



PICES Accomplishments in 2021— Note from the Science Board Chair

Vera Trainer



PICES in the UN Decade of Ocean Science for Sustainable Development

During the United Nations Decade of Ocean Science for Sustainable Development (UNDOS; 2021–2030), PICES has been asked to envision “*the science we need for the ocean we want*”. For me, this creates a picture of flourishing fisheries, healthy marine animals and ecosystems, families enjoying recreation at the beach, and communities participating in the preservation of oceans. The science we need leads us toward these goals; research and collaborations that aspire to healthier oceans and people. PICES is at the forefront of conducting the science to create a better future for oceans and society.

Speaking of UNDOS, our proposed collaborative program with ICES, Sustainability of Marine Ecosystems through global knowledge networks (SMARTNET), was officially endorsed as a Decade “*Network Program*” in June 2021. SMARTNET will leverage the expertise and infrastructure of ICES and PICES to reach far beyond our established networks to advance and share scientific understanding of marine ecosystems. This program will facilitate cross-cutting inclusivity themes relating to gender equality, early career ocean professional (ECOP) engagement, and involvement of indigenous communities and developing nations.

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Small Pelagic Fish: New Frontiers in Science and Sustainable Management

November 7 - 11, 2022
Lisbon, Portugal



Food and Agriculture
Organization of the
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United Nations Decade
of Ocean Science
for Sustainable Development

Other initiatives endorsed by UNDOCS which PICES members are co-leading are the ICES/PICES/FAO [International Symposium on Small Pelagic Fish \(SPF-2022; #SPFSymposium2\)](#) scheduled for 7–11 November 2022 in Lisbon, Portugal; the [Marine Socio-Ecological Systems Symposium \(MSEAS\)](#), scheduled for 2022, which held a virtual teaser event on 8 December 2021; and the ICES/PICES Early Career Scientist symposium, scheduled for 9-12 May 2022 in St. John's, Newfoundland, Canada.

Our 30th Annual Meeting ([PICES-2021](#)) was held virtually by the People's Republic of China from 19–22 October 2021 over many time zones. There were [656 registered participants from 31 countries and every continent except Antarctica](#) participating in the scientific sessions.

During the Opening Ceremony for PICES-2021, the [Wooster Award](#) was presented to Dr. Sinjae Yoo for his sustained excellence in research and teaching of marine science in the North Pacific. The second [Zhu-Peterson Early Career Scientist Award](#) was presented to Dr. Erin Satterthwaite (USA), the co-chair of the SG-ECOP. Finally, the [PICES Ocean Monitoring Service Award \(POMA\)](#), was given to the Ecosystems and Fisheries-Oceanography Coordinated Investigations ([EcoFOCI](#)) program, a collaborative research effort by scientists of the Pacific Marine Environmental Lab and the Alaska Fisheries Science Center (USA). You can read more details about these awardees in the companion article in [this issue of PICES Press](#). I extend my heartfelt congratulations to all the winners!



Environmental sustainability

We continue to discuss PICES contribution toward environmental sustainability which is achieved, in part, by holding some meetings virtually. The virtual PICES-2021, including the preceding business meetings, sessions and workshops, was a resounding success. Although we all miss seeing one another in person, these virtual meetings reduce our

carbon footprint to play a small part in mitigating climate change. The [cumulative carbon savings](#) from holding virtual meetings was 1057 Tonnes – equivalent to taking 230 cars off the road for 1 year, not burning 450,229L of gasoline, and equivalent to CO₂ taken up by 17,478 tree seedlings over 10 years. This illustrates the importance of PICES scientists leading by example in adopting a combination of virtual and in-person meetings as a part of the organization's vision for the future. In the future, we will continue the PICES tradition of holding some in-person meetings with the realization that seeing one another in person is an irreplaceable way to connect. A proposal will be submitted for consideration at the 2022 Intersessional Science Board meeting (ISB-2022) for a Study Group (SG) on [Generating Recommendations to Encourage Environmentally-friendly Networking \(SG-GREEN\)](#), as a way to more formally structure the PICES approach to environmental sustainability. Please [contact me](#) if you are interested in participating in the visioning of a proposal for SG-GREEN.

PICES Cumulative Carbon savings Update: 1057 tonnes, realized through virtual meetings

- ISB-2020: 70 tonnes
- AP-CREAMS 2020: 14 tonnes
- MSEAS-2020: 182 tonnes
- PICES-2020: 689 tonnes
- ISB-2021: 102 tonnes

These Cumulative savings are equivalent to:

- Taking 230 cars off the road for one year
- Not burning: 450,229L of gasoline, ~529,925 Kg of coal, or 2447 barrels of oil
- CO₂ taken up by 1295 acres of forest, or 17,478 tree seedlings over ten years

For more information, please visit:
<https://meetings.pices.int/about/PICEScarbonSavings>



PICES 2021 Annual Meeting Highlights

The PICES-2021 theme was “Towards a shared vision of sustainable marine ecosystems.” PICES is well-positioned as a northern hemisphere leader of multi-national collaborations to further our understanding of the ocean’s natural systems. During the opening Science Board sessions of PICES-2021, Dr. Shion Takemura presented a social science study demonstrating with keyword searches how the PICES science focus has changed over the decade. A paper on the characterization of phytoplankton communities in the Gulf of Alaska using satellite remote sensing with in-situ validation was presented by Dr. Vishnu Suseelan. Dr. Erin Satterthwaite, our 2021 Zhu-Peterson award winner, presented the results of recent ECOP initiatives to foster international, intergenerational and cross-sectoral engagement in the North Pacific and beyond. Finally, Dr. Mark Saunders provided an overview of the [Basin-scale Events to Coastal Impacts \(BECI\)](#) program, highlighting past accomplishments and future plans.

Other topic sessions that were held this year focused on sustainable marine ecosystems, multiscale climate variability, atmospheric nutrients and microbial community responses, ocean deoxygenation, predictions of extreme events in the North Pacific, use of environmental indicators, and applications of artificial intelligence. Four workshops were also held prior to PICES-2021, and there is [more information on these in this issue](#). The many speakers, followed by questions and conversations, showed the great versatility and commitment of PICES and partner scientists to connecting with their colleagues by sharing their science virtually. I extend my thanks to all the presenters and organizers.

All PICES expert groups, including working groups (WG), sections and advisory panels (AP), met virtually prior to PICES-2021. I am impressed by commitment shown by many of the PICES groups who met online for many hours. Their reports can be found on the [PICES website \(www.pices.int\)](#) under the “Members” tab, with accomplishments that are too numerous to summarize here. However, I want to highlight the overarching accomplishments of 2 PICES Study Groups whose future plans will have impacts on all of PICES science during the UNDOS and beyond.

Early Career Ocean Professionals

The SG on early career ocean professionals (SG ECOP) took on the challenge to explicitly define the role of ECOPs as

an integrated part of PICES to ensure that young voices are heard, detailed in the SG-ECOP Engagement Plan which will be posted soon on the PICES website. This Plan will help steer the new AP on ECOPs (AP-ECOP) which was recently approved by GC to ensure that valuable institutional knowledge will be retained and new generations will have greater sense of shared ownership and buy-in of PICES initiatives. ECOPs are planning to develop a North Pacific ECOP node of the Global ECOP program, and are also establishing a mentor-mentee platform. More information about ECOP accomplishments and activities can be found in a companion article in this issue of PICES Press. Please continue to include ECOP in new PICES Expert Groups and support their involvement with PICES by becoming a mentor.

Science Communication

Communication of our key and important scientific findings to the global community, including scientists from a wide range of disciplines, policy makers and the general public has built upon past PICES science communication efforts and was the focus of the SG-Scientific Communications (SG SciCom). The Study Group drafted a communications strategy and implementation plan which will guide the newly approved AP for Scientific Communications (AP SciCom). One of the focal areas of the AP-SciCom will be to transition to a new PICES website landing page that invites the world to learn more about our transformative science. A framework for collection, creation, and regular dissemination of PICES Science content will be developed by AP-SciCom. Please feel free to share your ideas for how to better communicate our science with this new AP.

New Expert Groups – Moving into the FUTURE

Governing Council approved several new PICES Expert Groups in 2021. In addition to those mentioned above, they include the Joint PICES-Pacific Salmon Commission SG on Scientific Cooperation in the North Pacific Ocean (SG-SCPSC), the WG on Climate Extremes and Coastal Impacts in the Pacific (WG 49, with an approved 5-year term), and the WG on Sub-mesoscale Processes and Ecosystems (WG 50). Congratulations to all PICES members who were involved in proposing these new EG. All requests for WG extensions were approved, as GC recognized how challenging it has been this year to complete the planned activities. Please find the [summary of GC decisions here](#).

The overarching science program of PICES is FUTURE, Forecasting Understanding, Trends, Uncertain and Responses of the North Pacific Ecosystem. As FUTURE continues its new chapter (Phase III), we are increasingly thinking about how EG can collaborate within PICES and how PICES can enhance its work with other organizations. More details on the accomplishments and plans for FUTURE can be found in a [companion article in this issue of PICES Press](#).



We look forward to the next Open Science Meeting (OSM) of FUTURE which has been delayed until 2023 or 2024. FUTURE will play a key role in defining the PICES role within the UNDOS and will work closely with the Joint [PICES/ICES SG UNDOS](#) to integrate FUTURE plans with SMARTNET, the UNDOS networking program. The SG-UNDOS has received a 6-month extension of its term to continue planning UNDOS activities.

In total, the PICES Secretariat [hosted](#) 44 virtual business meetings, 4 virtual workshops, 6 science sessions and 1 ePoster session in September & October 2021; 1 virtual Governing Council meetings in November 2021, and numerous meetings with collaborating organizations, sometimes at 4am! The dedication of all the members of the Secretariat: Dr. Sonia Batten, Dr. Sanae Chiba, Dr. Alex Bychkov, Ms. Christina Chui, Ms. Julia Yazvenko, Ms. Susan Hannah, Ms. Saeseul Kim, Ms. Rosalie Rutka, Ms. Lori Waters and Mr. Robin Brown (retired) are greatly appreciated.

Publications

Several interesting publications have been approved and are posted on the PICES website or in the peer-review literature. Please take a look at these compelling scientific communications if you have not already done so. All PICES-sponsored publications require review by Science Board (SB) and approval by GC before being posted on the website. A publication that built upon the contribution of S-HAB to the Harmful Algal Event Database ([HAEDAT](#)) by Hallegraeff et al. 2021. [Perceived global increase in algal blooms is attributable to intensified monitoring and emerging bloom impacts](#) was published in *Nature Communications Earth Environment*. A publication led by Jennifer Boldt, on [Quantifying ecosystem responses to environmental and human pressures in the marine ecosystem off the west coast of Vancouver Island](#) was published in 2021 in the journal *Ecological Indicators* and highlights accomplishments by [WG-36](#) (Common Ecosystem Reference Points across PICES Member Countries). A 2020 paper led by members of [WG-43](#) on Small Pelagic Fish is by Peck, MA et al. 2021, titled [Small pelagic fish in the new millennium: a bottom-up view of global research effort](#), was published in the journal *Progress in Oceanography*. In a collaborative paper between FIS with ICES, Carsten Hvingel et al. published a paper in the *ICES Journal of Marine Science* titled, [Cold-water shellfish as harvestable resources and important ecosystem players](#). [WG-37's Final Report on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions](#) will be published as a PICES Scientific Report. Finally, [WG-35](#) has completed PICES [Special Publication 7, Marine Ecosystems of the North Pacific Ocean 2009–2016: Synthesis Report](#), available in hardcopy and on [PICES website](#).

Collaborations

Many of the issues that facing our oceans are too big to tackle with one organization or one country. At PICES-2021, several external organizations and programs attended. Several strategic partners (CLIVAR, ICES, IWC, APN, NPFC, SCOR, SOLAS, BECI, IPHC, IMBeR, NPRB, Future Earth)** were invited to the Science Board meeting to discuss ongoing and future collaborations with PICES. These partners will be vital in PICES expanding its influence and geographical scope during UNDOS.

PICES is often requested to provide science and technical expertise in special projects dealing with marine issues in countries outside the PICES region. One special project, begun in 2020, is the [Ciguatera Project](#). Supported by the Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan, it aims to build local warning networks to assess, detect, and avoid human ingestion of [ciguatera fish poisoning](#) in Indonesian, using smartphone technology to monitor environmental conditions and fisheries. This project will work with local coastal communities, with the aim of assisting the Indonesian government to enhance its capacity for collecting data to improve management practices. The second PICES Special Project is [SEAturtle](#) (Sea turtle ecology in relation to environmental stressors in the North Pacific region), funded by the Ministry of Oceans and Fisheries of Korea. The aim of this project, which will end in 2022, is to research the endangered sea turtle populations found in the southern waters off Korea, Japan, and China in order to better understand the threats to their habitat and ecology in relation to anthropogenic activities. The SEAturtle Project Science Team members have demonstrated the migration route of sea turtles using Iridium satellite-tracked tags.

Science Board Elections



It is my great pleasure to inform you that Dr. Sukyung Kang, Korea, was unanimously nominated the PICES Science Board Chair-Elect. Sukyung has been an active leader in PICES for many years, through her role as co-chair of FUTURE! I look forward to working with Sukyung in her transition to SB Chair, scheduled at the end of the PICES Annual Meeting in 2022.

In closing, I am hopeful that we will meet again in person in 2022. I am truly grateful to be part of such a visionary international science organization. As we look to the future, let us work toward greater diversity and inclusion, collaboration with underrepresented communities and their people, and clear and concise communication of our science with the world! I wish you all a fulfilling end to 2021 and a very happy, healthy 2022.

Attending SB@PICES-2021:

Science Board

Vera Trainer, Science Board Chair
Igor Shevchenko, rep. Russia, SB Vice-Chair
Steven Bograd, FUTURE SSC Co-Chair
Sukyung Kang, FUTURE SSC Co-Chair
Akash Sastri, BIO Chair
Xianshi Jin, FIS Chair
Mitsutaku Makino, HD Chair
Guangshui Na, MEQ Chair
Emanuele Di Lorenzo, POC Chair
Sung Yong Kim, MONITOR Chair
Jeanette Gann, TCODE Chair

Governing Council (GC) Members and Advisors

Prof. Enrique N. Curchitser, PICES Chair
Dr. Tetsuo Fujii, PICES Vice-Chair
Dr. Michael Seki, F&A Chair
Mr. Andrew Thomson, GC (TBC)
Dr. Bernard Vigneault, GC (TBC)
Mr. Hideki Uezono, GC (TBC)
Prof. Fangli Qiao, GC (TBC)
Mr. Antao Wang, GC (TBC)
Dr. Se-Jong Ju, GC (TBC)
Mr. Do-hyung Koo, GC (TBC)
Dr. Aleksei Baitaliuk, GC (TBC)
Dr. Oleg A. Bulatov, GC (TBC)
Dr. Jack A. Barth, GC (TBC)
Dr. Chul Park, PICES Past-Chair (TBC)

PICES Secretariat

Sonia Batten, Executive Secretary
Sanae Chiba, Deputy Executive Secretary
Alex Bychkov, Ex-officio
Lori Waters, Science Board Support

Invited Guests

William Karp, ICES
Jörn Schmidt ICES
Erin Satterthwaite, FUTURE Earth
Janelle Curtis, DFO Pacific Biological Station /NPFC
Alex Zavolokin, NPFC
Matt Baker, NPRB
Patricia Miloslavich, SCOR
Sinjae Yoo, SCOR
Mark Saunders, BECI
Josep Planas, IPHC
Aoi Sugimoto, Japan FRA
John Claydon, IMBeR
Imai Kaori, Foreign Affairs, Japan

*PICES Standing Committees

BIO - Biological Oceanography Committee
FIS - Fishery Science Committee
HD - Human Dimensions Committee
MEQ - Marine Environmental Quality Committee
POC - Physical Oceanography and Climate Committee
MONITOR - Technical Committee on Monitoring
TCODE - Technical Committee on Data Exchange

PICES Partners, and acronym definitions - (see links above):

CLIVAR – Climate and Ocean - Variability, Predictability and Change
ICES – International Council for the Exploration of the Sea
IWC - International Whaling Commission
APN – Asia-Pacific Network for Global Change Research
NPFC – North Pacific Fisheries Commission
SCOR – Scientific Committee on Oceanic Research
SOLAS –Surface Ocean Lower Atmosphere Study
BECI – Basin Events to Coastal Impacts
IPHC –International Pacific Halibut Commission
IMBER – Integrated Marine Biosphere Research
NPRB – North Pacific Research Board
Future Earth

Highlights from the FUTURE SSC's 2021 Annual Meeting

Steven Bograd and Sukyung Kang



FUTURE Science Program

Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems

Collaborating to Understand the Predictability and Sustainability of Social-Ecological-Environmental Systems (SEES)

The FUTURE Scientific Steering Committee held its 7th annual meeting since 2014. FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) is PICES' second integrative science program, which was launched at PICES-2009. This year's virtual meeting took place October 5–8th, 2021. The 3-day affair was led by Steven Bograd and Sukyung Kang who are the Co-Chairs of the FUTURE SSC. It was attended by 14 SSC members, 3 guests and 6 representatives from the PICES Secretariat, who hosted the online meeting.

Review of 2021 activities



We welcomed a new SSC member at our annual meeting. Dr. Chengjun Sun (left) has replaced Dr. Guangshui Na as a member from China. Welcome Dr. Sun, and thank you Dr. Na for all of your contributions to FUTURE over the past few years!

The SSC reviewed our activities since our last virtual meeting at PICES-2020. A key accomplishment was the completion of the FUTURE Product Matrix, which links products developed by PICES expert groups to specific objectives and questions of the FUTURE Science Program, allowing for an easily accessed catalog of FUTURE-relevant products as well as a synthesis of products and a gap analysis of unmet objectives. Over the past year, Saeseul Kim, PICES Secretariat Intern worked with SSC members to develop the methodology for, and complete the Product Matrix. We expect to work with the Secretariat to post the Product Matrix on the [PICES website](#) in the near future.

The SSC held an additional virtual meeting on November 17th to outline a journal manuscript that will use the Product Matrix to highlight key achievements of the FUTURE program, identify knowledge gaps and the reasons they remain, and determine next steps for addressing FUTURE's goals. The Product Matrix will be included in the FUTURE Phase II Final Report, which SSC members plan to complete next year.

The SSC continued planning its next FUTURE Open Science Meeting (OSM), which would highlight and synthesize accomplishments of the FUTURE Phase II (2014-2020) Science Program, including applications of the [Social-Ecological-Environmental Systems \(SEES\) framework](#). There will also be an emphasis on reviewing initial and planning future PICES activities associated with the UN Decade of Ocean Science for Sustainable Development (UNDOS). Due to travel constraints and delays related to the Covid-19 pandemic, and with many other meetings now being scheduled for 2022-23, the SSC decided to target spring 2024 for the meeting. A sub-group will continue to work with the Secretariat on meeting planning and logistics, including exploring alternate meeting structures such as 'ideation' workshops to develop 'ocean solution roadmaps' and events aimed at early career ocean professional participation.

