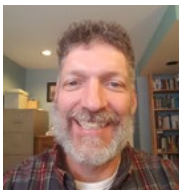
I am profoundly grateful for Drs. Paul Spencer, John Morrongiello and Shin-ichi Ito inviting me as an ECOP convener. Compared to other co-convenors, I had less experience in drafting session proposals and inviting the speakers. I participated in the discussion via email but still felt that I made a limited contribution to this session. On the other hand, I realized that improving the ability of synthesizing a session topic, as well as building a broad network with researchers of various backgrounds, was important and beneficial for a scientist in early career.

The next challenge was preparing the agenda and rating the ECOP Financial Support Priority. I really appreciated that I received the financial support for PICES meeting when I was a student. Therefore, I knew the importance of financial support to ECOPs, especially for those who had no or few budget for international meeting. I rated the priority cautiously, to make sure more ECOP could get opportunities to share their results in PICES meeting without heavy financial burdens. It was a challenging work for me at the first time. Making presentation schedule was also a challenge. The order of the presentation could be decided by research target, area, method, etc., but it would be complicated if you were considering two or more features of an abstract. After reading through all the abstracts submitted to S9 and discussing with other convenors, we decided the presentation order by observations, modeling, stock assessment.

As an extension of ICES/PICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (WGGRAFY), many S9 presenters had known each other before and set up a cooperative relationship before PICES meeting. To increase the opportunities for communication, as well as greeting people who were new to S9, we convenors organized a dinner before session 9. Although I did not participate in WGGRAFY before, I got familiar with S9 members and knew more details about their research, which helped me moderating the presentations in S9.
The timetable of S9 was divided into 4 parts, and I chaired the part after morning coffee break and afternoon coffee break. Although I was nervous, I tried my best moderating the presentations and discussions and managing the time constraints. Our sessions attracted a diverse and engaged audience, with lively discussions and feedback from the participants. I learned a lot from the session members, speakers, and attendees, who shared their knowledge, insights, and experiences on temperature size rule and the effect of climate change on fish growth as well as fisheries. I also gained valuable skills and confidence in leading and facilitating scientific sessions. However, I also realized that there is room for improvement, for example, adding a summary of the main points and recommendations by the end of the oral presentation. I believe I could do better next time.

Chenying Guo (guochenying@scsio.ac.cn) is a Postdoctoral fellow in State Key Laboratory of Tropical Oceanography (LTO), South China Sea Institute of Oceanology (SCSIO), Chinese Academy of Sciences. She conducted laboratory experiments for fish swimming and respiration and built up a growth-migration model of fish species based on the experiments. Chenying is an ECOP in PICES.

John Morrongiello (john.morrongiello@unimelb.edu.au) John is a Senior Lecturer in Marine and Freshwater Biology at the University of Melbourne and is passionate about fish biology. He works in both marine and freshwater systems investigating how animals respond to environmental change on contemporary and evolutionary time scales. He co-chairs the Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY).



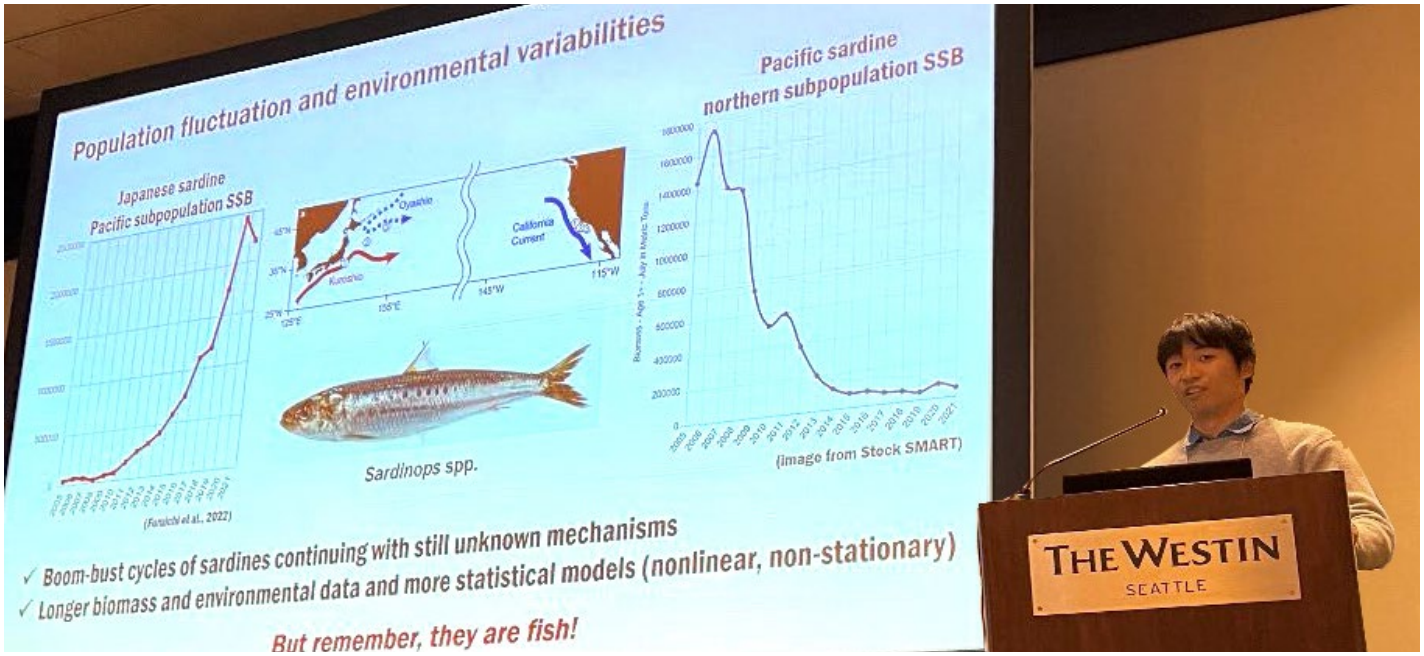
Paul Spencer (paul.spencer@noaa.gov) Paul Spencer is a fisheries research scientist at the Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration. His research focuses on fisheries stock assessment and management, and the effects of environmental variation and climate change on fishery population dynamics. He co-chairs the Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY).

Dr. Shin-ichi Ito (goito@aori.u-tokyo.ac.jp) is a Professor at the University of Tokyo. His fields and topics of research range from physical to fisheries oceanography. He co-chairs the Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY) and member of the joint PICES/ICES Section on Climate Change Effects on Marine Ecosystems (S-CCME) and Advisory Panel on Early Career Ocean Professionals (AP-ECOP).

PICES-2023 Reports

S10 - Improved detection and understanding of factors affecting changes in North Pacific forage communities and implications to ecosystems

Matthew Baker, Jennifer Boldt, David McGowan, Akinori Takasuka, Motomitsu Takahashi



Tatsuya Sakamoto, Instituto Português do Mar e da Atmosfera (Portuguese Institute for the Sea and Atmosphere, IPMA), Portugal.

Background

Forage species serve an important intermediate trophic role in marine ecosystems, yet an understanding of how they drive trophodynamics in the North Pacific remains poorly known. The species composition, condition, and availability of forage species to predators can be sensitive to physical and biological changes and variable production at lower trophic levels. Forage populations are prone to large variations in production, which can affect their availability to predators. North Pacific forage species include both commercially and non-commercially exploited taxa including small pelagic fishes (e.g., herring, sardines, anchovies, smelts, and sand lance), early life stages of groundfish, salmon, and crabs, mesopelagic fishes, and other important invertebrates (e.g. squids, euphausiids). In marine ecosystems where the most abundant forage species are unexploited taxa or life stages, detecting changes in species composition, abundance, and distribution is often particularly challenging due to a lack of directed monitoring, and may have profound ecological and socio-economic impacts at the ecosystem level. An improved understanding of how changes in the abundance and distribution of unexploited forage species impacts exploited species and other predators is critical for commercial interests, as well as for economic and food security of Indigenous and coastal communities in the North Pacific.

During the 1.5 day session, there were 25 oral presentations (including two invited talks) and 2 poster presentations. Of these, there were 11 oral and 2 poster presentations by Early Career Ocean Professionals. On Day 1, conveners provided an introduction to the session, which was followed by an invited talk presented by Tatsuya Sakamoto, and then 16 oral presentations. On Day 2, Mayumi Arimitsu presented the second invited talk, followed by 7 oral presentations and a closing discussion. Oral and poster presentations covered most of those topics solicited. One gap that was not covered was the inclusion of traditional or local ecological knowledge to improve monitoring and data synthesis of forage species. A talk that would have addressed this topic was submitted and accepted to this session; however, the speaker was not approved for travel by their institute.

Session topics and main takeaway messages from S10 presentations

1. Improvements in monitoring and data synthesis of forage species:
   a. integrating multiple data sources (surveys, predator diets)
      i. Spatio-temporal models can be used to integrate and account for differences among multiple surveys and account for variable sampling effort in space and time to estimate species abundance and distribution. This helps

address questions about potential competition or predation interactions, shifts in spatial distribution and phenology, and the effects of climate change. In the California Current, spatio-temporal models of long-term larval fish sampling programs indicate that larval fish species navigate the tradeoff between shifting location vs phenology differently. Sea surface height and temperature were found to be important predictors of the center of gravity of some species, with species at lower latitudes more sensitive to shifts. In the Gulf of Alaska (GOA) and Eastern Bering Sea (EBS), larval groundfish size in late spring varied with temperature but there was no broad evidence for long-term trends in size-at-date. To improve estimates of abundance of data-limited, non-target forage species, spatio-temporal models that combined both acoustic and bottom trawl surveys were developed and compared to single survey (acoustic) methods. In the northern GOA, joint species distribution models of seabirds and forage fish reveal that seabirds have a strong response to forage fish density and distribution. Spatio-temporal models applied to trawl survey data provided insights into potential competitive interactions modulated by climate change. Climate driven increases in California Current coastal ocean temperatures could be changing juvenile sablefish distributions, resulting in higher spatial and trophic overlap that could negatively impact juvenile Pacific salmon through competition for food.

ii. Ocean circulation model simulations used in conjunction with biological samples were used to determine likely origins and transport of larval grenadiers, a data-poor species. The impact of climate change on larval grenadier transport and the fact that larvae cross between multiple large marine ecosystems has implications for fisheries management.

iii. The examination of the abundance and diets of fish and gelatinous organisms improves the understanding of trophodynamics of ecosystems in the context of increasing ocean temperatures. In the EBS, jellyfish and small pelagic fishes showed low spatial overlap, implying minimal competition in August; however, in areas of high overlap competition could be important in some months. Groundfish diets provide indicators of distribution and abundance of their prey (forage fish). In the EBS, northward movement of forage species and changes to predator-prey overlap were attributed to increased temperature. Off the west coast of North America, Pacific hake acoustic survey data and hake diets provide indicators of euphausiid abundance and distribution.

iv. Design- and model-based estimates were compared to understand the effects of survey design and timing on the ability to detect shifts in species phenology.

b. gear modifications for improved retention of forage species,

i. A combination of survey techniques and advanced technologies can leverage an existing survey to provide value-added estimates of forage fish. Pocket nets and a stereo camera were mounted on a trawl net used during an acoustic-trawl survey to inform selectivity curves and escapement and abundance estimates of forage fish species.

c. advances in monitoring tools (biogeochemical and genetic analyses, autonomous vehicles), and

i. Isotope analyses can improve the understanding of forage fish population structure and dynamics. For example Pacific Sardine eye lens isotope analyses can be used to test population structures and otoliths isotope analyses provide clues to growth rates. Early life history stages of sardine populations in the western and eastern North Pacific have different metabolic and growth rates corresponding to contrasting temperature variations, which could explain their opposing population abundance trends.

ii. Indicators of prey quality include lipids, energy density and protein vary among species, life history stage, and region. Off the west coast of Canada and northern US, acoustic trawl surveys and fish lipid analyses revealed the quality of mesopelagic fish as prey. On a mass basis, myctophids contained more total lipid than any other fish family. However, some store lipids as wax esters, which are poorly digested and are associated with poor growth. In addition, interspecific and regional variability in fatty acid profiles of fish and invertebrates indicate trade-offs when consuming any single species.

iii. eDNA metabarcoding can be used to identify the presence of marine mammals and their prey species and the persistence and distribution of eDNA in the water in the California Current.

Mayumi Arimitsu, US Geological Survey Alaska Science Center, USA.

eDNA metabarcoding can also improve the understanding of ecosystem trophodynamics. For example, copepods were identified as important hubs in the food web and that many omnivorous mesozooplankton groups are not strongly dependent on diatoms and dinoflagellates in neighboring waters of the Kuroshio Current. Metabarcoding of fish stomach contents can reveal the previously underestimated importance of some prey items. For example, this method revealed that protozoans and gelatinous zooplankton are major prey items of early life stages of skipjack tuna in the western North Pacific.

2. Describing changes in forage communities and impacts on predators;

   a. Several talks identified changes in the forage fish communities and potential interactions with and impacts on predators. For example, joint species models of seabirds and forage fish in the northern GOA indicated that more abundant seabird species require higher density patches of forage fish. In the EBS, the spatial overlap of small-sized Walleye Pollock and the foraging range of their predators, Northern Fur Seals, provides different and additional information on the dynamics of small pollock that informs an ecosystem-based approach to fisheries management.

3. Advances in knowledge about interspecific interactions and bottom-up and top-down processes that affect forage species used to inform ecosystem-based fisheries management or reduce uncertainties in stock assessments and population forecasts of exploited species.

   a. A mechanistic modeling framework was applied to identify the relative importance of food web-dependent vs. transport-dependent recruitment mechanisms modulated by environmental conditions.

   b. Ecosystem trade-offs can be explored under different management rules and climate change scenarios, with a climate-informed ecosystem management strategy evaluation using an Atlantis end-to-end ecosystem model.

   c. A suite of ecological metrics can be computed from Ecopath with Ecosim models to quantify Pacific salmon trophic interactions. Results suggest there are top-down impacts on salmon by sharks as well as intra- and interspecific competition among salmon in the North Pacific.

PICES-2023 Workshop Reports

W1- Creating Concise and Compelling Fact Sheets to Amplify Your PICES Work

Julie Claussen and Vera Trainer

This workshop was organized by the Advisory Panel on Science Communications (AP-SciCom) members, Tammy Norgard, Vera Trainer, Natsuko Nakayama, Andrea White, Alexandra Davis, and led by the invited speakers: Julie Claussen and Sogawa Sayaka. The goal for this PICES 2023 TCODE/FUTURE/HD Topic Workshop: *"Creating Concise and Compelling Fact Sheets to Amplify your PICES work"* was to create Fact Sheets that would educate and advertise the work of PICES expert groups who play a significant international role in understanding the science of the North Pacific Ocean.

It is often difficult for newcomers to grasp the organizational structure, mandates, and activities of the various PICES expert groups. Fact sheets can be used to make an outstanding first impression, educate community members and target audiences and increase organizational recognition about the value and relevance of scientific work being conducted under PICES. Fact Sheets provide an easy overview and are especially useful for graduate students and early career scientists. Moreover, creating Fact Sheets challenges PICES scientists to analyze the goals and objectives of their expert groups, and to efficiently describe their achievements concisely and clearly.

Prior to the workshop, templates were constructed to serve as guides and to present a unified look for all PICES Fact Sheets. In addition, a planning form was sent to expert group chairs, enabling them to outline the essential information to use in their Fact Sheets.

During the workshop, our invited speakers, Julie Claussen and Sayaka Sogawa, shared their expertise in communicating scientific knowledge clearly and effectively. Julie Claussen, of the Fisheries Conservation Foundation and the American Fisheries Society Science Communication Training Team, provided details on developing concise messaging for Fact Sheets using the ABT (And – But - Therefore) narrative structure. PICES expert groups have a wide array of activities, research, and results to share, yet distilling that information down to a manageable level to convey the main message can be difficult.

The first decision to make when constructing a Fact Sheet is deciding what the target audience needs to know. Participants were asked to consider: does the audience have knowledge of the PICES organization, or will the focal audience be from outside the organization? Does the audience have specific scientific knowledge (for instance, would they know the background about nutrient availability), or is some basic information needed first? Deciding on the make-up of an audience and considering their background and level of knowledge will drive the amount of detail that needs to be presented.

Participants were then asked to consider the main goals for preparing a Fact Sheet. Three distinct goals were presented:

1. capturing the audience's attention,
2. making sure they understand the information, and
3. providing the audience with a "hook," something to remember.

In today's world of competing information and short attention spans, we need to change how we tell our science stories. Scientists tend to organize our information around facts, yet presenting only the facts makes it difficult for broader audiences to pay attention, understand, and remember our message. One way to help achieve these goals is to use the ABT framework. This framework provides a basic structure to organize our science stories and has been scientifically shown to capture the reader's attention through the balance of facts, suspense, and resolution. The framework starts with "And," which provides the background that is relevant to the target audience and sets the stage for the topic. The second part of the framework is "But," which is the problem we are presenting. The key here is focusing on one over-arching problem instead of a series of issues. And last is "Therefore," which is the solution or actions that address the problem.

The next presentation focused on visuals. The group looked at examples that would either amplify a message or detract from the main goals. Participants were asked to consider various elements in their graphics that would help an audience pay attention, understand, and remember

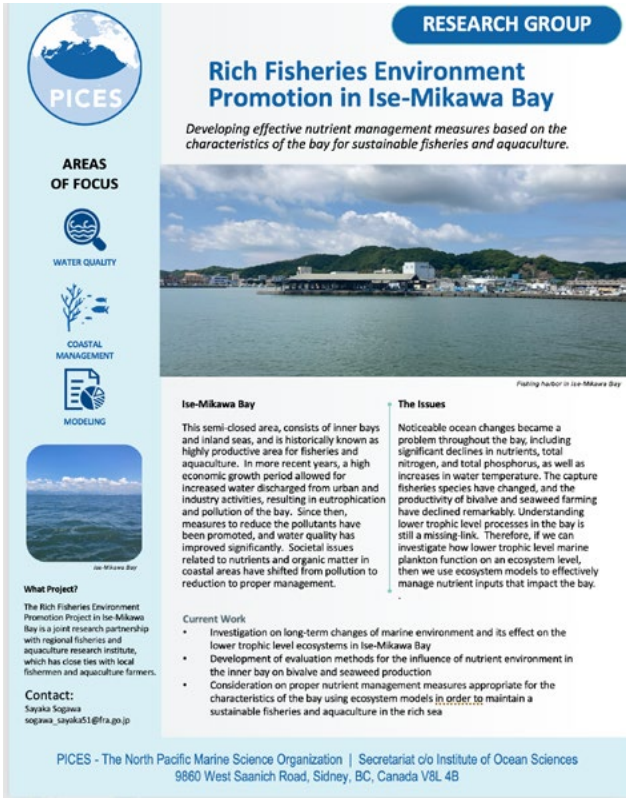
their fact sheet information, including image quality, rule of thirds, contrast and color, font considerations, single versus multiple photos, etc.

A lively discussion followed on the PICES Fact Sheet template design. The group was in strong agreement that each fact sheet should only be 1 page. Participants spent some time working on simplifying a layout (see examples, below) that would make it reader friendly for all PICES countries. It was agreed that if readers wanted more information, the Fact Sheets should refer them to a main contact or a webpage.

Sayaka Sogawa, Japan Fisheries Research and Education Agency Socio-Ecological Systems Division, provided the group with a case study on her research program and how she organized her information about her program for a fact sheet. Participants were able to see how she selected her focal areas and what key actions she wanted to highlight. The group also discussed barriers that can exist when translating information into English and the need to consider language barriers when constructing PICES Fact Sheets.

During the workshop, there was an insightful discussion on the need for a Fact Sheet focused on PICES. Even for those attending PICES meetings, there exists confusion on the organizational structure of PICES and the work that it does. In addition, people felt there needed to be a short statement on "Who is PICES" on each Fact Sheet. Participants had great insight on the purpose of working group and section Fact Sheets, how they could be marketed and who these should be directed to. This led to a discussion on the PICES "brand." The workshop participants recommended that branding consistency guidelines and a marketing strategy for PICES should be discussed in the future.

Expert group co-chairs will be contacted by the Workshop organizers, who will provide a Fact Sheet template and instructions for constructing one-page Fact Sheets for each PICES expert group. The goal is to have these completed by the end of PICES2024. Fact Sheets will be shared on the PICES website and social media and will be available to send to potential colleagues and new partners.



Fact sheet examples for Advisory Panels (bottom) and Research Groups (below).

PICES-2023 Workshop Reports

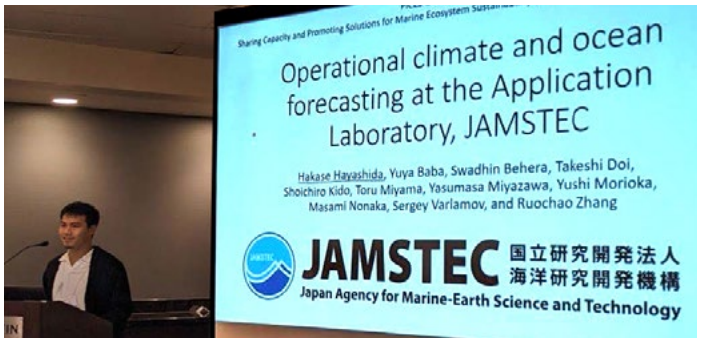
W2- Sharing Capacity and Promoting Solutions for Marine Ecosystem Sustainability within the UNDOS

Hannah Lachance and Steven Bograd

At PICES-2023, SmartNet, FUTURE, TCODE, HD and AP-ECOP hosted a Workshop titled *"Sharing Capacity and Promoting Solutions for Marine Ecosystem Sustainability within the UN Decade of Ocean Science,"* to provide updates on SmartNet, and other UN Decade of Ocean Science for Sustainable Development (UNDOS or UN Ocean Decade) activities and facilitate a broad discussion within the PICES community on possible collaborations, next steps and contributions to the UNDOS goals. Here we present a few highlights from the workshop. Participants are pictured above.

The workshop opened with an overview of the workshop objectives and agenda, provided by co-convener Steven Bograd (USA). Co-convener Hannah Lachance (USA) then provided a brief overview of the UN Ocean Decade highlighting the outcomes, levels of endorsement, general structure, etc. Both Steven and Hannah provided a refresher and update on several UNDOS programmes including Sustainability of marine Ecosystems through Global Knowledge Networks (SmartNet), Sustainability, Predictability, and Resilience of Marine Ecosystems (SUPREME), Marine Life 2030, Fisheries Strategies for Changing Oceans and Resilient Ecosystems by 2030 (FishSCORE 2030), Global Ecosystem for Ocean Solutions (GEOS), and Empowering Women for the UN Decade of Ocean Science for Sustainable Development (Empowering Women).

Following the overviews we dove into the invited speakers, starting with Dr. Hakase Hayashida (Japan), who presented on *"Operational climate and ocean forecasting at the application Laboratory, JAMSTEC."* Dr. Hayashida's presentation gave an overview of the regional forecasting capacities that have been developed at the Japan Agency for Marine-Earth Science and Technology.



Invited Speaker, Dr. Hakase Hayashida (Japan), presented on "Operational climate and ocean forecasting at the application Laboratory, JAMSTEC".

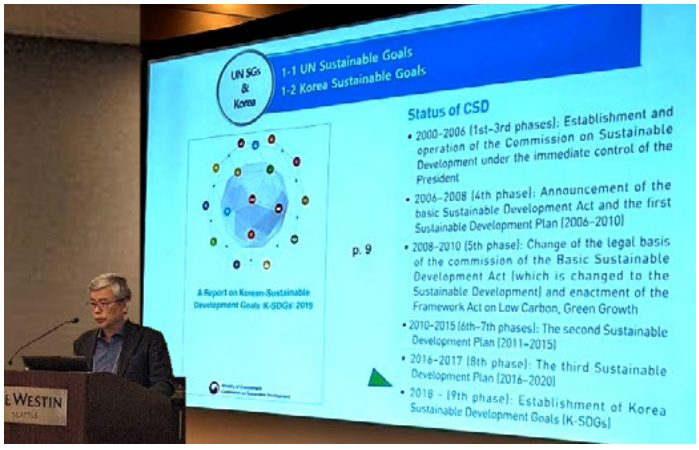
After Dr. Hayashida, Dr. Matt Savoca (USA) presented on the UN Ocean Decade endorsed project titled *"Global Plastic ingestion Bioindicators"* which sits under the SmartNet programme. This project aims to define a list

of indicator species to help monitor the effects of plastic ingestion in global marine ecosystems.

Dr. Matt Savoca (USA) presented on the UN Ocean Decade endorsed project titled "Global Plastic ingestion Bioindicators" which sits under the SmartNet programme.

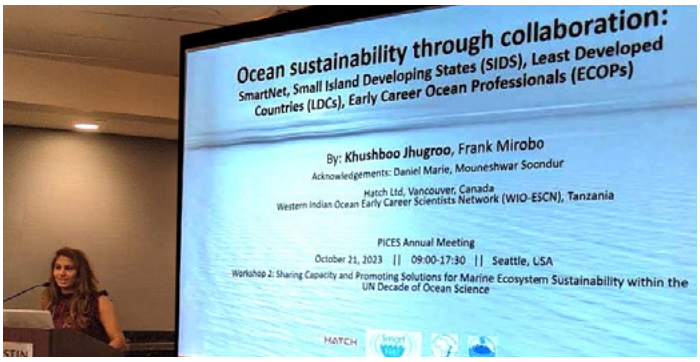
Next up we heard from Dr. Alison Deary (USA) who provided a brief overview of PICES 2023 Workshop 10: *"Towards climate-informed ecosystem-based fisheries management by building international collaborations and standardizing indicators"* which occurred at the same time as our workshop but covered several relevant topics to the UNDOS actions participating in workshop 2.

After the workshop 10 overview, we returned to our list of speakers and heard from Professor Wonho Yih who presented on *"UNDOS Implementation Research Group, a new born program of Korea MOF for international cooperation."* This presentation highlighted Korea's national contributions to the UN Ocean Decade including a new effort to fund 10 biennial research projects ('23-'28) where each project will include 1 mentor scientist and 2 early-settlement scientists after post-doctoral research.



Professor Wonho Yih (Korea) presented on *"UNDOS Implementation Research Group, a new born program of Korea MOF for international cooperation."*

Our next invited speaker was Dr. Kushboo Jhugroo (Canada) who presented on "Ocean sustainability through collaboration: SmartNet, Small Island Developing States (SIDS), Least Developed Countries (LDCs), Early Career Ocean Professionals (ECOPs)." Dr. Jhugroo's presentation



Invited Speaker, Dr. Kushboo Jhugroo (Canada), presented on "Ocean sustainability through collaboration: SmartNet, Small Island Developing States (SIDS), Least Developed Countries (LDCs), Early Career Ocean Professionals (ECOPs)"

highlighted challenges facing SIDS and her last slide, which highlighted potential collaboration areas, fuelled the afternoon discussion portion of our workshop. We took the 7 potential areas of collaboration identified through Dr. Jhugroo and Frank Mirobo's survey and discussed as a group how PICES could possibly leverage its existing structure and expertise to help meet some of the needs. The potential areas of collaboration (in bold) and discussion around them are summarized below:

Ocean literacy through engaging storytelling

- PICES and UNDOS networks could be leveraged to share stories
- The film developed at PICES 2023 will be an excellent resource to share within and beyond the PICES community
- Bottom up collaboration and communication is needed
  - PICES 2022 video training
  - Ocean Art at PICES meetings (2022 and 2023)
  - Community connections

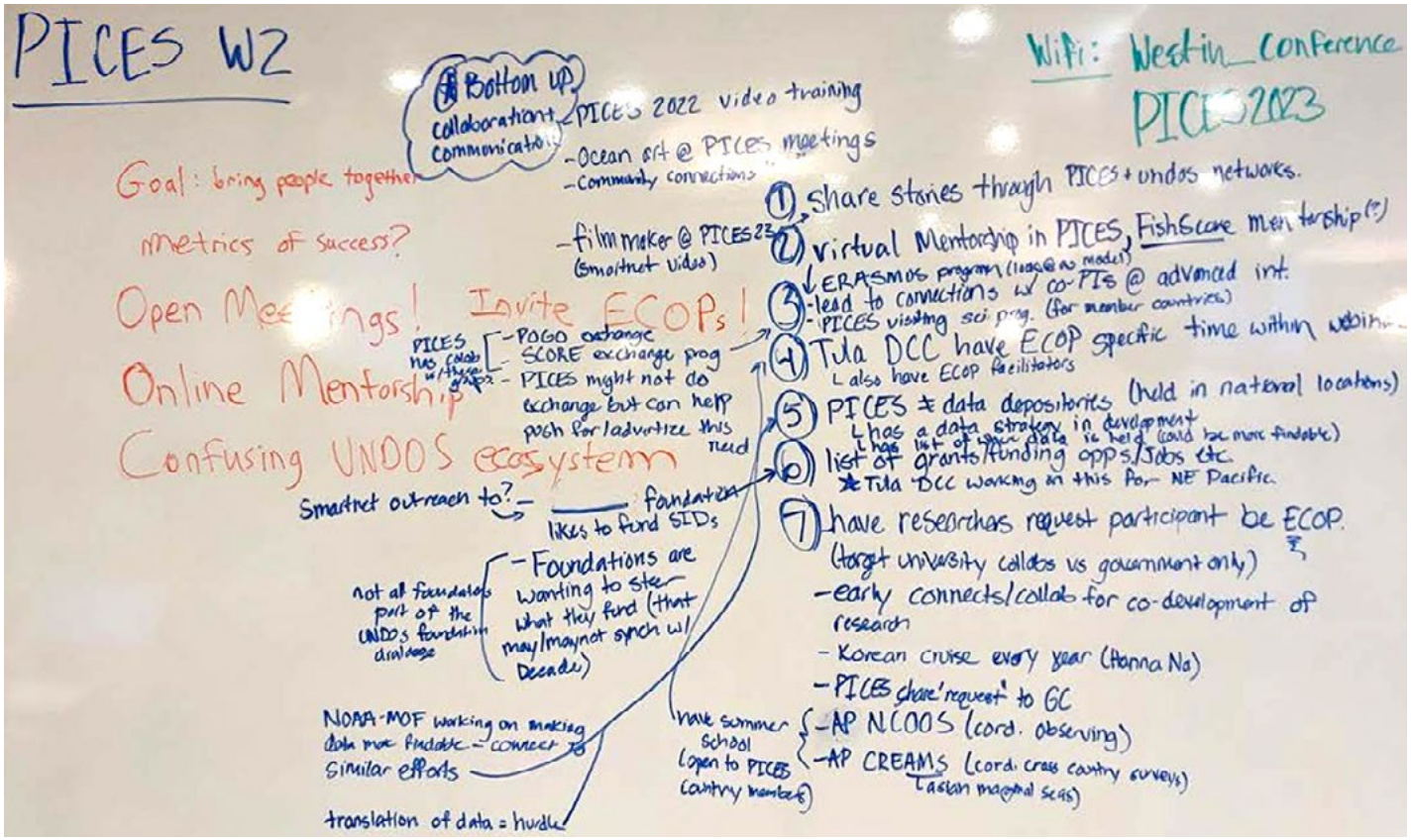
Establishment of a mentorship program

- Expand PICES mentorship program to include a virtual mentorship component to reach more mentors/mentees both within and beyond PICES member countries

Development of exchange programs at advanced institutions

- Having ECOPs/SIDS/LDCs engaged with PICES scientists could lead to connections, collaboration and exchanges at advanced institutions
- PICES has a visiting scientist program that is open to PICES member countries
- PICES also has collaborations with POGO and SCOR which also have exchange programs

(Continued on next page).