The FUTURE SSC hosted a 3-hour virtual workshop in June 2021 to engage the PICES community in planning for a [new expert group on 'Climate Extremes and Coastal Impacts in the Pacific'](#). Approximately 40 people participated in the workshop, where several decisions were made:

- a. there is strong interest in developing a single transdisciplinary Working Group on this theme;
- b. we anticipate a relatively large membership to account for disciplinary expertise, representation from ECOPs and the indigenous community, and participation of partner organizations, including CLIVAR and APN;
- c. we anticipate strong collaborations with SmartNet and other UNDOS Programs and activities; and
- d. we requested a longer than usual lifetime of 5 years to be more fully effective. Following the workshop, SSC members and interested PICES participants finalized the WG-Extremes proposal, which was presented to, and approved by, PICES Science Board and Governing Council. WG-Extremes will now secure members and begin activities in 2022.

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

A key component of Phase III of FUTURE is engagement with the UNDOS. Towards this objective, PICES worked with ICES partners to submit a joint program proposal, *Sustainability of MARine ecosystems Through knowledge NETworks (SmartNet)*. SmartNet was officially endorsed as an UNDOS Network Program in June 2021 (see *PICES Press*, vol. 29, no. 2), and has formed the ICES-PICES Ocean Decade (IPOD) Steering Committee to plan and implement the Program. IPOD has met several times this year to strategize the co-design and governance structure of SmartNet. Initial activities of the Program include:

- a. published a SmartNet introduction in the *Eco Magazine UNDOS special issue*;
- b. planning for national surveys to gauge interest and engagement in UNDOS;
- c. planning for a virtual Town Hall associated with the February 2022 Ocean Sciences Meeting to introduce potential stakeholders to SmartNet and other UNDOS Programs;
- d. planning for participation in the February 2022 UNDOS-sponsored Laboratory on 'A Productive Ocean'; and
- e. preparing a manuscript on our plans for co-design and stakeholder engagement for an UNDOS special volume of *ICES Journal of Marine Science*. We anticipate that PICES engagement in UNDOS will accelerate in the coming months.

Upcoming FUTURE activities

The FUTURE SSC prepared an Action Plan for the coming year, which includes:

- a. facilitating development of WG-Extremes, along with developing greater synergies amongst existing Expert Groups;
- b. coordinating PICES engagement in UNDOS, through collaborations with SG-UNDOS, IPOD, and the new AP-ECOP;
- c. finalizing and distributing a FUTURE Phase II Product Matrix and Final Report;
- d. working with the Secretariat to update FUTURE material on the PICES website;
- e. planning for the next FUTURE Open Science Meeting to be held in 2024; and
- f. preparing for 2022 inter-sessional and annual meetings.



Endnote 1: FUTURE SSC-2021 Meeting Participants Members

- Steven Bograd (USA, Co-Chair)
- Sukyung Kang (Korea, Co-Chair)
- Jennifer Boldt (Canada)
- Emanuele Di Lorenzo (USA)
- Tetsuo Fujii (Japan)
- Oleg Katugin (Russia)
- Jacquelynne (Jackie) King (Canada)
- Vyacheslav Lobanov (Russia)
- Mitsutaku Makino (Japan)
- Hanna Na (Korea)
- Fangli Qiao (China)
- Ryan Rykaczewski (USA)
- Chengjun Sun (China)
- Thomas Therriault (Canada)

PICES Secretariat

- Sonia Batten (PICES Executive Secretary)
- Sanae Chiba (PICES Deputy Executive Secretary)
- Alex Bychkov (PICES Special Projects)
- Lori Waters (PICES Science Publications/SB support)
- Saeseul Kim (PICES Intern)

Guests/Observers

- Vera Trainer (Science Board Chair)
- Sung Yong Kim (MONITOR)
- Raphael Roman (SG-ECOP)
- Erin Satterthwaite (SG-ECOP)

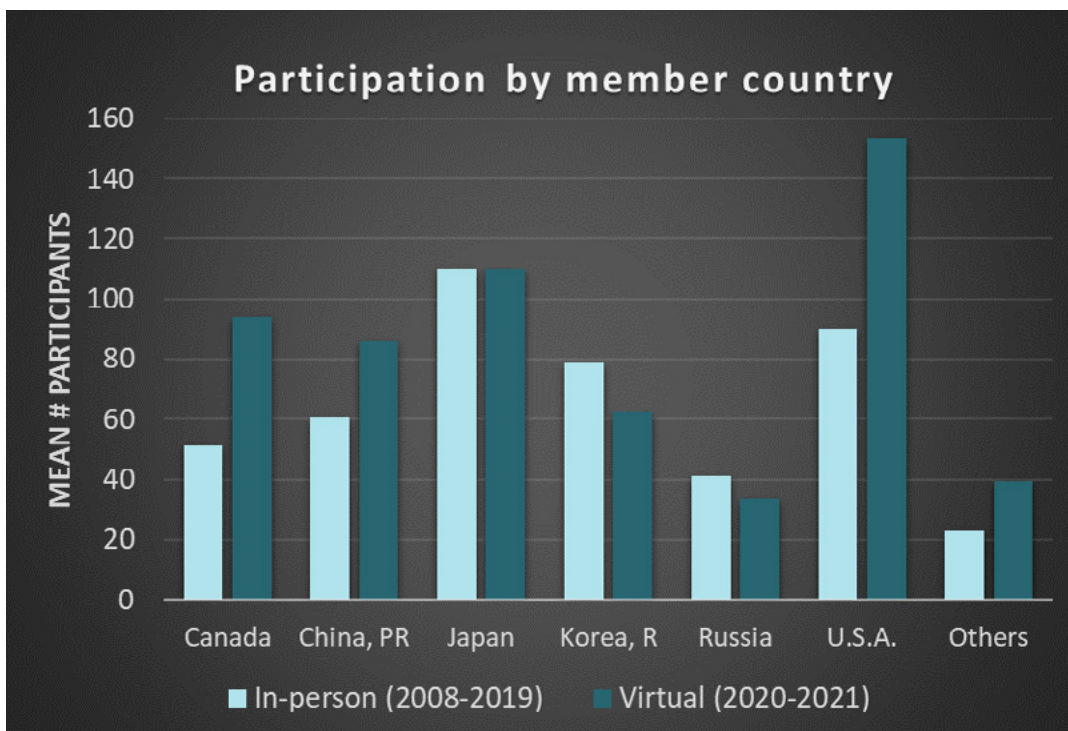
Highlights from PICES-2021

Sonia Batten



The recent PICES annual meeting, PICES-2021, had the greatest number of attendees of any PICES annual meeting so far (656) and attendees joined us from a record 31 countries. Business meetings for PICES Expert Groups also saw record participation by observers from partner organisations (39). Some may not have been able to join us if travel had been required. While we definitely look forward to meeting in-person again, this was one benefit of meeting virtually: PICES reached a wider audience. Observers represent a diverse range of organizations from global bodies concerned with capacity development to Regional Fisheries Management Organizations, national or regional ocean observing groups and a variety of others as indicated here. One of the ambitions of the PICES/ICES United Nations Decade of Ocean Science for Sustainable Development (UNDOS) program, [SmartNet](#), is to expand our partnerships beyond our historic geographic and disciplinary realms. The increased participation at PICES-2021 is one step towards that goal.

A significant challenge for a virtual annual meeting is that PICES member countries alone span 17 hours of the world’s time zones, leaving us with a small window of time each day when it’s feasible for people to meet. This means that it takes several weeks to get through all of the various expert group meetings, workshops and topic sessions in a virtual format. We are grateful for the stamina and patience shown by PICES members again this year! Some of our member countries had considerably higher numbers of participants than at a typical annual meeting, while others showed more similar numbers to in-person annual meetings (see below). Perhaps the timing of the virtual events (evening for eastern Pacific, morning for western Pacific time-zones) favoured North American participation with the after office-hours timing meaning fewer conflicts. Other articles in this edition describe and highlight the achievements of the expert groups over the past year, as well as the scientific workshops and sessions held at PICES-2021 that demonstrate the progress being made in science collaboration in the North Pacific, despite our second consecutive year meeting on-line.



Thank you to PICES Partners for participating in PICES-2021



Congratulations to PICES-2021 Award Recipients

PICES-2021 Chair Award

The establishment of the PICES Chair Award was approved at the 2016 inter-sessional Governing Council (GC) meeting. 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](#): *promote and coordinate marine scientific research in order to advance scientific knowledge of the area concerned and of its living resources, and promote the collection and exchange of information and data related to marine scientific research.* The 2021 award presentation ceremony began with Prof. Enrique Curchitser (Chair of PICES) introducing the award and announcing the recipient, Dr. Laura Richards.

PICES-2021 Chair Awardee: Dr. Laura Richards (Canada)



Those who have been associated with PICES over the years without doubt will have crossed paths with Dr. Richards. She was the PICES Chair between 2012 and 2016, and prior to that, the Vice-Chair between 2010 and 2012. She has been a Canadian Delegate of the PICES [Governing Council](#), and was a two-term Chair of the [Finance and Administration Committee](#) between 2004 and 2008. She was an active member of the Fisheries

Science Committee and participated in several Expert Groups including [SG-RSP](#) (Revising Strategic Plan); [SG-SI](#) (PICES Strategic Issues); [SG-RPFR](#) (PICES Rules of Procedure/Financial Regs); [SG-RAM](#) (Restructuring PICES Annual Meeting). She had particular skill at nurturing international partnerships, and helped to establish PICES' relationships with many organizations such as ICES, NPAFC, NOWPAP, and ISC. This was a valuable contribution towards furthering PICES recognition as an authority for Marine Science Information.

Through these roles, Dr. Richards carried out several transformational initiatives in PICES. As the F&A Chair, she led review and updating of PICES [Rules of Procedure](#) and PICES [Financial Regulation](#), which revised Governance and Financial Management structures to better fit the needs of a maturing organization. She collaborated to set the bold ambitious vision for scientific and technical innovations and cultural diversity throughout the revised PICES [Strategic Plan](#). These two activities have helped guide PICES since 2016. She also supported and promoted the establishment of PICES [Open Access Policy](#) which helps increase uptake of PICES Science by outside organizations. Lastly, she has been instrumental in recruiting young scientists to PICES and has served as PICES ambassador within Canada.

"On a personal note, Laura has been a mentor to me since I joined the PICES, in particular, since I became a US delegate of the Governance Council." – Enrique Curchitser.

Congratulations to Dr. Richards, and thank you very much for your long-term service and leadership to help the PICES community thrive.

Dr. Laura Richards's acceptance remarks



"Thank you so much. It really was an honour for me to have served in PICES organization for more than 20 years, and to contribute in my small way to nurture PICES science. While I really appreciate this award, my true reward

has been to witness how the PICES community has now laid the foundation for collaborative North Pacific research that is addressing today's issues – such as climate change and other pressing issues. I know the PICES organization continues to be in very capable hands, and I want to wish you all the best for your future endeavors. Thank you very much."



PICES-2021 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-2021 Wooster Awardee: Dr. Sinjae Yoo



At PICES-2021, Dr. Vera Trainer (PICES Science Board Chair) announced the recipient of the 20th Wooster Award, Dr. Sinjae Yoo, (also President of the Scientific Committee on Oceanic Research - SCOR). A video was presented outlining Dr. Sinjae's intriguing career path and significant contributions to the ocean science community, and passing along congratulatory messages from PICES

members, his international colleagues and his family. The following text is excerpted from the video script.

"Dr. Sinjae Yoo is a biological oceanographer who served as a research scientist at the Korea Institute of Ocean Science and Technology (KIOST), based in Busan, Korea, for more than 30 years. He retired from KIOST in 2020 and is currently a consultant for the International Cooperation Department at KIOST. He has also been a professor at the [Korea Maritime and Ocean University](#) and the [University of Science and Technology](#), Korea. Sinjae has also served as the President of the Scientific Committee on Oceanic Research (SCOR) since 2020. Since joining KORDI in 1988, (which is now KIOST) Sinjae's scientific interests have been primary production and phytoplankton dynamics, which he has studied in Korean waters. In the early 1990s, he became fascinated by the synoptic views provided by remote sensing and began to use satellite data to study phytoplankton. Recently, he has expanded his major research direction to the theoretical study of ecological interactions.

Over the years, Sinjae has been involved in various PICES activities. In the 1990s, he participated in the MODEL Task Team of the Climate Change and Carrying Capacity (CCCC) Program. After 2000, he contributed to the activities of the [Biological Oceanography Committee](#) and the [Science Board](#). More recently, he served on the Science Board as Vice-Chair (2007-2010) and Chair (2010-2013). One of his most recent services is as Co-Chair of WG-35, who - through the significant efforts of the Co-Chairs and working Group members, published the third [North Pacific Ecosystem Status Synthesis Report](#) (NPESR III) in 2021.

Looking at his success as a scientist, you may think his career path has never wavered. However, just like everyone else, he had a moment standing at the fork in the road in his younger days.

Sinjae was born in 1955 in Daegu, a city located in the south-eastern province of Korea. During his junior high and high school years, Sinjae was interested in history and biology. He was also fascinated by various hand-on science experiments, including launching home-brewed rockets. His journey to be a future scientist seemed to go well. But, at the College of Natural Sciences of Seoul National University, Sinjae came across a drama group with which he spent more time than with other activities. During his college years, he participated in six productions with this group as an actor and later as a director. Outside film, Sinjae was very much interested in theatre, music, and piano. When he finished his BSc, Sinjae hesitated while deciding his future career. However, passion toward science made Sinjae decide to continue in science. After finishing his MSc in Oceanography at Seoul National University, Sinjae moved to New York to study biological evolution at the State University of New York at Stony Brook, where he devoted himself to theoretical and experimental studies to explain the evolutionary mechanisms of gamete dimorphism. With this study, He received his PhD in 1987. He was inspired to continue doing science in part by G.E. Hutchinson's book "The Ecological Theater and the Evolutionary Play" by G. E. Hutchinson. This legendary essay on ecology and evolution tells us the secret of the nature from micro to universe scales, and it even explores the amazing connection of arts and natural science. It tells us "The world is a stage, all living things on the Earth are actors in the drama of evolution". In this way, Sinjae realised his perfect place to work as an actor and scientist as well. The ocean became his stage, science is the story to play, and a research project is a drama to direct.





"The ocean science community was lucky to get talent like Sinjae. On the other hand, that was a huge loss to the Korean movie industry. Who knows, if Sinjae chose a different career, he would have been a star of a super popular TV series, or a world-famous movie director. In fact, because of his decision, the Korean movie industry had to wait for their first OSCAR Best Movie Award until 2020."
~ Sanae Chiba (PICES Secretariat)

Sinjae has never lost his love for movies. He is known as a big fan of Stanley Kubrick films.

"Stanley Kubrick does not remain in one area, and even if it takes him a long time, he ventures into different genres. Eventually, Dr. Yoo was greatly influenced by Stanley Kubrick's attitude, going on to challenge himself with multiple areas of research. During his spare time, he continued studying English and other numerous fields. This hard work, I believe, is the foundation of Dr. Yoo's energetic adventures he had outside Korea." ~ Christina Kong

Sinjae has been internationally very active. He was involved in various projects such as the UNDP/GEF Yellow Sea Large Marine Ecosystem (2005-2011), and Asian workshops on Ocean Color (2005-). He has served as a member of various international ocean science organizations and frameworks, including IOC/Coastal GOOS Panel (1987-2000), International Ocean Colour Coordinating Group (IOCCG; 1997-2000), CGOOS (Coastal Ocean Observing System), and the Scientific Steering Committee of the International IMBER Project (2009-2012). Below are messages from his international colleagues.

"Sinjae, congratulations for winning the Wooster Award. As everybody else know, as the co-chair of WG35, I could not ask for a better co-chair than you. Not only are you an eminent scientist, you have the remarkable ability to connect science to a broader audience whether they are students or senior administrators. The other thing that turned out very helpful was you can introduce thorny issues into the conversation and guide participants to very constructive outcomes. But most of all, I think you have a terrific sense of humour and are great at sharing it with other people. So once again, congratulations!"
~ Peter Chandler, Co-Chair of WG-35

"Hello Sinjae, how are you. Congratulations all the way from Townsville. This year, having you as the SCOR President has been really enjoyable, and I look forward to (the SCOR annual meeting) in the next week. We SCOR is very, very proud of your award from the PICES, you are very well deserved for all your contribution to ocean science. Thank you very much and congratulations, enjoy!"
~ Dr. Patricia Miloslavich, SCOR Executive Director

"Many congratulations to Dr Sinjae Yoo for the 2021 Wooster Award. Sinjae was a very gracious host during my final mission to Korea as the Chief executive of Plymouth Marine Laboratory. We visited the KIOST Headquarters in Busan and the Jeju Research Institute. He also introduced me to the sites and flavours of Jeju Island during the blossom season. I was very pleased to welcome him to PML when he arrived in 2019. I wish him all the best for the future."
~ Dr. Stephen De Mora, Former Chief Executive of Plymouth Marine Laboratory –

"After 2005, we started KJWOC (Korea-Japan Workshop on Ocean Color, later Asian Workshop on Ocean Color)...so a lot of memories (evidence) of drinking parties."
~ Dr. Joji Ishisaka, Nagoya University

[Thank you to Joji for sharing lots of memorable party photos with Sinjae's big smile with his colleagues and students. These photos are indeed the evidence of successful science collaboration. Sinjae enjoys parties and drinking.]

"His favorite drinks are Hirezake and Makgeoli, with puffer fish and Agujjim (Steamed monkfish) as accompaniment. With his gentleman voice and features, he was popular wherever he went... The funny thing is, he knew this fact and took pleasure in other people admiring him!" ~ Jisoo Park

Here is a testimony of Se-Jong Ju, Sinjae's younger "brother" at KIOST: "Dr. Sinjae Yoo had inspired me to continue my Ph.D. program in Oceanography when he was hired as a research scientist at KORDI because of his research attitude and appearance (he looked very smart, sharp, and enthusiastic). At that time (1994), I almost asked him to be my adviser for my Ph.D. program (he may not know this until now). However, luckily it didn't happen! Then about 15 yrs later (2006), I started my career at KORDI (now KIOST) and I became his best(?) colleague and younger brother(?). I am sure he won't agree on this, but recently I obviously feel that way since getting old at the same speed and sharing the same ideas and thoughts.... But, when we go to the bar or restaurant to drink, I feel like he doesn't treat me that way. I must always keep an eye on his beer to avoid leaving his glass empty. If his cup is empty for less than a minute, he starts complaining. I think he needs me as a bartender, not a researcher. By the way, I would like to express my gratitude for his great contribution and dedication to the PICES community therefore he deserves to receive the 2021 Wooster award! Congratulations!!!" ~ Se-Jong Ju

Sinjae is such a great bro and hero to everyone. But we must remember, Drama needs a heroine. Sinjae and his wife, Myungsook have been side by side through the voyage of their lives. Also, The "Theatre Yoo" has a little actor and actress, his daughter Chaewon and son Chisun. Chisun is currently a PhD Candidate studying at the City & Regional Planning Center for Quality Growth and Regional Development (CQGRD), the Georgia Institute of Technology.