Whiteboard exercise to see how PICES and PICES member countries could help meet the potential for collaboration items outlined in Dr. Jhugroo's presentation.

Invitations to enhance integration at workshops, trainings, conferences, etc.

- Tula DCC have time within webinars where the speaker and ECOPs have specific time together at the end of the webinar; they also have ECOP facilitators
- PICES has occasional summer school trainings as well (see here for list of past trainings)

Insights or experiences with data sharing and creating data depositories

- While PICES is not a data depository (data is held in national locations), PICES does have a data strategy in development that will help encourage and facilitate data sharing
- NOAA-MOF are working on making data more findable. Worth connecting to this and other similar efforts
- Translating data was flagged as an additional hurdle

Seeking diverse funding opportunities for research and event attendance

- Generating a list of grants/funding opportunities and/or jobs that could be circulated on a regular basis was raised
  - The Ocean Decade Collaboration Center Northeast Pacific is working on this for the Northeast Pacific
- SmartNet could be well poised to reach out to foundations that like to fund SIDs to support this need

Participation in research vessel voyages inclusive of ECOPS from SIDS and LDCs

- PICES member countries could be encouraged to include a wider range of participants beyond later career government only professionals.
- PICES has at least two advisory panels focused on coordinating surveys (AP-NPCOOS and AP-CREAMS) so expressing this request to those groups could be beneficial.
- The need to connect early to co-develop research in SIDs and LDCs was flags vs just coming to their EEZ without a commitment to co-develop and provide a training opportunity for local professionals
- Hanna Na mentioned there is a Korean cruise every year

PICES-2023 Workshop Reports

W3- GlobalHAB - Solutions to Control HABs in Marine and Estuarine Waters

Vera Trainer and Marc Suddleson

Front row (L-R): Nobuharu Inaba, Dail Laughinghouse, Javier Paredes Mella, Michelle Lepori-Bui, Colleen Kellogg, Ruoyu Guo, Natsuko Natayama, HoGeun Jang, Vera Trainer. Center row (L-R): Pengbin Wang, Misty Peacock, Natasha Melo Buckiewicz, Svetlana Esenkulova, Heather Raymond, Quay Dortch, Genki Terauchi, Kathy Coyne, Jorge I. Mardones, Taegyu Park, Yoichi Miyake. Back row (L-R): Megan Schulz, Takafumi Yoshida, Don Anderson, Marc Suddleson and West Bishop (remote), Kevin Claridge, Andrew Ross, Charles Trick.

The workshop titled *"GlobalHAB International Workshop on Solutions to Control HABs in Marine and Estuarine Waters"* was held for 2 days (October 21 and 22, 2023) at PICES-2023 in Seattle, WA, USA, jointly sponsored by GlobalHAB, NOAA and PICES. The workshop was specifically designed to focus only on the small number of harmful algal bloom (HAB) control methods that have been tested in marine and estuarine waters and explore solutions to technical, environmental compliance and public perception challenges. To clarify, control methods focus on the organisms themselves, either killing them or removing cells and toxins from the water. An example is the use of clay spray to control fish-killing HABs, such as *Cochlodinium polykrikoides,* which has caused mass mortalities of aquacultured fish, especially in the western Pacific.

The societal desire to have access to a greater variety of safe and effective bloom control options has become more urgent given the continued development of coastal regions for aquaculture, tourism, and other uses that are impacted by HABs. This workshop provided a forum for international dialogue to foster *in situ* experimentation, and support assessments of social, economic, and environmental costs and benefits of various approaches to control HABs in marine and estuarine waters. A discussion of strategies for navigating environmental compliance in different countries highlighted the ways that national regulatory policies could be adjusted to quicken the pace of developing safe and effective HAB control approaches worldwide.

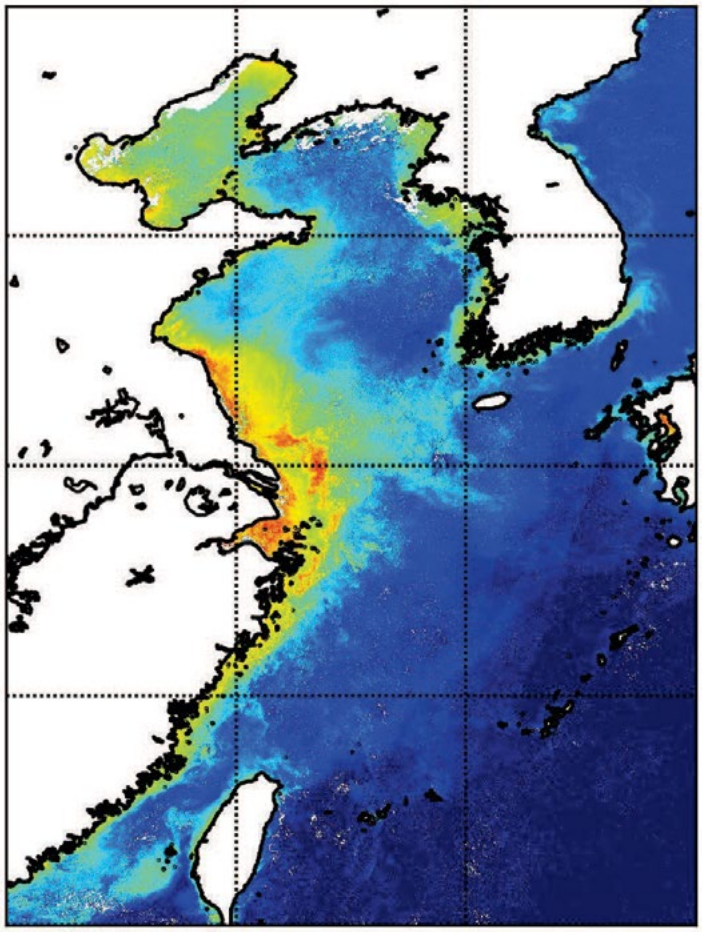
Nearly 30 participants with expertise in research, development, and deployment of control in in estuarine and marine environments. Specific examples were discussed, including natural and modified clay dispersal (Korea, Japan), viruses (Japan), algicidal bacteria isolated from coastal lagoons (USA), algicidal bacteria associated with seagrasses and seaweeds (Japan), and bubble curtains (Chile). Presenters shared how they resolved technical and environmental compliance hurdles to enable in situ deployments and the group explored various solutions to common barriers. Freshwater cyanobacterial HAB experts shared examples of control methods in inland lakes and reservoirs and offered strategies to help marine and estuarine researchers navigate environmental compliance issues such as permitting and application licensing. An industry partner raised awareness of additional research requirements that may enable companies to bring control methods into the marketplace.

A follow-up intersessional writing workshop is planned for February 2024 to summarize the worldwide approaches in HAB control as both a commentary and a scientific report in peer-reviewed scientific journals.

PICES-2023 Workshop Reports

W4 - Hanging social-ecological-environmental system of the North East Asian Marginal Seas: New challenges for integrative marine science (FUTURE / POC)

Takafumi Yoshida and Sunghyun Nam



Convenors: Vyacheslav Lobanov (V.I. Il'ichev Pacific Oceanological Institute, Russia), SungHyun Nam (Seoul National University, Korea), Mitsutaku Makino (University of Tokyo, Japan) and Takafumi Yoshida (NOWPAP CEARAC, Japan)

Invited speaker: Hiroaki Saitoh (University of Tokyo, Japan)

Co-sponsor: Northwest Pacific Action Plan (UNEP NOWPAP)

Background:

AP-CREAMS, Advisory Panel for a CREAMS (Circulation Research of East Asian Marginal Seas)/PICES Program in East Asian Marginal Seas, organized a half-day workshop on changing social-ecological-environmental system of the North East Asian Marginal Seas: New challenges for integrative marine science on 20 October 2023.

The western North Pacific is one of the areas of the global oceans which is most affected by climate change and anthropogenic impacts. On the other hand, people living in this region use and strongly depend on the resources/services from the ocean. For sustainable use of ocean resources and services, it is important to study the climate and anthropogenic impacts on marine ecosystems, and to develop a strong link between marine science and socio-economic requirements.

This workshop aimed to:

- Provide a forum to discuss all aspects of marine science
- Clarify a vision of international comprehensive marine research in this region that meets the current needs of society.

List of presentations:

1. Hiroaki Saito (Japan) - Marine ecosystems in Southeast Asia: Status, emerging issues and scientific contribution for the sustainable use (invited talk)

2. Saranya J.S. (Korea) - Unraveling the types and dynamics of marine heat waves in the East Sea (Japan Sea)

3. Zeyu Zeng (Canada) - Climate change alters social-ecological trade-offs in achieving ocean futures' targets

4. Hanna Na (Korea) - Potential predictability of skipjack tuna (Katsuwonus pelamis) catches in the Pacific Island countries

5. Peng Sun (China) - The Effects of Selective Harvest on Exploited Population and Economic Benefits

Summary of presentations and discussion:

Workshop was held from 9:00-12:00 on 20 October. Unfortunately Dr. Lobanov, corresponding convenor could not participate in the workshop due to a visa problem, and Dr. Makino could not join the event because he had other business meeting held in parallel. Some oral presentations were also cancelled due to either visa or flight problems. The workshop was started with a brief introduction by Dr. Nam, including the outline of the workshop and an announcement of absence of some participants.

Dr. Hiroaki Saito (University of Tokyo, Japan), invited speaker, introduced one of the best practices on collaboration among scientists of the South East Asia region; Collaborative Research and Education Project in Southeast Asia for Sustainable Use of Marine Ecosystem (CREPSUM) supported by Japan Society for the Promotion of Science.

Goals of CREPSUM are to establish an international science and education network for the Southeast Asia marine ecosystems, to progress marine ecosystems studies on emerging issues for conservation and sustainable use of marine ecosystem services, and to contribute to UN Decade of Ocean Sciences and UN SDG 14 targets. The members of this project published many field guides, identification guides and scientific papers and use them for promotion of capacity building for young scientists and local stakeholders. Dr. Saito shared his experience in developing such human network for facilitating the research and development on marine ecosystems and integrative marine science targeting the Southeast Asia.

Ms. Saranya J.S. (Seoul National University, Korea), an Early Career Ocean Professional (ECOP) gave a talk about *"unraveling the types and dynamics of marine heatwaves"*. The impact of marine heatwaves (MHW) to marine ecology in surface and subsurface local waters was dynamically assessed using a numerical simulation model with in-situ observations, and unsupervised machine learning clustering techniques. The results identified three types of MHWs in the region, implying significant influences on marine ecosystems and human societies in the region, under a warming climate.

Dr. Zeyu Zeng (University of British Columbia, Canada) made a presentation entitled "Climate change alters social-ecological trade-offs in achieving ocean futures' targets." To predict the impacts of climate change on marine ecosystems in the East China Sea and the northern South China Sea, Ecopath with Ecosim model was used. The maximum potential economic benefits from fisheries were predicted to increase with future climate change scenarios; however, the uncertainty for rebuilding the ecological robustness by climate changes would increase at the same time.

Dr. Hanna Na (Seoul National University, Korea) gave a talk entitled "Potential predictability of skipjack tuna (Katsuwonus pelamis) catches in the Pacific island countries." The statistical relationship between the skipjack tuna catches in the Western Central Pacific and ocean environmental variables in El Niño and La Niña climate conditions was investigated, and it was suggested that the subsurface temperature or near surface salinity can be a better predictor of ecosystem and the skipjack tuna catch variability. The presentation provides an example of connections between hydrographic/environmental study and fisheries/ecosystems.

In the presentation by Dr. Peng Sun (Ocean University of China, China), "The Effects of Selective Harvest on Exploited Population and Economic Benefits," she introduced an investigation of the stow net size-selective harvest using Bio-Economic Model, and showed that the mesh size of stow net fishing gives the most important variable effect on the economic value of small yellow croaker. For sustainable use of small yellow croaker resources, it is recommended to enlarge the mesh size as much as possible, even with high fishing mortality. The presentation provides an example of connections between fisheries/ecosystems and social-economic studies.

After these five presentations, meeting participants discussed and shared relevant information on the need of communication between science and stakeholders, led by Dr. Yoshida. This workshop aims to contribute to various global targets such as UN Decade of Ocean Science and UN Sustainable Development Goals in the North East Asian Marginal Seas. To achieve such global targets, central/local governments and all stakeholders should implement measures for sustainable ocean development based on scientific information. However, the existing networking effort between science and socio-economics is not sufficient due to limited opportunities and financial support. Scientists are expected to make more efforts not only to study marine science but also to develop more communication networks among the various stakeholders including the government.

PICES-2023 Workshop Reports

W5 - Bio-indicators of meso to global-scale marine pollution: techniques for integration and standardization

Yutaka Watanuki (Japan), Patrick O'Hara (Canada, DFO), Mirian Kim (Korea), Andrew Ross (Canada)

Rates of discharge of pollutants including heavy metals, persistent organic pollutants (POPs), and plastics are increasing despite concerted effort to control them. Many of these pollutants are transported through air and water currents from a diversity of sources, then deposited in remote regions, including Arctic and Antarctic Seas, impacting ecosystem health in these regions. During past PICES meetings, the Marine Environmental Quality (MEQ)and Biology (BIO) Committees (and the Marine Birds and Mammals Advisory Panel (MBM-AP), which is now the Section on Marine Birds and Mammals (S-MBM)) co-convened workshops and symposia in relation to the status and impacts of marine pollution. This workshop aims to develop standardized techniques to monitor the level of pollution in the remote regions where conventional sampling is difficult using bioindicators (MBMs, Sea Turtles, Fish, Squid, Mussels, and species from other taxa that can be used potentially as pollution bioindicators) as in situ samplers, producing indicator data of ecosystem health. For example, MBMs are useful bio-indicators of marine pollution as they bio-accumulate and magnify the low concentration of pollutants found in water to levels that are more easily detectable and measurable. As well, pollutant concentrations measured in MBM species can be considered average pollution levels integrated across a range of spatial scales, from meso to global, depending on life-history traits of the bio-indicator species. However, using MBMs as bioindicators for various pollutants requires the standardization of techniques for measuring and reporting concentration of each pollutant in each tissue for each species, as a suite of magnification factors, as well as differing half-lives among toxins, affect concentrations. Not all possible sentinel species occur in all subregions of the North Pacific, and for this reason we need to integrate further the concentration of pollutants in various tissues from various species. For example, plastic loading in stomachs of Northern Fulmar has been used successfully as indicator of plastic pollution in Europe and northern North Pacific, but this species does not occur in the south-central N Pacific. In this workshop, we planned to review and compare approaches used for detecting and measuring pollutants in different tissues in various species. We also welcomed original works on multiple tissues of a single species or those on a single tissue from multiple species. We discussed the approach for standardization and integration of the concentration of pollutants in the tissue of MBMs and the other possible sentinel organism for the North Pacific.

W5 was held on 20 Oct 2023 as planned (See attached Table 1). Unfortunately two presentations were cancelled; Fernanda Ferreira Paula Landim, et al. and Lauren Roman and Denise Hardesty. After the workshop they kindly sent presentations and information, which are included in this report. We had 10 attendees in the room and 3 on-line participants. The presentations, questions and answers, and general discussion are outlined below.

Yutaka Watanuki (corresponding convenor) introduced the workshop, explaining that Marine Birds and Mammals (MBM) are useful indicators of marine pollution as they bioaccumulate environmental pollutants and are able to integrate exposure across a range of spatial and temporal scales. To use them as global and long-term indicators, we used species and individuals with different trophic level, age, sex, distribution, and migration. Therefore, each pollutant, tissue and species represent a suite of biomagnification factors such as trophic level, sex and age of the sampled individual, migration, sample component (e.g. part of stomach), and cause of death (e.g. by-catch vs. stranding). For example, many factors are known to affect occurrence, size and mass of plastics in the stomach of seabirds so these cause biases (Table 3) when we use such information as indicator of spatial -temporal variation of marine plastic pollution. Hence, the use of MBM as bioindicators requires standardization of techniques for measuring and reporting pollutant concentration.

Jennifer Hoguet (invited speaker) described the Seabird Tissue Archival and Monitoring Project (STAMP), a long-term standardized specimen collection biobank managed by the US National Institute of Standards and Technology (NIST). This biorepository, which has been running for more than 20 years, contains over 100,000 samples. Seabirds are good indicators of bioaccumulated contaminants and, in particular, their eggs are conveniently packaged, easy to collect and handle, decompose slowly, and provide an index of parental offloading of toxins. Eggs from seabird colonies are therefore collected, banked at STAMP, and analyzed for anthropogenic environmental contaminants. Control material has also been prepared from Murre eggs for quality assurance/quality control (QA/QC) of contaminant analysis by NIST and other labs. Contaminants measured in samples from the Gulf of Alaska include mercury (Hg), polychlorinated biphenyls (PCBs), and legacy pesticides such as 4,4'-DDE. Requirements for a long-term and successful biobank like STAMP include: appropriately trained staff; a stable environment (e.g., temperature, humidity, light) monitored around the clock; consistent and standardized procedures (e.g., use of Field Data Sheets to record egg collection and measurement, and the separation and storage of eggs components); a detailed inventory; and a formal tissue access policy.

Jennifer Provencher talked about an ecosystem approach to monitoring physical litter and microplastics, with a focus on Arctic Monitoring and Assessment Program (AMAP) guidelines. The steps used to establish a monitoring plan include prioritization, documentation (of the accumulation of litter and/or microplastics), and the implementation of standardization or harmonized protocols. As well, it is important to ensure that low effort is required to establish sampling, that appropriate methods are currently available and/or aligned with monitoring activities outside the (Arctic) study region, and that historical data are made available (in several Arctic regions). The AMAP priority recommendations for monitoring were:

1. immediate trend monitoring
2. initial baseline mapping/future trend monitoring, and
3. a need for sampling measurement and development.

The AMAP exercise was captured in a Summary (4 pages), Monitoring Plan (24 page) and Technical Guidelines (244 pages). Jennifer also mentioned a related *Special Collection in Arctic Science* (open access) and a Litter and Microplastic Expert Group (LMEG) co-chaired by Canada and Norway, as well as scope for joint/overlapping indicators between PICES and ICES. In response to a question from co-convener Patrick O'Hara, Jennifer said that not many whale species are suitable for monitoring in the Arctic since they don't appear to accumulate plastics (which appear mainly in their scats).

Stephanie Avery-Gomm reviewed progress towards a long-term monitoring program for plastic pollution, including a review and recommendations for plastic ingestion bioindicators. She mentioned the different types of monitoring (baseline, trend, compliance, effects, risk-based, source and surveillance) and assessing the status of plastic ingestion by North Pacific marine organisms, based on Frequency of Occurrence (FO) for plastic ingestion across taxa and taking into account method and spatial biases. She also introduced a flowchart or rubric evaluation process developed by PICES Working Group 42 to identify bioindicator species, starting with an initial screening that included a series of Yes/No questions about accessibility (e.g., common, available and/or by-caught?), prior sampling (n > 10 sampled?) and frequency of occurrence of plastics in the species (FO > 0?). If the answer to all three screening questions is "Yes," then the rest of the rubric can be completed, including questions regarding species distribution (in the North Pacific and globally), the threat of human exposure, residency in the (PICES) region, and whether or not the species (or a congener) is already used as a bioindicator. Using this approach, practitioners identified the long-nosed Lancet Fish, Blue Mussel, Green Turtle, and Northern Fulmar as the principal bioindicator species representing different North Pacific ecosystems. Stephanie also mentioned the Global Plastic Ingestion Bioindicators (GPIB) project sponsored by UNDOS, which aims to coordinate research on plastic ingestion by marine wildlife and evaluate all species with a record of plastic ingestion.

Soojin Jang spoke about external morphology monitoring of wild marine mammals and their use as indicators of ocean health, given that marine mammals are a generally long-lived taxa and include top-level predators of the ocean food chain. It is possible to measure pollutants (heavy metals, organic contaminants) in stranded animals via analysis of biopsies. However, extrinsic skin markings can serve as manifestations of disease or (severity) of injury, while drones can be used to collect images from which the identity, sex, age, and skin markings of living animals can be determined. The properties of these skin markings (i.e., shape, severity, permanence, distribution on the body, and changes over time) can be related to regional environmental changes and unusual events. Categories include natural marks, skin lesions, tumors, scars and abrasions due to contact with sharp objects, vessels, propellers, fishing gear, etc. Examples include tattoo disease (caused by foxvirus), entanglements (which are often fatal to cetaceans and other marine mammals), and boat strikes (which are related to the number and operation of marine vessels). In summary, morphological changes in marine mammals can be related to changes in environmental conditions, the spread of infectious diseases, and the degree of interaction between specific individuals, providing a way

to evaluate population health and assess anthropogenic inputs. Pros include the ability to understand changes over time and identify habitat changes at the population levels while cons include the amount of effort required and the limitations of using a drone, or a camera alone, to collect the required images.

Miran Kim talked about the use of invasive and non-invasive methods to assess plastic debris ingestion by seabirds, which are an abundant and widely distributed group of predators that forage at sea/on the coast and ingest plastic, making them good bioindicators for this type of marine pollution. Invasive methods include the (opportunistic) analysis of stomach contents while non-invasive methods include analysis of pellets and degustations (which are relatively easy to sample). In a Korean study to compare these two approaches the shape, size and composition (polymer type, as determined by FTIR) of microplastic particles from pellet, bolus, and stomach contents were determined. Swinhoe's storm petrels were found to accumulate plastics in their stomachs (primarily as fragments in bolus and stomach contents) whereas for black-tailed gulls the FO was highest in pellets, suggesting that gulls can excrete plastics more effectively that petrels. The ingested plastics were composed mainly of polypropylene and polystyrene. To summarize, pellets (non-invasive method) were good for monitoring plastic ingestion in gulls whereas stomach contents (invasive method) were better for monitoring plastics in petrels.

Yutaka Watanuki described the analysis of mercury (Hg) in pelagic seabird feathers as a potentially useful indicator of marine pollution. Feathers are easy to store and to sample at bird colonies, and are equilibrated with blood contents at the time they are replaced. Streaked shearwaters replace both their primary and tail feathers from the inside out. The outermost (R6) tail feathers are the most suitable for monitoring Hg in wintering area, since Hg content of each feather reflects exposure during the 2-week molting period of that feather in late winter. Hence, later-wintering Hg content of R6 tail feathers could be a good indicator of exposure. Linking individual birds to their wintering areas was subsequently used to create and coarse-scale Hg pollution map at the meso-scale (~500 km). However, it is necessary to consider a number of bias factors including age, sex and trophic level. Birds were not aged so instead, 40 individuals were tracked for up to 2 years and accumulation of R6 [Hg] in consecutive two years was analysed. R6 [Hg] in 2021 was found to correlate with R6 [Hg] in 2022, suggesting that age is not a significant biasing factor, while the absence of a correlation between R6 [Hg] and a $\delta^{15}N$ suggests that trophic level also does no bias HG content. Sex bias may be controlled using a linear relationship although there is a need to measure, and normalize for, Hg in the environment.

Fernanda Ferreira Paula Landim (via e-mail), basically suggests using automated techniques with computer vision to measure plastics in samples (using the Saturna system) and standard colour wheels for colour. Lauren would even go so far as to say we should be RBG scaling (i.e., three measures of intensity) rather than classifying into preset categories (i.e., colour wheel). Cross-contamination is often an issue, particularly with microplastic samples.

General Discussion

- **Standardization of sampling and analytical techniques** Development/adoption of standard procedures, methods (esp. those used elsewhere) is needed, especially for characterizing plastics. Generate control materials for method development and validation (both for plastic characterization and for contaminant loading). Also associated contaminants may serve as indicators for type of plastic debris. Jennifer Lynch is looking for suggestions as to the most sought-after material/microplastic type for the preparation of control materials. Imaging flow cytometry (incl. with imaging flow cytobots, or IFCBs) is an emerging tool for detecting and measuring microplastics (e.g. use fluorescence, morphology to characterize and differentiate between plankton and microplastics). Plastic pollution in the ocean is really a 3-D problem and there is clearly a need for more boat-based research for investigating plastic with depth. How seabird samples help this problem is unknown. In general, stable storage conditions, managed access to samples, materials are needed. Also overlap/harmonization of species, methods, standards, protocols are needed. Need to use blanks and appropriate storage containers to account for variability between projects.
- **Choice of sample types and bioindicator species.** Samples can represent groups of species, groups of contaminants, spatial distributions, and timing (e.g. shearwater tail feathers). Criteria/rubric to screen bioindicator species for specific (classes of) pollutants.
- **Effects of pollutants in marine ecosystems.** Marine birds and mammals can indicate impacts of pollutants on ecosystem. Could log condition of bioindicator species when samples are collected, and relate to pollutant loading. Blocking of GI tract is a potentially lethal effect of plastics, whereas endocrine-disrupting chemicals (EDCs) associated (and ingested) with plastics could produce sub-lethal effects, along with physical transfer of microplastics into tissues.
- **Consider biasing factors. Age, sex, trophic level.** Half-life of pollutants in the tissue. Spatial and temporal scales. Eggs represent pollution in areas where individual birds feed (even though eggs are collected at the same location). eggs represent exposure just prior to egg-laying (parental offloading? What proportion? Differs between species?). Not easy to identify the place and time of exposure, but if we know the ecology of the species then that is valuable/useful information. Chemical additives of plastics in the stomach of seabirds are transported into their tissues (subcutaneous fat, liver, blood). Detecting and quantifying these chemicals in the preen grand oil can be used as an index for determining global pattern of plastic pollution, after considering various biasing factors that might affect their utility as such an index.

Table 1. List of presentations

Presenters	Presentation
Y. Watanuki., P. O'Hara , M. Kim	Introduction
Jennifer C. Hoguet and Rebecca S. Pugh (Invited)	Seabird Tissue Archival and Monitoring Project (STAMP) as an example of a long-term standardized specimen collection
Jennifer Provencher et al. (Oral, online)	An ecosystem-scale litter and microplastic monitoring plan under the Arctic Monitoring and Assessment Programme (AMAP)
Matthew S. Savoca , Stephanie Avery-Gomm, et al. (Oral, online)	Towards a North Pacific Ocean long-term monitoring program for plastic pollution: A review and recommendations for plastic ingestion bioindicators
Soojin Jang and Mi Yeon Kim (Oral)	External morphology monitoring of wild marine mammals using Photo-id and UAVs
Miran Kim et al. (Oral)	Assessing plastic debris ingestion of seabirds using invasive and non-invasive methods in Korea
Hikaru Odagiri, Yutaka Watanuki, et al. (Oral)	Feather mercury of a pelagic seabird can be useful indicator of marine pollution
Fernanda Ferreira, Paula Landim, et al. (Cancelled)	An improved standardisation method for characterising plastics ingested by marine mega fauna and those in their environment
Lauren Roman and Denise Hardesty (Cancelled)	Harmonisation in the context of management – Reporting on marine debris in the environment and interactions with mega fauna
P. O'Hara, M. Kim, Y. Watanuki.	Discussion

Table 2. Factors causing biases in the occurrence of plastics in the stomachs of seabirds in addition to the spatial and temporal variations of the level of exposures

Factors	Biases	References
Causes of death	Occurrence of plastics in birds from fisheries by-catch (long-line) is different from that from stranding along the beach	Colabuono et al., 2009; Roman et al., 2020.
Parts of stomach	Plastics occur much more in gizzard than provencularis	Ryan and Jackson, 1987; Moser and Lee, 1992.
Species	Occurrence of plastics high in Albatross, Shearwaters, and Petrels (60-90% of individuals), relatively high in Storm-petrels and gulls. Relatively low in alcids (<20%) and low in shags/cormorants and in penguins	Many references.
Age	In species that vomit food for feeding chicks, occurrence of plastics is higher in fledgling than adults	Van Franecker et al., 2011; Bond and Lavers, 2013; Verlis et al., 2013.
Migration	Possibly depends on wintering areas	?

PICES-2023 Workshop Reports

W6 - Developing an integrative conceptual framework of urban impacts on marginal ocean ecosystems (BIO, HD, MEQ)

Brian Hunt, Kathryn Sobocinski, Yoonja Kang, Julie Keister

Coastal oceans are global hotspots for marine productivity, reflected in high primary producer biomass and fisheries yields. Contributing to this productivity is land-ocean connectivity, including freshwater and material contributions from land that can modify hydrodynamics and enhance micro and macronutrients concentrations. Among marine environments, coastal oceans are also uniquely vulnerable to human impacts. Approximately 40% of the human population lives within 100 km of the coast. The anthropogenic impacts associated with human settlement and development can disrupt critical land-ocean linkages. Urbanization, a pervasive form of land use change, has wide ranging effects, including shoreline modification, pollution, and changes to freshwater runoff and the quantity and quality of material flux to the ocean. However, while localized studies have examined specific urban impacts, a unified concept of urban oceans is lacking. Such a concept needs to take into account the interacting effects of the geographic, climatic and oceanographic setting of the urban environment, history of urbanization and associated impacts, and the backdrop of climate change and sea level rise. This workshop reviewed the state of the knowledge of urban oceans through 1) presentations from diverse knowledge holders that specifically addressed the interactions between cities and coasts, focusing on case studies from the North Pacific, and 2) breakout and plenary discussion of key interactions / processes at the city-coast interface. In addition, the workshop participants explored the role of different knowledge types in understanding urban oceans, and challenges and solutions to sustainable urban oceans.

Presentations

Angela Danyluk [invited] *Sea2City design challenge*
Presented a case study from Vancouver, British Columbia, of how coastal cities can plan a resilient community and restore ecosystem health. Discussed the role of community engagement, through workshops and visual tools, to convey a vision for what the future can look like – important for the public and urban planners alike. Highlighted the importance of awareness of sea-level rise and the urgency to develop flexible adaptation strategies. Critically, this presentation highlighted the need for a decolonization approach and inclusion of indigenous and community perspectives and values in identifying baselines, project design, and evaluation of success.

Emily Howe [invited] Salish sea stormwater
Presented work from Washington and Oregon on estimating and mapping stormwater discharge, a fast-growing source of water pollution due to continued growth of impervious surfaces. Provided insights into the role of green infrastructure in mitigating stormwater outflow. Highlighted the importance of setting objectives for species conservation based on data, and tailored to different scales, i.e., matching scales of management objectives to the landscape scale of the organism. Emphasized the importance of visualizations to convey the message – using accessible google earth platform.

Kate Menzies [invited] *Tsleil-Waututh Nation's approach to understanding urban impacts on Burrard Inlet*
Underscored the legal obligation of the Tsleil-Waututh Nation to protect Burrard Inlet (Vancouver, British Columbia), heavily impacted by colonization through cumulative effects of shoreline change, habitat loss, contamination, and fisheries. This severely impacted the Tsleil-Waututh Nation's way of life, e.g., seafood no longer safe to eat. Discussed the role of shifting baselines in setting restoration targets, and presented efforts being led by the Tsleil-Waututh Nation to establish the pre-contact baseline for Burrard Inlet. Objective to have a safe and sufficient harvest. Ways to get there include proactive restoration, research and monitoring, policy development and collaborative decision making, increasing Tsleil-Waututh Nation's visibility on lands and waters, and improving the Tsleil-Waututh Nation's member access to lands and waters.

Jacques White *Salish Sea Survival Project*
Presented an overview of the Salish Sea Marine Survival Project, including findings on top-down and bottom-up effects on salmon survival. Identified the importance of cumulative and synergistic effects in salmon survival. Highlighted that estuarine habitat is critically important—estuaries with higher intact habitat have higher salmon survival. Gave examples of compost boxes to filter stormwater and remove 6PPD-Quinone, and shoreline softening to improve habitat.

Hem Nalini Morzaria-Luna *Assessing cumulative impacts in Puget Sound*
Gave an overview of Atlantis model development for Puget Sound. Forward simulation is being used to assess vital signs. Some questions being addressed are impacts of ocean warming on food webs, ecosystem impacts of jellyfish aggregations, and ecosystem effects of contaminants and nutrients derived from land / freshwater inputs.

Junsung Noh *Living Shoreline and Sustainable Saltmarsh Planting in the Green-living Tech, South Korea*
Gave an overview of a "Coastal new deal" – testing salt marsh restoration to provide habitat that will sequester carbon, soften shorelines to protect against erosion with sea level rise, and support oyster production: Green living (plants), blue living (oysters), soft living (softening shorelines). Needs a trio of science, policy, and media to be successful. A self-sustaining mesocosm system being used to test living shorelines.

Eliza Heery *Does the luxury effect occur in urban marine ecosystems?*
Luxury effect: as wealth increases biodiversity increases; attributable to green space in affluent areas. Is this happening in the marine environment? Processes of marine urbanization do not occur equally across the seascape - luxury effect, e.g., access to shorelines and environmental justice; spatial distribution of pollution, wastewater; zoning policy consequences for ecosystem services received.

Kathryn Sobocinski *Urban Seas are Hotspots of Stress in the Anthropocene Ocean*
Discussed pressures faced by urban environments globally, and highlighted the importance of cumulative impacts at the ecosystem level. Local oceanographic environment is critical to the effects of urban drivers, determined by tidal flows, currents, freshwater inputs, etc.. Urban seas problems are solved on land (policy on lands), and solutions span disciplines, domains of knowledge and jurisdictional boundaries, i.e., complex systems that necessitate complex solutions.

Speed talks – posters

- **Dilan Sunthareswaran** *Using Fatty Acids to Profile Particulate Organic Matter from Urban Sources and Measure its Uptake into the Food Web in Vancouver, BC*
- **Sadie Lye** *Using Stable Isotopes to distinguish and trace stormwater to particulate organic matter (POM) in the urban ocean in Burrard Inlet, Vancouver B.C.*
- **Yoonja Kang** *Coastal warming heightens direct impacts of seawater temperature on nutrients near aquaculture farms*
- **Hyeong-Kyu Kwon** *Significant contributions of fish-farm activities to the distributions of nutrients and trace elements in the coastal water off Jeju Island, Korea*

Key Takeaways from Presentations

Several themes emerged from the presentations including the need for intersection of science with social science, to include the human perspective. Understanding the scale of the problem in space and time is critical, as well as the interconnectedness that leads to cumulative effects and species-to-ecosystem impact. The complexity of these urban ocean systems extends across the entire social-ecological system, e.g., stakeholders and rightsholders in these environments are diverse, have varied jurisdictions and motivations and need to be included in restoration/regenerative uses. Visualization and storytelling are powerful tools to convey information to diverse parties and bring them together on common goals.

Discussion

Breakout session 1: State of the knowledge - Interactions / processes at city-coast interface

- **How do cities impact coasts?**

  Impacts could broadly be divided into direct environmental impacts, e.g. shoreline modification, pollution (light, biogeochemical, etc.), operating at different spatial and temporal scales, from species to ecosystem level; and indirect effects of regulations, policy, governance. Highlighted that urban impacts are socio-ecological in nature, e.g., impact on people's access to resources, cultural practice.

- **How do coasts impact cities?**

  Coasts attract people to cities, affecting population growth and density, while influencing and supporting cultural practice, economies and food systems. Coasts confer city resilience to environmental extreme stressors, e.g., tsunamis, and climate change.

- **What are the critical knowledge gaps?**

  There is a gap in regulations between land and sea—regulatory power ends on the land. Indicators of urban impacts on the ocean are still largely missing, in part due to a lack of thresholds for species and ecosystems effects. There is a lack of consensus on baselines to guide targets for urban ocean health, and a risk of shifting baseline syndrome. Identification of urban ecosystem services would help in setting targets, even if some of these services would only benefit certain sectors. There is a need to incorporate Indigenous knowledge in guiding objectives, and involvement in co-decision making. How do we get policy makers / enforcers / planners in on conversations about healthy oceans?

Breakout Session 2: What is the role of different knowledge types?

Having different knowledge types and perspectives at the table can identify different problems / solutions. Indigenous knowledge and stewardship has a critical role in attaining and sustaining healthy urban oceans, and should be included equally with other types of knowledge in planning for and implementing goals.

What are the challenges with connecting different knowledge types?

Different vocabularies require extra effort in communicating and listening, while weaving together different knowledge types is challenging – how can this be done well? Bringing different sectors together can be very challenging but once established can become self-sustaining, and can build trust over time. Having a clear vision when starting efforts can be foundational to define knowledge gaps and barriers.

There is a high demand on Indigenous knowledge and there is a need to be sensitive to capacity to meet demands. Furthermore, care needs to be taken to use Indigenous knowledge without being extractive, including involvement in planning, decision making, and management process.

Group Discussion 2: What do solutions to healthy urban oceans look like?

- Solutions need to start with goal setting, e.g., being able to eat food from the urban ocean. Solutions should be inclusive of different perspectives, knowledge types, stakeholders and rightsholders; and need to be flexible to change in climate, values and information. Solution frameworks need to be prepared for things to get worse—long term planning.

Next Steps

The participants of Workshop 6 expressed interest in developing and funding an active working group to formalize an integrative conceptual framework of urban impacts on marginal ocean ecosystems.

Workshop Participants

Conveners

- Brian Hunt (University of British Columbia, Canada)
- Kathryn Sobocinski (Western Washington University, USA; presented)
- Yoonja Kang (CNU, Republic of Korea; presented)
- Julie Keister (NOAA, USA; not able to attend)

Presenters

- Angela Danyluk (City of Vancouver, Canada; invited speaker)
- Emily Howe (The Nature Conservancy, USA, invited speaker)
- Kate Menzies (Tsleil'Waututh Nation, Canada)
- Jacque White (Long Live the Kings, USA)
- Hem Nalini Morzaria-Luna (Long Live the Kings, USA)
- Junsung Noh (Seong University, Republic of Korea)
- Eliza Heery (University of Washington, USA)
- Dilan Sunthareswaran (University of British Columbia, Canada; workshop assistant)
- Sadie Lye (University of British Columbia, Canada; workshop assistant)
- Hyeong-Kyu Kwon (Seoul National University, Republic of Korea)

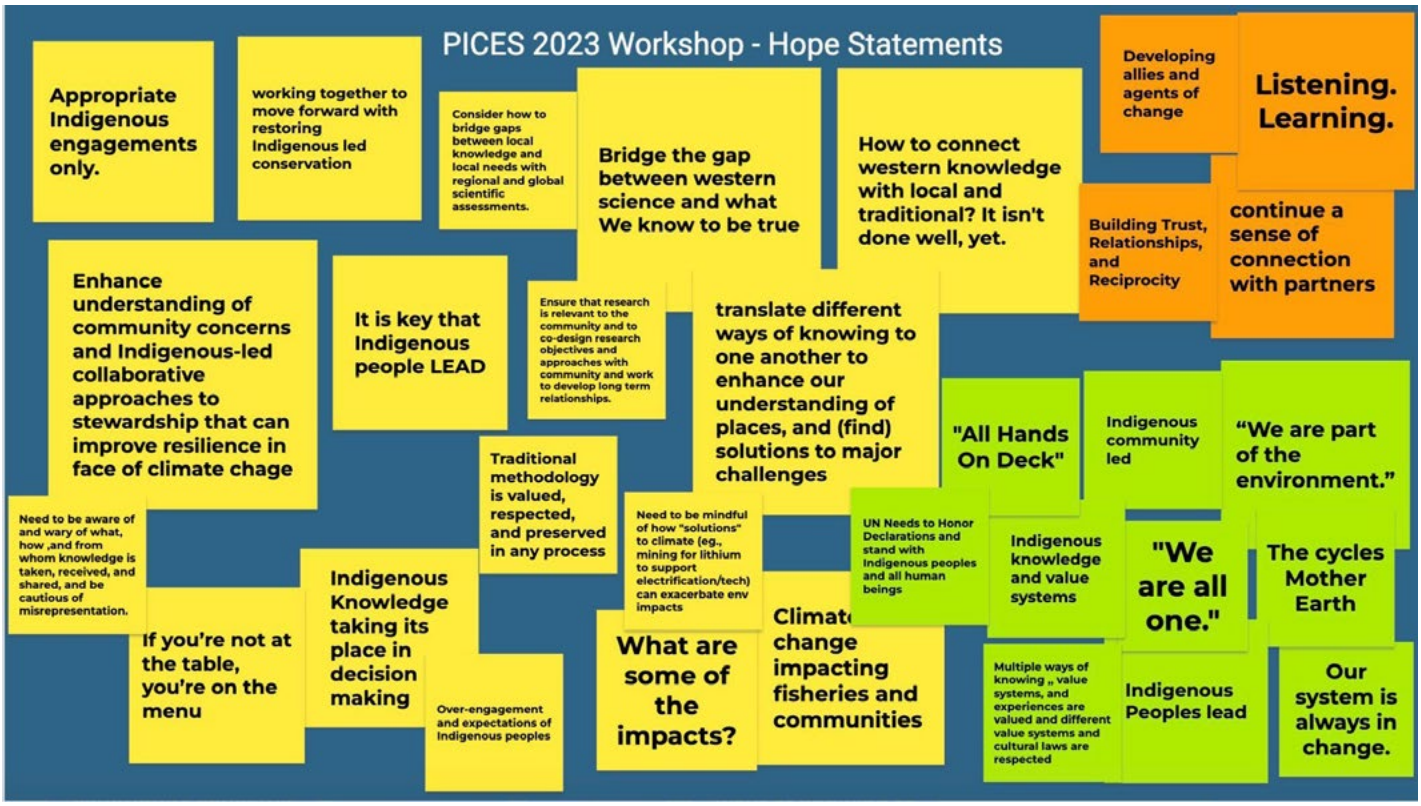
Additional participants

- Natasha Buckiewicz (University of British Columbia, Canada; workshop assistant)
- Anna McLaskey (University of British Columbia, Canada)
- Anu Rao (Tsleil'Waututh Nation, Canada)
- John (Tsleil'Waututh Nation, Canada)
- Lindsey Ogston (Tsleil'Waututh Nation, Canada)
- Hayley Crozier (Tsleil'Waututh Nation, Canada)
- Cora denHartigh (Tsleil'Waututh Nation, Canada)
- Isobel Pearsall (Pacific Salmon Foundation, Canada)
- Liz Duffy (Long Live the Kings, USA)
- Rebecca Martone (Tula Foundation, Canada)
- +5-8 participants in the morning session presentations

PICES-2023 Workshop Reports

W9 - Indigenous and Community-Led Approaches to support climate change adaptation and Ecosystem Resilience in the North Pacific and Arctic

Kathryn Sheps, Rebecca Martone, Sarah Wise, Rebecca Ingram, with workshop particpants



A jamboard used to capture ideas and messages from participant introductions and intention statements shared on Day 1 of the workshop, we chose to use a jamboard for this portion of the conversation to enable remote/online participants to share their reactions.

The Ocean Decade Collaborative Center for the Northeast Pacific (DCC) and NOAA's Alaska Fisheries Science Center (NOAA) jointly convened a workshop, *Indigenous-led approaches to support climate change adaptation, resilience and informed management in the North Pacific and Arctic*, that was held October 20th and 21st as part of the PICES 2023 Annual Meeting in Seattle, WA. Our aim was to share ways to weave together multiple knowledge systems and identify pathways to expand collaborations and partnerships in ecosystem research, climate change adaptation, and informed management processes.

The conveners set three main objectives for this workshop:

1. Bring together marine and coastal knowledge holders (including Indigenous and Traditional Knowledge holders, climate scientists, and ocean practitioners) to share stories, lessons, and perspectives of living with changing marine ecosystems.

2. Provide a safe space to build relationships, and share stories and lessons learned from Indigenous-led work.

3. Facilitate a cross regional knowledge network of Indigenous Knowledge holders, community leaders, and ocean practitioners to facilitate ongoing collaboration beyond the PICES annual meeting.

The workshop consisted of a one-day "closed door" invitational and participatory deliberative dialogue session, and a second half-day open-door knowledge sharing session open to participation from anyone registered for the PICES Annual Meeting. Participants joined the workshop from across the NE Pacific and beyond: participants included members of Indigenous communities from Washington, British Columbia and Alaska, as well marine scientists and "boundary spanners1" from the US, Canada, EU, and Australia.

Day 1

Day 1 started with a blessing, and a shared commitment to productive and collaborative work. The group participated in a comprehensive round of introductions so that

[1] A 'boundary spanner' is an individual who can connect people across social, societal or cultural silos (Hatch et al., 2022)

participants could learn about the backgrounds and expertise of everyone in the room. During this period, some members reminded the group of the urgency of this work, particularly given the rapid pace and far-reaching effects of climate change on Indigenous communities. There was shared discussion on climate driven impacts on coastal communities in the North Pacific and Arctic including dramatic declines in key subsistence and commercial marine species, increased marine traffic and associated impacts, reduced sea ice, increased storm events (both in frequency and severity), and changing ecological systems. Indigenous communities are coping with these changes with limited resources and capacity, further exacerbating the harmful effects. The group was reminded that Indigenous coastal communities have been experiencing, engaging with, and learning from ecological changes for millennia: "We are still here and we will continue to adapt." It was agreed that climate research must embrace a commitment to benefit frontline Indigenous communities.

Discussion continued, focusing around collectively addressing two questions:

1. What are some ways that communities and scientists are weaving Indigenous Knowledge and Western science together to inform climate adaptation and coastal and ocean stewardship?

2. What are some of the elements that you think are critical for enabling successful collaboration?

These questions were considered in open dialogue, as a large group.

Indigenous Knowledge and Knowledge Systems

Participants described their relationships with Indigenous Knowledge and Indigenous Knowledge Systems. People shared a general agreement that Indigenous Knowledge is not a monolithic entity that can just be 'engaged with' or 'blended' with Western science, as one participant described it, "as ingredients in a recipe." Everyone has different knowledge, and people come to know things in different ways based on their own experiences, values, and relationships. Indigenous Knowledge Systems derive from millennia of observation, and place-based relationships in which many Indigenous peoples continue to coexist with plants, animals, elements, environments, and ecosystems, rather than from observations of systems that are viewed or valued as separate from the observer. Participants reported that Indigenous perspectives often view these relationships as intimate, in which human and non-human members are engaged in caring and caretaking relationships with each other.

In this formulation, Indigenous Knowledge Systems are values-based systems, complete within themselves and deeply embedded in cultural understanding and experience, and cannot easily be compared to Western ways of knowing. Often Western knowledge considers values and responsibilities as distinct from observation. When considered from Indigenous perspectives, Western scientific approaches appear to divorce observations from outcomes; its values can be seen as uncaring, or even violent, because of the lack of reciprocities and care relationships.

Discussing the Differences Between Indigenous Knowledges and Mainstream Science

Having established some shared understanding about Indigenous Knowledge Systems and their complexity, the group moved to the question about how to work alongside--or in tandem with--Western scientific knowledge and approaches (see Question 1). Participants talked about their experiences, either their own, or those with which they were familiar, working with multiple knowledge systems. Many people shared that they felt like Western scientists did not fully appreciate or understand the ways in which their requests, or attempts at collaboration were mis-matched with the kinds of knowledge being sought. This included treating Indigenous Knowledge and Indigenous Knowledge Systems as less valid than Western scientific approaches, both due to prejudice, racism, and the continuing impacts of colonialism, as well as the lack of existing best practices, frameworks, or accessible tools to help integrate various worldviews in a scientific rubric. Several participants spoke of a lack of care in the treatment of Indigenous Knowledge, and by extension, Indigenous People are given in some Western scientific approaches. This engaged the curiosity of some participants: what would it mean for oceanographers to not consider themselves apart or separate from the waters and ecosystems they observe and study? How could we bring this kind of relationality into ocean sciences?

Participants discussed the differences in values between Western science and Indigenous approaches. Western science emphasizes broad knowledge sharing and values communication and sharing ideas and results far and wide. This cultural value differs from many cultures, which may link responsibility and obligation with knowledge holding: only those with the permission and teachings to understand how to responsibly care for the knowledge are able to hold and share knowledge. In these contexts, open and liberal communication may not be seen as a positive attribute.

Participants often returned to the idea of Western scientists as needing to listen--in more than one way--to other

cultures, perspectives, and ways of seeing the world. This requires not just listening to what community members say, but also understanding broader interrelationships and impacts with ecosystems and people. Participants wanted to be clear that speaking to one community member about a particular piece of work was likely not sufficient for meaningful community engagement. As Indigenous Knowledge Systems are often relational, knowledge in those systems can also be personal and intimate, and community members may disagree about various observations, approaches and protocols. Further, it is important to remember that community members may hold different forms of knowledge relevant to a particular question. In order to meaningfully engage with Indigenous communities when doing research, it is important to engage with the community, and seek perspective and guidance from multiple knowledge holders, rather than rely on one voice, unless directed by the community to do so.

Reciprocity

In order to act as allies for Indigenous communities, Western scientists should be mindful that reciprocity is a core value and necessary for any type of collaborative work. Researchers should consider how they are reciprocating and offering value to the Indigenous communities in which they work. There were many examples mentioned--whether organizing science work so that it is primarily responsive to community needs, ensuring the research tackles questions of importance to communities, supporting community systems in place, and appropriately compensating and crediting community members for their time and contributions. Participants shared experiences where Western scientists asked questions that were seen as not relevant or useful for the community they were engaging. Experiences of extractive work, where scientists 'take' or 'use' Indigenous Knowledge without permission and without appropriate context were also shared. These experiences lead to poor outcomes for the research, the relationships, and the possibility of future collaborations.

Elements of Successful Collaboration

When asked what elements were necessary for successful collaboration (see Question #2), participants overwhelmingly pointed to the need to address the resourcing of these collaborations, particularly the way science funding can be shared with participating community members and the length of time that scientists are willing to commit to engaging and working within communities. Capacity limitations (whether limitations on funding or labor resources) was a central topic. The need for long-term funding and funding available to support Indigenous participation in initial, early, and ongoing planning stages of work were emphasized. Several participants agreed that longer-term funding and support for Indigenous communities engaged in scientific research helps to create better scientific outcomes, as it allows for the development of checks and balances, as well as gives time and space for Indigenous communities to participate fully. Often community members, especially those working with Guardians or in stewardship positions, are active in multiple projects and fielding requests for further or new collaborations, above and beyond the work they may be doing for their own communities and organizations. This also calls back to the need for collaboration to be reciprocated by Western scientists, as discussed earlier. One way that collaboration and exchange can be reciprocated by Western-based institutions is by providing funding that can be used to build or increase capacity for engagement, participation and collaboration within Indigenous communities.

Building Trust and Equitable Partnerships in Urgent Times

After the lunch break, participants moved into three smaller groups for continuing discussion. Participants engaged in conversation about the kinds of supports needed for different actors to show up for equitable scientific collaborations. Participants also tackled a thorny question: it is often said that relationships are built at the speed of trust, but climate change can present urgent challenges to coastal communities - how can we ensure even urgent needs are met? The conversations across the three breakout groups were substantially different, but touched on some common themes and ideas.

All the groups discussed the need to acknowledge, and address power dynamics in collaborative projects and processes. One group talked about the necessity of Western scientists to acknowledge that bridging the gap between Western and Indigenous perspectives requires respecting the social and cultural values on which those differences in perspectives are based. One participant described this as the difference between managing "a resource" as opposed to managing "a revenue". Another person described the difference between a "natural resource" and an "ancestor or family member". Multiple examples of this difference were mentioned by participants. One example is salmon on the Pacific coast, where fisheries management is based on maximizing sustainable yields (as informed by the Western value of profit maximization). In contrast, many Indigenous perspectives focus on human-ecological-salmon relationships, maximizing the livelihoods of the salmon, as well as the many people and other species who depend on them. The group provided additional examples of how differences in values inform both regulatory structures and decision-making, which can lead to real harm for Indigenous communities, further deteriorating trust between communities and researchers This points to a fundamental difference across multiple perspectives and approaches. It is important to note that many Indigenous People rely heavily on coastal and

marine resources: they live with the risk of ecological deterioration in their communities, which directly affects their--and those of their children's and grandchildren's--health, social wellbeing, cultural cohesion, and ecosystem processes. Participants agreed that Indigenous-led research is necessary for more robust and balanced research that can inform improved decision-making across regions. Given the rapid and profound effects of climate change, the urgency for more inclusive and equitable research was recognized. There was acknowledgment of slow changes (such as this workshop at the PICES Annual Meeting); however, it was noted that the speed of change is not equivalent to the speed at which key populations and essential habitats are declining.

Context matters

While there may be some lessons that can be learned in one location and applied to the benefit of people and place in other jurisdictions, participants shared examples about how this tendency to categorize and generalize across locations, ecosystems, and species can lead to inaccurate findings and mistaken understandings. Several participants compared this kind of piecemeal approach to examples of preferred holistic approaches--rooted in Indigenous perspectives--to collaboration. One example was shared about Western scientists trying to communicate about a species of fish, using one of its Indigenous names. The scientists in question did not understand that the name of that fish was only used in certain contexts and locations and not others. This led to confusion among community members and the scientists were unsuccessful at gaining the knowledge they were seeking. Employing more holistic approaches to collaborating with Indigenous Knowledge holders early in research planning and designing critical questions might have avoided this kind of confusion.

Principles of data equity and sovereignty were also discussed. As one participant stressed, "data are key to empowering Indigenous communities." Many talked about the imbalance in how knowledge is viewed and leveraged within Western science. If Western science can 'confirm' what Indigenous Peoples have known and passed down in teaching for generations, this confirmation is sometimes necessary for Indigenous participants to be treated equitably in collaboration with Western scientists. Participants mentioned the OCAP principles (Ownership, Control, Access and Possession) as a critical correction to past data practices - permission needs to be sought and granted in order to collect data and work in Indigenous lands and waters, and at every stage in the scientific process, from very early stages of articulating a hypothesis all the way through and including authorship to Indigenous collaborators.

Day 2

The final half- day of the workshop provided an opportunity for participants to share the work that they have been involved with in their communities, showcasing examples of Indigenous-led research in ecosystem management, climate change adaptation and resilience. A wide range of project types and approaches were shared from across the NE Pacific and the Arctic in a variety of formats. This agenda was decided upon collaboratively by workshop participants at the end of the first day of discussions, and all workshop participants had the opportunity to share their work with interested members of the PICES community.

After an opening to start us off in a good way, participants from northwestern Alaska shared stories and experiences as climate change has driven substantial social, economic, and ecological changes in their communities. One participant shared his experience of mourning the loss of "the mother ice" every year (the first solid winter sea-ice) and the many resources the ice brings to his marine resource dependent community: walrus, seal, polar bear, among others. The effects of climate change are leading to the uncertain arrival of mother ice, a reduction in the thickness of this ice, and diminished access to these critical species and practices. He also shared teachings that his grandfather directed him to pass along relating to climate change, and the need to protect ecosystems and his way of life so that they are not lost permanently. Another participant shared a short film about Indigenous-led research (Ikaaġvik Sikukun or "Ice Bridges")2 that occurred in his community. The project focused on the thickness of sea-ice, examining how decreasing sea ice leads to increased risk, and reduced access to subsistence foods in his community. Not only is the sea-ice less safe to travel on, but decreased mobility leads to decreases in hunting which has real impacts on the food security of his community. Another participant from the Yukon River Drainage Fisheries Association3 (YRDFA) presented information on several of their collaborative projects with Alaska Native communities in the Yukon region. In partnership with communities along the Yukon River watershed area, YRDFA has conducted research on a range of topics of interest to communities including, invasive species, salmon health, Traditional Knowledge, water quality, and community resilience.