"Congratulations, dad! I am glad that PICES approves of you, although me and my sister always tease you as a "fake doctor". As I get older, I have a better understanding of what you have achieved and how hard it was to make such a commitment. And I am even more proud of you. Hope we can get together soon and celebrate together with delicious beers. Congratulations again, and I am so proud of you!"
~ Chisun Yoo

After your retirement from KIOST last year, Sinjae, you may dream about being a gentleman of leisure, Imagining yourself enjoying Maitai on the tropical beach with your beautiful wife. But we don't want to let you go yet because PICES and ocean science still needs you. And, as an actor and drama director, we know you know this... "The Show Must Go On, no matter what it takes."

PICES wishes hearty congratulations and a big toast to our friend and colleague. We are looking forward to seeing you keep shining in your next adventure.

Dr. Sinjae Yoo's acceptance remarks:

"I don't know what to say. Sometime ago, when Sanae Chiba (PICES Deputy Executive Secretary) asked me to attend this ceremony, I didn't suspect this, although there was something unusual in her tone... but I thought as a SCOR representative, I should attend this ceremony. I didn't suspect this, because I've never thought I'm entitled to this great award. There are so many better scientists who have contributed more than me. I'm just overwhelmed. You're too generous! I feel I am paid for the things I haven't delivered yet, so, I think I should work harder to pay this back. Thank you for this video as well. Thank you."



PICES-2021 Zhu-Peterson Award



The Zhu-Peterson Award was developed and recommended by Science Board, and established by PICES Governing Council in 2019, and is the most recent PICES award. The award is named in honor of the late Professor Minguan Zhu, formerly of the First Institute of Oceanography, State Oceanic Administration (now Ministry of Natural Resources), China, and the late Dr. William Peterson, 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 actively engaged in PICES. This ECS Award may be given annually to an individual 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 ECS, 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 ECS 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-2021 Zhu-Peterson Awardee: Dr. Erin Satterthwaite



The 2021 Zhu-Peterson Award for Early Career Scientists was awarded to Dr. Erin Satterthwaite, the CalCOFI Coordinator at the Scripps Institution of Oceanography. Dr. Satterthwaite received her Ph.D in applied marine ecology and conservation in the Environmental Science and Policy Department at Bodega Marine Laboratory, University

of California, Davis in 2018. Her dissertation focused on marine ecosystem dynamics which is crucial knowledge for marine spatial management and conservation of biodiversity. Since 2019, she has worked as a postdoc for the project of the [FutureEarth](#) and [National Center for Ecological Analysis and Synthesis](#) (NCEAS) “Designing the observing system for the world’s ocean – from microbes to whales” which aimed to design a

roadmap for implementation of biological observation in the next decades. Presenting the outcome of this project, she received the PICES MONITOR Best Presentation award for early career scientists in 2019. She published more than 15 scientific papers, being invited to major international events such as at Capitol Hill Ocean Week in 2020.

Dr. Satterthwaite’s outstanding achievements are not limited to scientific research but also her engagement in promotion and networking of early career scientists at a global level. She was the co-founder of the IOC/UNESCO Early Career Ocean Professional Informal Working Group, and in PICES, she leads [SG-ECOP](#) (2020-2021) and is the ECOP representative on the Joint PICES/ICES Strategic Initiative for UN Decade of Ocean Science.

Congratulations to Dr. Satterthwaite on being the honourable recipient of the Zhu-Peterson Award. We are thrilled to see your excellent leadership in the ECOP community to be the major players in the UN Decade of Ocean Science.



Dr. Erin Satterthwaite’s acceptance remarks

“Thank you so much. I don’t even know what to say. This is truly an extreme honor, and I am just filled with gratitude. I feel so lucky to be a part of this wonderful PICES community, and it really is community. I’ve just been enamoured with PICES since I joined - it really drew me in. As Vera (Trainer; SB Chair) likes to say - I love your quote about a lot of PICES serendipity, and I really do feel like many aspects of this journey have been very serendipitous. All the amazing people that I’ve met - and I want to mention a couple of people. Steven (Bograd), thanks for introducing me to PICES. I’m reflecting back and thinking that I had no idea what it was, but thought “alright, this sounds great!”. Also, Vera, thanks for sitting down to lunch with me that fateful day to discuss engagement in PICES. And Sonia, thanks for all your professional personal insight. And to all the other early career professionals that I’ve met in this process, it has really been a privilege to work with you all - the leadership and work that everyone has brought to PICES through the SG-ECOP. I’m excited to see where this journey takes this or us. Thank you all so much, I really really appreciate it!”

PICES Ocean Monitoring Service Award (POMA)

Progress in many aspects of marine science is based on ocean observations, monitoring, and the management and dissemination of the data provided by these activities. Long-term monitoring observations are particularly critical to detecting and understanding ecosystem changes. Monitoring activities are often taken for granted or even targeted for budget cuts when organizations experience financial constraints. With this in mind, PICES created the POMA. This is its 13th presentation.

The POMA aims 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 innovative advances in ocean monitoring. The award also strives to enlighten the public on the importance of those activities as fundamental to marine science. It draws attention to an important aspect of the PICES Convention that is not so much in the limelight: *“to promote the collection and exchange of information and data related to marine scientific research in the area concerned.”*



PICES Ocean Monitoring Service Awardee: EcoFOCI

With five submissions for the awards, competition for the 2021 POMA was keen. The honorable recipient of the POMA for 2021 is the NOAA's Ecosystems and Fisheries-Oceanography Coordinated Investigations (EcoFOCI) program.

EcoFOCI is a collaborative research effort by scientists at the Pacific Marine Environmental Lab (PMEL) and Alaska Fisheries Science Center (AFSC) focusing on the unique and economically-important high-latitude ecosystems of Alaska. The EcoFOCI team consists of physical and chemical oceanographers, atmospheric scientists, and fisheries

biologists, and has been conducting extensive monitoring since its establishment in 1984, for understanding ocean conditions and ecosystem dynamics in the Gulf of Alaska, eastern Bering Sea, and the US Arctic.



A large component of the EcoFOCI program is biophysical moorings by PMEL. The program holds long-term year-round biophysical mooring data of over 25 yrs, helping to fill the gaps left by ship-based observations. These measurements provide a foundation for understanding the mechanisms that drive the productive region. Also, as the core of the program, AFSC has archived over 35 yrs of ichthyoplankton and zooplankton collections.

EcoFOCI has supported more than 800 publications, and the data products have been applied for effective management of living marine resources, for example, decision-making for the Alaska walleye pollock total allowable catch. Through the cooperative field observations and summer internship program, the project has contributed to the career development of many early career scientists.

EcoFOCI has also participated in several North Pacific Research Board programs including the Bering Sea Project, recognized by the Department of Commerce with a Gold Medal in 2015 for leading and conducting a comprehensive, integrated ecosystem research program that reveals how climate cycles affect the United States' largest fishery.

Congratulations to all of the participants of the EcoFOCI for the POMA. Dr. Heather Tabisola provided a few words of acceptance on behalf of the program:

Dr. Heather Tabisola's POMA acceptance remarks

“Thank you so much, this is a really amazing award. I think as was said by the previous Wooster Award recipient, there was so much work to be done, and it's amazing to be recognized for what the program has done. I've only been in the group for 6 years myself, but it's been a privilege to work with PICES and EcoFOCI, and we really are looking forward to the next generation of ocean observing, sharing data with the public, getting Early Career Scientists involved in and moving ocean science forward. Thank you.”

Early Career Scientist Best Presentation Awards 2021

At PICES annual meetings, Early Career Ocean Professionals (ECOPs) / Early Career Scientists (ECS) are particularly encouraged to submit abstracts to present their work. These presentations offer an excellent opportunity for ECOPs/ ECS to share their science, and presenters are also eligible for the Best Oral/Poster Presentation Awards. Scientists are eligible for these awards if:

- they are less than 36 years old, or defended their PhD thesis within the last 5 years;
- the presented paper is primarily their research; and,
- they will present the paper.

Awardees are chosen by PICES Scientific Committees.

ECS Best Presentation Awardees 2021

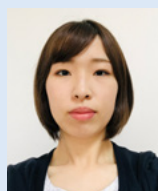
The following Certificates of Recognition were awarded:



- **Best Poster Presentation: Mei Ishikura**
Effects of the Kuroshio Large Meander on euphausiids in Suruga Bay, Japan
presented at the scientific sessions and workshops sponsored by PICES Science Board.



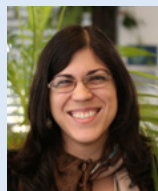
- **Best Recorded Oral Presentation: C. Anela Choy**
*Widespread plastic ingestion in an abundant pelagic fish species, *Alepisaurus ferox*, across the subtropical North Pacific*
presented at the scientific sessions and workshops sponsored by the Marine Environmental Quality Committee.



- **Best Live Oral presentation: Minako Kurisu**
Estimation of the contribution of combustion Fe in marine aerosols over the North Pacific using Fe stable isotope ratios
presented at the scientific sessions and workshops sponsored by the Biological Oceanography Committee.



- **Best Live Oral presentation: Lu Sun**
Auto-detection of marine mammals from drone photos based on deep learning
presented at the scientific sessions and workshops sponsored by the Technical Committee on Data Exchange.



- **Best Live Oral presentation: Ana C. Franco**
Impact of natural and anthropogenic deoxygenation on the habitat distribution of Pacific Halibut
presented at the scientific sessions and workshops sponsored by the Physical Oceanography and Climate Committee

PICES-2021 Workshop Reports: BIO/FIS Topic WS1: Can we link zooplankton production to fisheries recruitment?

Convenors: Toru Kobari (Japan), Karyn Suchy (Canada), and Hui Liu (USA)

PICES BIO and FIS Committees sponsored a 1-day workshop, convened on October 18, 2021, to examine aspects of the linkage of zooplankton production to fisheries recruitment. The workshop objective was to understand functional and structural roles of secondary production on fisheries dynamics and production. This workshop was virtual using Zoom and thus all topics were presented using pre-recorded MS PowerPoint or video files. It held the following 11 presentations and 37 attendees from four countries: Canada, USA, Japan, and Russia:

1. Yusuke Manako [Community structure of fish larvae associated with advections of the Kuroshio and its neighboring waters](#)
2. Toru Kobari [Comparison of plankton community structure, standing stocks and productivity along the Kuroshio at the Tokara Strait](#)
3. Gen Kume [Distribution, feeding habits, and growth of chub mackerel, *Scomber japonicus*, larvae during a high-stock period in the northern Satsunan area, southern Japan](#)
4. Lian Kwong [Evaluating pathways of environmental association with mesozooplankton and fisheries production](#)
5. Tomoko Kusano [How to adapt growth and productivity of fish larvae to the Kuroshio](#)
6. Yusuke Tokumo [Importance of gelatinous zooplankton on plankton food web in the Kuroshio based on metabarcoding analysis](#)
7. Karyn D. Suchy [Model-based spatiotemporal variability in mesozooplankton productivity in the Salish Sea](#)
8. Hui Liu [Promising perceptions of linking zooplankton production to fisheries dynamics](#)
9. Shin Kazuno [Source of coastal waters advected to the Kuroshio using particle-tracking experiments on high-resolution coastal ocean model](#)
10. Megan N. Wilson [The Tortoise and the Hare: distinct early growth strategies in a nearshore groundfish persist in the seasonally variable Northern California Current](#)
11. Theresa A. Venello [The effect of zooplankton community composition on variability of trophic transfer efficiency in the NE Pacific](#)

To stimulate discussions on each presentation among the participants and to focus workshop objectives during the limited discussion time (1 hour), co-convenors prepared another platform (Google Drive) before this workshop that all presentation files were uploaded and any attendees could post their questions, comments and suggestions on them. This platform might be useful for non-native speakers to understand their questions, comments and suggestions and to provide their answers to them.

The workshop discussions were focused on two questions:

1. *"what are necessary for zooplankton to evaluate fishery dynamics and production?"* and
2. *"what are advantages/disadvantages for current zooplankton production methodologies and measurements to be linked with fishery dynamics and production?"*

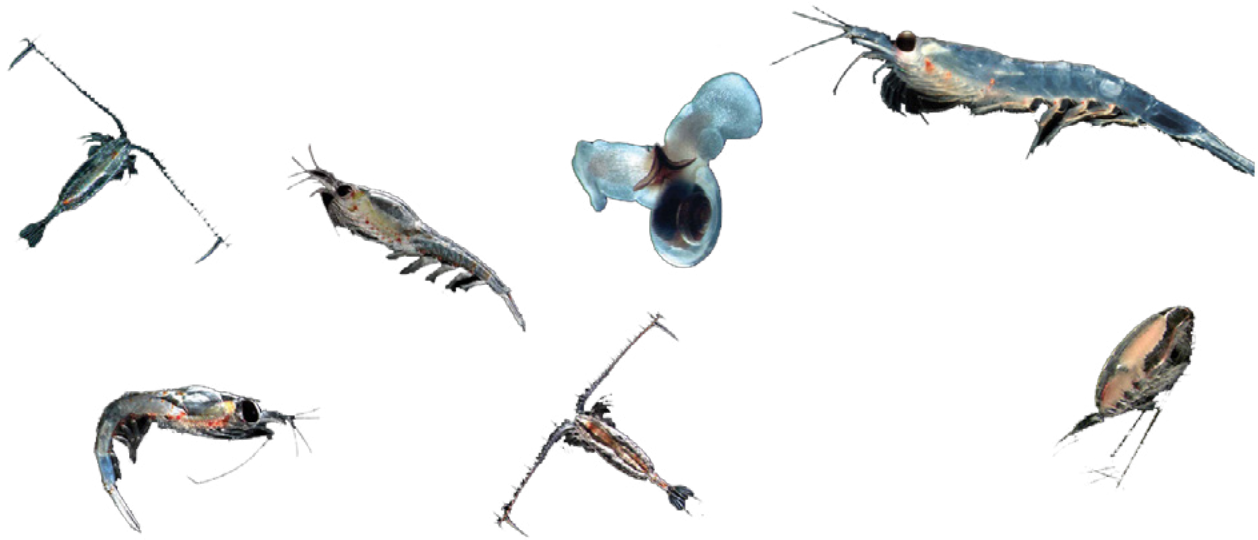
To achieve effective and efficient discussions, co-convenors asked all presenters to provide their ideas to these questions before workshop. Main points of their ideas were summarized as follows.

Q1: What are necessary for zooplankton to evaluate fishery dynamics and production?

For evaluating fishery dynamics and production, we need spatiotemporal data sets:

- with application to monitoring activities for accumulating production data sets in time and space;
- with high spatiotemporal resolution using ecological modelling on ocean dynamics;
- We also need taxon-based data sets;
- breaking down to taxonomic levels as a proxy of food availability for fishes;
- expanding to non-crustacean groups or major functional groups for differential prey preference;
- to focus specific taxonomic groups having significantly trophodynamics hub among various trophic pathways.

After sharing these ideas from presenters, many comments and suggestions were provided from attendees to this workshop.



As a major issue for this workshop question, our discussions were focused on the availability of zooplankton production rates for fish recruitments and stock assessments based on time-series data sets. While zooplankton production rates are rare among the time-series currently available in the PICES region, all attendees shared that direct measurements of zooplankton rate process are crucial for understanding mechanistic link of fish recruitments and stock assessments to lower trophic levels. As these issues were associated with the second question, we moved to the next discussion.

Main points of the ideas to the second question from presenters were summarized as follows.

Q2: What are advantages/disadvantages for current zooplankton production methodologies and measurements to be linked to fishery dynamics and production?

As advantages, zooplankton production data sets:

- are directly comparable to fish population dynamics or fishery stocks through larval growth and survival;
- provide information to understand biological mechanisms;
- are representative of carrying capacity for fish populations.

As disadvantages:

- zooplankton production data sets are still low resolution in time, space and taxa;
- measurement methodologies are tedious and time-consuming for operation and not practical to generate time-series.

As described above, direct measurements on zooplankton production rates are always desired for stock assessments of various fishes since these rates are representative of biological mechanisms. However, many attendees felt that these disadvantages made data accumulation and utilization difficult. Co-chairs of PICES Working Group 37 introduced the two practical approaches based on the WG scientific reports, zooplankton production rates estimated with the empirical and physiological models applicable to time-series and direct measurements with biochemical approaches like enzyme activities in time-series.

Giving the extensive discussions, co-conveners mentioned that the continuous scientific activities are needed to link zooplankton production to fish recruitment and/or stock assessment through some approaches in future. As one of them, all attendees were informed on 1-day session proposed for the PICES 2022 Annual Meeting in Korea.



Figure 1. Attendees of Workshop 1 during PICES-2021

PICES-2021 Workshop Reports: FIS Topic WS2: Pelagic and forage species – predicting response and evaluating resiliency to environmental variability
Convenors: Matthew Baker (USA), Brian Hunt (Canada), Hui Liu (USA), Elizabeth Siddon (USA)

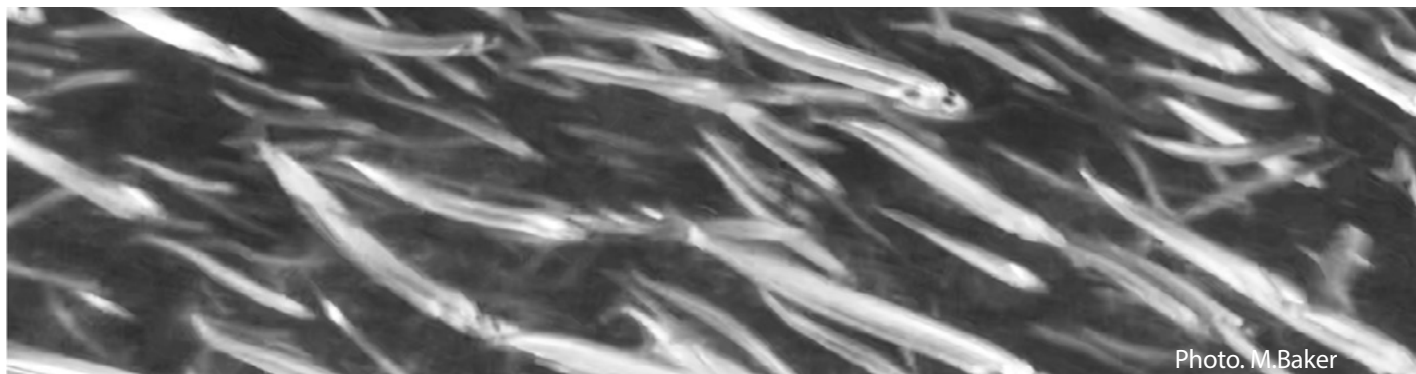


Photo. M.Baker

Climate and environmental variability influence pelagic ecosystems with direct and indirect impacts on pelagic and forage fish populations. These species are particularly responsive to shifts in the physical environmental and the phenology of biological production at lower trophic levels. Forage fish are also the link between planktonic food webs and higher trophic levels in the global ocean. Despite their critical role in North Pacific ecosystems, forage fish have remained understudied due to the majority of research resources and effort being focused on the predatory species that they support. This knowledge gap is increasingly pressing as the North Pacific advances into new climate and ocean modes. This workshop built on the 2018 Session in Yokohama, Japan, and related collaborations, to share results on trends in pelagic and forage fishes in the North Pacific, including work using experimental, observational, and modeling approaches.

This 2021 workshop aimed to use the North Pacific as a case study for global forage fish responses to climate change and determine the attributes important in understanding how different populations respond in similar or divergent ways to common drivers. Two overarching themes were examined, (1) adaptation/resiliency, and (2) forecasting, to better define our current state of knowledge.

Experts from around the North Pacific convened for a one-hour session. Regional presentations were used as a springboard for discussion around the objectives outlined above, focusing on the following objectives:

- Define our current state of knowledge
- Identify data gaps, research needs and tools and models to further research in this area
- Develop a hierarchical/ranked list of short- and long-term research priorities

As a final product from this work, we plan to develop a manuscript that synthesizes research on the influence of climate and environmental variability on forage fish populations in the North Pacific, and provides guidance on ways to rank and prioritize data gaps, as a step towards focusing direction for short and long-term research objectives.

This workshop convened forage fish researchers from around the North Pacific and used regional presentations as a springboard for discussion on common ecosystem drivers, similarities, and dissimilarities among regions. Discussions aimed to further identify data gaps, research needs, and useful tools and models to further research. The workshop recruited participants from throughout the Pacific (Canada, Chile, China, PR, Japan, Korea, Mexico, Taiwan, R.O.C, USA), including participants from a 2018 PICES session on the Influence of climate and environmental variability on pelagic and forage species (see attachment S11 Monitor Session, Convenors: Matthew Baker (USA) corresponding, Sei-Ichi Saitoh (Japan), Mary Hunsicker (USA), Elizabeth Siddon (USA)); researchers who had submitted abstracts for talks and posters to this 2021 workshop (see below; <https://meetings.pices.int/publications/presentations/PICES-2021>); and other researchers and regional experts that had expressed interest in participating (see "participants" section).

The workshop agenda (see below) began with introductions and an overview of the workshop themes. Polls (see below) were conducted in advance of the session on two separate themes:

1. State of the knowledge (what do we know?)
2. How do we synthesize information about forage fish dynamics and apply it (e.g., forecasting)

The results of the first poll were detailed and presented to workshop participants. Subsequently, PICES staff coordinated the separation of participants into four breakout groups, each led by one of the workshop convenors. The first breakout session focused on “important themes and insights related to adaptation and resiliency”. Following the breakout discussions, participants gathered in plenary and the convenors summarized the discussion from each breakout session. The results of the second online poll were then presented to workshop participants and breakout sessions and subsequent plenary discussion were held on the theme of “advances and challenges to understanding mechanisms and forecasting”. The workshop closed with a discussion on synthesis and next steps for the group. Summaries of the discussions follow.

Session I – State of the knowledge (what do we know?)

How well do we understand forage fish response to environment?

- Requires nuanced answer as there are many species; some we know a lot about and others not
- Most well understood system is the California current

What are the top drivers of forage fish populations?

- Physical system and plankton quality and quantity (interactions are important, increased temperatures may allow for increased growth but only in the presence of abundant prey)
- MHW and increased metabolic demands (increased top-down pressure)
- Thermal habitat
- Critical habitat
- Environmental variability and interactions with phenology of critical life stages (bottom-up)
- Predation and either relative intensity of predation pressure or spatial overlap with predatory species (top-down)
- Both top-down and bottom-up drivers and their interactions are important
- Interspecies competition among forage species, jellies, and early life stage fishes of a similar trophic level
- Critical life stages and associated stage-specific mortalities
- Foraging arena theory
- Larval dynamics and early life history

What is the most important data gap in understanding forage fish response to environmental variability?

- Understanding productivity patterns in the system (primary production)
- Understanding secondary production (zooplankton)
- Patchiness of sampling versus patchiness in space in time of fish distributions
- Lack of understanding in what we are missing in their dynamics (beyond season, e.g., winter)
- Understanding constraints to use of available data (are we extrapolating beyond the data)

- Understanding how environmental conditions influence recruitment, including emergence timing, larval and juvenile mortality and growth dynamics related to necessary minimum for persistence
- Understanding the influence of environmental forcing and variability on recruitment, mortality, and interspecies competition at critical life stages
- Lack of data (data gaps are large for most species)
- Gaps in the data (e.g., temporal gaps, spatial gaps, diet)
- Research and management is focused on commercial species, not other forage species
- Understanding relative importance and interactions between bottom up and top down processes

What is the most important short-term research priority?

- Hard to know where to start
- Lack of information outside of summer period
- Identify critical periods and life stages
- Data collection and indices of abundance, condition, and population dynamics
- Accurate indices for relative abundance (populations rise or fall relative to environmental trends)
- Understanding biological rates at levels sufficient to inform models (e.g., growth rates, age structure)

What is the most important long-term research priority?

- Increased sampling footprints in both space and time
- Development of predictive models for distribution, abundance and recruitment
- Maintenance and enhancement of line surveys (biophysical interactions, plankton)
- Understanding potential for adaptation/resiliency
- Forecasts and projections of abundance and distribution
- Dealing with issues related to non-stationarity
- Understanding resilience and adaptability (what pace of change are forage fish able to keep up with)
- Developing framework to inform management

Session II – How do we synthesize information about forage fish dynamics and apply it

What are the threats to forage fish populations?

- Climate change and fisheries; climate much more nuanced; reduction, consumption,
- Climate change and phenology (seasonality and changes in match-mismatch dynamics)
- Climate change and influence on transport, stratification and phenology
- Interactions with fisheries
- Aquaculture fisheries (growth of aquaculture a threat)
- Human impacts (e.g., exploitation, deep-sea mining effects on micronekton)

What knowledge sources / systems should be included and monitored for understanding forage fish?

- Environmental indices, targeted to inform recruitment, mortality, growth
- Spawning dynamics and habitats
- Interspecies competitive effects
- Recruitment indices
- Age and growth data
- Identifying critical life history stages
- Integrated observing systems: surveys and satellites
- Local knowledge (e.g., insights from fisherman may depend on the scale of the system)
- Index standardization able to bridge across biases in data streams
- Predators as samplers (e.g., predatory fishes, seabirds)

What are the challenges to understanding and managing forage fish populations?

- Competition interactions
- Relationships are non-stationary (seemingly robust relationships breakdown over time)
- Understanding where correlations fall apart - is this a reflection of spurious correlations OR real effects that reflect a shift in the system dynamics
- Lack of mechanistic understanding for processes
- Past may not inform present or future
- How to pull apart interactions of prey/predators (e.g., understanding effect of distribution, targeting prey or predator avoidance)

What knowledge sources / systems should be included and monitored for understanding forage fish?

- Interaction with industry - talk to people on the water, talk to industry
- Importance of incorporating different perspectives (communities/fishermen)
- Solicit and use traditional knowledge to set Bayesian priors
- Building trust
- eDNA
- Acoustics
- Robots
- Simultaneous integration of multiple sampling approaches (e.g., drone/trawl/acoustics)
- Diet-based estimators / samplers of predator diets from surveys or catch

How might that be expanded / What are limitations?

- Predators as samplers
- Remote sensing (acoustics, gliders, buoys; limitations=biomass estimates)
- eDNA (presence/absence indices; limitation = no relative abundance)
- Spatially indexed - spatial temporal - covariance from various indices
- Hard to get traction with stakeholders
- How to be inclusive of different types of knowledge

What are ways to incorporate information from different knowledge streams or data sources?

- How to address constraints related to spatial and temporal resolution
- How to integrate datasets not designed to complement each other
- How to address known biases in one area by employing data streams in others
- Environmental indices targeted to inform life history relevant to recruitment, mortality, growth
- Ecosystem status reports
- Spawning dynamics and habitats
- Interspecies competitive effects
- Recruitment indices
- Age and growth data
- Standardization of indices
- Identifying critical life history stages
- Use of fisheries observers as a resource
- Potential to use indices to distill multiple data types from different knowledge types
- Use diet studies of predators (e.g., groundfish/salmonids) as a way to develop indices
- Incorporate local and traditional knowledge
- Use spawning indices and beach surveys conducted at community level
- Direct targeted surveys to pelagic environment
- Use acoustics to better estimate pelagic and forage species
- Moored camera arrays - residence time

How can synthesized information be applied to a management or applied context?

- Management strategy evaluation – simultaneously consider targets for multiple stakeholders
- Management strategy evaluation – explicitly account for large areas of uncertainty and disparate sources of information
- Early warning system from people on the water (fisherman)
- Importance of building trust
- Improve and expand survey design
- Define and identify opportunities for collaborative research
- US talking about forage fish being incorporated into conservation management; Magnuson Stevens act (including forage fish – given role / importance in ecosystems)

Parallel Initiatives

- ICES/PICES Forage fish symposium November 2022
- ICES / PICES forage fish working group
- Project getting together information on diets of forage fish consumers (Ric Brodeur/Brian Wells) Integrated pelagic ecosystem survey – collect diet data and monitor forage species (Jennifer Boldt; <https://waves-vagues.dfo-mpo.gc.ca/Library/40780156.pdf>)

Workshop Participants

- Anne Beaudreau (University of Washington, USA)
- Brian Hunt (University of British Columbia, Canada)
- Carolina Lang (Instituto de Fomento Pesquero, Valparaíso, Chile)
- Che-Chen Chuang (National Taiwan Ocean University, Taiwan, ROC)
- Chris Rooper (DFO, Canada)
- David McGowan (NOAA-AFSC, USA)
- Dongwha Sohn (Pusan National University, Korea)
- Eleni Petrou (University of Washington, USA)
- Elizabeth Siddon (NOAA-AFSC, USA)
- J. Coronado-Álvarez (Universidad Autónoma de Baja California, México)
- Jennifer Boldt (DFO, Canada)
- Jim Ruzicka (NOAA, USA)
- Kelsey Swieca (Oregon State University, USA)
- Matthew Baker (NPRB, USA)
- Ryan Rykaczewski (NOAA-PIFSC, USA)
- Steven Bograd (NOAA-SWFSC, USA)
- Wei Yu (Shanghai Ocean University, Shanghai, China)
- Yan-Lun Wu (National Taiwan Ocean University, Taiwan, ROC)
- Yi Xu (DFO, Canada)
- Hui Liu (Texas A&M University, USA)

Workshop Presentations and Posters

Decadal climate indices effect on spatiotemporal distribution in Indo-Pacific yellowfin tuna. Yan-Lun Wu, Kuo-Wei Lan, Karen Evans, Muhamad Naimullah, Lu-Chi Chen, Po-Yuan Hsiao, Che-Chen, Chuang, Wei-You, Lee.

Annual variations of grey mullet related to sea surface temperature and multiscale climate indices. Che-Chen Chuang, Ming-An Lee, Po-Yuan Hsiao, Yan-Lun Wu.

Catch rate and distribution of narrow-barred spanish mackerel in relation to oceanographic factors. Lu-Chi Chen, Kuo-Wei Lan, Jinn-Shing Weng and Chen-Te Tseng.

Ocean acidification in the Pacific off Mexico. Luz de Lourdes A. Coronado-Álvarez, J. Martín Hernández-Ayón, T. Leticia Espinosa-Carreón and Orión Norzagaray-López.

Oceanographic and trophodynamic underpinnings of larval anchovy success in the northern California Current. Kelsey Swieca, Su Sponaugle, Moritz Schmid and Robert Cowen.

Impact of environmental variability on jack mackerel spawning grounds in the Southeast Pacific. Carolina Lang and Villy Christensen.

Effects of environmental variability on the spatial dynamics of common squid in Korean waters. Dongwha Sohn Sangil Kim, Minkyong Bang, Changsin Kim and Jung Jin Kim.

Response of abundance and distribution of a top predator squid to short-lived eddies in the Eastern Equatorial Pacific. Wei Yu, Xingnan Fang and Xinjun Chen.

Workshop Agenda

- Introductions – Workshop Themes
- Results of Online Poll 1 [poll available during introduction]
- Breakout Session: Important themes and insights related to adaptation/resiliency
- Plenary [report of discussions from Convenors]
- Results of Online Poll 2 [poll available during introduction]
- Breakout Session: Advances and challenges to understanding mechanisms and forecasting
- Plenary [report of discussions from Convenors]
- Synthesis and Next Steps

Online Polls

Poll 1: State of the knowledge (what do we know)

- How well do we understand forage fish response to environment?
- Rank in order of importance physical, chemical, biological (could include fisheries) drivers of forage fish populations
- What are the top two drivers of forage fish populations?
- What is the most important data gap in understanding forage fish response to environment?
- What is the most important short-term research need?
- What is the most important long-term research need?

Poll 2: How do we synthesize information and apply it (integrating, synthesizing, forecasting)

- List the top three most important drivers of future forage fish populations.
- What are the most important knowledge bases / systems for understanding forage fish?
- What are ways to incorporate information across different knowledge or data streams
- How can synthesized information be applied to a management or applied context
- What are the critical links to the human dimension?
- What is the primary motivation for supporting forage fish research?

Survey Results

Table 1. Survey respondents (n=9)

Category	Sub-category	Number
Position	Academia	4
	Government	5
Expertise	Biological oceanography	3
	Fisheries oceanography	5
	Genetics	1
Geographic region	North East Pacific	8
	Bering Sea, Chukchi Sea	1
Interest in contributing to synthesis paper	Yes	4
	Maybe	5

Table 2. Summary of answers to survey questions (9 respondents).

Question	Answer
How well do we understand forage fish responses to environmental variability? [scale 1 (not well) - 5 (very well)]	2.55
What are the top drivers of forage fish populations? List up to three, in order of importance.	Food webs: food availability; Habitat: Environmental conditions, e.g., SST, circulation, phenology; Predation; Competition; Fishing Pressure
What is the most important data gap in understanding forage fish response to environmental variability?	Overwintering Ecology; Nearshore populations; Trophic Interactions; Predation across life stages; Movement / habitat use; Seasonal data; Food quality effects; Environment effect on recruitment.
What is the most important short-term research priority?	Effect of food availability on production; Coordination & integration of zooplankton and forage fish sampling; Effect of food quality; Habitat use across life stages; Ecosystem approach; Indices of abundance
What is the most important long-term research priority?	Role of forage fish in ecosystems; Predictive models of abundance and distribution; Climate change impacts on productivity; Increase sample frequency; Environmental forcing of recruitment, mortality, and interspecies competition at critical life stages; Improving data availability and interdisciplinary collaboration.
What are the top impending threats to forage fish populations? List up to three, in order of importance.	Increasing predators; Climate change - warming, shifting trophic environment, phenology change; Overfishing; Habitat degradation;
What knowledge sources/systems should be included and monitored for understanding forage fish?	Pelagic fish surveys; Forage fish diets; Predator diets; Oceanography; Traditional / local ecological knowledge; Genetics; Commercial fisherman; Local communities; Remote sensing
What are ways to incorporate information from different knowledge or data sources?	Time series analysis; Modeling; Review papers; Interdisciplinary approaches; Feedback from non-scientists; Multi-disciplinary / multi-knowledge holder workshops where knowledge types are equally weighted.
How can synthesized information be applied to a management or applied context?	Provide indices of pre-recruit abundance to managers; Forecasting models; Precautionary approach for critical ecosystem resource; Give more weighting to knowledge type other than fisheries science; Provide indices and tools driven by the needs of multiple stakeholders.
How are forage fish important people?	Food resource across trophic levels; Ecosystem support; Commercial fisheries; Livelihood; Culture; Economy; Tourism; Aquaculture; Ecosystem services; Early warning of change - "sea canary".
What is the primary motivation for supporting forage fish research?	To be able to inform ecosystem based fishery management; Critical ecological role; Livelihood; Fisheries.

Workshop Convenors

Dr. Matthew Baker is the Science Director at the North Pacific Research Board in Anchorage, AK, USA. He is also affiliate faculty at the School of Aquatic and Fishery Sciences at the University of Washington and the Fisheries Aquatic Science and Technology at Alaska Pacific University. His research focuses on pelagic and forage fishes, groundfish ecology, ecosystem drivers of fisheries dynamics, and applied management. He serves on the Scientific Steering Committee of Integrated Ecosystem Research Programs in the Gulf of Alaska and Arctic, the North Pacific Anadromous Fish Commission IYS Steering Committee, and as an Associate Editor for *Deep Sea Research II* and *Frontiers in Marine Science*. In PICES he serves as a chapter author on the North Pacific Ecosystem Status Report (WG-35) and contributing members of the PICES/ICES Working Group on Small Pelagic Fish (WG-43), and PICES/ICES Working Group on an Integrated Ecosystem Assessment for the Northern Bering Sea and Chukchi Sea (WG-44).

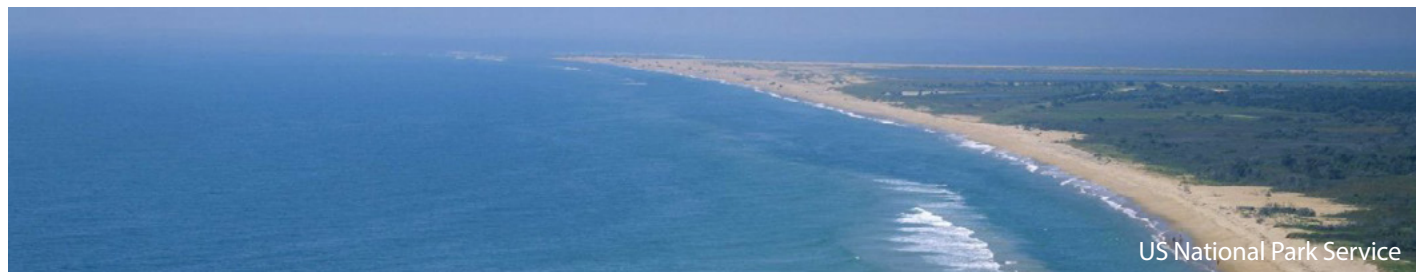
Dr. Elizabeth Siddon is a Fisheries Research Biologist at NOAA's Alaska Fisheries Science Center in Juneau, Alaska. She leads the eastern Bering Sea ecosystem assessment for the Ecosystem Monitoring and Assessment Program within the Recruitment Processes Alliance. The Recruitment Processes Alliance uses a mechanistic approach to understand how climate and ecosystem shifts mediate fisheries recruitment dynamics in Alaskan waters. Elizabeth is also the lead for the Eastern Bering Sea Ecosystem Status Report used in implementing Ecosystem-Based Fisheries Management for Alaskan fisheries. She serves as a member of the North Pacific Fishery Management Council's Bering Sea Fisheries Ecosystem Plan Team aimed at strengthening fisheries and ecosystem management in the Bering Sea. She also serves on the steering committee of the Aleutian/Bering Sea Initiative that develops science, information, and partnerships to address environmental change affecting the lives, lands, and waters of the Aleutian Islands and Bering Sea regions. In PICES, she serves as a chapter author on the North Pacific Ecosystem Status Report (WG-35).