From Haida Gwaii, participants shared work involved in creating a marine planning program based on Haida Knowledge about the oceans: the Haida Gwaii Marine Plan4, a collaboration between the Council of the Haida

[2] Ice Edge, the Ikaaġvik Sikukun Story: https://www.youtube.com/watch?v=P9RzfGtLWHo
[3] https://yukonsalmon.org/
[4] https://haidamarineplanning.com/initiatives/haida-gwaii-marine-plan/

Nation and the Province of British Columbia. Another participant shared a recent collaboration between Parks Canada and the Haida Nation, X̲aayda Gwaay.yaay K̲uugaay Gwii Sdiihltl'lx̲a: The Sea Otters Return to Haida Gwaii[5]. This project explored how the recent return of Sea Otters (ku*k̲uu in Haida language) might be understood and related to by the community on Haida Gwaii.

Two presentations from participants focused on the ways in which they were learning from other Indigenous communities in order to find solutions to problems in their own home communities. A member and staff of the Swinomish Indian Tribal Community shared about how learning the ancient Indigenous practice of clam gardens from relatives in British Columbia was leading to a revitalization of knowledge and culture in his Washington State community, which was an emotional and meaningful experience for this participant[6]. An Indigenous participant from Australia currently living in Washington State discussed how he was learning from communities along the NE Pacific coast, and noted similarities and differences between Indigenous-led approaches to ecosystem and fisheries management across continents: he planned on sharing this experience with Indigenous communities in Australia.

Next, we had a screening of a short film, Tsunami 11th Relative, that documents an example of a culturally sensitive coastal resilience project around Tsunami safety on Vancouver Island, BC with the Ka:'yu:'k't'h'/ Che:k:tles7et'h', Nuchatlaht, Ehattesaht, Mowachaht / Muchalaht, and Quatsino First Nations. Indigenous elders spoke about their experiences with tsunamis and storms that have affected their coastal community and described how Indigenous Knowledge about tsunamis has helped Western scientists better understand impacts of sea-level rise and coastal hazards on this region, as well as helped develop culturally sensitive disaster response and management plans.

We closed our workshop with words from an Elder from St. Lawrence Island, Alaska, stressing the importance of working together to face the climate crisis, and the consequences of our failures. These words were a call to action and a reminder of the urgency of the work we are doing together, and the need to continue to move forward, despite the complexity and challenges.

Conclusions

We hope PICES continues to equitably engage with Indigenous leaders in the US and Canada, as well as across the North Pacific when designing and implementing research. There are many examples of excellent, rigorous Indigenous-led work happening across the northeast Pacific coast; this workshop was a crucial first step to more equitably include multiple voices and perspectives in marine science. We encourage PICES to engage with Indigenous leaders and boundary spanners in these meetings--as well as on the PICES planning bodies--to support equitable collaborative research.

If PICES, as an organization, is interested in engaging more Indigenous leaders and including more Indigenous approaches:

- It is not appropriate for Indigenous People and perspectives to be siloed in only a few workshops, instead, integrated throughout the committees and working groups;
- PICES already deals with cultural differences, so perhaps it would not be difficult to include additional cultural perspectives;
- Indigenous participants must be supported financially and with other resources - i.e. honoraria for speakers and Indigenous Knowledge holders in addition to travel and accommodation support and stipends - most other participants are part of national delegations, and have other forms of support for their work;
- Engagement and outreach is a big task, but would be an important one - do not leave this to national governments that are often already in conflict with Indigenous communities and First Nations over resource and ecosystem management;
- PICES needs to provide more time for edits and review by participants prior to publication of PICES reports; and,
- It is important to acknowledge, address, and work to rectify inequities in participation, funding and recognition, and recognize that this work needs to be part of PICES's mission, if it wishes to increase Indigenous participation in PICES working groups and events.

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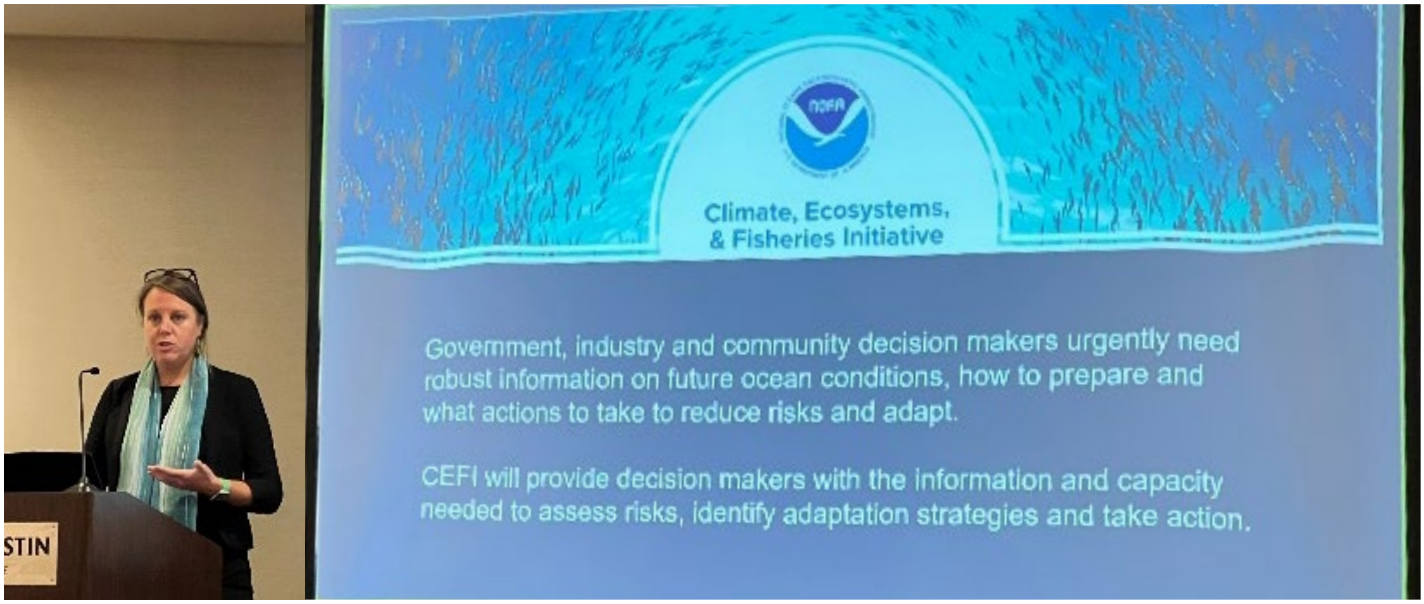
5 https://parks.canada.ca/pn-np/bc/gwaiihaanas/nature/conservation/restauration-restoration/kuu

6 https://wsg.washington.edu/research/clam-gardens/

PICES-2023 Workshop Reports

W10 - Towards climate-informed ecosystem-based fisheries management by building international collaborations and standardizing indicator



Convenor Kirstin Holsman (NOAA, AFSC) presents during the W10 workshop.

Convenors

- Alison L. Deary (US FWS, USA)
- Kirstin Holsman (S-CCME; USA, AFSC -NOAA)
- Lewis Barnett (NOAA, USA)

Co-convenors

- Xiujuan Shan (S-CCME. China),
- Kathy Mills (ICES, SICCME, USA, GMRI)
- Alan Baudron (ICES, SICCME, Scotland)
- Andrea Nieimi (DFO, Canada)
- Sukgeun Jung (Jeju National U, Korea)

Overview

Climate change is having profound impacts on marine ecosystems and fisheries. According to the latest IPCC assessment, climate change is intensifying, and some changes are irreversible on the scale of human lifetimes. Marine ecosystems and associated fisheries will therefore continue being impacted by climate change in decades to come, posing a growing risk for global food security and socioeconomic benefits. Additionally, high-latitude ecosystems such as the Arctic, are experiencing unprecedented changes in ocean conditions (e.g., ocean heating, loss of sea ice, rising sea levels) that have impacted biological and ecological processes, societal and traditional uses of Arctic natural marine resources, and economic activity including tourism, shipping, and oil and gas exploration. Despite the clear need to mitigate climate-induced risks and to adapt to future climate change, accounting for climate impacts when developing fishery management plans and policies remains challenging. For instance, despite ongoing efforts, the EU's Common Fisheries Policy still has a low adaptability to climate change.

The emergence of ecosystem-based fisheries management (EBFM) has shown that it is possible to account for external drivers such as environmental conditions and/or predation when managing a fishery. A challenge to detecting, monitoring, and communicating changes in environmental conditions in an EBFM framework is that sampling methodology is not often standardized, which complicates regional and international syntheses. Stakeholders are also increasingly involved in the management process and can provide hands-on knowledge crucial in shaping policies to manage marine resources. By connecting science among international collaborators and Indigenous communities, we are better poised to detect, monitor, and respond to changing environmental conditions. These recent advances towards holistic fisheries management provide steppingstones towards climate-informed EBFM. In coordination with an ICES ASC session, we held an interactive workshop to discuss emerging issues around climate-informed EBFM, build relationships with international partners, and promote cross-fertilization especially when generating robust indicators to monitor climate change.

Convenor Lewis Barnett (NOAA, AFSC) taking a selfie as a break comes to an end during the workshop.

The 1.5-day workshop was a hybrid format that included a mix of 10-minute "spark" oral presentations, 20-minute oral presentations, and discussion sessions on the following topics:

- Case studies of accounting for climate impacts in management measures & showcasing policies applied 'in practice'
- Best practices and approaches for considering large-scale and long-term climate impacts
- Reconciling long-term projections and short-term tactical management
- Advances needed for climate-ready fisheries management to be widely adopted
- Data standardization, its application to ecosystem-based management, and the optimization of sampling platforms to monitor climate change across a variety of ecosystems and trophic levels.

Summary

Over the day and a half workshop, participants heard 21 presentations. The breakdown of talks included two 30-minute invited presentations, one by Kathy Mills (Gulf of Maine Research Institute (GMRI)) and a second by Kalei Shotwell (National Oceanic and Atmospheric Administration (NOAA), Alaska Fisheries Science Center (AFSC)). Six presentations were 20-minute standard conference style talks and an additional 13 talks were 10-minute spark presentations. Presenters were affiliated with 8 different institutions and three countries. The institutions included four different NOAA (US) offices (three fisheries science centers and the Pacific Marine Environmental Laboratory), US Fish and Wildlife Service (US), GMRI (US), Japan Fisheries Research and Education Agency at Hokkaido National Fisheries Research Institute, and the National Marine Environmental Forecasting Center (China). For the afternoon of day 1, we averaged 30-35 in-person participants with an additional 3-4 virtual attendees. On day 2, we averaged 21 participants in-person with an additional 2 virtual attendees.

Despite the need for integrating climate information into ecosystem-based fisheries, many hurdles exist for implementation. With that in mind, we built six discussion sessions into the agenda to stimulate conversation across participants, to engage with speakers directly, to break down communication barriers, and to openly discuss strategies to improve data standardization. In the summary below, we highlight some of the themes from the discussion sessions and take-home messages from our invited speakers. The workshop was also organized into two parts: Part A focused on climate-informed EBFM modelling and coordination on day 1 through mid-morning on day 2 and Part B focused on EBFM data standardization. Due to the number of talks, we will not provide a summary of each talk. However, if this is of interest, please email the convenors, Alison Deary (alison_deary@fws.gov), Kirstin Holsman (kirstin.holsman@noaa.gov), Lewis Barnett (lewis.barnett@noaa.gov), and Kathy Mills (kmills@gmri.org), and we will provide a copy of the detailed notes from the workshop.

A few themes emerged during Part A's discussion session on day 1 that focused on (1) the skills needed to meet climate-informed fisheries management goals, (2) the strategies to break down barriers and to improve intellectual accessibility to climate topics, and (3) the education needed to build trust within inter- and trans-

disciplinary fields, as well as with stakeholders. Further expanding on the discussion theme 3, to best integrate climate information into a fisheries management framework, climate scientists need to learn about the fisheries management process and engage with it at various levels to understand how information is used to inform decisions and to identify where flexibilities exist in the framework. Additionally, the science associated with climate and fisheries is evidence-based, meaning that as the best available science in support of both fields is updated, changes to fisheries management are often required. Without proper education and mentorship, these changes can be deemed as the initial process being incorrect, when instead it is evidence of the incorporation of new data. Some of the suggestions offered to address the themes discussed included NOAA's National Marine Fisheries Services Open Science coordinator position, which has been filled by Eli Holmes. With this role, Eli will be identifying the technical limitations and skills needed to facilitate open, collaborative, and reproducible science. The morning of day 2 (Part A) brought a presentation on the implementation of two tools, Ecosystem Status Reports and Ecosystem Socio-Economic Profiles, that complement each other to fill a known gap in the communication of ecosystem information to make climate-informed management decisions. A theme of the subsequent discussion focused on tradeoffs between strategic, long-term projections (end of century) and tactical, short-term projections (this year) and the application of each type of projection to EBFM. Tactical projections are emphasized during the stock assessment process each year to determine the following year's catch (i.e., what are the conditions this year that will impact next year's catch). However, multi-year data are valuable because they provide context of patterns and their trajectory, which are not incorporated into the stock assessment model. Although these multi-year patterns may not change a tactical decision, they do call attention to factors that are relevant across stocks when considering long-term climate-ready fisheries. Additionally, synthesis approaches that engage with diverse partners can mitigate internal data limitations that exist within each partner's organization to generate a robust and continuous product. It is also important to develop products at the appropriate scale for specific regions and communities, which aligns well with earlier discussed themes related to accessibility and trust by providing products that are most relevant for partners based on their needs. This discussion concluded Part A of the workshop.

Mid-morning of day 2, the workshop shifted to focus on the theme of EBFM data standardization (Part B), which was sub-divided into spark presentations focused on (1) Modelling and ecosystem synthesis, (2) Benthos, and (3) Fish. Discussion sessions were nestled between each sub-division, facilitating conversations related to the guidance provided in the spark presentations, cited needs, and questions raised by the presenters. Discussions were engaging and oftentimes related to themes from discussion during Part A, such as technical skills needed to robustly standardize ecosystem data products and the limitations to standardization, which are often associated with human resources and infrastructure. However, institutional changes are underway to train individuals in the skills needed to build and curate public data repositories to support open and transparent science. When implemented, standardization during sample collection, analysis, and the communication of ecosystem information maximizes efficiencies, streamlines workflows, is reproducible, generates best practices for the field, and creates stronger partnerships. Additionally, a benefit of standardized approaches that are collaborative and in support of open science is that they leverage expertise across a wider network, creating a broad foundation and accelerating advancement across the field. A lesson that was highlighted during the discussion was the value of thinking about uses of ecosystem products by engaging with stakeholders early and frequently. This approach often maximizes efficiency, prioritizes objectives based on shared needs, and is rewarding. Aligned with topics from Part A, it builds trust with stakeholders and increases accessibility to ecosystem data.

The workshop concluded with a synthesis discussion facilitated by Ali Deary, Lewis Barnett, and Kirstin Holsman. Communicating uncertainty is important even though models do well at capturing the trend, as extreme events are more difficult to predict. However, projections are valuable in the context of climate-ready fisheries because they are tools for thinking about potential future scenarios. A closing thought was related to the power of networking and how open research communities stimulate rapid evolution of methods within a field by providing a venue to build upon each other's work, which is necessary to assess the influence of climate change on fisheries at appropriate spatial and temporal scales.

PICES-2023 Workshop Reports

W11 - Science advances needed to understand "the new ocean": our rapidly changing ocean environments

Francisco Werner, Shin-ichi Ito, and Salvador E. Lluch Cota

Group photo from the 2023 "Science advances needed to understand our rapidly changing ocean environments" Workshop (W11). Not all attendees are pictured.

Oceanic environments are changing rapidly in response to climate forcing. During the past two decades we have witnessed unprecedented and perhaps sustained or irreversible modifications of ocean physics (e.g., occurrence of marine heat waves – MHWs, stratification), biogeochemistry (e.g., changes in pH levels, oxygen minimum zones – OMZs), populations' redistribution (e.g., latitudinal shifts, migration patterns), as well as ecosystem structure and function (e.g., changes in the food web and energy flows related to shifts in planktonic communities). In some ways, these changes have resulted in a "new ocean."

Our oceans have also become more crowded through the growing presence of multi-sectoral uses (e.g., commercial and recreational fisheries, aquaculture, renewable energy, etc.). As such, we are at a point where not only do we need to study and understand our "new ocean," but we also need to develop novel ways of sampling, observing, and quantifying it. Fortunately, significant advances in our ability to sample and quantify our ocean's new states have resulted from a robust evolution in observational (e.g., uncrewed systems, molecular approaches, satellite/remote sensing) and analytical (e.g., high-performance computing, artificial intelligence/machine learning – AI/ML, etc.) capabilities.

Workshop W11 focused on framing questions that can help define the next levels of understanding of our "new ocean," as well as identifying the challenges in doing so. We aimed to prioritize questions that we need to take on as a scientific community and discuss our capabilities to address these.

Questions guiding the discussion included:

1. What should our science foci be in the study of our rapidly evolving "new ocean" (and its integration in the broader Earth system)?
2. Do we have the necessary observational and analytical capabilities, either existing or within reach? and if not, where should we direct our investments?
3. Do we have the necessary human capabilities/training to address these challenges? And if not, where should we direct our investments?
4. What are the biggest obstacles to be solved to address these challenges?
5. How could PICES and partner scientific communities contribute/engage? How do we sustain needed efforts beyond the present UN Decade of Ocean Science?

The workshop was held over one full day on October 22, 2023. The first half-day included invited presentations on the state of our science to help identify and focus future questions and needs. The workshop started with a brief introduction by **Drs. Cisco Werner** and **Shin-ichi Ito** (unfortunately **Dr. Salvador Lluch-Cota** was unable to attend), outlining the background and a brief discussion of the workshop's objectives. Following the opening welcome, **Dr. Fei Chai** gave the first presentation on *"The new ocean: Physics and biogeochemistry."* He noted the impacts of ocean warming and marine heatwaves, extreme events (typhoons and winter storms), declining oxygen and hypoxia due to coastal eutrophication,

and the need for sustained biogeochemical (BGC) observations on autonomous platforms, and modeling. **Dr. Sukyung Kang** followed with a presentation on *"The new ocean: Living marine resources*." She stressed the importance of Electronic Monitoring (e.g., collected on commercial fisheries vessels); the need for collaborative research in the implementation of AI/ML and modeling; enhancing technical capacity development, e.g., through intensive training courses; accessible data sharing and standardization; and for monitoring networks extending from marine organisms to marine environments.

Dr. Jan Newton then presented on *"The new ocean: Modernizing our observational capabilities*." Her presentation highlighted the need for consideration of the whole ecosystem, including humans, and the importance of forging long and trusted partnerships with stakeholders & rightsholders. She discussed the value of cutting across institutional boundaries (academia, federal, tribal & local governments), as well as non-governmental and community-based organizations. She underscored the importance of capacity building and the need to tightly couple observations with modeling and with societal needs, ending with the provision of accessible information products, co-designed with users. **Dr. Charles Hannah** elaborated on *"The new ocean: Modernizing our methods of analysis"* and stressed the need to focus on extreme events and to look for nonlinear relationships and casual pathways (with AI/ML being part of a rapidly expanding toolbox). He advised not to expect current ecosystem states to last, i.e., that marine ecosystems are complex adaptive systems and that functional relationships will change.

Dr. Momoko Ichinokawa then presented on *"The new ocean: Modernizing our management advice."* She highlighted challenges including the need to further quantify uncertainty, especially for ecosystem uncertainties related to estimating fish populations, e.g., (i) how will uncertainty be estimated? and (ii) how will alternative assumptions result in different predictions? She also noted that modelling and evaluation processes are integrated processes involving different types of science, hence the importance of building capacity and networking between generalists and specialists. In her presentation, she echoed earlier calls for the importance of good communication between scientists and stakeholders. **Dr. Charlie Stock** was unable to attend in person, but his contribution on *"The new ocean: Prediction within an Earth System context"* addressed points including that (i) effective "new ocean" predictions must rest on mechanistic and empirical foundations; (ii) the "new ocean" arises from multiple drivers/impacts, generating questions across space and time scales; (iii) regional frameworks need to generate coastwide predictions and projections that probabilistically span the range of ocean futures; (iv) improved coastal observing systems needed to underpin these activities; and (v) the link from physics/BGC to ecosystem impacts is challenging, but we know enough to get started and build on new tools (observations, AI/ML, models). The final invited presentation was that of **Hana Matsubara** on *"The new ocean: ECOP perspectives*." She identified possible barriers for ECOPs (Early Career Ocean Professionals) to participating in "new ocean" research and management activities. Among the barriers noted were: (i) lack of funding and career opportunities, (ii) lack of community interactions and networking, (iii) language, and (iv) capacity development. Recommendations included: actively integrating ECOPs into research funding applications/proposals, co-authorship on papers, and collaboration with ECOPs from other nations.

In the afternoon's open session, **Drs. Werner** and **Ito** summarized the overall presentations and discussions. Five breakout groups were formed based on the recommendation of Dr. Wu-Jung Lee (an ECOP) and were asked to rank their top 2 or 3 priorities needed to address the "new ocean" – using the above trigger questions as needed. Many excellent ideas were generated, including:

- ***External communication of the idea of the "new ocean."*** While the scientific community is aware of the evolving properties, impacts, and uncertainties of our "new ocean," e.g., MHWs, ocean acidification, OMZs, etc., these need to better communicated to the broader public. A recommendation was to support the idea of producing a peer-reviewed Opinion, or Perspectives piece that can be transmitted to the general public and to policymakers. Corollary ideas included:
    - Focusing on how PICES can transform the way it communicates science, and the need to incorporate communication specialists to increase public awareness and support for what the "new ocean" has/will entail.
    - Developing capacity within PICES for transdisciplinary communication and communication to lay audiences. Not only communication by and to specialists, but also to include generalists and people who are not focused on the sciences but who can work across disciplines.
    - Integration of ECOPs in such capacity development, communication, and transdisciplinary work.

Modernize PICES data to address "new ocean" questions. There was general agreement among W11 participants that data sets need to be modernized (e.g., be AI/ML-ready), and accessible in standardized electronic formats. This would facilitate their use in analyses, inclusion in data assimilative models, and applied

to address integrative questions and build on previous PICES programs [e.g., the CCCC (or four C's) Program[1]], or considered in the development of new programs [e.g., BECI (Basin-scale Events to Coastal Impacts; https://beci.info)].

Science-to-policy-relevance of "new ocean" reports and assessments. In addition to communicating about the "new ocean," the idea of focusing PICES on making the best use of existing data and model output for informing policy decisions was endorsed. A suggested approach was to create a "data heroes/ambassadors" group that could improve data-accessibility by building-up and preparing existing data sets and model output for use by all (scientists, modelers, policy analysts, etc.). It was also agreed that the data and associated analyses should – where possible – be relevant to establishing links from science to policy and policy to action. Examples of new data-uses include:

- PICES' North Pacific Ecosystem Status Reports (NPESRs): modernizing data sets and framing the NPESRs around the "new ocean" could result in a more focused and timelier production of the reports.
- PICES' assessment and communication of the impacts of the "new ocean" on urgent topics (e.g., how to sustainably obtain food from the North Pacific) as in similar IPCC fact-sheets.

Finally, it was noted that incorporating ECOPs with strengths in communication and data utilization and sharing not only brings new expertise and perspectives to the initiatives but also contributes to human capabilities/training to understanding the 'new ocean'.

Concluding remarks

We close by sincerely thanking all Workshop 11 participants for their active, thoughtful, and candid participation, including insightful contributions from ECOPs. The "new ocean" W11 workshop generated many excellent ideas, most of which can be implemented. Some can be acted on in the short term (such as the completion of a communication Perspectives paper on the "new ocean"), while others, such as revisiting a 4-C's-like program, or other newer related programs, might take a few years. It was also clear from the W11 discussions that the participants agreed on the need to increase the size and the diversity of our international – PICES – community to take advantage of the breadth of ideas that our groups (scientists, communities with local/traditional ecological knowledge, ECOPS, managers, decision/policymakers, etc.) bring to the table. Integration of these approaches will result in better use and interpretation of rapidly evolving technologies, and together with improved model-data integration, to advance actionable predictive capabilities to help the communities that depend on the understanding and the information we generate about the "new ocean."

[1] See Batchelder and Kim (2008) Lessons learned from the PICES/GLOBEC Climate Change and Carrying Capacity (CCCC) Program and Synthesis Symposium, *Progress in Oceanography*, 77:83-91.

Dr. Francisco "Cisco" Werner (cisco.werner@noaa.gov) is Director of Scientific Programs and Chief Science Advisor of NOAA's National Marine Fisheries Service. He leads NOAA Fisheries' efforts to provide the science needed to support sustainable fisheries and ecosystems and to continue the progress in ending overfishing, rebuilding fish populations, saving critical species, and preserving habitats. Cisco's research has focused on the oceanic environment through numerical models of ocean circulation and marine ecosystems. He has studied the effects of physical forcing on lower trophic levels and the subsequent effect on the structure, function and abundance of commercially and ecologically important species. Cisco's participation in PICES began in the early 1990's with the NEMURO Model Task Team and he is currently the US Government Delegate to PICES.

Prof. Shin-ichi Ito (goito@aori.u-tokyo.ac.jp) is a Professor at the University of Tokyo. His fields and topics of research range from physical to fisheries oceanography. His studies include the processes of the formation of ecological hotspots in offshore regions, fish response to climate change using ecosystem models, fish migration using microchemistry, and fish distribution using environmental DNA (eDNA). He co-chairs the Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY) and he is a member of the joint PICES/ICES Section on Climate Change Effects on Marine Ecosystems (S-CCME) and the Advisory Panel on Early Career Ocean Professionals (AP-ECOP).

Dr. Salvador E. Lluch Cota (slluch@cibnor.mx) is a Principal Researcher at the Fisheries Ecology Program of the Centro de Investigaciones Biológicas del Noroeste (CIBNOR) in Mexico. Salvador conducts multidisciplinary, cooperative research on the effects of climate variability and change on ecosystems and marine resources at many scales, ranging from the large-scale population dynamics of small pelagic fish to the ecophysiological responses of benthic marine species. He has been actively involved in PICES activities for more than 20 years, attending workshops and conferences and organizing events, including two symposia on Transitional zones held in La Paz, Mexico, in 2002 and 2022. Salvador is currently a member of the Joint ICES/PICES Working Group on Small Pelagic Fish (WGSPF).

The PICES "SEAturtle" Special Project (2019–2023):

What we learned about the sea turtles of Jeju Island over the last 5 years, and what we should do in the future

Taewon Kim, Soojin Jang, Sook-Jin Jang, Kyungsik Jo, Connie Ka Yan NG, Michelle María Early Capistrán, Hideaki Nishizawa, Mi Yeon Kim, George L. Shillinger and George Balazs

Public domain images of sea turtle species discussed in this report. Top row L-R: Greens (*Chelonia mydas*), Loggerheads (*Caretta caretta*), Hawksbills (*Eretmochelys imbricata*). Bottom row L-R: Leatherbacks (*Dermochelys coriacea*), and Olive ridley (*Lepidochelys olivacea*).

There are seven species of sea turtles worldwide, primarily inhabiting tropical and sub-tropical waters with the majority of species classified as endangered. Jeju Island, the southernmost island in South Korea, is the northern extent of sea turtle ranges, situated at the border between the temperate and subtropical zones. The PICES SEAturtle Special Project was established with funding from the Korea Institute of Ocean Science and Technology (KIOST) to research the sea turtle populations found in the North Pacific regions, centered on Jeju Island to enhance the understanding of their habitat use and ecology related to anthropogenic activities.

The project had 2 key questions:

1. How the sea turtles found in Jeju Island, Korea, Kyushu Island, Japan, and Hong Kong, China are connected to the other identified populations in the North Pacific areas?

2. What are the major environmental stressors to the sea turtles in the North Pacific regions?

There are historical records of nesting sea turtles on Jeju Island. Fishers and *Haenyeo* (traditional women divers) have long maintained a culture that considers sea turtles to be the sacred daughters of the Dragon King. However, no nesting sea turtles have been observed on the beaches of Jeju Island since 2007 (Ng et al., 2020). Sea turtles are encountered (as bycatch or stranded) within surrounding waters throughout the year. Additionally, a significant number of individuals end up as bycatch within the pound nets surrounding Jeju Island during the summer (Kim et al. 2019), or are killed by other human-related threats (e.g., ship strikes, plastic pollution, and fishing). Ironically, because of this, we could readily identify the species present in waters surrounding Jeju Island. Dead turtles, including greens *(Chelonia mydas*), loggerheads (*Caretta caretta*), hawksbills *(Eretmochelys imbricata*), and leatherbacks (*Dermochelys coriacea*), have been encountered in waters all around Jeju Island. Olive ridley turtles (*Lepidochelys olivacea*) are also occasionally identified in this area.

We initiated satellite tracking studies of rescued green sea turtles during 2016 (Jang et al. 2018). When sea turtles were found alive within open surface pound nets we were able to attach satellite tracking devices to their carapaces. The PICES SEAturtle Special Project was then initiated and has been undertaken from 2019 to 2023 (Kim et al., 2019). A total of 16 individuals (14 greens and 2 loggerheads) were tagged with Iridium transmitters. The sea turtles tagged with PICES-funded trackers between 2019-2020 were given Korean names (see PICES Press Vol. 29. Nov. 2. P. 37). We successfully obtained signals from 15 individuals overall. Seven out of 12 green sea turtles released in Jeju Island exhibited residency to Jeju and did not transit to other countries.