Dr. Brian Hunt is an Assistant Professor at the Institute for the Oceans and Fisheries, University of British Columbia. He is an ecosystem oceanographer with broad interests in the structure and function of pelagic marine ecosystems, and their response to climate forcing and anthropogenic impacts. His research has focused on plankton dynamics, the response of these lower trophic levels to bottom-up forcing by climatic and oceanographic conditions, and the implications of changes in prey quantity and quality for mid-trophic levels, including forage and juvenile fish, as well as top predators. Brian's research is wide ranging, spanning interests in the Antarctic, tropical South Pacific, New Zealand, Mediterranean, North Pacific and Arctic. He is Associate Editor for *Frontiers in Marine Science*, a steering committee member for the International Years of the Salmon and Coastal Rainforest Margins Network and was a synthesis committee member for the Salish Sea Marine Survival Project.

Dr. Hui Liu is an Associate Professor of the Department of Marine Biology of Texas A&M University at Galveston, TX, USA. He obtained his Ph.D. in Oceanography and MS in Statistics at the University of Alaska Fairbanks. He conducted his postdoctoral work at Hatfield Marine Science Center and at Northeast Fisheries Science Center of NOAA. His research focuses on zooplankton and fish to seek the mechanisms and processes underlying the population dynamics and interactions among marine organisms in combination with field and modelling-based approaches. He has conducted research in a broad geographic area including the Gulf of Alaska, the Yellow Sea, Georges Bank, California Current systems, the Gulf of Mexico and the Arabian Gulf. He serves as an Associate Editor for *Canadian Journal of Fisheries and Aquatic Sciences*. In PICES he serves as a contributing member of the PICES Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions (WG-37).

PICES-2021 Workshop Reports: AP-NPCOOS/MONITOR/TCODE/BIO/FUTURE Topic Workshop WS4: Monitoring Essential Biodiversity Variables in the coastal zone

Convenors: Jack Barth (USA), Charles Hannah (Canada), Vyacheslav Lobanov (Russia); Hanna Na (Korea); Naoki Yoshie (Japan)



Essential Biodiversity Variables (EBVs) are needed to understand complex changes in biodiversity. Examples of EBVs include allelic diversity, population abundance, species distribution, phenology, taxonomic diversity, habitat structure, etc. The EBVs for the ocean are distinguished from the Essential Ocean Variables (EOVs) that we are currently measuring to understand biomass, diversity, and abundance of the marine ecosystem. These biology and ecosystem EOVs are part of a larger set of EOVs measured worldwide that include physical, geochemical, and cross-disciplinary variables like temperature, oxygen, and ocean sound. Understandably, the EBVs and EOVs are complementary, and the EBVs need to be integrated into an EOV observation network. The observation communities are encouraged to harmonize monitoring systems for delivering regular and timely data on the ecosystem changes by identifying the EBVs, clarifying their relationship to the EOVs, and establishing how they should be sampled and measured in the coastal zone.

There is not yet a consensus about what to monitor among the various EBVs and how to monitor them. Moreover, there is not yet sufficient consistency in the national or regional biodiversity monitoring system and sharing of information. In order to address this issue within the PICES community, the following key questions were asked at this workshop: 1) what is the current state of monitoring EBVs in each PICES country, 2) what new technologies are being developed which will help monitor EBVs (e.g., eDNA, satellite mapping of macro algae), 3) which technologies are moving beyond the pilot stage to the mature stage, 4) what is state of the art in getting EBVs into databases and getting them out via user friendly interfaces, and 5) what are national perspectives on the societal and sciences goals of the various EBVs?

A novel workshop structure was used by PICES this year. All of the talks were prerecorded and participants watched the talks before the meeting. This allowed the workshop itself to be devoted to discussion and planning. In addition to watching the talks, participants were encouraged to read three papers so that there was a common understanding of EBVs and EOVs (Pereira et al.

2013, Miloslavich et al. 2018, and Muller-Kruger et al. 2018). There were 12 contributed talks (see the list below), and they spanned the spectrum from the need for alignment between science requirements and policy goals to the details of computing several classes of EBVs from zooplankton data. Six of them presented examples focusing on the coastal zones in the eastern North Pacific. From their informative talks, it was identified that different organizations and projects have adopted diverse measurements, but some important biodiversity dimensions, such as genetic diversity, are often (or mostly) missing. There were three talks introducing the monitoring program outside the eastern North Pacific: a monitoring program targeting tidal flats in the western North Pacific, the national marine ecosystem monitoring program in Korea, and the Arctic observing network, respectively. Another two talks analyzed the monitoring system globally, particularly, a talk by Dr. Erin Satterthwaite presented how to link marine ecosystem data to action with the context of climate change and in the context of developing the global observing system for marine life. Finally, there was one talk on how to deliver the information to the end-users.

The workshop started with welcoming the participants and introducing the goal of the workshop, which includes a journal article describing the current state of the art in both the measurement of EBVs in the coastal zone and in making the data widely available. After the introduction, each presenter reviewed and discussed important points from their presentations. More than 30 people, including the presenters, participated in the plenary discussions and the smaller breakout groups. One of the key issues for the group discussion was understanding the distinction between the EOVs and the EBVs. Many of the participants have agreed that the EOVs are the better framework for discussing the ocean observing systems, whereas the EBVs are how societal goals, such as the ecosystem framework for management, are framed. At a high level, the EOVs are the ocean state variables that can be measured, and the EBVs are the biodiversity variables that get computed using the EOVs. Thus, systematic ocean observing systems are essential to delivering both EOVs and EBVs.

The primary output from the workshop is expected to be a journal article. To this end, 12 participants have agreed to contribute to the paper, and a paper outline has been started using Google Docs. The paper will be structured using the five questions above. This workshop was supported by MONITOR, TCODE, BIO, and FUTURE.

List of the presentations and presenters

(Note: some require registration and login).

- Characterizing phytoplankton phenology patterns in the Northeast Pacific coastal waters using the GlobColour Project (Sejal Pramlall)
- Assessment of the distribution of tidal flats in the Northwest Pacific region (Takafumi Yoshida)
- Overview of the National Marine Ecosystem Monitoring program in Korea (Young Nam Kim)
- Contributions of fisheries surveys to monitoring essential ocean, climate, and biodiversity variables: A synthesis from the U.S. West Coast (Natalya D. Gallo)
- Adoption and implementation of Seagrass Essential Ocean Variables (EOVs) (Margot Hessing-Lewis)
- High temporal resolution phytoplankton compositions and environment drivers in the northern Salish Sea, British Columbia, Canada (Justin A. Del Bel Belluz)
- "Wishing I'm Fishing": OceanView - A fisherman's lifelong app (Chieh Hsu)
- Sustaining Arctic Observing Networks: A Roadmap for Arctic Observing and Data Systems (SAON-ROADS) (Sandy Starkweather)
- Integrating coastal zooplankton monitoring programs into an Essential Biodiversity Variable (EBV) framework: Current status, challenges, and new developments, for Canada's west coast (Akash Sastri)
- Marine Biodiversity Observing in the Northern California Current: Understanding changing plankton community composition and seascape habitats (Maria T. Kavanaugh)
- Linking marine ecosystem data to action within the context of climate change: Toward developing the global observing system for marine life (Erin V. Satterthwaite)
- Mobilizing essential salmon biodiversity variables collected by the Hakai Institute Juvenile Salmon Program via the Canadian Integrated Ocean Observing System (Brett Johnson)

Key references

Pereira et al. 2013. Essential biodiversity variables. *Science*, 339(6117), 277-278. <https://www.science.org/doi/full/10.1126/science.1229931>

Miloslavich et al. 2018. Essential ocean variables for global sustained observations of biodiversity and ecosystem changes. *Global Change Biology*, 24(6), 2416-2433. <https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14108>

Muller-Karger et al. 2018. Advancing marine biological observations and data requirements of the complementary essential ocean variables (EOVs) and essential biodiversity variables (EBVs) frameworks. *Frontiers in Marine Science*, 5, 211. <https://www.frontiersin.org/articles/10.3389/fmars.2018.00211/full>

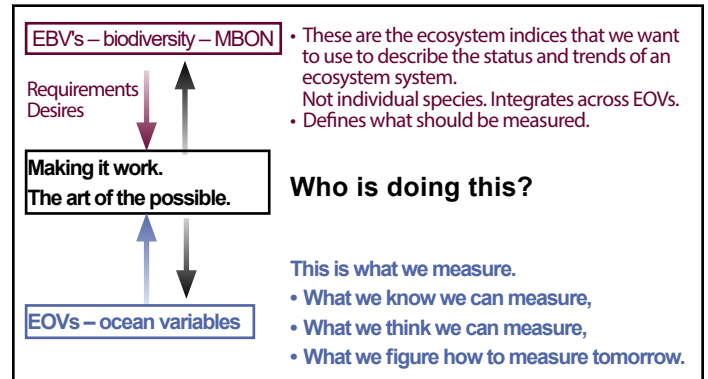


Figure 1. Schematic of one way to think about the relationship between EBVs and EOVs presented at the workshop.

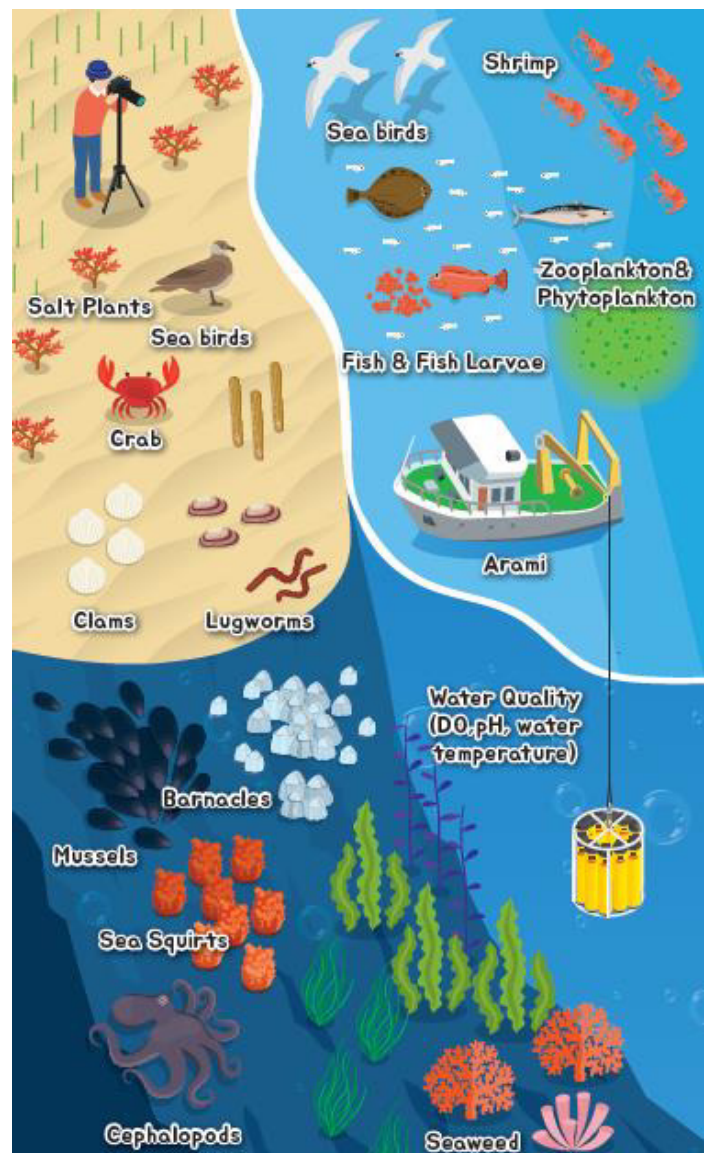
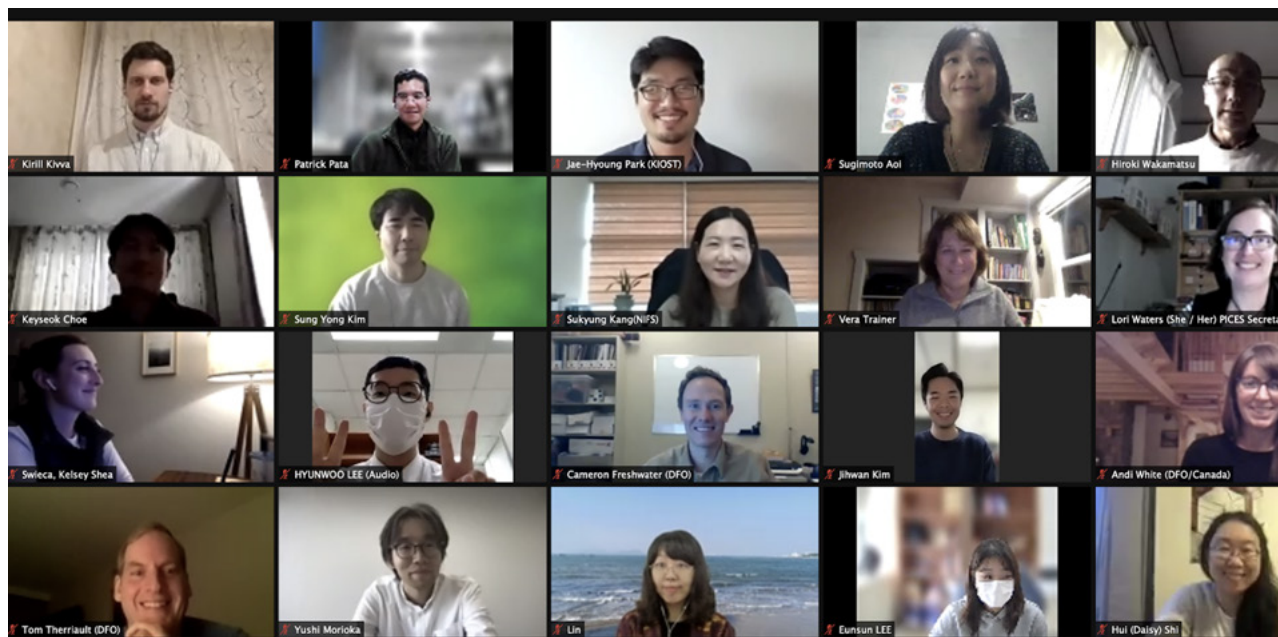


Image from Y.N. Kim et al., W4-RecordedOral-3 (PaperID=15068)

PICES-2021 Workshop Reports: FUTURE Topic Workshop WS5: Engaging Early Career Ocean Professionals in PICES to further the next generation of integrated ocean sustainability science

Convenors: Erin Satterthwaite, Raphael K. Roman, Cameron Freshwater, Vera Trainer, Hanna Na, Hannah Lachance, and SG-ECOP members



Intergenerational diversity is central to sustainability since it relies on meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. As such, early career ocean professional (ECOP) engagement is a central focus of PICES and the UN Decade of Ocean Science for Sustainable Development (2021-2030) since emerging ocean leaders bring fresh ideas, sustained engagement and scientific cooperation, and diverse perspectives to the next chapter of scientific discovery.

Within the context of PICES, ECOPs are self-identified individuals who are in the process of, or within 10 years of, completing their professional training in areas relevant to ocean knowledge or within 5 years in their current position. We specifically use the term 'professional' to be inclusive of both researchers and practitioners. Broadly, the ECOP community is anyone interested in facilitating the professional development and support of ECOPs, and thus is inclusive of all career stages.

An ECOP community is necessary to foster the development and engagement of professionals in ocean-related sectors, especially in the context of international collaboration. It takes time to learn, understand, and become integrated into complex, intergovernmental structures, as well as to develop the individual relationships and skills necessary to participate effectively. By involving ECOPs from the inception of ideas for new PICES expert groups and other planning processes, allowing for shared development and ownership, they are more likely to feel invested in and willing to support the design, implementation, and adaptation of science. Also, the sustainability of organizations relies on retaining and sharing institutional knowledge between people at different career stages. Finally, diverse perspectives allow for thinking more "outside the box," which provides valuable sources of innovation and will help to renew and regenerate PICES and its collaborative organizations. This visionary thinking, coupled with the experience and insight of scientists in mid- to late career stages, could transform the organization and address global challenges related to ocean sustainability & environmental stewardship.

Since its inception in 2020, the Study Group on ECOPs (SG-ECOP) has been actively engaged across a variety of initiatives within PICES and in cooperation with international partners, such as ICES, ECOP Asia, and the Global ECOP Program. Most recently the SG-ECOP has increased its international engagement by participating in a range of UN Decade of Ocean Science for Sustainable

Development (2021-2030) activities. One outcome of the SG-ECOP has been to identify opportunities for engagement and key needs of the community. Some of the needs expressed by ECOPs have been: 1. to connect and get to know each other, 2. to better understand the nature of interdisciplinary and international scientific collaborations within PICES, and 3. to integrate their research interests within PICES through a new mentorship program.

In line with these needs, during the PICES 2021 Annual Meeting, the ECOP workshop, “Engaging Early Career Ocean Professionals in PICES to further the next generation of integrated ocean sustainability science”, brought together about 52 ECOPs and experienced, seasoned mentors from all PICES countries for interviews and networking sessions.

The workshop began with a keynote presentation by the Governing Council Chair, Enrique Curchitser, where he shared an overview of PICES, how it functions, and ideas for how ECOPs might best contribute to the organization. He highlighted that, “PICES can be like a ‘family’ – you tend to develop friendships and collaborations with the folks you see often”.

“PICES can be like a ‘family’ – you tend to develop friendships and collaborations with the folks you see often”

~Enrique Curchitser
Chair of PICES

Following the PICES keynote address, Raphael Roman, SG-ECOP member, gave an introduction to the study group (“ECOP 101”) and its engagement within PICES. He presented the results of a recent survey distributed among the PICES community, and showcased the key needs and goals identified and shared by PICES ECOPs in their shiny new engagement plan. In addition to the SG-ECOP outcomes listed above, the survey identified increased involvement within PICES via science communication initiatives, diversity, equity, and inclusion (DEI) activities, interdisciplinary collaborations or public policy engagement as important to the PICES ECOP community. He closed by highlighting some important action items proposed for PICES ECOPs in 2022, such as the upcoming ECOP Advisory Panel and plans to develop a North Pacific ECOP node of the Global ECOP Programme. All ECOPs are welcome!

The core of the workshop was focused around ‘Ask a PICES Veteran’ sessions which showcased PICES mentors around 4 topics including:

1. Marine Ecosystems: Se-Jong Ju and Shin-ichi Ito;
2. PICES Structure: Vera Trainer and Enrique Curchitser;
3. International collaboration: Andrea White and Steven Bograd; and
4. Human Dimensions/Science Communication: Natalie Ban and Lori Waters.

These sessions emphasized how the PICES mentors initially got involved in PICES, their path within PICES, and their advice for engaging within PICES to further international science collaborations. A few pieces of advice were highlighted throughout the sessions:

- Get to know expert group leads & national delegates. In order to participate and get more involved in PICES, reach out to expert group leads and get to know your national delegates. Mentors highlighted the value of asking PICES mentors, including expert group leads, national delegates, and other PICES members, for help in connecting with other people.
- Participate in working groups & committees. Participation in working groups is really helpful. After that, the next steps (becoming a chair/leader) can follow naturally. For example, Steven Bogard shared that the physical oceanography and climate committee (POC) was his first opportunity to become an active member within PICES.
- Enjoy the social events. Participate in poster sessions, working groups, and social activities that lend themselves to more casual conversations. For example, enjoy the sporting event during the Annual Meetings. The sporting events allow for more personal communications and help to build friendships beyond science.
- Embrace serendipity & collaboration. You may not know how the journey will unfold or the connections you make, but after some time, you may begin to weave a shared path with your peers and colleagues from different countries.
- Apply the Social-Ecological-Environmental-Systems (SEES) framework in the context of your work. Recently, the FUTURE programme developed a framework of integrating social-ecological-environmental systems (SEES) within PICES to encourage communication and cross-disciplinary work. An [early career award](#) was recently created to encourage ECOPs to apply the SEES approach in their work. The winner of this award will receive full travel funding to attend the next Annual Meeting and an oral presentation at the opening plenary session.

ECOP Engagement Opportunities in PICES

Low commitment opportunities
(One off events or opportunities to expand your research network and learn more about PICES)

- Attend PICES Annual Science Meeting (registration is free!)
 - Oct 19-22, Oct 25-29 2021; Virtual; [website](#)
 - Attend the ECOP workshop (WS; Oct 20, 2021)
 - Participate in the interactive e-poster session (Oct 28, 2021)
- Attend the 4th ICES PICES Early Career Scientist Conference
 - 9-12 May 2022; St. John's, Newfoundland, Canada; [website](#)
- Sit in on an Expert Group, Scientific or Technical Committee, or Scientific Program meeting
 - See the list of groups [here](#); contact the group's chair to inquire about sitting in on a meeting or see the links available to all registered annual meeting participants to sit in on a group's business mtg.

Medium commitment opportunities
(Minimal commitment, semi-frequent meetings)

- Help establish the PICES Mentorship program
 - Build your future career through helping establish the PICES mentorship program
 - Reach out to an ECOP member for more details (see p. 2)

Full commitment opportunities
(~1-3 yr commitment, monthly meetings, occasional intersessional work)

- Join a Working Group, Study Group, or Advisory Group
 - Contribute to international marine science initiatives and learn project planning/management.
 - Contact a Governing Council [member](#) or the Science Board [Chair](#) for more information

To join the PICES ECOP Community fill out this [form](#) @PICES_MarineSci

Возможности взаимодействия ECOP в PICES

Минимальное вовлечение
(Мероприятия, которые позволяют вам расширить научное взаимодействие в плане работы в PICES)

- Зарегистрируйтесь в ежегодной научной встрече PICES (регистрация бесплатная!)
 - Он-лайн на [сайте](#), в период 18-29 октября 2021;
 - Посетите рабочую встречу ECOP (WS, Октябрь 20, 2021)
 - Участвуйте в интерактивной сессии с плакатами (Октябрь 28, 2021)
- Участвуйте в IV Конференции Молодых Ученых ICES PICES
 - 9-12 Май 2022, St. John's, Ньюфаундленд, Канада. [сайт конференции](#)
- Примите участие в заседаниях Экспертной Группы, Научного или Технического комитета
 - Спросите группу можно посмотреть [здесь](#); свяжитесь с председателем по поводу участия в заседании рабочей группы, или [продлите по ссылке](#), доступный всем зарегистрированным участникам PICES

Среднее вовлечение
(минимальная длительность, редкое участие во встречах)

- Помогите создать программы наставничества PICES
 - Постройте свою будущую карьеру, участвуя в программе наставничества PICES.
 - Свяжитесь с участником ECOP для получения более подробной информации (see p. 2)

Полное вовлечение
(~ 1-3 года обязательство, еженедельные встречи, межсессионная работа)

- Присоединяйтесь к рабочей, исследовательской или консультативной группе
 - Участвуйте в междисциплинарных научных мероприятиях и изучайте управленческие проекты.
 - Свяжитесь с председателем научного совета для получения детальной информации

Присоединяйтесь и создайте свою PICES ECOP группу заполнения [здесь](#) @PICES_MarineSci

북태평양해양과학기구(PICES) 신진해양전문가(ECOP) 모집

PICES: North Pacific Marine Science Organization
ECOP: Early Career Ocean Professionals

PICES를 경험해보세요!
(연구네트워크를 확장시킬 수 있는 기회)

- PICES 연례 학술대회 참여
 - 2021년 10월 18-22일, 10월 25-29일: 온라인 학회(등록비 무료)
 - ECOP 워크숍에 참가해보세요 (WS; 2021년 10월 20일)
 - e-포스터 세션에 참석해보세요 (2021년 10월 28일)
- 4th ICES/PICES 신진연구자 학술대회(Early Career Scientist Conference)
 - 2022년 5월 9-12일; 캐나다 뉴펀들랜드에서 개최
 - ICES와 PICES 공동학술대회
- 다양한 회의 참석
 - 전문가그룹, 과학 기술 위원회, 과학프로그램 리스트 보기
 - 장석하고 싶은 회의가 있다면 워 리스트를 참고하여 그룹 대표에게 연락주세요

보다 적극적으로 참여하고 싶다면
(최고 참여율 직인의 역할이 필요합니다)

PICES 멘토링 프로그램 수업을 도와주세요

- 여러분의 경력에 도움이 될 것입니다
- 자세한 사항은 공급하다 ECOP 멤버에게 연락주세요(2페이지 참조)

전문가그룹에 참여할 수 있는 기회
(1-3년 동안 정기적으로 회의에 참여해야 하며, 다른 전문가 그룹과의 협업에 참여할 수 있습니다)

워킹그룹, 자문단 또는 스터디그룹에 합류

- 국제 해양과학 발전계획 작성에 기여하고, 다양한 과정의 기획/관리를 경험해보세요
- 더 많은 정보는 [Governing Council](#) 위원 또는 [Science Board](#) 대표에게 문의 바랍니다

PICES ECOP 가입을 원하시면 [여기](#)를 클릭해주세요 @PICES_MarineSci

To conclude the session, Hannah Lachance, SG-ECOP member, shared some of the engagement opportunities for ECOPs in PICES which included:

1. Joining the ECSC4 conference (May 9-12, 2022), an excellent way for ECOPs to expand their networks, not only in the North Pacific but also across the North Atlantic, and will help build invaluable global connections;
2. Sit in on an expert group, scientific or technical committee, or scientific program meeting;
3. Help establish the PICES mentorship program;
4. Join the business meeting of an Expert Group, such as a Working Group, Study Group, or Advisory Group, and express your interest in their work. Through these efforts we are also working to craft personalized invitations and encouraging more inclusive, accessible and welcoming language (i.e., sharing important operational and scientific highlights in all 5 official languages).



Some SG-ECOP members.

In closing, as one of the PICES mentors said, "There is definitely greater recognition of the value of diverse ideas and intergenerational conversations, with multiple demonstrated benefits to research projects and initiatives – The times are changing, which is good!". We are grateful to the mentorship and support during the ECOP workshop and are looking forward to the next chapter of diverse engagement within PICES.

The western North Pacific during the 2021 warm season

Kazuhiro Nemoto

The western North Pacific was characterized by large positive anomalies of sea surface temperature (SST) in the area from 30°N to 45°N in June and July, and south of Japan in September 2021 (Figure 1). In particular, remarkably positive SST anomalies were observed from the area around Japan to the dateline around 40°N in July. This condition is mainly attributed to strong high pressure system from south of the Aleutian Islands to the area around the northern part of Japan, which brought much more solar radiation and weaker sea level wind than usual. In contrast, negative anomalies were observed east of Japan from August to September in 2021 (Figure 1).

The second-longest period of Kuroshio large-meander event

The Kuroshio is the western boundary current of the North Pacific subtropical gyre and takes three typical paths south of Japan: the typical large meander (LM) path, the offshore non-large meander path, and the nearshore non-large meander path (Kawabe, 1995). Since the summer of 2017, the Kuroshio has taken a LM path, which signifies the Kuroshio current flows southward off Shikoku Island and off Kii Peninsula and then turned northward off Tokai Region. In 2021, after a small perturbation propagated off Tokai Region in early May, the Kuroshio has taken a stable and typical LM path south of Japan and its southernmost position off Tokai Region was located at around 30°N during almost the period (Figure 2). As of October 2021, the period of meander event had continued for 4 years and 3 months, which is the second longest since records began in 1965 (Figure 3 and Table 1).

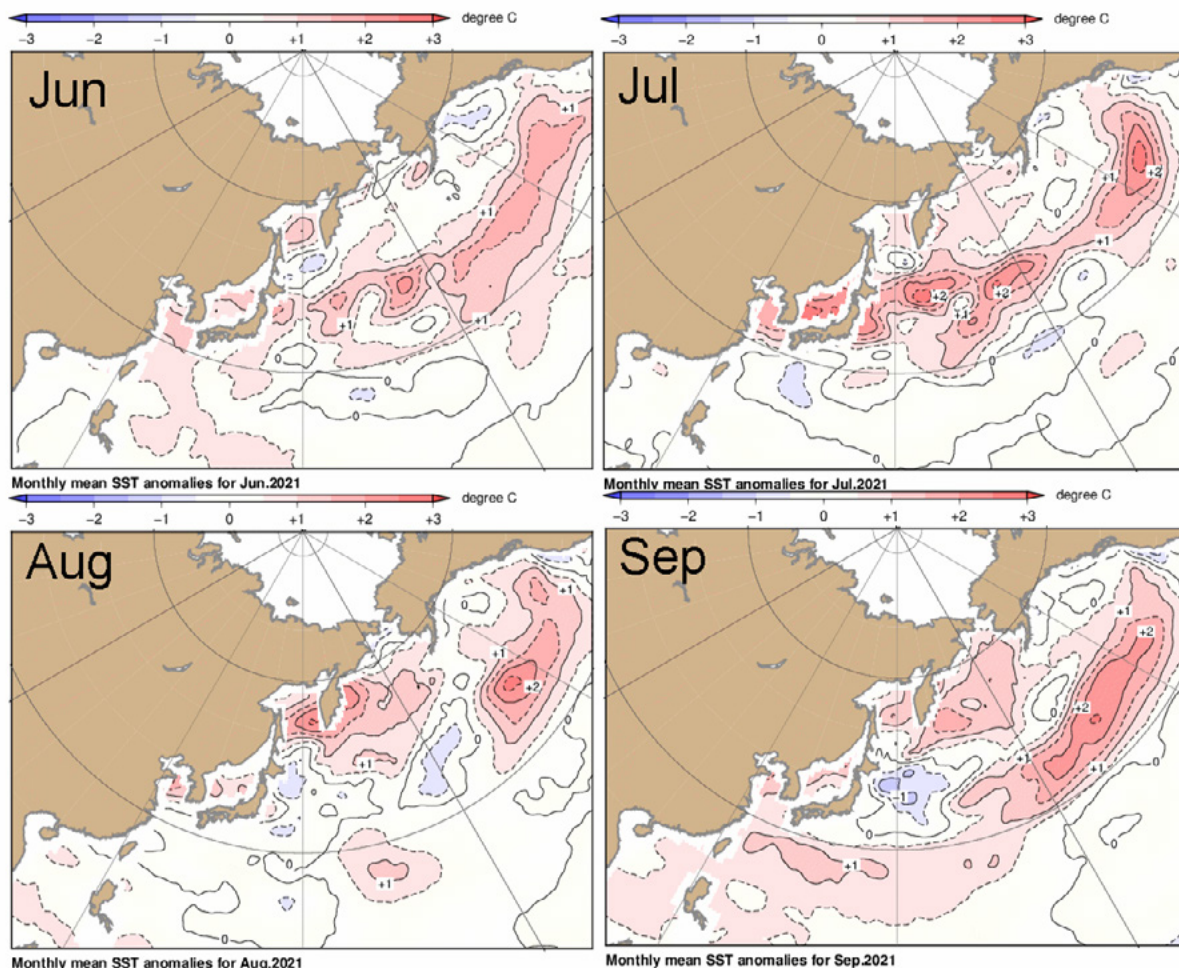


Figure 1. Monthly mean SST anomalies from June 2021 to September 2021. Monthly mean SSTs are based on JMA's COBE-SST (centennial in-situ observation-based estimates of variability for SST; Ishii et al., 2015). Anomalies are deviations from the 1991-2020 climatology.

Table 1 Historical Kuroshio large-meander periods since 1965.

Period	Duration
Aug. 1975 – Mar. 1980	4 years, 8 months
Nov. 1981 – May 1984	2 years, 7 months
Dec. 1986 – July 1988	1 year, 8 months
Dec. 1989 – Dec. 1990	1 year, 1 month
July 2004 – Aug. 2005	1 year, 2 months
Aug. 2017 – Ongoing	4 year, 2 months (as of Oct. 2021)

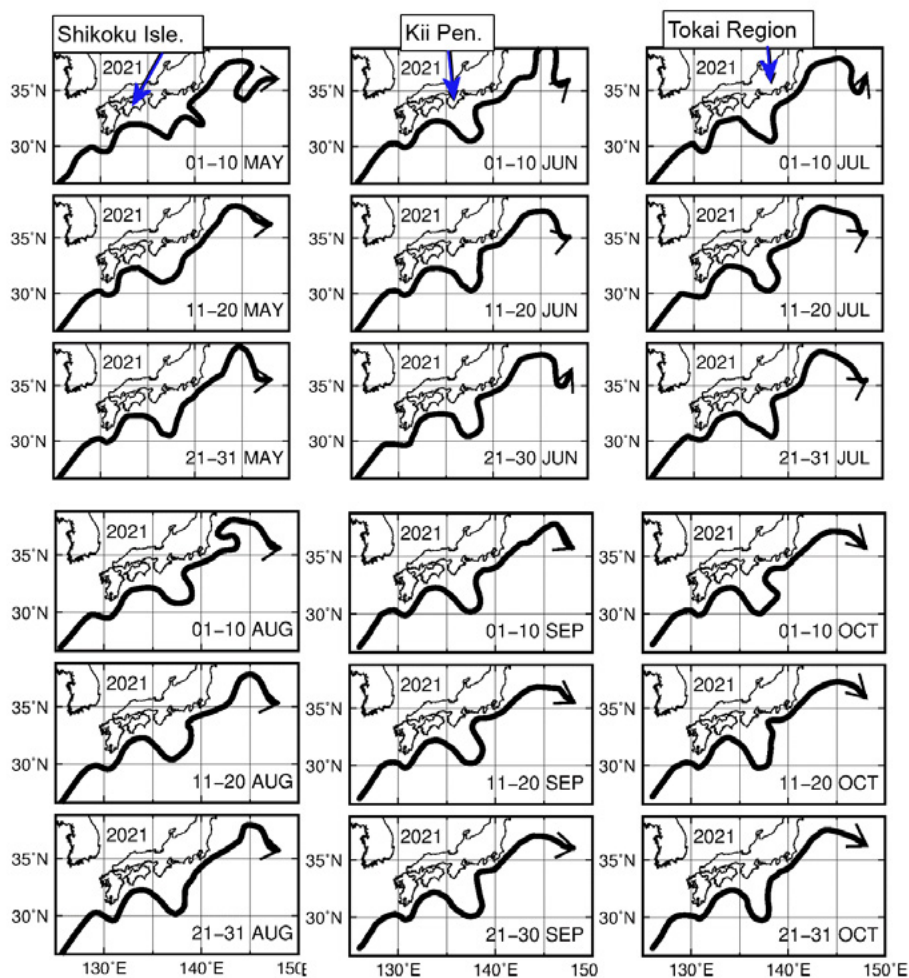


Figure. 2. JMA’s subjective Kuroshio path analysis from 1 – 10 May to 21 – 31 October.

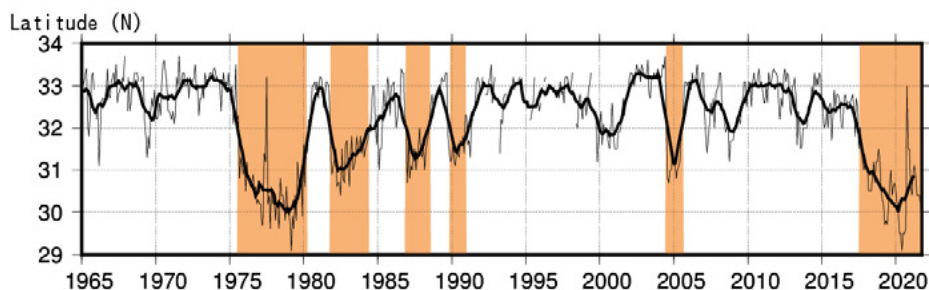


Figure. 3. Time-series representation of the southernmost latitude of the Kuroshio path south of Japan (136–140°E). Shading indicates periods of Kuroshio large-meander events, the thin line indicates monthly values, and the thick line indicates 13-month running means.