Green sea turtles found all year round on Jeju Island

In a previous study (Jang et al. 2018), we confirmed that some juvenile green sea turtles (*Chelonia mydas*) overwintered around the coast of Jeju. Beginning in 2019, we deployed satellite tags on fourteen green turtles to investigate their overwintering movements and behaviors around Jeju Island. Four of these green turtles (SCL 67.5 ± 11.5 cm) stayed in the waters of Jeju through winter.

Green sea turtles are generally found in warm tropical and subtropical regions. When water temperatures drop below 14°C, the metabolism of green sea turtles slows and they hibernate or migrate to warmer waters (Ogren & Mcvea, 1995). In Jeju, the water temperature drops to 13°C in winter. The four green sea turtles that wintered in Jeju Island did not move to warmer areas. Instead, they modified their behavior, extending their dive durations while reducing their activity. Maximum dive times increased (maximum dive durations: 367.4 minutes) with decreasing temperatures. Their individual home ranges were consistent across seasons. The size of home range varied for each sea turtle from 0.021 to 6.411 km^2 (1.97 ± 3.02 km2 (Mean ± SD). Tagged turtles exhibited residency in Jeju waters for a minimum of 163 days and maximum of 587 days. Dive durations shortened during the transition from winter to spring, and turtles appeared to increase their activity accordingly.

Our results suggest that the coast of Jeju Island may function as a seasonal foraging ground and overwintering site for green sea turtles of mixed ages. The Jeju coast appears to be an important potential wintering area for green sea turtles in the western part of the North Pacific. With increased climate-change induced warming, rising water temperatures may increase the likelihood of increased sea turtle visitation to Jeju Island. In this context, Jeju Island may serve as a potential climate refuge for western Pacific green sea turtle populations. Long-term in-water monitoring studies on sea turtles inhabiting the water around Jeju Island oriented is necessary to ensure effective sea turtle conservation in the Northwestern Pacific region.

The other sea turtles that moved far from Jeju Island

Four green sea turtles moved away from Jeju Island, in the direction of southern Japan which hosts important rookeries. We attached satellite tags to two nesting green sea turtles in Ishigaki Island, Yaeyama Islands, Japan on July 27, 2022. The two individuals remained in the Yaeyama Islands throughout the tracking period (~6 months). Two loggerhead sea turtles also dispersed far from Jeju Island. During the tracking period, they moved between waters in Korea, Japan and China. Behavioral and environmental tag-derived data, including latitude, temperature, diving duration, and movement patterns, will be analyzed alongside environmental variables such as

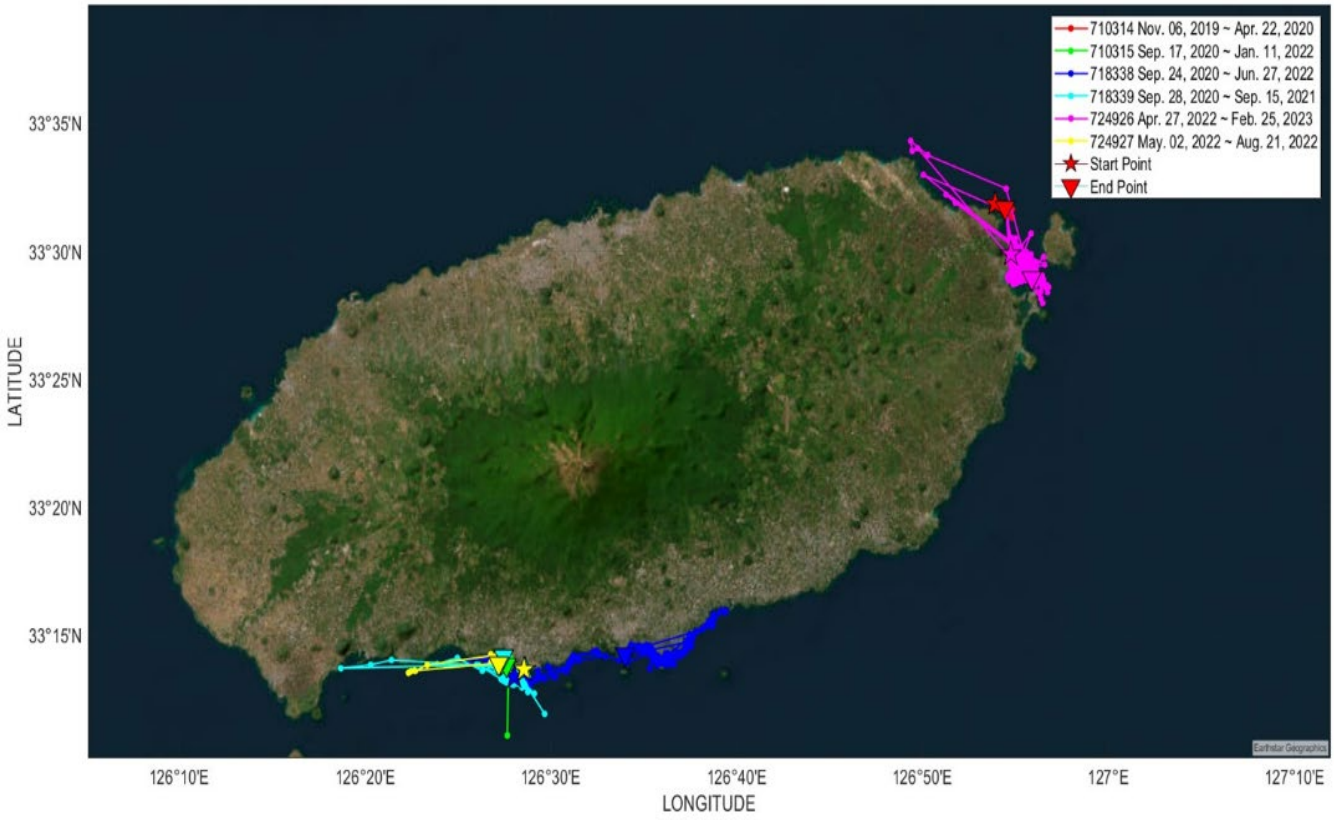


Figure 1. Satellite tracked movements of green turtles (Chelonia mydas) staying near Jeju Island.

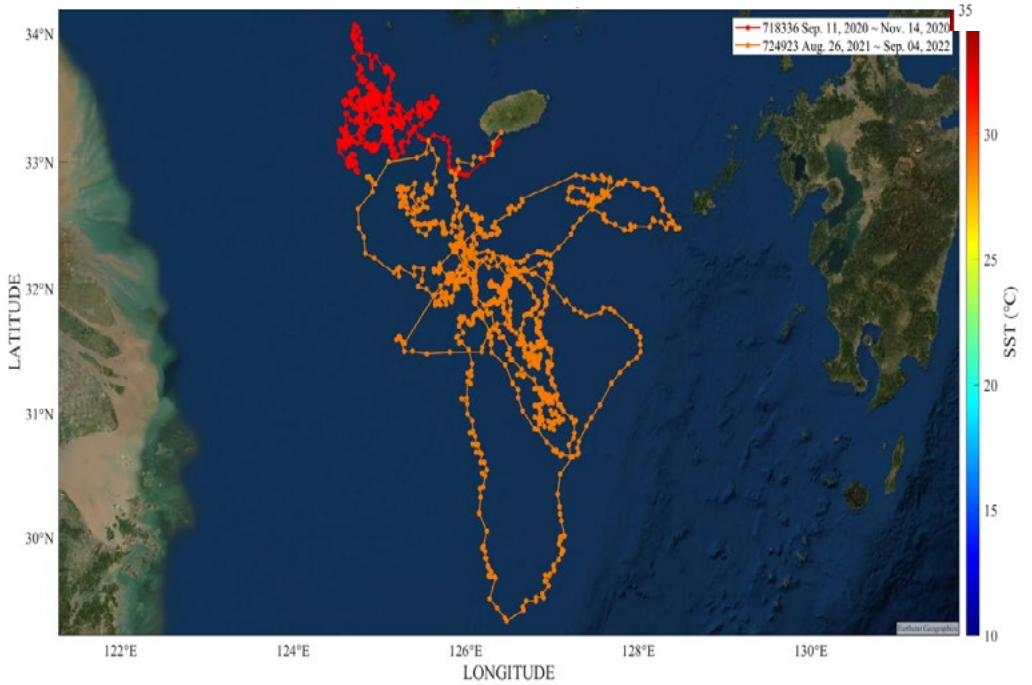


Figure 2. Satellite tracked movements of green turtles (Chelonia mydas) moved away from Jeju Island.

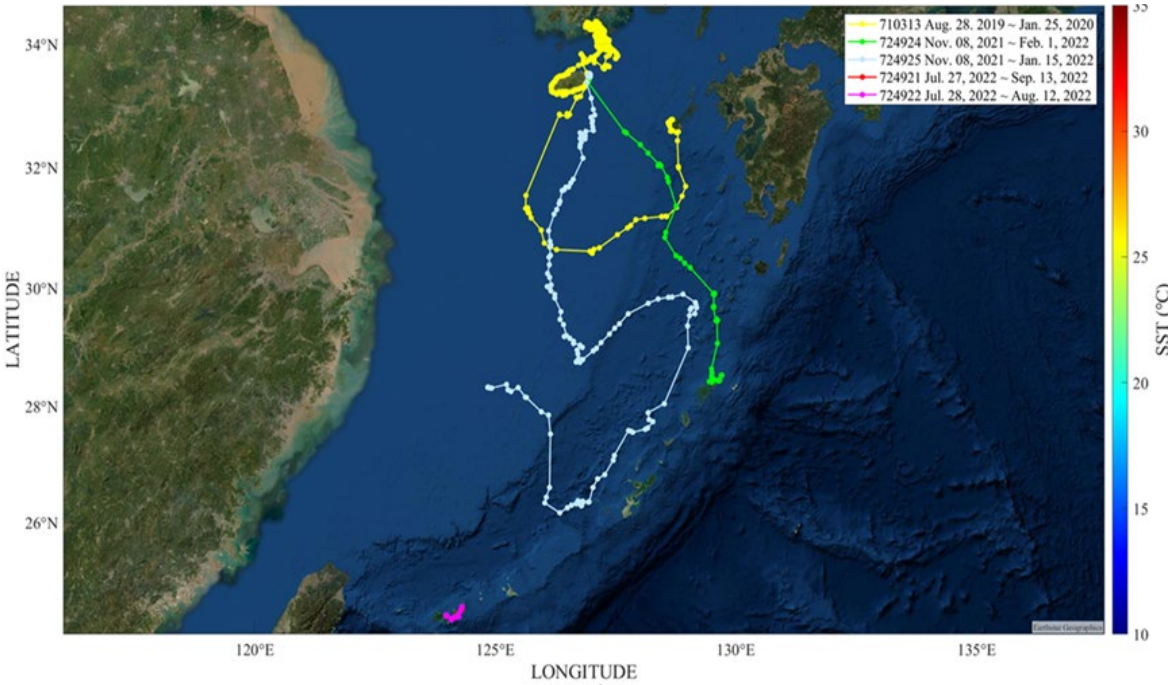


Figure 3. Satellite tracked movements of loggerhead turtles (Caretta caretta).

chlorophyll a (chl-a) and CDOM (colored dissolved organic matter) using geostationary ocean color satellite data. Our objective is to understand the factors influencing sea turtle movement, exploring both well-known factors such as water temperature and food distribution, and indirect factors identified through research.

Genetic connectivity between sea turtles in Jeju Island and ones in their neighboring rookeries

We explored the genetic connectivity of sea turtles between Jeju Island in the Korean Peninsula and neighboring rookeries to track their natal origin. The investigations into their travel pathways started relatively late, in 2008 (Moon et al. 2009), even though their appearance in the Korean peninsula was first noted quite a long time ago (officially since 1949; Kim et al. 2017). To date, dispersal patterns of Korean turtles have been observed using satellite tracking technology (Moon et al. 2009; Moon et al. 2011; Jang et al. 2018). However, little is known about their origin due to technological limitations. Mitochondrial DNA (mtDNA) sequences are a useful tool

for tracing natal origin. In this project, we analyzed mtDNA sequences from a total of 31 turtles including 9 rescued individuals and 22 individuals found dead around the Jeju Island (18 green, 8 loggerhead, 2 olive ridley, 2 hawksbill, and 1 leatherback sea turtles). Our results revealed a high genetic connectivity, of both Jeju green and loggerhead turtles (C. *caretta*), to rookeries in the southern islands (Ryukyu Archipelago) of the Japanese Archipelago. They suggest that Jeju sea turtles originated primarily from this region. We also ascertained that sea turtles encountered in Jeju migrated from the central western Pacific. For green turtles, mtDNA haplotypes only observed in rookeries around the Philippines in the Sulu Sea were detected in the Jeju aggregate. Additionally, the DNA sequences of olive ridley and hawksbill turtles (E. *imbricata*) in the Jeju aggregate showed a high similarity to those found in Malaysia, Indonesia, and northern Australia. We attempted to determine the natal origin of Jeju turtles using genetic data for the first time, however, limitations such as small sample size and limited reference genetic data challenged our efforts to identify the natal origin precisely for all five species, particularly for the three sea turtle species: olive ridley, hawksbill, and leatherback turtles (D. *coriacea*). Our study provides essential foundational information but also highlights the need for further investigations into sea turtles, particularly the three species and their unexplored habitats. Such research is necessary to gain a precise understanding of their ecology and to develop effective conservation strategies.

Presuming the pathways of sea turtles by using shells of commensal barnacles

Developing effective conservation strategies for endangered sea turtles demands an understanding of their distribution, habitat utilization, and migration patterns. Traditional methods like mark and recapture, satellite telemetry, and genetic research face challenges in terms of low returns, high costs, and limited resolution. To address these issues, alternative methods using commensal barnacles that live on sea turtles, have emerged. Commensal barnacles leave a chronological isotopic history in their shells, reflecting the temperature and oxygen isotopes of the ambient seawater. The study, conducted on stranded sea turtles in Korea, utilized secondary ion mass spectrometry (SIMS) to analyze isotopic values in barnacle shells.

Our study focused on four sea turtles stranded on Jeju Island: two loggerheads (*Caretta caretta*), one hawksbill (*Eretmochelys imbricata*), and one green (*Chelonia mydas*). Using SIMS, isotopic values (δ^{18O} and δ13C) were extracted at intervals from the shells of barnacles (*Chelonibia testudinaria*), and calculated points were then analyzed to determine dates based on the barnacles' growth rate. δ18O values were employed to align coordinates on the isoscape, constructed using the Balanomorph Barnacle Paleotemperature Equation (BBPE). Meanwhile, δ13C was utilized to enhance the precision of assumptions, narrowing down coordinates where changes

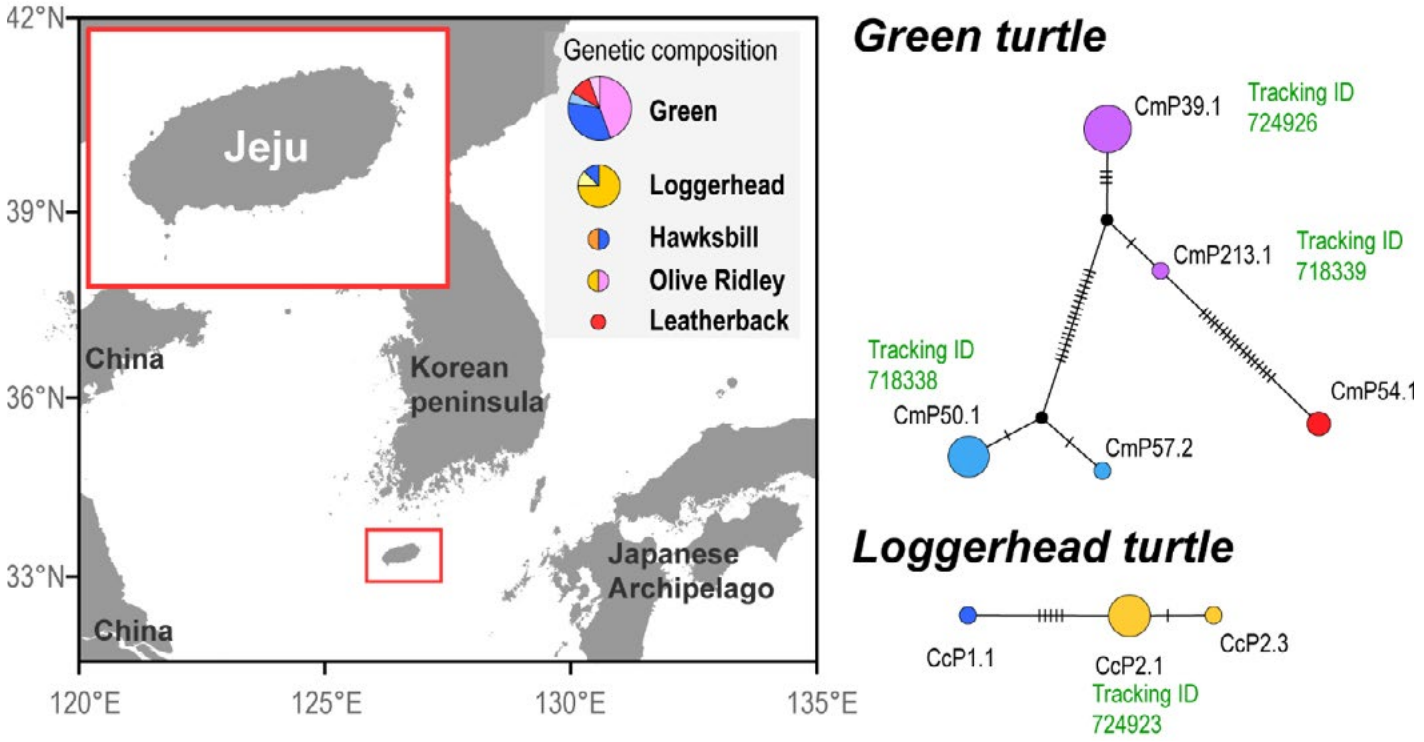


Figure 4. Genetic compositions of sea turtles found in Jeju Island.

in salinity and carbon isotopes correlated. This was done by considering that $\delta^{13}C$ is influenced by riverine carbon sources. Notably, one loggerhead followed a meandering trajectory through the Philippines, the Island of Taiwan, and the Ryukyu Islands, while the other took a direct route from the eastern Philippines to Jeju Island. The hawksbill embarked on a northward journey from the southern part of Jeju Island, and the green turtle predominantly stayed in the vicinity of Jeju Island.

The investigation into sea turtle migration routes through the analysis of isotope values in commensal barnacle shells is an underutilized approach. The combination of insights into migration patterns and the efficiency of SIMS in maximizing data from limited samples opens up new avenues for understanding and conserving endangered sea turtle populations. As technology and methodologies continue to advance, further research in this field holds the promise of refining and expanding our knowledge of sea turtle ecology and behavior.

Possible link between derelict fishing gear and sea turtle strandings

Derelict fishing gear (DFG) is a growing concern within marine ecosystems. During the summer of 2020, we conducted a dive survey in selected areas on the northwest coast of Jeju Island, where strandings frequently occur, in areas with and without reports, to find out whether sea turtle strandings were caused by DFG. The study collected submerged marine debris and categorized them by material and use. A total of 403 items were discovered within the investigation area covering 4,750m^{2}. The collected debris comprised fishing-related DFG, including fishing lines, lures, ropes, nets, buoys, weights, hooks, and miscellaneous plastic, metals, fiber, or glass. Notably, DFG constituted 71.46% of the total items, with fishing lines and fishing lures surpassing the prevalence of ropes and nets. When comparing the DFG found in areas with divergent sea turtle stranding rates, the high-stranding area exhibited a greater presence of thicker and longer derelict fishing lines. This discrepancy in derelict fishing lines suggests an increased risk for sea turtles, potentially leading to severe health issues such as feeding restrictions, respiratory problems, or behavioral impairment. The necropsies further supported the impact of derelict fishing lines, revealing injuries, particularly in the oral cavity, as contributing factors to the sea turtles' mortality.

The underwater investigation revealed DFG, primarily less than 1 mm thick, often featuring shrimp-shaped fishing lures, indicating a probable origin from recreational fishing activities. Recreational pursuits like rock fishing and breakwater fishing were identified as sources introducing this gear into coastal marine ecosystems, posing a threat to marine animals, including endangered sea turtles, Indo-Pacific bottlenose dolphins (Tursiops aduncus) and finless porpoises (Neophocaena sunameri). To address sea turtle conservation and broader marine ecosystem protection,

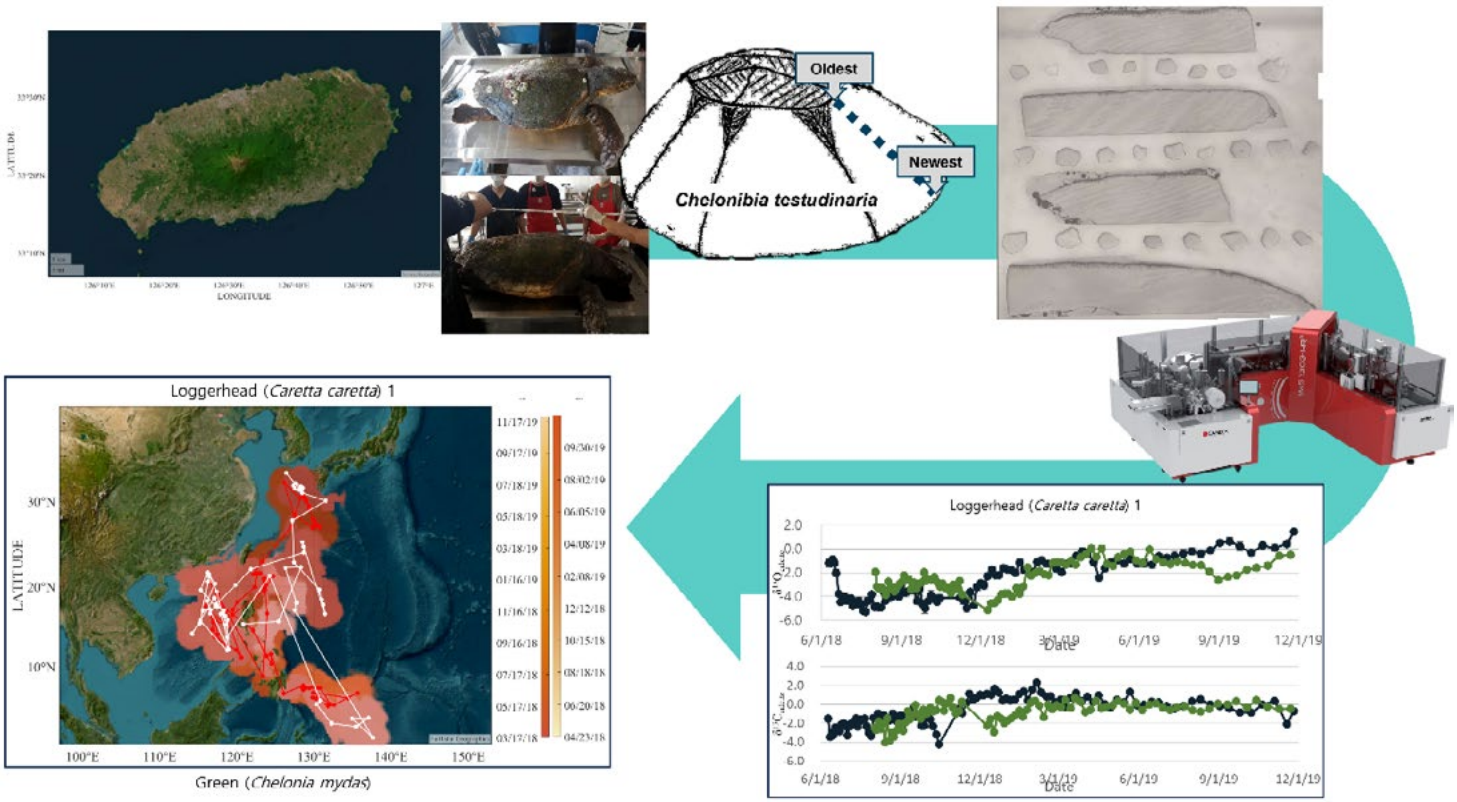


Figure 5. Schematic explanation of presuming the pathways of stranded sea turtles using commensal barnacles.

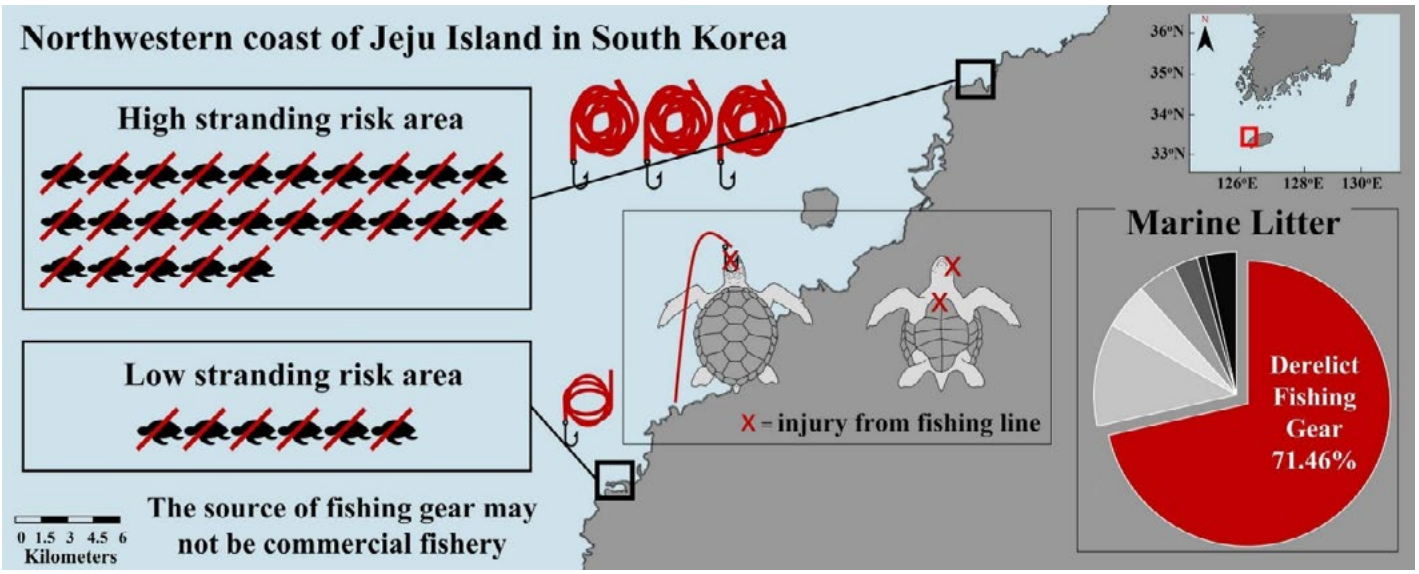


Figure 6. Graphical abstract of the study on possible link between sea turtle strandings and derelict fishing gears in coastal area (Jo et al., 2023).

the study advocates for heightened awareness, further research initiatives, and urgent governmental regulations. The emphasis is on the pressing need for regulatory measures, particularly given the potential higher threat posed by derelict recreational fishing gear compared to that from urban commercial fishermen. The study calls for collaborative efforts to effectively address and mitigate the adverse consequences of marine pollution on vulnerable marine ecosystems and their diverse species. Likewise, this study can help identify spatial distribution of high-risk areas for strandings, contributing to the development of effective conservation and management plans.

Plastic debris is also threatening sea turtles who ingest plastic garbage and microplastics. In our necropsy study, the guts of all the large marine animals investigated, including sea turtles, were contaminated by microplastics (Park et al. 2023).

What we should do in the future

Despite hardships related to COVID 19 restrictions during our project period, we were successful in conducting diverse and meaningful research projects on in the sea turtles inhabiting the waters of Jeju Island, supported by PICES special project funding. Given that there is a warming trend in the sea of Jeju Island, more sea turtles are expected to be observed. There is the urgent need for sea turtle conservation due to their role in sustaining marine ecosystems. The Korean government has designated five species of sea turtles found in Korean waters as protected marine species and continues to release juvenile sea turtles hatched in captivity in Jeju to restore sea turtle populations. However, these policies are not enough, more research and diverse policy efforts are needed to conserve sea turtles visiting Jeju Island. Jeju Island's significance as a foraging ground for green and loggerhead turtles highlights its role in safeguarding these creatures. Our research efforts enhance understanding of sea turtle behaviors and migration patterns and inform our understanding about the connectivity of green turtle aggregations of Jeju with rookeries in Japan and other neighboring regions, stressing the importance of protecting Jeju Island in collaboration with stakeholders across sectors and regions. The data obtained from satellite tagging projects informs management and conservation strategies and enriches our understanding about sea turtle movement ecology and ecophysiology. If our aim to is to understand and protect imperiled sea turtle populations in the North Pacific, we need to advance collaborations such as our PICES SEAturtle initiative between neighboring countries across the North Pacific, including Mainland China and Japan.