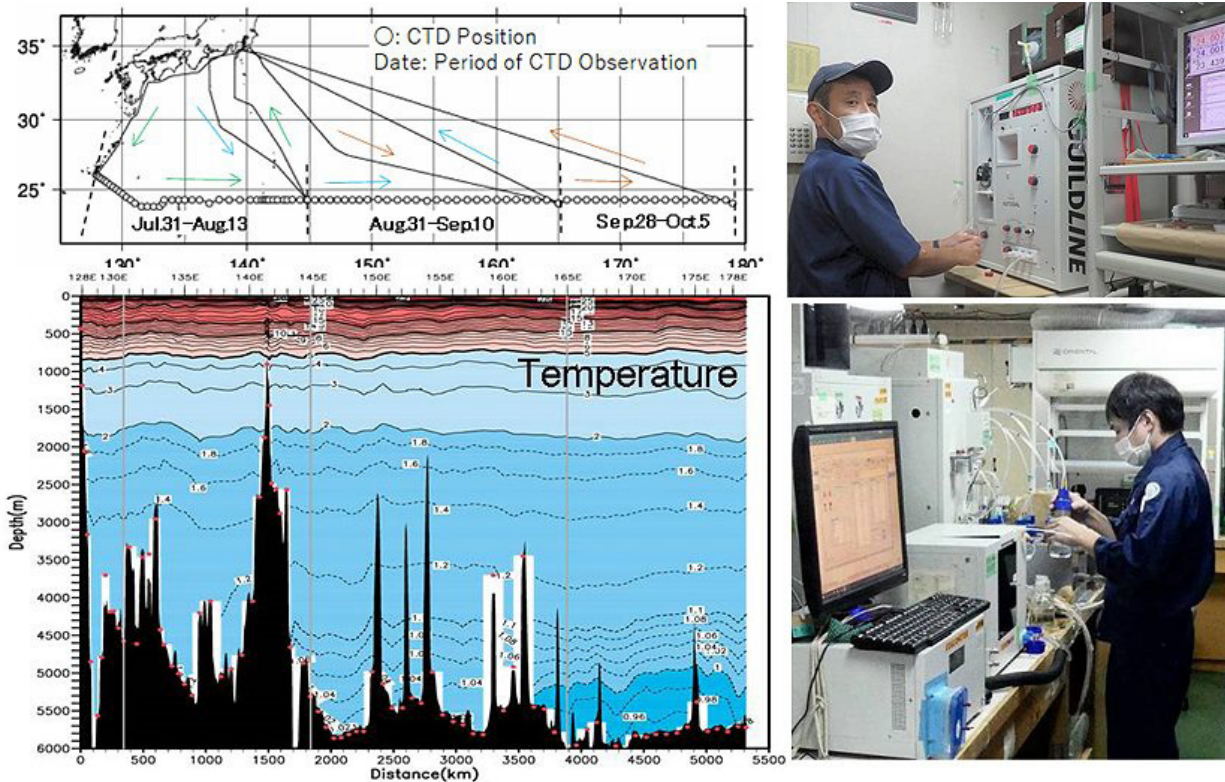
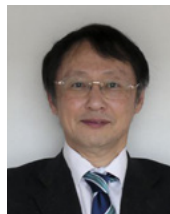


Figure 4. Full-depth oceanographic observation in the summer of 2021 along 24°N in the western North Pacific by JMA.



JMA Oceanographic Observation in the summer of 2021

JMA (Japan Meteorological Agency) has conducted a GO-SHIP hydrographic observation once a year in the western North Pacific, except for the cancellation due to the Covid19 pandemic in 2020. The observation along 24°N was successfully made for the first time in two years after taking measures against infectious diseases; Covid19 antigen tests before cruises, wearing a mask onboard and staying at coastal area of Japan for several days after departures in case for Covid19 outbreaks. The cruise was divided into three round trips from Japan, because of restrictions on entry into overseas ports. We are going to estimate accumulations of anthropogenic CO₂ into ocean and temperature changes in deep water based on the observation in 2021.



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The Bering Sea: Current Status and Recent Trends

Edited by Lisa Eisner

Climate

The Bering Sea and its surroundings during April through September 2021 were subject to a mean sea level pressure (SLP) pattern that was fairly typical for the time of year. As shown in Figure 1, relative to the climatological average for the years of 1981 through 2010, the SLP was somewhat above normal from eastern Siberia extending across the western portion of the Aleutian Island chain, and in the eastern portion of the domain from the western mainland of Alaska across Bristol Bay. The SLP anomalies and their gradients were small for the remainder of the eastern Bering Sea shelf and deep Bering Sea basin near the dateline. As a result, the mean winds were close to normal, with surface speed anomalies less than 1 m s^{-1} , with the exception of slightly stronger wind anomalies from the west extending off the central portion of the Kamchatka Peninsula.

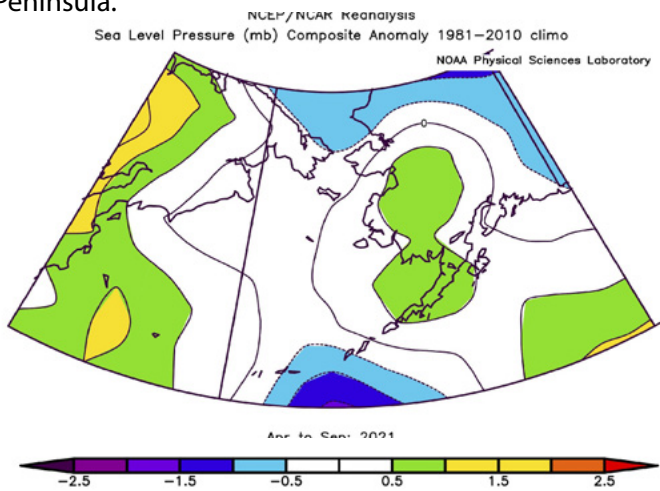


Figure 1. Mean sea level pressure (SLP) anomalies (mb) from the NCEP/NCAR Reanalysis for April - September 2021. Figure courtesy of Nick Bond, University of Washington (UW)/ Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES).

The sea surface temperatures during April through September 2021 (Figure 2) were warmer than normal south of roughly 60° N , and near normal farther north, with the exception of the Gulf of Anadyr, where there was a small region of cool temperatures, again with the period of 1981 through 2010 as baseline conditions. For the Bering Sea as a whole, 2021 reflects a continuation in a moderation in upper ocean temperatures from the extreme warmth of 2019. This recent change in the context of the variability over the last 50 years is illustrated in the time series of average temperatures for the Bering Sea east of the dateline (Figure 3). An overall upward trend in SST for this region during April through September is evident, punctuated by considerable interannual variability. In

particular, this time series illustrates not just how warm it was during the years of 2014 through 2019, but how cold it was during a series of years preceding, with especially cold temperatures during the summer of 2012. Those cold years were characterized by extensive winter sea ice and summer bottom water “cold pools” on the eastern Bering Sea shelf; these features of the Bering Sea oceanography were restricted to the northern portion of the Bering Sea during the warm years that followed. How long will Bering Sea upper ocean temperatures remain near the values typical of the latter years of the 20th century? We will have to wait to see, of course, but continued warming is “baked in” to the global climate system (pun intended) and it is likely to be just a matter of time before Bering Sea temperatures set new records.

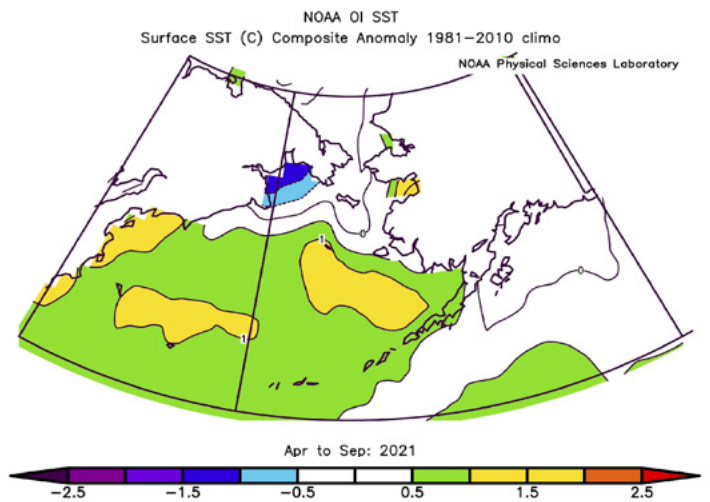


Figure 2. Mean sea surface temperature (SST) anomalies ($^\circ \text{C}$) from the NCEP/NCAR Reanalysis for April - September 2021. Figure courtesy of Nick Bond, UW/CICOES.

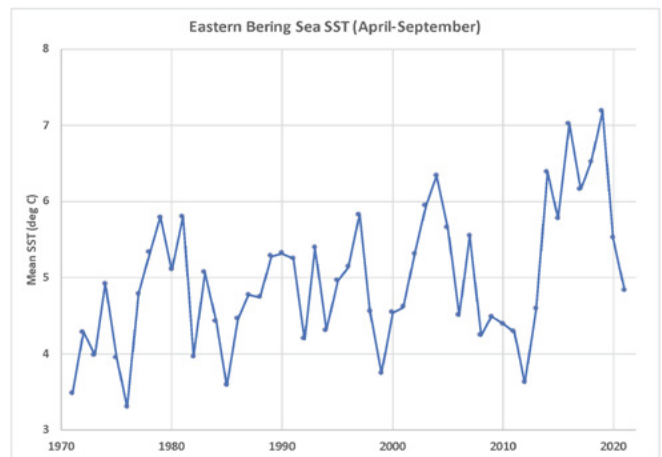


Figure 3. Mean SST ($^\circ \text{C}$) for April-September for the eastern Bering Sea, specifically the region of $55\text{-}65^\circ \text{ N}$, $180\text{-}160^\circ \text{ W}$. Figure courtesy of Nick Bond, UW/CICOES.

Seawater carbon dioxide in the eastern Bering Sea

The mooring at site 2 (M2, 56.87°N, -164.06°W), outfitted with a surface buoy nicknamed Peggy, has provided measurements in the southeastern Bering Sea since 1995. Led by NOAA PMEL's EcoFOCI program, the biophysical mooring measures temperature, salinity, nitrate, chlorophyll, and currents. Subsurface sensors are deployed at M2 year-round, but Peggy is deployed from April to October, during the ice free season. Beginning in 2011, EcoFOCI partnered with the Ocean Acidification Research Center (OARC) at the University of Alaska Fairbanks (UAF) to include sensors to monitor marine carbon dynamics to understand ocean acidification. Ocean acidification is the decrease of ocean water pH caused by the ocean absorbing anthropogenic carbon dioxide from the atmosphere. Our observations show a strong seasonal signal in the partial pressure of carbon dioxide ($p\text{CO}_2$) of the surface seawater at M2. During the spring bloom, phytoplankton growth draws down the $p\text{CO}_2$ -SW from near air values ($p\text{CO}_2$ -Air). The $p\text{CO}_2$ -SW increases throughout the deployment and is usually well-mixed and near $p\text{CO}_2$ -Air by the time we recover the gear in October. This year, disruptions to our cruise schedule have given us a unique opportunity to make surface observations during the winter. In 2021, we observed a rapid and intense, biologically driven drawdown of $p\text{CO}_2$ -SW (Figure 4). The timing of the 2021 spring bloom was near the median of our 10-year record. At the end of October 2021, a large, low-pressure storm passed just south of M2 with maximum winds of 60 mph (96.56 km/h) observed by Peggy. Storms can bring deep water, with higher $p\text{CO}_2$, to the surface. After the storm, we observed $p\text{CO}_2$ -SW higher than $p\text{CO}_2$ -Air, meaning the surface ocean became a CO_2 source to the atmosphere. We know about outgassing events in the Bering Sea, but we rarely observe this due to few winter observations. These

surface observations are used to quantify the regional carbon cycle and provide a comprehensive carbonate chemistry assessment for the Bering Sea. Funding for this work is provided by AOOs, NOAA OAP, and the State of Alaska.

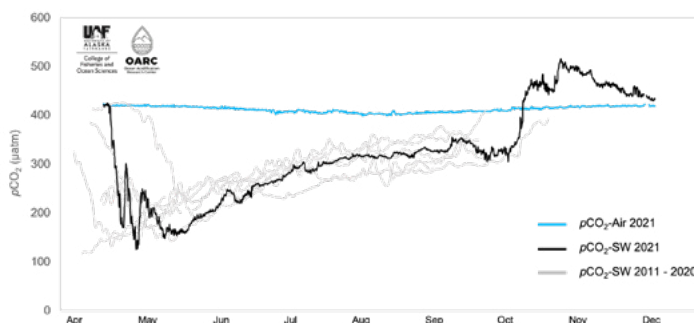


Figure 4. Partial pressure of carbon dioxide for surface seawater ($p\text{CO}_2$ -SW) and air ($p\text{CO}_2$ -Air) at the M2 mooring in the SE Bering Sea. Data for 2021 are preliminary. Figure courtesy of Natalie Monacci, UAF.

Eastern Bering Sea crab biomass

In 2021, total mature male biomass of commercial crab stocks in the eastern Bering Sea was the lowest on record (Figure 5). Declines were most notable for snow crab (*Chionoecetes opilio*), with a 55% decline in mature male abundance that resulted in an 88% reduction in the total allowable catch for the 2021/22 directed fishery. Declining trends in immature snow crab abundance observed on the 2019 NOAA Alaska Fisheries Science Center (AFSC) summer bottom trawl survey continued in 2021, and abundance estimates for immature males and females in 2021 showed 96% and >99% declines, respectively, from 2018 estimates. Bristol Bay red king crab (*Paralithodes camtschaticus*) showed moderate increases in mature males, although declines in mature female abundance prompted the closure of the 2021 Bristol Bay red king crab fishery.

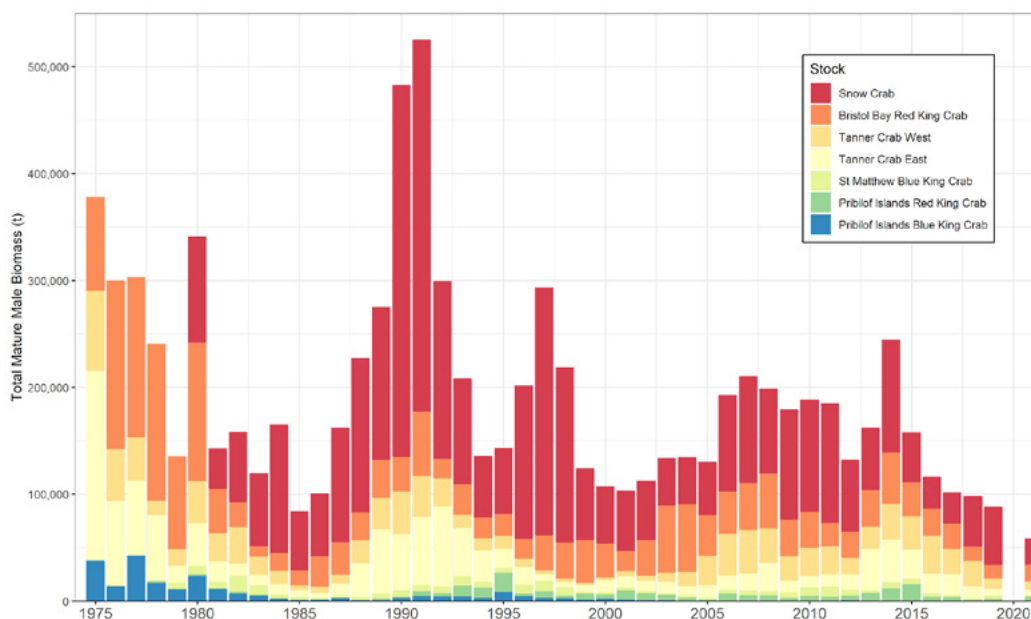


Figure 5. Historical mature male biomass (t) for size commercial crab species caught on the NOAA AFSC summer eastern Bering Sea bottom trawl survey (1975-2019, 2021). Figure courtesy of Erin Fedewa, NOAA, AFSC.

Northern Bering Sea juvenile Chinook salmon abundance

A mixed-stock juvenile (first year at sea) Chinook salmon (*Oncorhynchus tshawytscha*) abundance index is estimated from surface trawl catch and effort data in the northern Bering Sea (NBS) from annual late summer (September) surveys conducted by NOAA AFSC. This index is based on surface trawl catch-per-unit-effort (CPUE) data expanded to the survey area and adjusted for mixed layer depth (MLD). Notably, the mixed-stock abundance of juvenile Chinook salmon in the northern Bering Sea was below average in 2021 and has been below average since 2017 (Figure 6). Juvenile abundance has steadily declined from its latest peak in 2013.

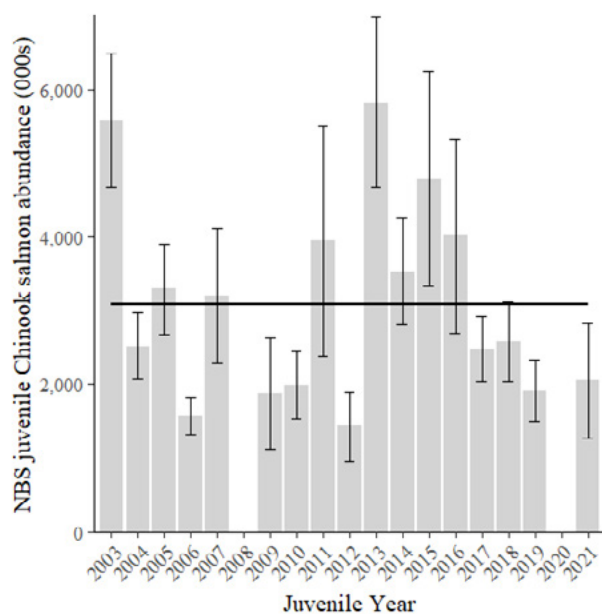


Figure 6. Juvenile Chinook salmon abundance estimates in the northern Bering Sea, 2003 to 2021. Error bars show one standard deviation above and below mean estimates. Figure courtesy of Jim Murphy, NOAA, AFSC.

Early life-history (freshwater and early marine) survival of Yukon River Chinook salmon is the primary factor influencing juvenile abundance in the northern Bering Sea. On average, 87% of the juvenile Chinook salmon in the northern Bering Sea are from the Yukon River (Howard et al. 2019; Murphy et al. 2021). Although spawning abundance varies from year to year, juvenile abundance is most closely related to juvenile survival or the number of juveniles-per-spawner. Below average juvenile abundance is expected to contribute to below average adult returns three to four years in the future (juveniles typically remain at sea for three to four years before returning to freshwater to spawn).

For additional information, see <https://www.ktoo.org/2021/11/22/bering-sea-survey-finds-declining-chinook-salmon-populations/> and <https://apps-afsc.fisheries.noaa.gov/refm/reem/ecoweb/index.php>



Russian surveys in the western Bering Sea

The joint surveys by two research vessels (*RV Professor Kaganovsky* and *RV TINRO*) were conducted in the Russian EEZ by the Pacific Branch of the Russian Research Institute of Fisheries and Oceanography (TINRO) in September, 2021 (Figure 7). The scientists aboard *RV Professor Kaganovsky* conducted a bottom trawl survey in the Anadyr Bay and its southern vicinities on the shelf, and an acoustic midwater trawl survey along Koryak and Kamchatka coasts on August 28 – September 19 (in total 119 trawl stations, with temperature salinity (TS) vertical profiling and zooplankton sampling at each). The off-shore region of the Russian EEZ was surveyed by *RV TINRO* on September 16 – October 2 (53 trawl stations with midwater trawling, TS profiling of the 0–1000 m layer and 4–5 water samples for chemical analyses at each station).

Generally, typical oceanographic patterns were observed, though weak positive anomalies of water temperature prevailed in the surface, subsurface and intermediate layers, with exclusion of the northern Gulf of Anadyr where they were negative. The St. Lawrence Cold Water Pool at the shelf bottom was smaller than usual and was limited within the Russian EEZ by the 80 m isobath. On the section across Kamchatka Strait, a strong geostrophic flow southward out of the Bering Sea was detected: 5.0 Sv in the layer 0–1000 m calculated relative to the zero level of 1500 m; this considerably exceeded the mean (climatic) value of 3.4 Sv.