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List of Authors

Taewon Kim (ktwon@inha.ac.kr) Department of Ocean Sciences, Inha University, Incheon, Republic of Korea, Program in Biomedical Science and Engineering, Inha University, Incheon, Republic of Korea

Soojin Jang Marine Animal Research and Conservation, Jeju, Republic of Korea

Sook-Jin Jang Ocean Georesources Research Department, Korea Institute of Ocean Science and Technology, Busan 49111, Republic of Korea

Kyungsik Jo Program in Biomedical Science and Engineering, Inha University, Incheon, Republic of Korea

Connie Ka Yan NG Department of Chemistry and State Key Laboratory of Marine Pollution, City University of Hong Kong, Kowloon Tong, Hong Kong Special Administrative Region, People's Republic of China (kayan.ng.connie@gmail.com), Golden Honu Services of Oceania, Hawaii, U.S.A.

Michelle María Early Capistrán Oceans Department, Stanford University, Pacific Grove, CA, USA

Hideaki Nishizawa Graduate School of Informatics, Kyoto University

Mi Yeon Kim Marine Animal Research and Conservation, Jeju, Republic of Korea

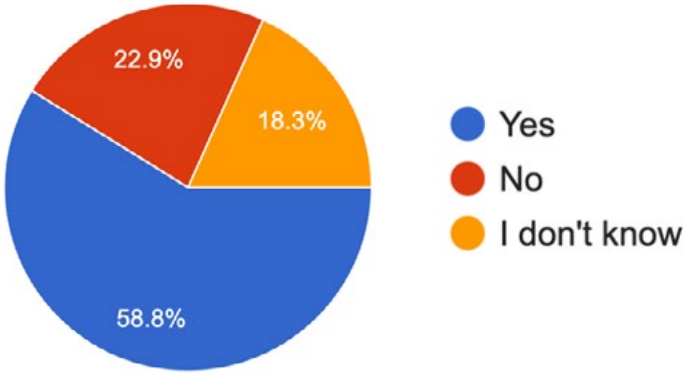
George L. Shillinger (george@upwell.org) Upwell Turtles, Monterey, CA USA

George Balazs Golden Honu Services of Oceania, Hawaii, U.S.A.

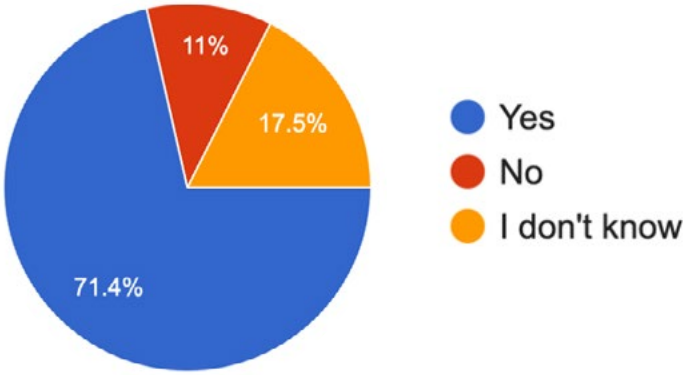
SG-GREEN *(Generating Recommendations to Encourage Environmentally-friendly Networking)* Survey
Help us understand how to make the PICES annual meeting more sustainable

Vera Trainer

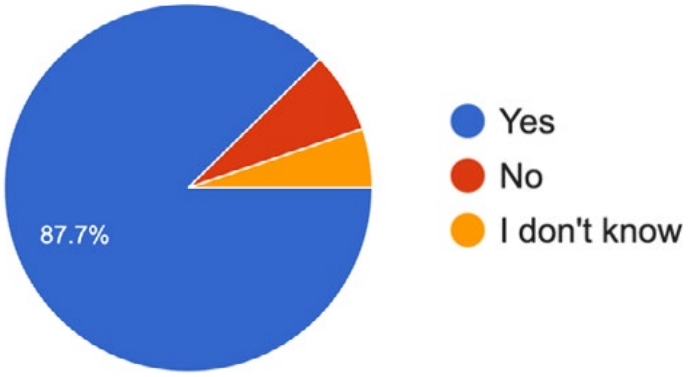
Will you pay a registration fee (less than the in-person registration fee) for virtual participation at the PICES Annual Meeting?



Would you like to see carbon offset recommendations as a topic for a PICES Expert Group to research?



Are you in favor of PICES eliminating plastic products (name tags, plastic bottles, plastic coffee cups, etc.) at its annual meetings?



The global demand for remote conferencing has surged in recent years, prompting a reevaluation of the balance between in-person meetings and virtual collaborations. Thus, the PICES Study Group on Generating Recommendations to Encourage Environmentally-friendly Networking (SG-GREEN) has developed a survey to better understand how to make the PICES Annual Meeting more sustainable and environmentally friendly.

At the recent PICES Annual Meeting, from 23-27 October 2023 in Seattle, WA, USA , over 670 participants attended the PICES 2023 Annual Meeting in Seattle, WA USA, either in person or virtually. Of those who attended, about 25% (158) filled out the SG-GREEN survey. This survey is a first step to help guide decisions on how we as an organization can reduce the environmental signature of our meetings while keeping these meetings viable economically. Although the response rate provides a reasonable insight, we wish to provide an opportunity for more meeting participants, along with those who could not attend, to add their opinions to the survey. SG-GREEN will leave the survey open for participation until 31 January 2024 (using the survey QR code or web link below).

As a teaser, at the left are some of the survey responses to date capturing the opinions of respondents in the categories of:

1. Virtual versus in-person meetings
2. Carbon offsets
3. Ocean preservation issues

If you have not already shared your opinions, please complete the SG-GREEN survey by 31 January 2024. It will take only 5 minutes of your time but will provide PICES a more clear assessment of how best to organize future annual meetings.

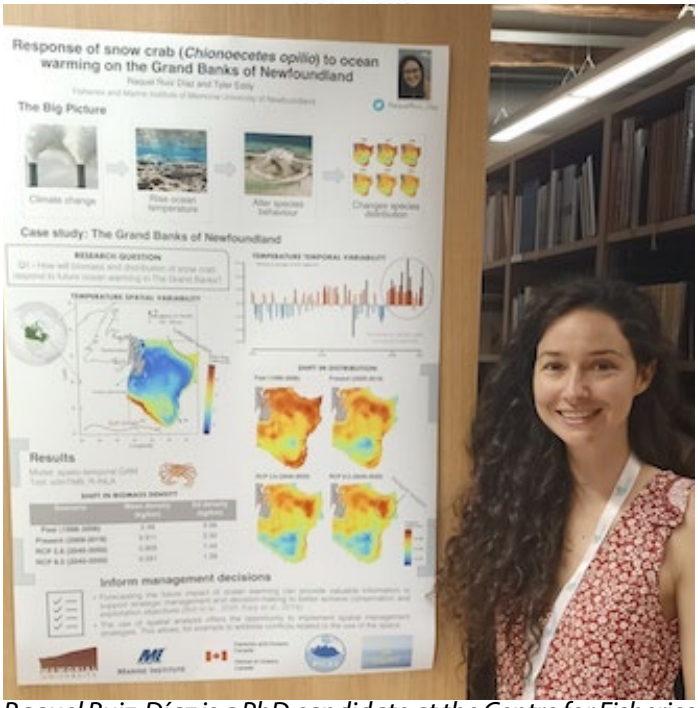
On your phone:

or on the web (2-3 second delay):
https://qr.page/g/2KVeIQvcHfP

Thank you for your help in considering what we can all do to reduce our carbon impacts.

Charting a Sustainable Future for the Ocean: Insights from the 2023 ClimEco8 Summer School in Koper, Slovenia

Raquel Ruiz-Díaz



Raquel Ruiz-Díaz is a PhD candidate at the Centre for Fisheries Ecosystems Research, Fisheries & Marine Institute, Memorial University, St. John's, NL, Canada, and was sponsored by PICES to attend ClimEco8.

In the picturesque coastal town of Koper, nestled along the shores of the Mediterranean Sea, a gathering of dedicated early career researchers embarked on a transformative journey at the ClimEco8 summer school. With the theme "Sustaining the Ocean We Need for the Future We Want," this immersive program offered a unique opportunity to explore the intricate links between our oceans and society, led by a wonderful panel of experts.

As I arrived in the idyllic town of Koper, the Mediterranean sun started to warm up my bones after a long winter in Eastern Canada. Its golden rays cast a gentle glow over the sea, turning its waters into a mesmerizing cyan hue. Within minutes, I found myself falling in love with the city's charm and natural beauty. Mornings at ClimEco8 were filled with anticipation as we gathered in the vibrant lecture halls. The air buzzed with intellectual curiosity, and esteemed experts, including Jessica Blythe, Laurent Bopp, Chris Cvitanovic, Beth Fulton, Gretta Pecl, Jerneja Penca, Ingrid van Putten and Rashid Sumaila, took the stage. Their presentations illuminated the intricate web of connections between climate, oceans, and the sustainability of our planet. From exploring the delicate balance of marine ecosystems to understanding the bio-economic impacts of climate change on coastal communities, the summer school explored a rich tapestry of topics relevant to the future of our ocean. These were not mere lectures; they were interactive sessions where questions were encouraged, and discussions sparked. Practical exercises, such as building network models and participating in experimental economic simulations, added a dynamic and engaging dimension to our learning experience.

Amidst the poster session, a sense of camaraderie flourished. Conversations flowed like the gentle Mediterranean waves, connecting minds from diverse backgrounds and countries. ClimEco8 was not just an educational endeavor; it was a celebration of human connections and the shared belief in the power of interdisciplinary science. In these vibrant exchanges, novel ideas took root, collaborative endeavors were born, and lasting bonds were forged.

One morning, Professor Rashid Sumaila graced us with the same inspiring talk he had given upon receiving the Tyler Prize. His words emphasized the importance of responsible resource management and the need to consider the next generations in our decision-making. The slogan that I will always remember was: "not everything, not everywhere and not all at a time". It was a powerful reminder of the role each of us plays in shaping a sustainable future. After school, when the sun painted the sky in hues of orange and pink, I found myself engaged in a spirited conversation with fellow participants. We passionately debated the vital role of sustainable practices in safeguarding the health and resilience of our oceans. Diverse perspectives merged, and the collective wisdom shaped our understanding of the challenges we face and the paths towards a sustainable future for our blue planet.

ClimEco8 underscored the significance of collaboration in creating interdisciplinary research as we strive for the future we envision. We understand that every action in the ocean has an impact on the ecosystem and/or the socio-economic wellbeing of fishing dependent communities, and that we are managing people, not the resources, or even better, we are managing WITH people (aka promoting co-management and participatory approaches). ClimEco8, with its captivating atmosphere and enriching discourse, has left an indelible mark on my scientific journey. I am very grateful to PICES for its economic support, and I would like to express my appreciation to Lisa Maddison for arranging everything. May the ripples of our shared experiences extend far and wide, inspiring a global movement towards a sustainable, resilient ocean that supports life and prosperity for all.

Raquel Ruiz-Diaz is a PhD Candidate in Fisheries Science at The Fisheries & Marine Institute, Memorial University. For her PhD research, Raquel is working on different methodologies (from species distribution to size-spectrum modelling) to enhance ecosystem-based fisheries management in The Grand Banks of Newfoundland. Raquel's main research interests are understanding the effects of climate change on the ecosystem, how climate affects species distribution and growth rates, and the socio-economic implications for harvesters and managers.

Engaging ECOPs in East Asia: Insights from 2023 Surveys in China, Japan, and the Republic of Korea

Raphael Roman

Background

In June 2021, the Early Career Ocean Professionals (ECOP) Programme was endorsed as a global network Programme of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) ("UN Ocean Decade" or "UNDOS"). Since then, it has been supporting ECOPs around the world by providing meaningful funding, training, networking and career development opportunities, and by generating capacity for cooperation and knowledge exchange. Our global membership has expanded significantly, comprising more than 4,000 ECOPs from 162 different countries, of which 8.2% are from or based in East Asia alone. The ECOP Programme currently has 5 regional and 42 national nodes established or in the making, including China, Japan and the Republic of Korea. Learn more about other existing nodes here.

What is an ECOP? (Global definition)

An Early Career Ocean Professional (ECOP) is a person that self-identifies as being early in their career, with 10 years or less of professional experience in any field related to the ocean. This definition includes post-secondary students and any volunteer roles, so not only employed/paid positions. The term 'professional' is used in order to be inclusive of professionals from various sectors of society.

Since 2022, the regional node of the ECOP Programme for Asia has launched and circulated several national need-assessment surveys to collect feedback and enhance their understanding of national contexts, cultural nuances, and challenges confronting ECOPs in the region (you can access existing survey reports here). Across East Asia, while the ECOP China team used the "Wenjuanxing" (问卷星) online tool to distribute their survey (which closed in January 2023), both ECOP Japan and ECOP Korea designed their national questionnaires on "Google Forms", disseminating them during the summer of 2023. The Korean survey is still accepting responses to this day (see link here). Additionally, all three surveys were bilingual and targeting both ECOPs living in the assessed country and nationals studying or working abroad.

Socio-Demographics

At the time of this preliminary analysis, the Chinese and Japanese surveys already closed and garnered 75 and 55 responses, respectively, while the ongoing Korean survey had accumulated 64 answers. The gender distribution of survey respondents is relatively well-balanced in both China and South Korea, where female ECOPs make up 58% and 55% of all respondents, respectively (Figure 1). Additionally, when examining the highest level of education completed by ECOP respondents in both China and South Korea, representation is relatively equal, although there are slightly more undergraduate degree holders in China (38%) and PhD graduates in South Korea (31.5%). On the other hand, the ECOP Japan survey responses are clearly dominated by male ECOPs (72%) and PhD holders (67.5%) (Figure 1), thus integrating an unintentional bias that needs to be kept in mind when interpreting results from Japan.

When breaking down participants by sector of affiliation, it is not surprising to see a majority (> 50%) of East Asian ECOP respondents working in research and scientific institutions (mainly academia) (Figure 2). This sector is particularly overrepresented in South Korea, where the figure reaches 97%. In the Chinese and Japanese surveys, a significant proportion of respondents (between 15-20% on average) engage in non-purely academic sectors, including NGOs, cultural organizations and schools, ocean management/policy and ocean industries (e.g., shipping, finance, start-ups and other public/private companies). A relative minority of ECOP respondents from China and Japan (< 6%) work as engineers or are involved in philanthropy.

Additionally, it is worth noting that 15% of ECOP respondents in China and 11% in Japan are freshwater specialists or work in freshwater systems or along the freshwater/saltwater interface, which are intrinsically connected to ocean processes. In the case of South Korea, virtually no ECOP respondents (< 2%) have reported being engaged in sectors outside of science and research (Figure 2).

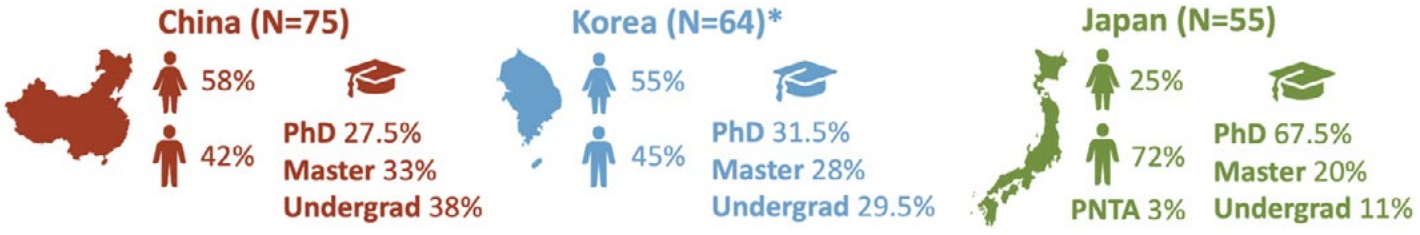


Fig.1 Graphical summary of gender and education statistics, expressed in percentages (%) and broken down by country. Note: "PNTA" stands for "Prefer not to say". The star "*" indicates the preliminary results from Korea, as the survey is still open and accepting responses.

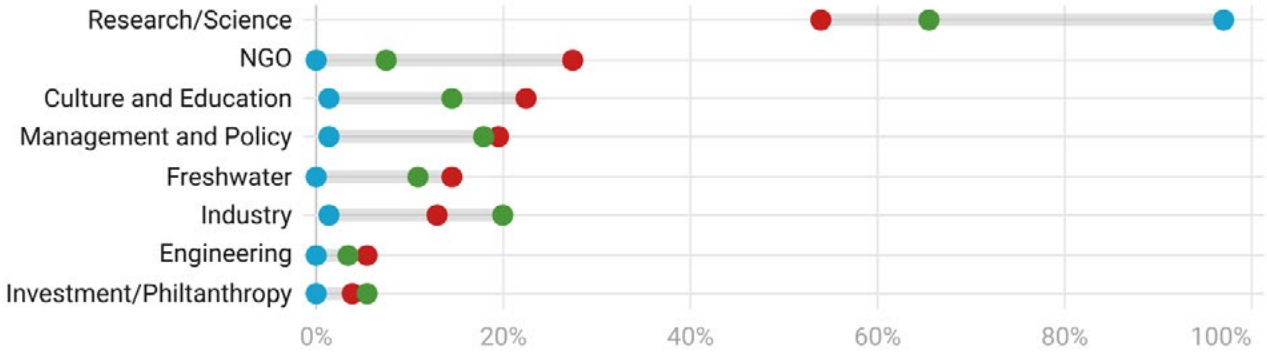
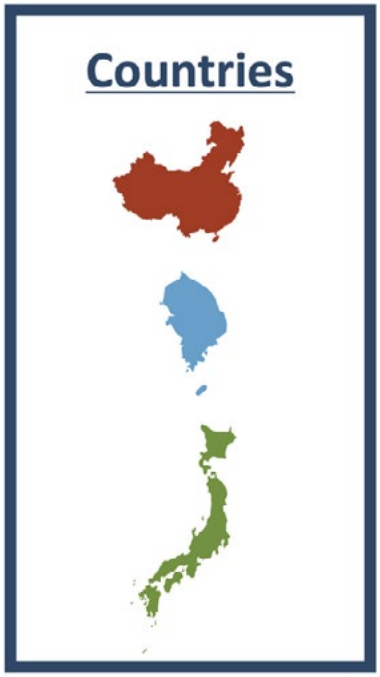


Figure 2. Percentage (%) of respondents selecting each sector and disaggregated by country (China, Japan and the Republic of Korea). Note: this is a multiple-choice question, meaning that respondents can select more than one option if they work across different sectors.

Engaging East Asian ECOPs in UNDOS (2021-2030)

These three national surveys have been disseminated during the third year of implementation of the UN Ocean Decade (i.e., 2023). From previous ECOP Asia surveys in 2021 and 2022, we observed that East Asian ECOPs were relatively better aware of the UN Ocean Decade framework and associated activities than other Asian subregions, especially in China and Japan. We were thus interested to delve deeper into this aspect and assess how aware and engaged ECOPs in East Asia are in 2023 in relation to the UN Ocean Decade. Predominantly, East Asian ECOPs (> 80%) have already heard or read about the UN Ocean Decade and its contribution to the global sustainability agenda, as shown in Figure 3. However, most of them have never engaged or participated in it (34% in Korea, 44% in China and 50% in Japan), and a significant proportion of respondents in both China (22%) and South Korea (34%) admit not being interested in learning more about the UN Ocean Decade. As we approach the halfway mark of the Decade, further efforts are needed to continue raising awareness of this global ocean framework initiative and, most importantly, to offer and foster more inclusive and tangible engagement opportunities for ECOPs to actively participate, lead and contribute to Ocean Decade Actions and related activities.

There are seven UN Ocean Decade Outcomes describing the ocean we want by 2030, which is envisioned to be cleaner, healthier, more resilient and productive, predicted, safe, accessible, and inspiring and engaging. Figure 4 illustrates which Decade Outcome(s) resonate with East Asian ECOPs, either through their work, research, studies or interests. On average, the outcomes that garnered the most attention among respondents were #2: "A Healthy and Resilient Ocean" (56%), #4: "A Predicted Ocean" (45%; which has particular relevance to Korean ECOPs), #6: "An Accessible Ocean" (37%), and #7: "An Inspiring and Engaging Ocean" (33%), despite the latter being the outcome that least resonated with Korean ECOPs (Figure 4). Outcomes #1: "A Clean Ocean" (29%) and #3: "A Productive Ocean" (27%; with strong relevance to Japanese ECOPs) remain significant focus areas for East Asian ECOPs, despite gathering slightly less responses on average.



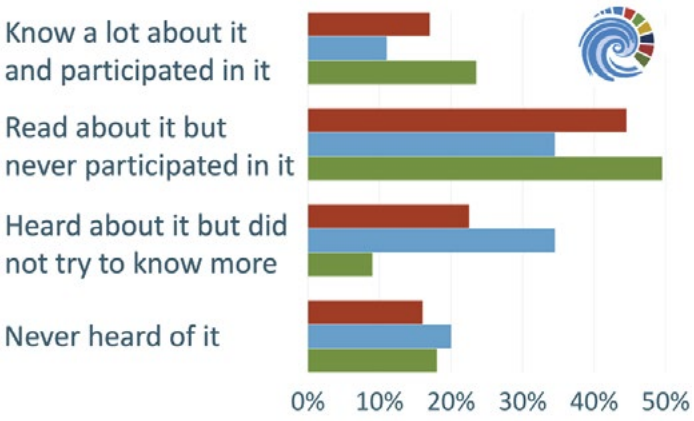


Figure3. Level of understanding of the UN Ocean Decade (% of survey respondents), disaggregated by country.

Figure 4. Percentage (%) of ECOPs involved or interested in each of the seven UN Ocean Decade Outcomes, disaggregated by country. *Note: this is a multiple-choice question.*

Interestingly, outcome #5: "A safe ocean" is the least popular one among survey participants, with, on average, only 19% of ECOPs selecting it (Figure 4). Considering how vulnerable to ocean-related hazards and natural disasters East Asian countries are, it is surprising to see this outcome as the one resonating the least with survey respondents in the region. While this finding could indicate that the relatively low survey response rates did not effectively capture the expertise landscape of ECOPs in each country, it may also have stemmed from confusions between outcomes #4 ("A Predicted Ocean") and #5 ("A Safe Ocean"), which is due to relative ambiguity in the short descriptions we provided in the questionnaires (we used the descriptions from this link). As a result, follow-up surveys will be needed to increase the number and diversity of responses to reach more ECOPs and verify whether these initial samples are representative of the current situation in each country. And instead of focusing on Ocean Decade Outcomes, such follow-up surveys should put more emphasis on the ten Ocean Decade Challenges, which are generally more relatable and specific.

Needs and Challenges of ECOPs in East Asia

Across East Asia, the lack of funding to support ECOPs' participation during conferences, workshops and high-level international events remains a pervasive issue, especially in Japan (57%) and South Korea (57%) (Figure 5). The other two major barriers that are commonly mentioned by ECOPs, most notably in China (> 50%), are insufficient opportunities for career advancement and skill development in the ocean space. Increasing and diversifying access to training programs and mentorship schemes is in high demand among East Asian ECOPs. Additionally, through open-ended answers, it is not uncommon for ECOPs to express their desire to have more contact with overseas scientists and experts, thus benefitting from increased cross-border knowledge sharing and collaborations. While gender inequality was scarcely reported by respondents, except for a small minority in Japan (9%), the language barrier with English remains a non-negligible issue, garnering 18.5%, 23.5% and 12.5% of responses in China, Japan and South Korea, respectively (Figure 5).

To cultivate impactful and meaningful international collaborations, drive innovation, and foster early-career leadership for ocean sustainability, it is imperative that we address the challenges faced by ECOPs, facilitate and nurture their professional development, and bridge existing engagement gaps.

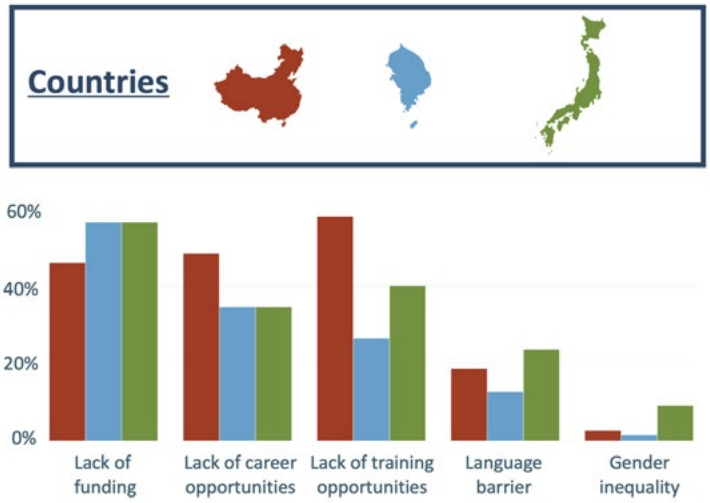


Figure 5. Percentage (%) of ECOPs selecting each barrier/constraint they are facing in the context of their work or studies (including UN Ocean Decade engagement), disaggregated by country. *Note: this is a multiple-choice question.*

Sailing for global ocean sustainability
An international science & policy workshop aboard the Statsraad Lehmkuhl

Erin Satterthwaite

A new perspective

Grasping the rough ropes, I began ascending the towering mast of the tall ship. As I climbed higher and higher, my heart thumped harder and harder. I looked up. The rigging reached toward the open sky, leading into the unknown. The salty breeze tugged at my weathered jacket and the rhythmic sway of the ship required an added intentionality to my precarious dance up the rope ladder. With each climbed rung, the ladder narrowed and the ship shrunk below me. The deck that just minutes before had seemed so grand, now was merely a speck below. When I reached the top, my body draped – in celebration and exhilaration – over the royal, the highest sail. Then I got to learning the business of a sailor. My shipmates and I worked together to unfurl the sail, releasing the heavy canvas that would propel us on our journey from Bergen to Lerwick.

Road to UNOC Workshop

The impetus for this journey aboard the tall ship, Statsraad Lehmkuhl, was a workshop focused on paving the way to the United Nations Ocean Conference (UNOC) in 2025. I had been enamored with the gorgeous tall ship Statsraad Lehmkuhl since seeing her arrive at the port of Bergen, Norway in April 2023. So I was extremely grateful to have the opportunity to participate on behalf of the North Pacific Marine Science Organization (PICES). The goal of the workshop was to explore and enhance the role of ocean science in shaping international science policy and action. The workshop brought together a wonderful group of ocean professionals from around the world and across diverse fields, including science, policy, industry, and communications. This gathering aimed to align existing efforts, foster transparency, and facilitate dialogue among scientists, policymakers, and industry leaders for a sustainable ocean future.

Ship as metaphor for sustainability

The tall ship, as a powerful metaphor for the global coordination needed for sustainability, was a perfect way to embark on this shared journey. I became part of the ship's crew, as in addition to the workshop events, our daily routine centered around watches. I spent four hours on watch duty during the day and another four at night, assisting in the ship's operations under the guidance of experienced sailors. We sang sea shanties to coordinate our movements while hauling the sails – a good reminder of the importance of synchronized efforts to move toward a shared destination. The tall ship

operates as an interconnected system, emphasizing the importance of resource efficiency and waste reduction. The ship's locomotion represents a sustainable approach: by harnessing the wind's energy, a natural, often abundant resource, the boat is propelled forward. The sailor's understanding of wind patterns, currents, and navigation mirrors the need for keen observation, environmental awareness, and responsible resource management. Finally, the tall ship's pace, dictated by the whims of the wind, and gentle steering encourages a long-term mindset of patience and consideration—values integral to sustainable living.

Sailing onward/The journey continues

I came to see the taut sails billowing in the wind as a representation of what can be achieved when diverse skills and efforts come together in a coordinated manner, navigating the challenges and harnessing the collective power for a shared destination. Key shared outcomes emerged from the workshop and included emphasizing the need for a new narrative in ocean science, better coordination among existing ocean science and policy initiatives, engagement with business and finance sectors, and collaboration leading to UNOC 2025. We also explored the potential of continued collaboration with the Stratsraad Lehmkuhl through the One Ocean Expedition which will circumnavigate the globe again in 2025 – seeking to generate awareness and disseminate knowledge about the pivotal role of the ocean in fostering sustainable development on a global scale.

This experience inspired a workshop proposal for PICES Annual Meeting in 2024 on "Exploring international knowledge co-production: Lessons learned from international marine science organizations at the science-policy interface". The proposed workshop will provide 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.

I greatly appreciated the opportunity to embark on this shared journey, build new relationships, and gain new perspectives. Though I have spent time below and on the surface of the ocean, this was the first time I had ever been above it in this way. I am grateful for this new perspective – the vast expanse of the sea below stretching endlessly in all directions, imbued with limitless potential. Ultimately, the tall ship embodies a foundational connection between human activity and the environment, symbolizing the potential for sustainable practices that can guide us toward a more balanced and resilient future.

PICES Regional Reports

The Bering Sea: Current Status and Recent Trends

Edited by Emily Lemagie and Elizabeth Siddon

Climate and sea surface temperature

The sea surface temperature (SST) and sea level pressure (SLP) of the Bering Sea during the period April through September 2023, relative to seasonal mean norms for the years of 1991 through 2020, are summarized in this section. The mean SST anomaly pattern during 2023 (Figure 1) was remarkably similar to that which occurred during the same six months in 2022. In particular, the SST was cooler than normal over the eastern Bering Sea shelf, especially near the western coast of Alaska south of 60˚N, and warmer than normal over the deep Bering Sea basin, especially west of the dateline. The corresponding SLP anomaly distribution is shown in Figure 2. Relatively low SLP was present in the southwestern portion of the domain of interest, with a negative anomaly centered near the southern tip of the Kamchatka Peninsula. This pressure field resulted in more wind from the south than usual in the western Aleutians and warmer than normal air temperatures (not shown). The warmer SSTs in the western Bering Sea (Figure 1) can also be attributed in part to substantial positive air temperatures in late winter and early spring of 2023. Over the eastern portion of the Bering Sea, weak SLP anomalies accompanied lesser gradients (Figure 2) and near-normal winds occurred in the time-average, but this 6-month period included separate spans of both strong and weak anomalies.

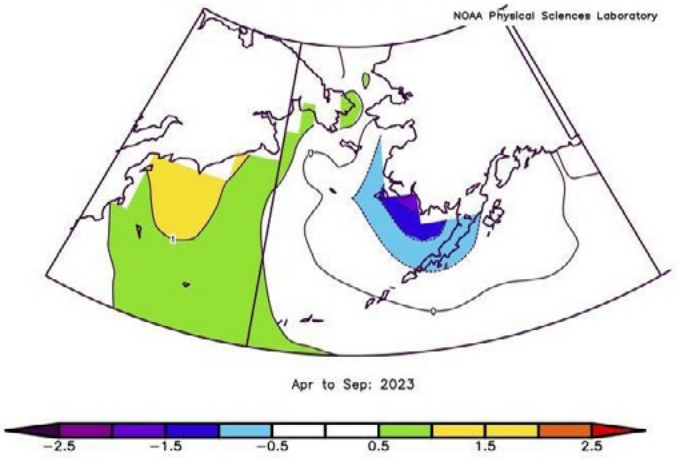


Figure 1. Mean SST anomalies (˚C) for April-September 2023.

The first two months of the entire 6-month period featured wind anomalies of about 2 m s^{-1} from the north for the eastern Bering Sea shelf south of St. Lawrence Island. It appears to have been the 10th strongest period of north winds for April and May combined in a record extending back 75 years. An important consequence was a marked delay in the retreat of sea ice on the shelf. The cool ocean temperatures due to the late retreat of sea ice persisted through the summer of 2023 despite near-normal weather accompanied by weak wind anomalies from the south.

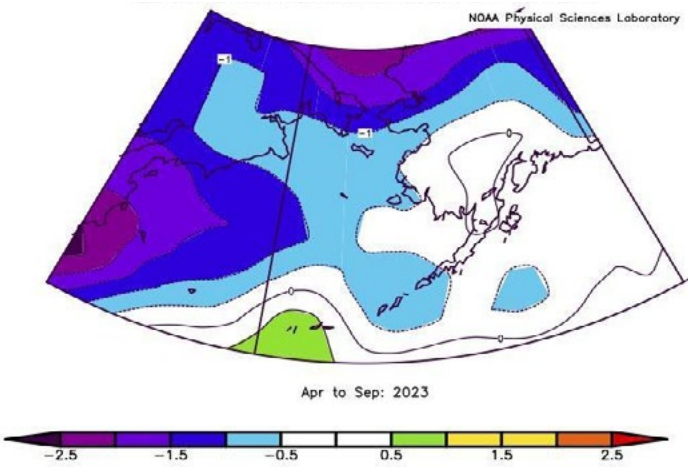


Figure 2. Mean SLP anomalies (hPa) for April–September 2023.

The year of 2023 represents the fourth year in a row of cooler temperatures in the Bering Sea following the abnormally warm period of 2014 through 2019 (Figure 3). Note the greater interannual variability in the mean April-September SST in the eastern versus western portion of the Bering Sea; the amplitude of these fluctuations complicate interpretation of long term trends. Especially for the eastern Bering Sea, will the really warm years between 2014 and 2019 remain outliers for many years, or will very warm conditions return? At the time of this writing, a moderately-strong El Niño is present in the tropical Pacific. Based on the typical outcomes associated with El Niño events in the past, and climate model projections, Alaska is expected to have a relatively warm winter. This usually results in reduced sea-ice and warm ocean temperatures on the eastern Bering shelf. But even if these conditions occur into spring 2024, we cannot yet say much, if anything, about how long they are liable to persist.

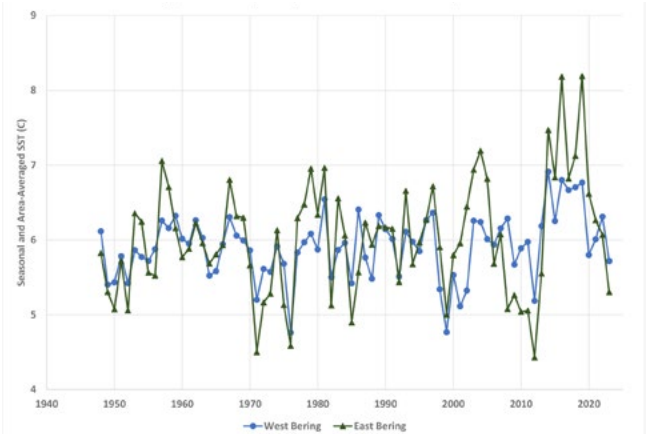


Figure 3. Time series of mean SST (˚C) for April-September for the western Bering Sea (52.5 -60˚N, 160 E -175˚W, blue trace with circles) and the eastern Bering Sea (52.5 – 62.5˚N, 175 – 160˚W, green trace with triangles).

Sea Ice Extent

Early spring 2023 sea-ice extent in the Bering Sea was significantly lower than 2022, though similar to 2020 and 2021. Except for a week in mid-February, the daily extent was below the 1991-2020 median nearly continually until late April. Typical of recent years, pack sea ice failed to reach the Pribilof Islands. Figure 4 shows the 90th percent daily sea ice concentration from AMSR2 high resolution passive microwave. The 90th percentile reduces the noise along the ice edge and generally captures the highest persistent sea-ice concentrations.

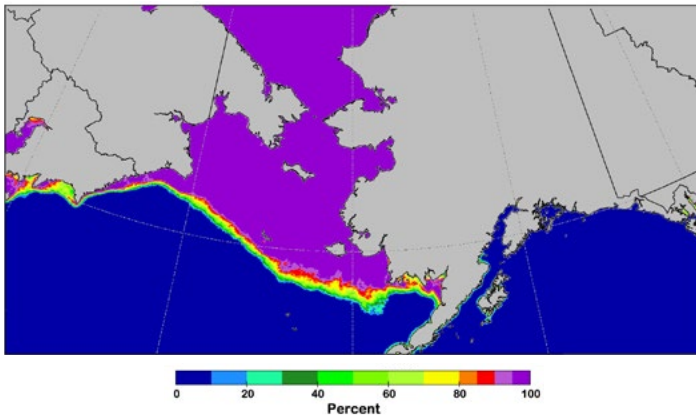


Figure 4. 90th percentile highest daily values of AMSR2 sea-ice concentration from February-April 2023.

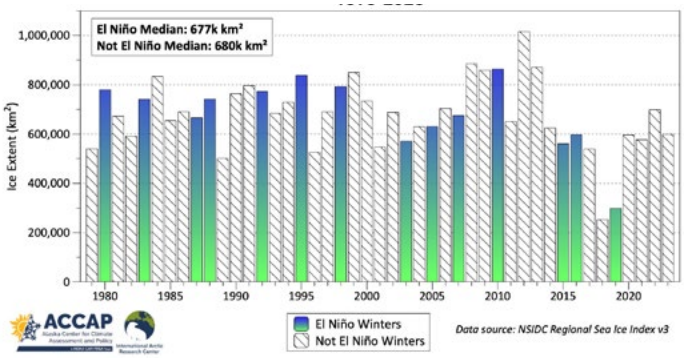


Figure 5. February-April average sea ice extent from NSIDC Regional Sea Ice Index v3.

The 2023-2024 sea-ice season is off to a slow start compared to the autumns 2021 and 2022, with ice extent as of November 24 a bit below the recent years average based on the high resolution Multisensor Analyzed Sea Ice Extent (MASIE) analysis, which is superior to passive microwave derived ice extent when ice is largely confined to near shore areas. The southern Chukchi Sea ice extent is similar but slightly lower than late November 2022. Ice growth in the remainder of 2023 will depend on the temperature and wind conditions, with rapid expansion of ice in the southern Chukchi Sea and Bering Strait if/when sustained northerly winds occur. South of St. Lawrence Island late November sea surface temperatures are slightly above the 1991-2020 average, with late winter sea-ice extent expected to be mostly dependent on the frequency and strength of southerly winds. El Niño is underway in the equatorial Pacific Ocean. However, there is variability in late winter sea-ice extent across the Bering Sea across El Niño years (Figure 5).

Bottom temperatures from ROMS

Estimates of bottom temperature are derived from the Bering 10K Regional Ocean Modeling System (ROMS) hindcast simulation, extended to the near-present using reanalysis-based input forcing. This hindcast simulation now extends from Jan 15, 1970 to Aug 16, 2023.

ROMS-estimated bottom temperatures in the northern and southeastern Bering Sea (NBS, SEBS, respectively) were near historical averages from August 2022 - August 2023 over most domains (Figure 6). Two notable exceptions include: 1) the outer (between 100–180m isobaths) southern domain, where temperatures were consistently near the coldest on record (~0.5°C below the seasonal average), and 2) the inner domain (<50m) for both NBS and SEBS regions, which was moderately cooler than average from about mid-April through August 2023.

For the outer southern domain, cool bottom temperatures were a continuation from the prior year, and since the outer domain SST was slightly above average for the 2022–2023 winter, waters were more vertically thermally stratified than average. For the inner northern and southern domains, both surface and bottom temperatures were near or slightly above their seasonal averages for the 2022–2023 winter, when the water column tends to be well-mixed from top to bottom, coupling the surface and bottom temperatures. However, beginning in mid-spring, a combination of freshwater melt and surface warming caused stratification, decoupling the surface and bottom layers. After this springtime stratification, surface temperatures in the inner domain remained near the seasonal average, while bottom temperatures showed delayed warming, and hence, were cooler than average for the 2023 spring and summer.

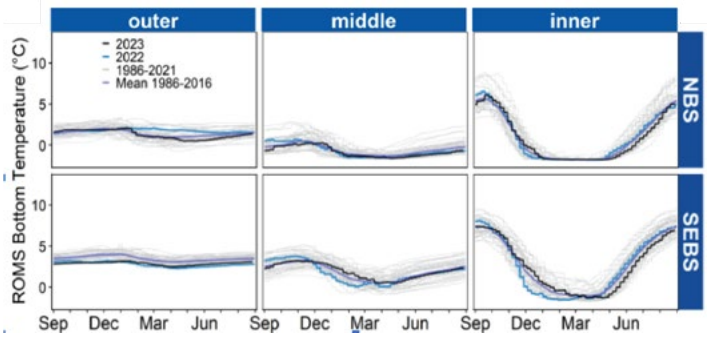


Figure 6. Mean weekly bottom temperature for the NBS and SEBS outer, middle, and inner shelf domains. The most recent year (2022–2023; through August 2023) is shown in black, 2021–2022 is shown in blue, and the historical mean is shown in purple. Individual years in the time series are shown in light gray.

St. Paul Island Community-led oceanographic monitoring

Community-led monitoring of temperature and salinity from the St. Paul Island breakwater has been made since 2014 using CTD data loggers. Instrumentation used since 2015 has also had a sensor measuring chlorophyll-a fluorescence, which provides a measure of phytoplankton concentration. Water depth at the sample site is approximately 8m. Water column profiles are collected nominally weekly and have been vertically and time-averaged into monthly means with the annual signal removed (Figure 7).

Between 2014 and 2021, salinity had been generally increasing at St. Paul Island. This trend has changed since August 2021 and salinities remained significantly below the high values reached in ~2019–2021 (Figure 7). It is not completely clear what is responsible for the reversal in the salinity trend, but it is likely that the increased presence of sea-ice (and subsequent ice melt) over the prior two years is a factor.

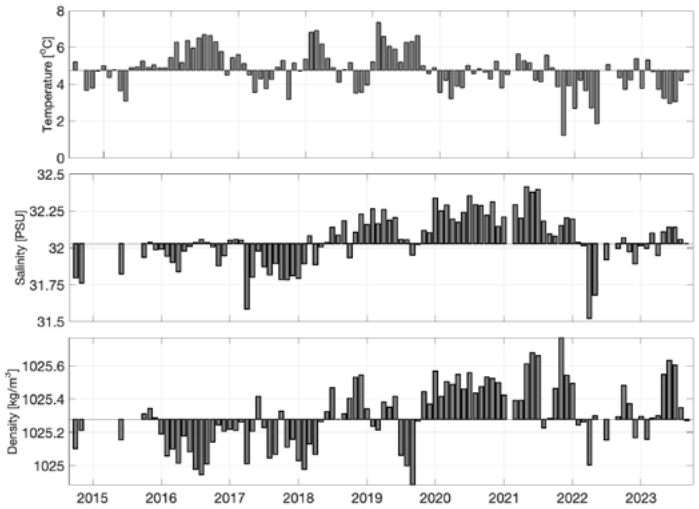


Figure 7. Monthly averages with the seasonal cycle removed for temperature (top), salinity (middle), and density (bottom) from St. Paul Island.

Chlorophyll-a fluorescence measurements show year-to-year variability in the timing of the spring phytoplankton bloom. While several years (e.g., 2018, 2019) show a relatively late and weak bloom, chlorophyll-a data from St. Paul Island in 2023 suggest the weakest bloom since at least 2017 (Figure 8), which corroborates satellite-derived chlorophyll-a concentrations observed over the EBS shelf (see Figure 10 in the following section).

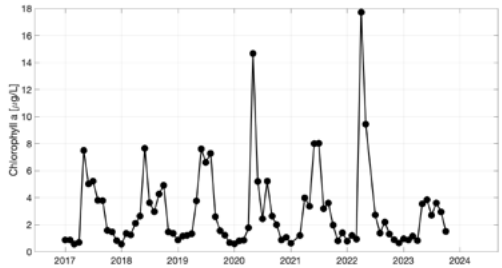


Figure 8. Monthly average of chlorophyll-a concentrations collected at St. Paul Island through August 2023.

Low chlorophyll-a yet high coccolithophore abundance over the eastern Bering Sea shelf in 2023

Ocean color satellite data from 1998–2023 was used to estimate average spring (Apr-Jun) chlorophyll-a concentrations. Eight-day satellite chlorophyll-a (chl-a, µg/L) at a 4 km-resolution from The Hermes GlobColour website was used. This is a standardized merged chl-a product, combining remote sensing data from SeaWiFS, MERIS, MODIS, VIIRS, and OLCI.

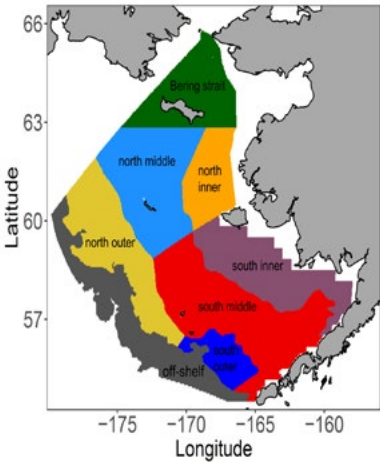


Figure 9. Map of the 8 shelf regions used for satellite chlorophyll-a analyses.

There was a high degree of interannual variability in satellite chlorophyll-a from 1998–2023. Both the south inner (<50m) and south outer shelf (100–180m) had below average values in 2023, similar to values in the period 2016–2022. Values in the south middle (50–100m), north inner, and north middle shelf region were also low for 2023. Values along the shelf–break (off-shelf region) were low in 2023, continuing an apparent decreasing trend since 2015. Combined results show spring chlorophyll-a concentrations were near all-time lows (based on data since 1998) in almost all regions (Figure 10).

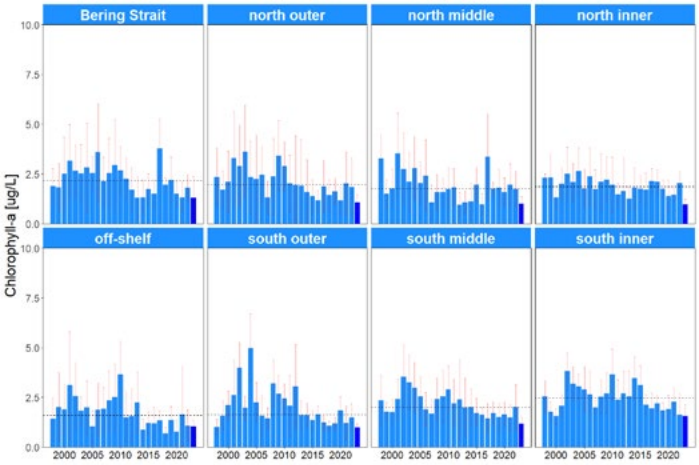


Figure 10. Average and standard deviation (SD) from spring (Apr–Jun) chlorophyll-a concentrations for 8 regions in the eastern Bering Sea (see Figure 9). Dotted black line denotes the long-term median (1998–2023) for each region.

Blooms of coccolithophores, a unicellular calcium carbonate-producing phytoplanktonic organism, are observed by satellite ocean color instruments due to their high reflectivity. An interannual index of the average area (km2) covered by coccolithophores during the month of September is calculated with monthly average mapped PIC data from satellite observations. We use monthly PIC data from the blended (multisensor) GlobColour product.

Annual indices were obtained from satellite data by averaging spatially over the inner and middle shelf (Figure 10). Coccolithophore blooms were particularly large during the early part of the record: 1997, 1998, and 2000. The index was low and remained low (<80,000 km2) through 2006. In 2007, the index rose to almost double that observed in 2006 (~125,000 km^2). A higher index (>100,000 km2) was observed in 2007, 2009, 2011, 2014, 2016, 2020, 2021, 2022, and 2023 for the middle shelf and in 2011, 2014, 2022, and 2023 (> 40,000 km2) for the inner shelf. In 2023, the coccolithophore index for both the inner and middle shelf was similar to 2022 and among the highest ever observed in the timeseries (Figure 11).

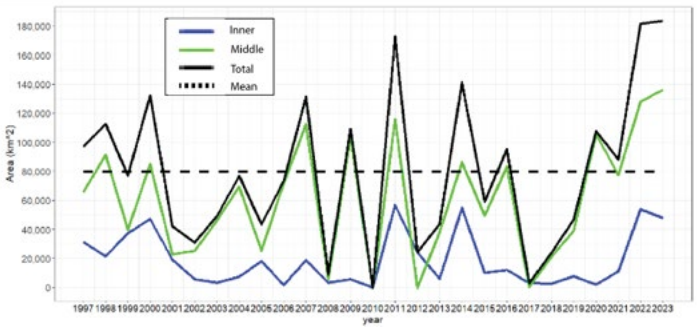


Figure 11. Coccolithophore index for the southeastern Bering. Sea shelf (south of 60°N) calculated from the GlobColour blended PIC product. Blue: average over the inner shelf (30–50m depth), Green: average over the middle shelf (50–100m depth), Black: total. The black dotted line is the time series average.

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Emily Lemagie (emily.lemagie@noaa.gov) is a physical research scientist at NOAAs Pacific Marine Environmental Laboratory (PMEL) studying ocean dynamics and the impacts on marine ecosystems in the North Pacific Ocean, Bering Sea, and U.S. Arctic. She is a PI for the EcoFOCI program leading studies of the dynamic relationships among climate, fisheries, and the marine environment.

Elizabeth Siddon (elizabeth.siddon@noaa.gov) is the Lead for Ecosystem-Based Fisheries Management at the Auke Bay Laboratories, NOAA Fisheries, Alaska Fisheries Science Center, in Juneau, Alaska. Elizabeth helps connect fisheries ecosystem science to management and leads the Ecosystem Status Report for the Eastern Bering Sea. The Ecosystem Status Report is used by regional fisheries managers at the North Pacific Fishery Management Council to inform fishing quotas each year.

PICES Regional Reports

The Western North Pacific: Current status and recent topic: Sea Surface Temperature in the 2023 Warm Season

Hideki Kaneko (Japan Meteorological Agency)

The western North Pacific was characterized by positive anomalies of sea surface temperature (SST) in the area between 40°N and 45°N throughout the 2023 warm season (Figure 1). In particular, positive SST anomalies exceeding +4°C prevailed off the coast of Sanriku, in the eastern area of Japan from July to September. Negative SST anomalies falling -1°C were seen in the southern area of Okinawa in June and in the north of the Sea of Okhotsk in September 2023.

The JMA's research vessel "Ryofu Maru" conducted oceanographic observations off Sanriku from point A to point B in July 2023 and observed water temperatures about 10°C higher than normal at a depth of 300 m at point W(Figure 2). Very high water temperatures off Sanriku are considered to be due to the northward migration of the Kuroshio Extension, which became more pronounced after April 2023.

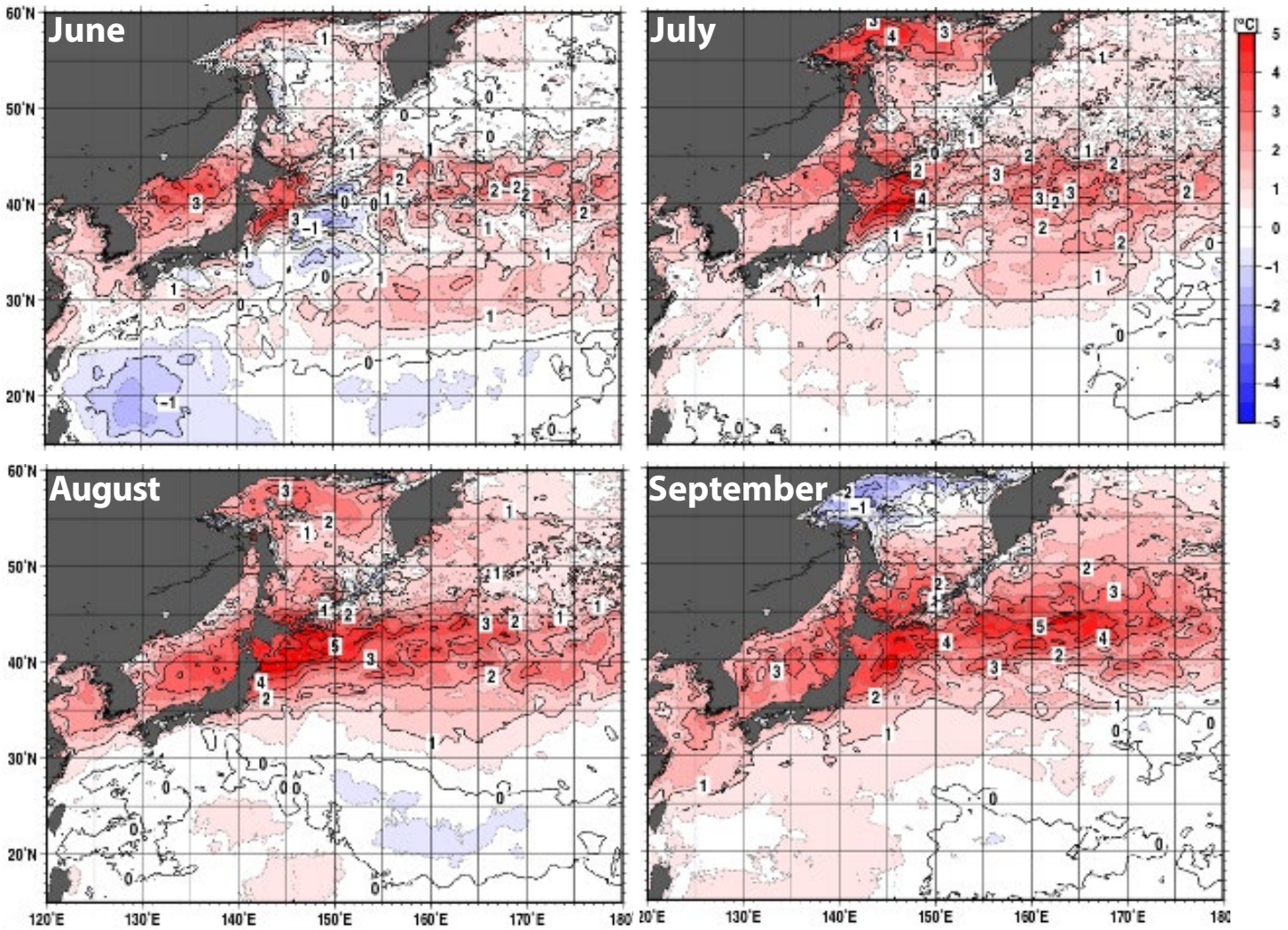

Figure 1. Monthly mean SST anomalies from June to September 2023. Monthly mean SSTs are based on JMA's HIMSST (HIgh-resolution Merged satellite and In-situ data Sea Surface Temperature). The difference from anomalies are deviations from the 1991-2020 climatology.

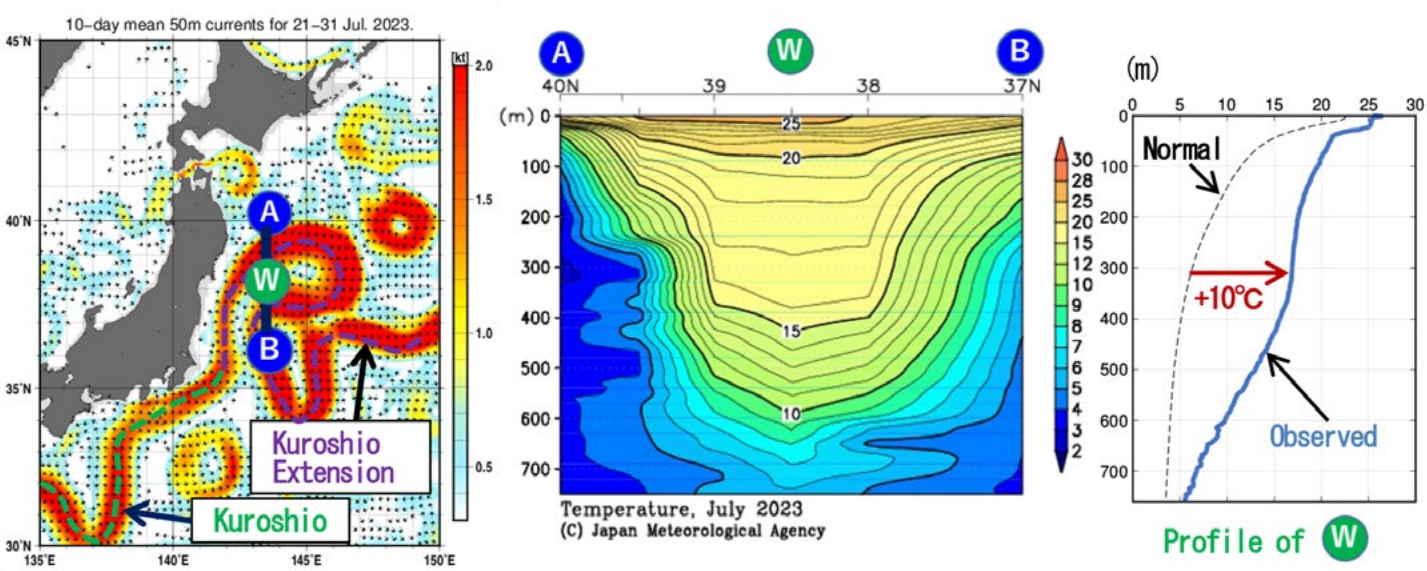

Figure 2. Sea current analysis chart in the eastern area of Japan in late July and oceanographic observation lines (from A to B) by JMA's research vessel *"Ryofu Maru"* (left). Vertical water temperature distribution from A to B to a depth of 700m. (middle). Comparison of vertical water temperature observed by *"Ryofu Maru"*(blue line) up to 700m depth with the normal (dashed line) at W point (the normal is the average from 1993 to 2017) (right).

The Kuroshio Large Meander and its impacts on fisheries

By Yutaka Hiroe (Japan Fisheries Agency)

1. The Kuroshio Large Meander

The western boundary current of the north Pacific subtropical gyre in the southern offshore waters of Japanis named the Kuroshio. The Kuroshio flows along the southern coast line of Japan, and then flows eastward. But it has long been known that a large meander is often seen in the eastern half of Japan. The Kuroshio has two periods which alternate. One period is when the large meander is stable and maintained for a long time (the Kuroshio Large Meander) and the other is when the meander moves eastward in sequence (non-Large Meander). From 1967 to 2005 (the time period with enough observations), there were five periods of the Kuroshio Large Meander.

In August 2017 the meander of the Kuroshio became large, and a period of the Kuroshio Large Meander started and has been maintained until now (October 2023). The length of this period is the longest in the six periods of the Kuroshio Large Meander since 1967. This was first reported by Kaneko and Sakamoto (2023) and the character of this period can be defined by the non-stationary nature of the path of the meander compared with the other five periods of the Kuroshio Large Meander.

2. Impacts of the Kuroshio Large Meander on fisheries

The oceanographic situation in the southern area of Japan is strongly influenced by the Kuroshio Current and the large meander after August 2017. The impacts of the Kuroshio Large Meander on fisheries were reported by Japan Fisheries Research and Education Agency (Kusaka, 2023).

The Kyucho (a sudden strong coastal current) occurred many times. The Kyucho is caused by the movement of the warm water of the Kuroshio along the Japanese coastline, as well as by direct inflow of the Kuroshio current into the coastal area. The Kyucho can break fishing gear such as fixed fishing nets. And in the Kuroshio mainstream, fishing is difficult because the strong currents prevent the fishing line from dropping vertically (as in the splendid alfonsino fishery).

Good catches were reported for some species (Japanese amberjack, Greater amberjack, Pacific bluefin tuna, Yellowfin tuna). These are species living in the warm water area and it has been suggested that the good catches were caused by not only the Kuroshio Large Meander but also by global warming.

Good catches of Skipjack tuna were reported in the western area and poor catches in the eastern area of the Kuroshio Large Meander. This was likely caused by the fishing ground being in a different position compared with the non-Large Meander period. With the Kuroshio current flowing on a different path, the fishing ground was moved far from the coast, making it difficult for fishing vessels to reach the fishing ground.

In the coastal area there were many reports of bad catches of whitebait. It was thought that one reason for the poor catches was disturbance of whitebait by the strong currents near the coastal area. However, as there were also some reports of brief good catches it was suspected there were other reasons than the Kuroshio Large Meander.

Growth of seaweeds in the coastal area became worse according to some reports. It was thought that poor growing conditions were caused by the warm water inflow to the coastal area. But the high temperature in the coastal area was not caused only by the path of the Kuroshio current, but also by the effects of global warming. There may also have been some effects of feeding damage by fish such as Japanese black porgy and Mottled spinefoot. The coastal ecosystem has changed gradually, including fish habitat and species composition. But the reasons for that change are complicated and are influenced by several factors.

As described above, there were many reports of fishery changes during these years. But the reports of the fishery changes were likely not caused only by the Kuroshio Large Meander. We must consider the longterm effects such as global warming as well as changes within the marine resources. But the impacts of the Kuroshio Large Meander on fisheries are significant, and must be studied. It is also important that when the long period of the Kuroshio Large Meander has ended studies are continued to assess its impact.

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Mr. Hideki Kaneko is a senior engineer at the Office of Marine Prediction of the Atmosphere and Ocean Department of the Japan Meteorological Agency, in Tokyo, Japan.

Mr. Yutaka Hiroe is the Principal Research Coordinator, Research and Technological Guidance Division, Resources Enhancement Promotion Department of the Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, JAPAN.

The Northeast Pacific: Update on marine heatwave status and trends

Andrea Hilborn, Charles Hannah, Tetjana Ross, Lu Guan and Andrew Leising

In coastal British Columbia, as autumn progressed, weather events and marine heatwaves have not been top of mind. Last year, in autumn of 2022, a MHW in the surface ocean of British Columbia persisted to the end of October, and corresponded with unseasonably warm air temperatures. This year has felt more "typical", as daylight shortened and we found ourselves digging in closets for hats, scarves and pairs of gloves instead of appreciating the extended t-shirt season. But zooming out, global temperatures are anything but typical.

In the last week alone the globe reached a grim record: November 17th and 18th not only were the hottest days ever recorded, but the global air temperature anomaly briefly breached 2°C (Figure 1; Copernicus, 2023). Though these data are still provisional, this threshold is famously enshrined in the Paris Agreement and extensively researched, defining a limit above which dramatic changes to the Earth system occur. Every month since May of this year has set global temperature records; many regions have been slammed with heatwaves amid a growing El Niño, and Marine Heatwaves (MHWs) have been present around the globe. The Florida Keys, for example, experienced widespread coral bleaching from water temperatures that exceeded 38°C in August, and is now taking stock of the following mass mortality of its coral reefs (see Hobday et al., 2023 for a more detailed MHW list). Global forecasts predict El Niño continuing through the winter, with 62% probability through April-June 2024 (NOAA 2023). NOAA forecasts have further predicted 30% of the global oceans will be in MHW status through the end of the year (NOAA, 2023). The Northeast Pacific has been less newsworthy in comparison to these events this year, though MHW conditions have been present.

Soon after our prior Northeast Pacific (NEP) update in June, satellite sea-surface temperature (SST) products showed an extensive surface MHW expanding along the North American west coast, impinging extensively on coastal waters from Oregon to south central Alaska by early August (Figure 2A, C). The maximum extent of this MHW occurred on August 29th, spanning approximately 7.5 million square kilometres, making it the 4th largest MHW observed in the NEP since 1981 (Figure 2B). In the BC EEZ (outlined in Figure 2A) the coastal MHW conditions had mostly receded by October, with much of the NEP slightly cooler or slightly warmer compared to the

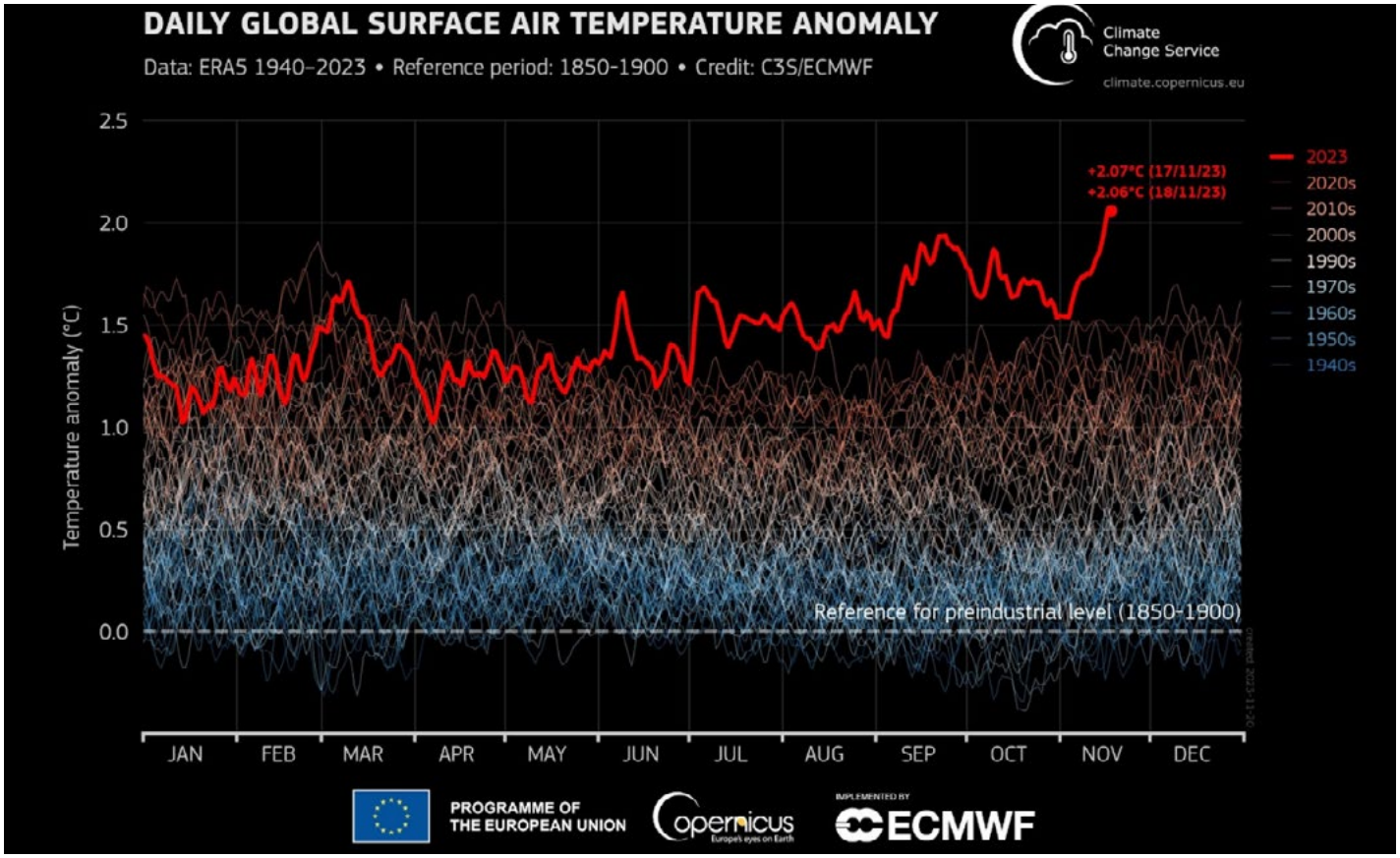

Figure 1. Daily surface air temperature anomalies. Credit: C3S/ECMWF (Copernicus, 2023)

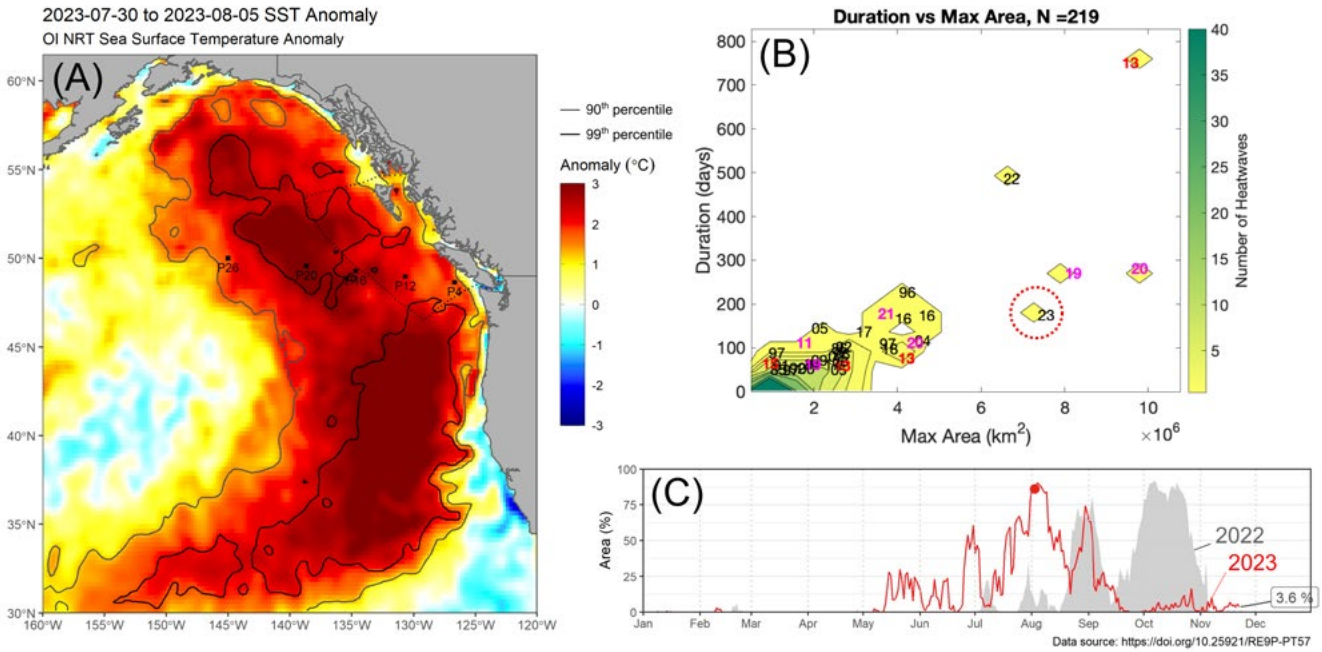

Figure 2. NOAA OISST anomaly from the week of July 30th (A), with approximate 90th and 99th percentiles from the 1991-2020 climatology (black contours). Selected stations along Line P are labelled as black dots, and the BC Exclusive Economic Zone is indicated with a dashed line. Annual MHW duration vs. maximum area for the NEP plotted in (B), with labels indicating year. The percent of area within the BCEEZ dotted line in MHW status (C) is shown for 2023 (red) and 2022 (grey). Time period of image (A) indicated with a red point. Data sourced from https://doi.org/10.25921/RE9P-PT57 and analyzed by the authors.

climatology in surface waters (Figure 2C). Recently, an area in the central NEP has remained slightly under 1°C cooler than usual, ringed by warmer waters with patches exceeding MHW thresholds. MHWs have persisted through autumn in the eastern North Pacific, and further south in tropical North Pacific surface waters (NOAA, 2023). In the recent two weeks, satellite SST has observed a MHW stretching northward along the California coast to British Columbia, with warmer temperatures corroborated by buoys in Queen Charlotte Sound and on La Perouse Bank on the west coast of Vancouver Island (see the DFO Github SST Page and NOAA California Current MHW Blobtracker for more information). Below the surface, a warm anomaly exceeding 0.9°C has been persistent in the central North Pacific (30-45°N and 160°E-150°W) since 2020 extending to 150 meters depth, the strongest extended warming observed since 1979 (NOAA, 2023).

Current predictions for the NEP for the winter of 2023-2024 have identified increased MHW risk in coastal surface waters until December or January. MHW probabilities range from 10-20% in coastal Alaskan waters, increasing to 30-40% adjacent to northern British Columbia, and greater than 40-50% from Vancouver Island extending further south along the U.S. west coast (NOAA PSL, 2023). MHW conditions are also expected to persist further east in the central and Northwest Pacific through the winter (NOAA, 2023). While new research has shown that strong warming in the Arctic, which changes the atmospheric circulation over the NEP, can increase MHW days during the summer (Song et al., 2023), negative Pacific Decadal Oscillation conditions (the phase currently observed) in the NEP have been associated with weaker MHWs (Ren et al., 2023). So, the NEP may be cooler this winter than we predicted 6 months ago when considering the El Niño outlook. However, with global temperatures in record territory and large, high-intensity MHWs seen in the NEP this summer, the impacts and extent of MHWs this winter remain to be seen.

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In Memoriam
Dr. Igor Shevchenko
22.08.1954 – 16.07.2023

Everyone at PICES was very sad to learn that Dr. Igor Shevchenko passed away on July 15, 2023. Igor had been involved with PICES activities from 1997 to the time of his passing, especially promoting the activities of the Technical Committee on Data Exchange (TCODE) in a calm and quiet manner that nevertheless managed to show his passion for the importance of data management and sharing. He was Chair of TCODE from 2001 to 2007. He also represented Russia in other scientific and administrative expert groups of PICES such as, Science Board, Finance and Administrative Committee, as well as serving as an adviser to the Russian National Delegates. We will certainly miss his dedication, enthusiasm and professionalism, which played a significant role in strengthening cooperation among ocean scientists from different countries within the PICES community.

Igor was employed by TINRO (now the Pacific Branch of the Russian Federal Institute of Fisheries and Oceanography) and as well as being a highly qualified professional in the field of computer science and mathematics that we saw in PICES, he was Secretary of the TINRO basketball club. His wife Irina says that *"Igor loved many things: basketball, good music, good books, good wine, to ride a bicycle, yoga classes. Perhaps the most long-term love was basketball. Igor started playing basketball at school. And according to him, it was his school of life. Basketball taught him a lot. In any team game people reveal themselves without pretense and learn to be in a team. And that how it was with Igor - he was not an individualist - he was a team player both on the court and in life. Igor will always be remembered as a team player: on the court, in the family, and at work."*

"We would like to express our deepest sympathy on the passing of Dr Igor Shevchenko. He was a truly great scientist and we are proud to have been his friends" ~ PICES TCODE members, 2023.

"Igor was one of the first PICES members to welcome me to TCODE, and always patiently answered all of my questions. His calm, quiet demeanor will always be remembered fondly, along with his devotion to PICES and his unwavering support for sharing of data management and sharing" ~Jeanette Gann

"Though my interactions with Igor were brief and few over the last two or three years through our membership in TCODE and SG-DATA, it was clear to me that Igor was a dedicated professional, who cared immensely about international cooperation, and furthering the field of ocean sciences. Igor maintained a steadfast approach to making continual progress on metadata federation despite difficult challenges. What struck me the most was his kindness, compassion and respect" ~Brett Johnson

Bernard Megrey (TCODE chair), Igor Schevchenko, Robin Brown and Toru Suzuki received the POMA 2009 from John Stein (SB chair) and Tokio Wada (PICES chair) in the opening session of PICES 2009 in Jeju, Korea.

TCODE participants at the TCODE meeting during PICES-2019, Victoria, Canada. Back row, from left: Igowanr Shevchenko, Georgiy Moiseenko, Manchun Chen, Toru Suzuki, Daisuke Ambe, Yutaka Michida, Sang-Hwa Choi, Jinkun Yang, Di. Front row, from left: Peter Chandler, Jeanette Gann, Joon-Soo Lee.

In Memoriam
Dr. Igor Shevchenko

22.08.1954 – 16.07.2023

PICES Events Calendar

- ICES/PICES Zooplankton Production Symposium (ZPS 2024)
  Hobart, Tasmania, Australia, March 17 –22, 2024

- Marine Socio-Ecological Systems Symposium (MSEAS)
  Yokohama, Japan, June 3 –7, 2024

- International studies of North East Asian Marginal Seas: from circulation and biogeochemistry to socio-economic research. 30th Anniversary of the CREAMS program.
  Seoul, Korea, July, 2024 - Dates TBC

- PICES-2024
  Honolulu, USA, October 26 – November 1, 2024

PICES-sponsored Capacity Development Events - check the PICES website for updates!

Partner Events

- Ocean Sciences Meeting (OSM)
  New Orleans, USA, February 18 – 23, 2024

- 9th World Fisheries Congress
  Seattle, USA, March 3 – 9, 2024

- UN Ocean Decade Conference
  Barcelona, Spain, April 10 – 12, 2024

- ICES ASC 2024
  Gateshead, UK, September 9 – 12, 2024

PICES by the Numbers

ECOP Diversity

The Advisory Panel on Early Career Ocean Professionals (AP-ECOP) tested a survey early in 2023 and then implemented it for PICES-2023 via the online registration portal. It was not made mandatory, but ECOPs were highly encouraged to fill it out to help the Advisory Panel (and the PICES Secretariat) better understand and track the registration demographics of ECOPs at PICES Annual Meetings and other sponsored events. This year, 380 ECOPs from 45 different countries registered for the 2023 PICES Annual Meeting, of which 154 (41%) were students and 226 (59%) non-students. For most ECOP respondents (76%), PICES-2023 was their first ever PICES event, while 5% of them were long-term attendees (>10 years). Among the students who registered, 8% of them were Undergraduates, 32% were enrolled in a Master's degree program and 63% were pursuing a PhD.

When examining non-student ECOPs (i.e., who were not students at the time of this survey), a large majority (~80%) held a PhD degree as their highest level of education. Additionally, the top 4 professions that they held were, in decreasing order: Postdoc (28%), Researcher (27%), University Professor/Lecturer (24%) and Government Scientist (20%). Other positions listed included: Consultants, Education Specialists, Project Coordinators, Entrepreneurs, etc.

In terms of sector (n=122), 51% of respondents were affiliated with academic institutions, 34% worked in government and 12% were associated with NGOs.

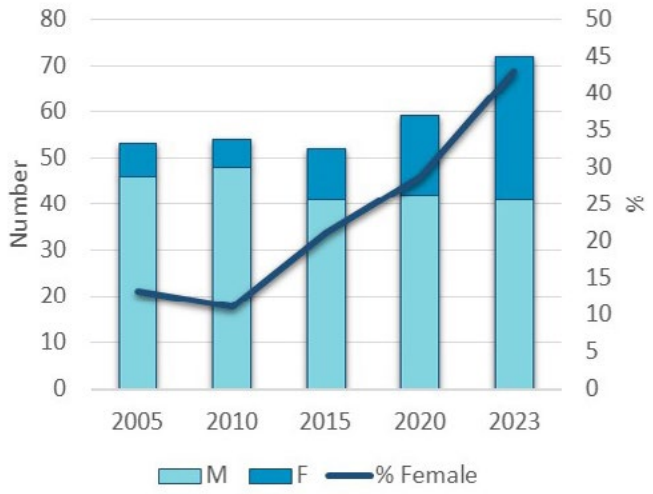

Figure 1. Number of Chairs/Co-Chairs and Vice-Chairs by gender over time (bars), together with the proportion that are female.

Gender balance

We are also now collecting voluntary information about gender of all participants during registration. Data shown below (Figure 1) are for in-person participants only, for PICES-2022 and PICES-2023, and show that this year there was a more even balance than in 2022.

Many global and national initiatives are actively working to promote female scientists in leadership roles. The data in Figure 2 show the trend over time for female Chairs, Vice-Chairs and Co-Chairs of PICES expert groups, demonstrating that there has been progress in achieving parity from about 20% female in 2005 to 45% in 2023:

Geographic diversity

The PICES process for nominating members to expert groups encourages participation by all member countries in each group, however, level of in-person participation by each member country at the annual meeting is somewhat dependent on the proximity to the meeting location. It should be noted that in 2022 and 2023 travel was also influenced by geopolitical and pandemic-related challenges too. PICES also attracts scientists from outside of our member countries too. With these factors in mind then, Figure 3 below shows that the host country accounted for a little over 40% of attendees in both years.

Although PICES annual meetings are not yet truly hybrid, during 2022 and 2023 we have promoted fully virtual and hybrid expert group meetings in association with the annual meeting, where possible, to enable those members who could not travel to participate in business meetings. The charts in Figure 4 show the different modes of participation by members of PICES expert groups. Membership is not always evenly distributed and it is common that only half of members can attend in any given year (historical data for in-person only meetings from 2008 to 2019 have member participation rates between 41-57%). The option for virtual participation as well as returning to a more typical travel situation led to a participation rate of 58% at PICES-2023, marginally higher than any other year in the last 15.

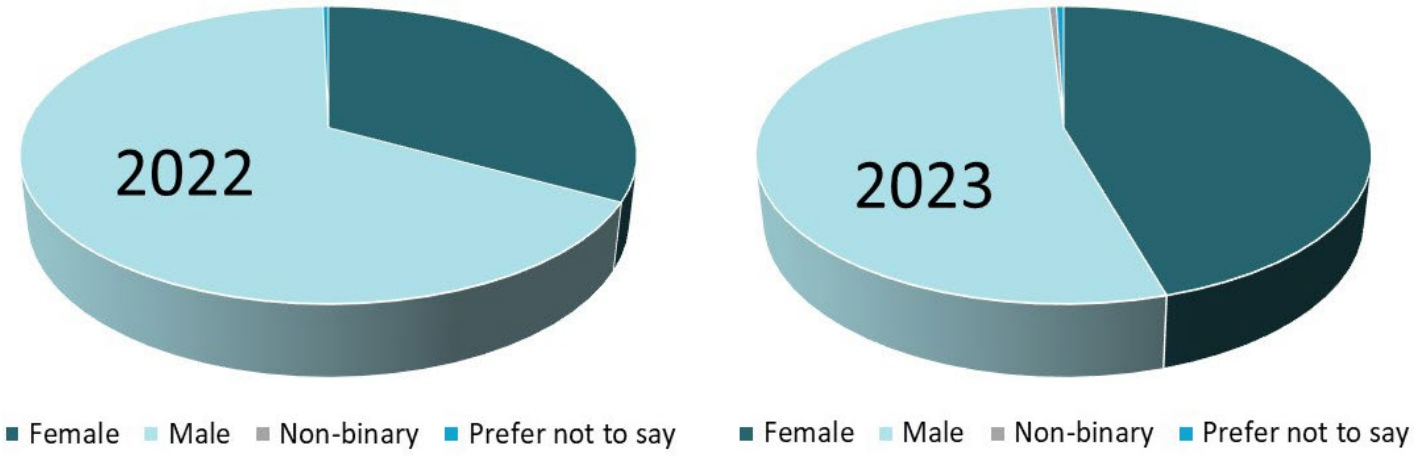

Figure 2. Participation by gender at the two most recent annual meetings.

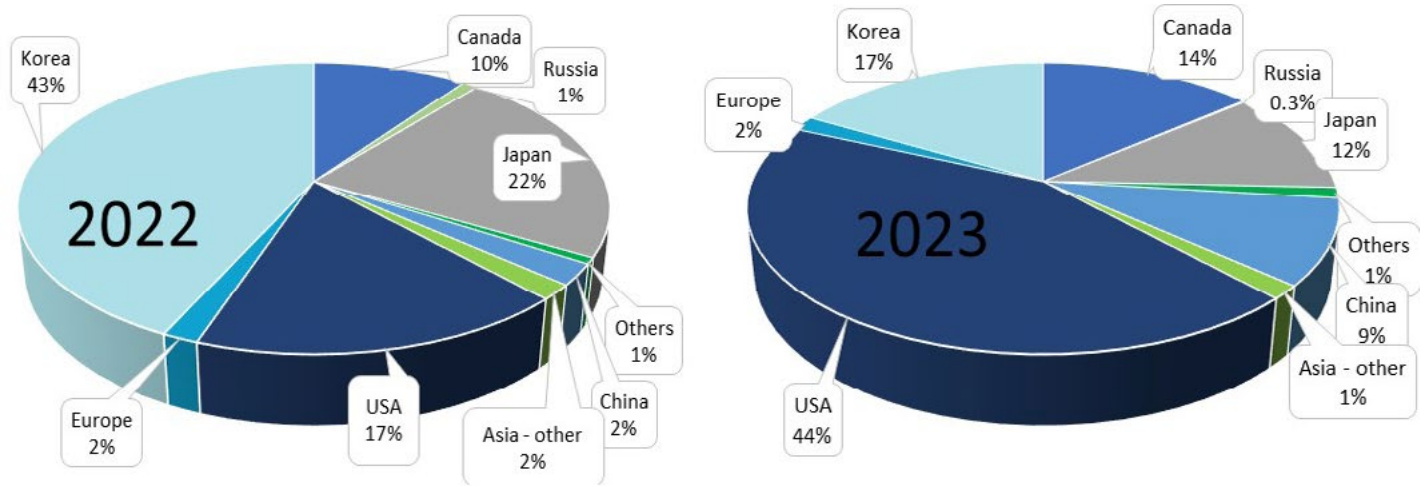

Figure 3. Country or region of residence for in-person participants at the two most recent annual meetings.

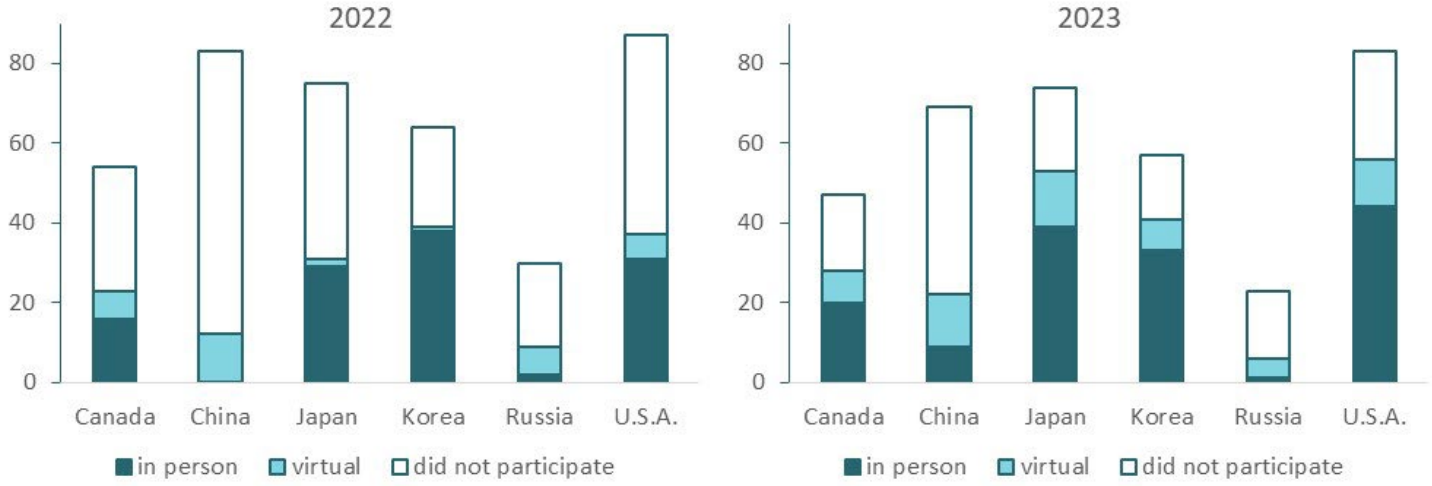

Figure 4. Number of members (y-axes) per country divided into the different modes of participation at the two most recent annual meetings: in-person, virtual, or not able to participate.

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Thank you for your contributions!

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