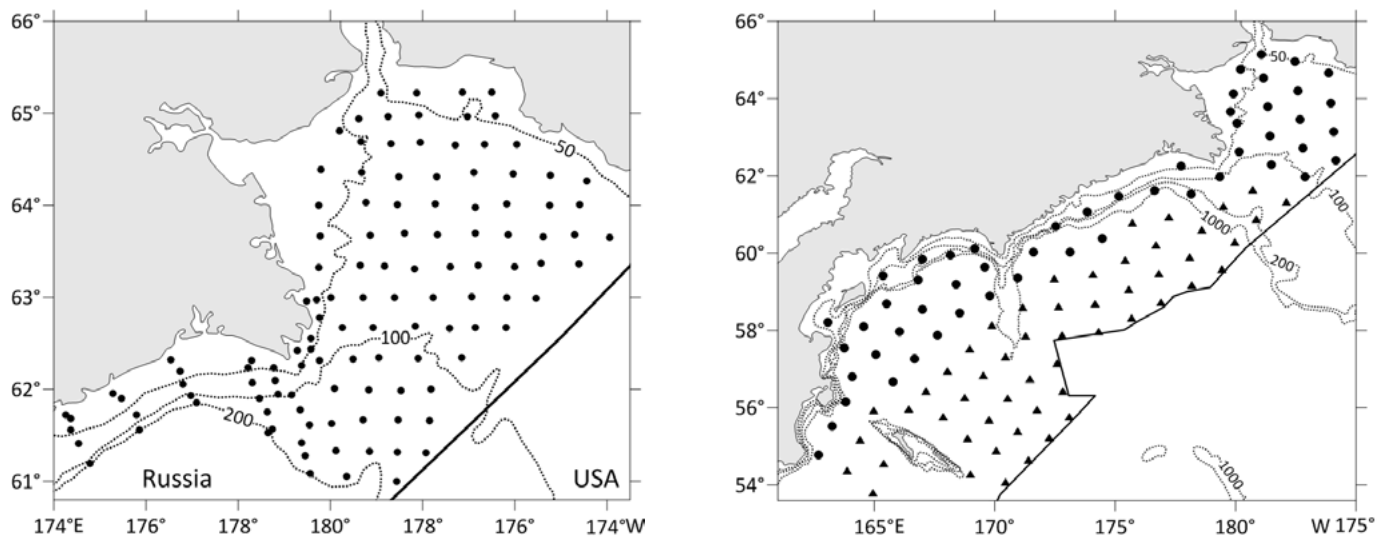


Figure 7. Maps of joint bottom (left panel) and acoustic midwater (right panel) trawl surveys conducted in the western Bering Sea during September, 2021. Circles – trawl stations, TS profiles, and zooplankton tows conducted by *RV Professor Kaganovsky*; triangles – trawl stations, TS profiles, and water sampling conducted by *RV TINRO*. Figure courtesy of Yury Zuenko, TINRO.

Acknowledgements:

Many thanks to the scientists who helped create this report: Dr. Nicholas Bond at UW/CICOES provided information on climate; NOAA AFSC scientists Dr. Erin Fedewa and Jim Murphy provided information on eastern Bering Sea crab biomass and the NBS juvenile Chinook salmon abundance, respectively; Dr. Natalie Monacci at the University of Alaska Fairbanks provided information on seawater carbon dioxide research; Dr. Yury Zuenko at the Pacific Branch of Russian Research Institute of Fisheries and Oceanography (TINRO) provided information on 2021 western Bering Sea trawl surveys.

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- Murphy, J., S. Garcia, J. Dimond, J. Moss, F. Sewall, W. Strasburger, E. Lee, T. Dann, E. Labunski, T. Zeller, A. Gray, C. Waters, D. Jallen, D. Nicolls, R. Conlon, K. Cieciel, K. Howard, B. Harris, N. Wolf, and E. Farley Jr. 2021. Northern Bering Sea surface trawl and ecosystem survey cruise report, 2019. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-423, 124 p.



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Northeast Pacific Update: Summer 2021 low oxygen event on the west coast of North America

Tetjana Ross, Ana C. Franco, John A. Barth, Akash Sastri, Marie Robert, Debby Ianson, Charles Hannah, Francis Chan, Richard Feely, Richard Dewey, and Angelica Peña

While hypoxic events are known to occur seasonally in coastal bottom waters along the west coast of North America, 2021 was more severely hypoxic. The onset of low oxygen water was the earliest in 35 years (NOAA, 2021), lasted longer (Lundeborg, 2021), was anomalously low (Figures 1 and 4), and covered a larger extent, reaching north into Canadian waters (Figure 5) where hypoxia is rare (Figure 6; Crawford and Peña, 2013).

The seasonal near-bottom hypoxia was observed as early as mid-May (Figure 1) on the Washington shelf. Low-oxygen water was observed near the seafloor over

the Washington, USA, continental shelf for much of the summer 2021. Oxygen levels continued to decrease throughout the summer, reaching “severe” hypoxia ($O_2 < 0.5$ ml/l) – that can harm important marine species like Dungeness crab (Keller et al, 2015) – at the end of July and even approached anoxia, zero oxygen, in late August/early September. This seasonal decrease in near-bottom DO is consistent with similar measurements off central Oregon (Adams et al., 2013), but these 2021 levels are lower than typical. The return of near-bottom DO to levels above hypoxia occurred in mid-late September (not shown) as early-season storms swept across the region.

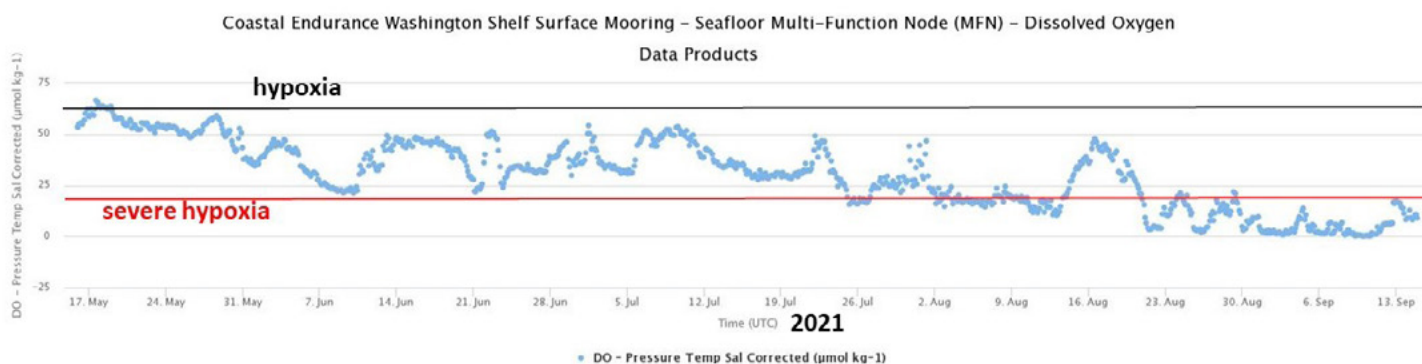


Figure 1. Near-bottom dissolved oxygen measured at the mid shelf off Grays Harbor, WA, USA, by an Ocean Observatories Initiative instrumented bottom platform in approximately 90 m of water. Black and red lines indicate the thresholds of 1.4 ml/l (equal to 62.2 $\mu\text{mol kg}^{-1}$) for hypoxia and 0.5 ml/l (equal to 22.2 $\mu\text{mol kg}^{-1}$) for severe hypoxia. Data are available at <https://oceanobservatories.org/>.

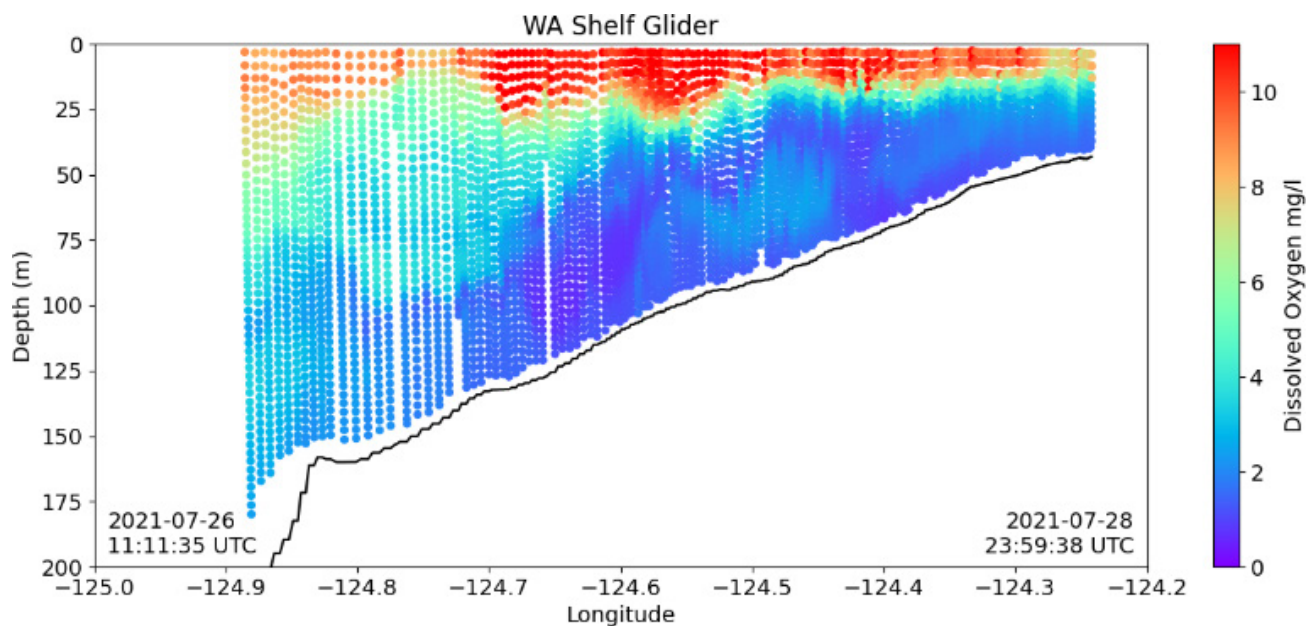


Figure 2. Dissolved oxygen measured from an underwater vehicle glider operated by Oregon State University on a cross-shore transect off Grays Harbor, Washington, USA (plots available at <http://nvs.nanoos.org> and data available at the U.S. Integrated Ocean Observing System Glider Data Acquisition Center, <http://gliders.ioos.us>). Hypoxic water occupies the lower three-quarters of the water column near the mid-shelf mooring location (~80 m isobath) and stretches from the outer continental shelf, shoreward to at least the 50-m isobath.

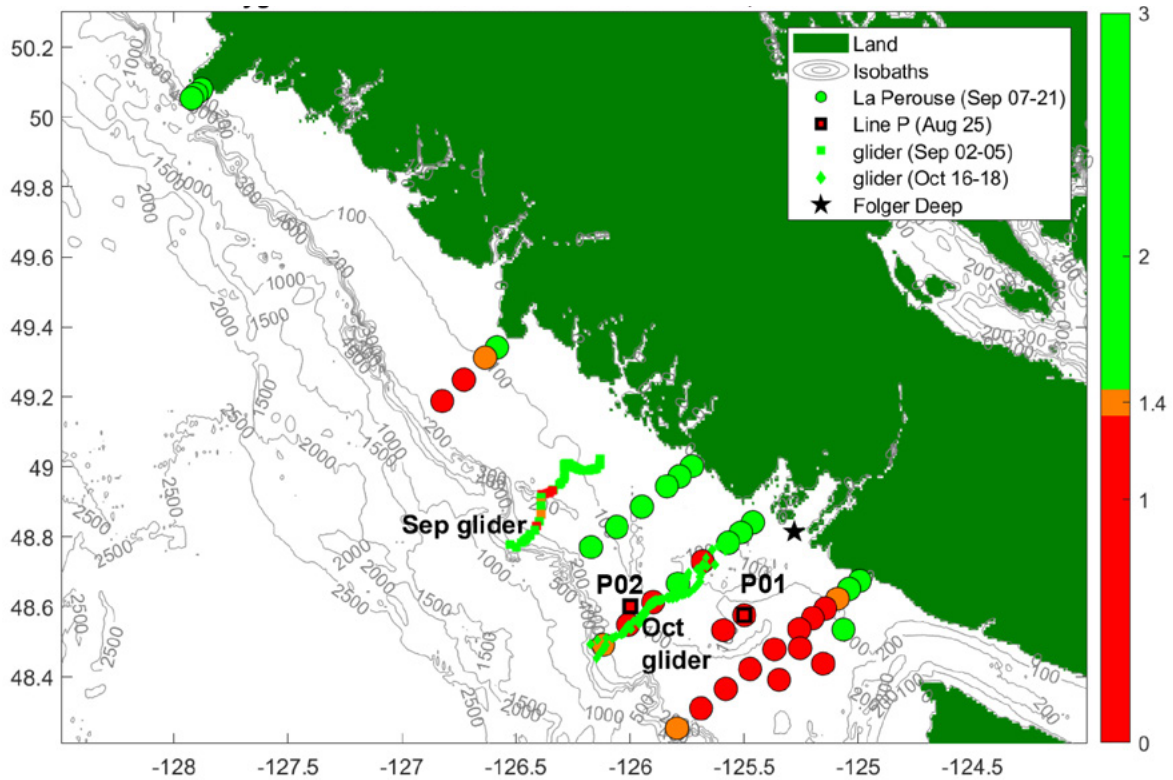


Figure 3. Map of near bottom oxygen along Vancouver Island using cruise and glider data collected between Aug 25 – Oct 18, 2021. The colour bar (in ml/l) is red for hypoxic waters (<1.4 ml/l, or approx. 62 $\mu\text{mol kg}^{-1}$), orange for 1.4 ml/l, and green for > 1.4 ml/l.

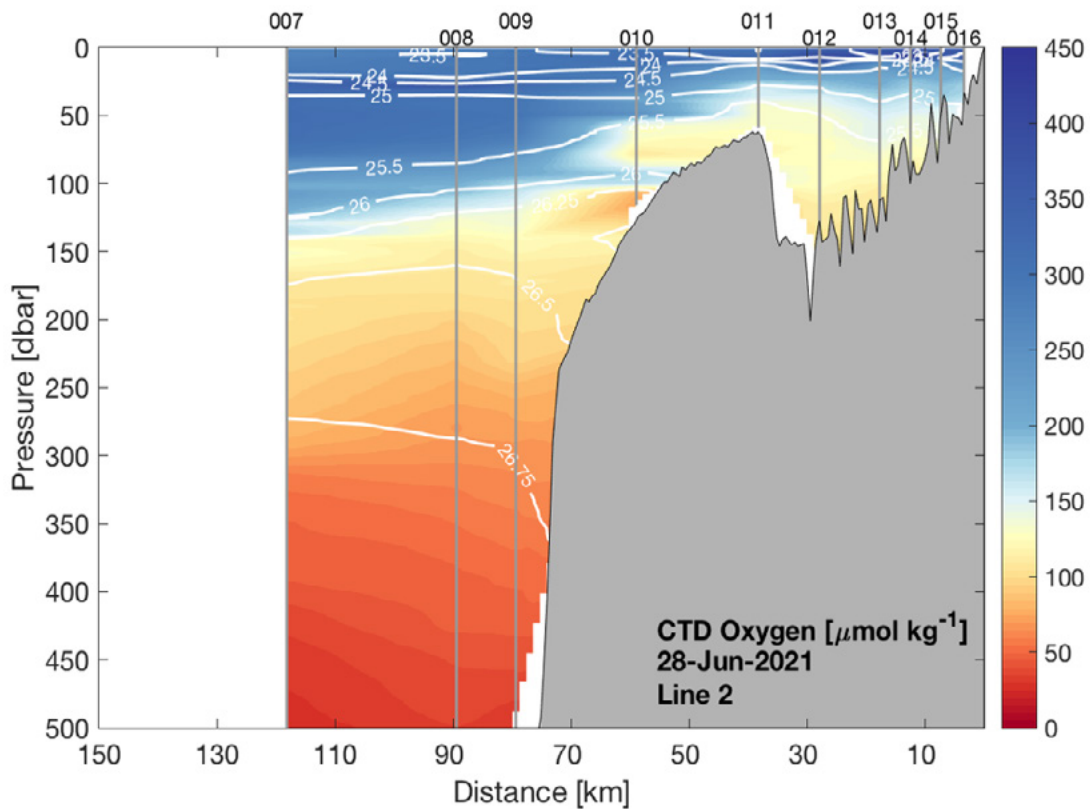


Figure 4 Section of dissolved oxygen concentrations off the Vancouver Island coast (near Barkley sound or $\sim 49^\circ\text{N}$). The thin white lines indicate isopycnals. All oxygen concentrations on the shelf are above 62 $\mu\text{mol kg}^{-1}$ (approx 1.4 ml/l). Credit: NOAA Pacific Marine Environmental Laboratory/Richard Feely.

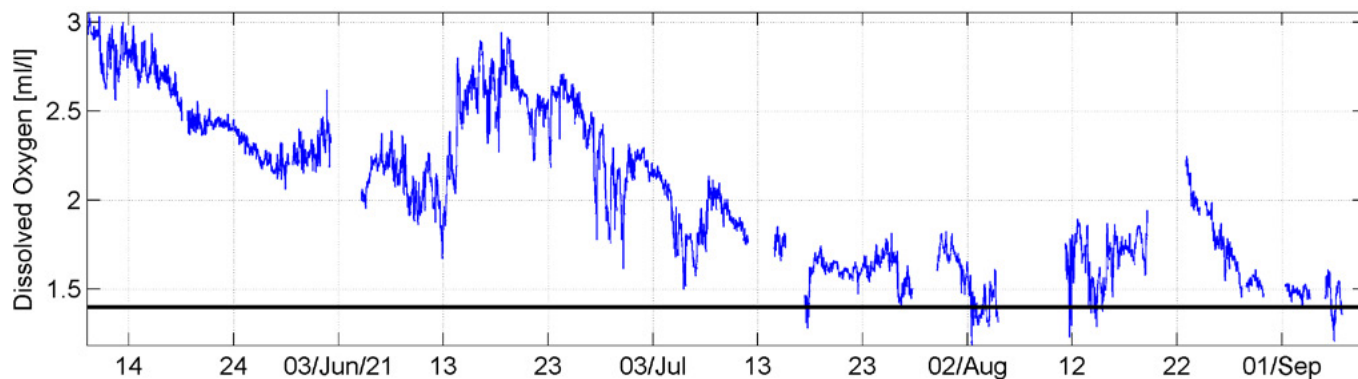


Figure 5. Time series of oxygen sensor data from Ocean Network Canada's Folger Deep mooring situated at 96 m depth near Barkley Sound on the west coast of Vancouver Island, British Columbia, Canada. The black line indicates hypoxia (oxygen below 1.4 ml/l).

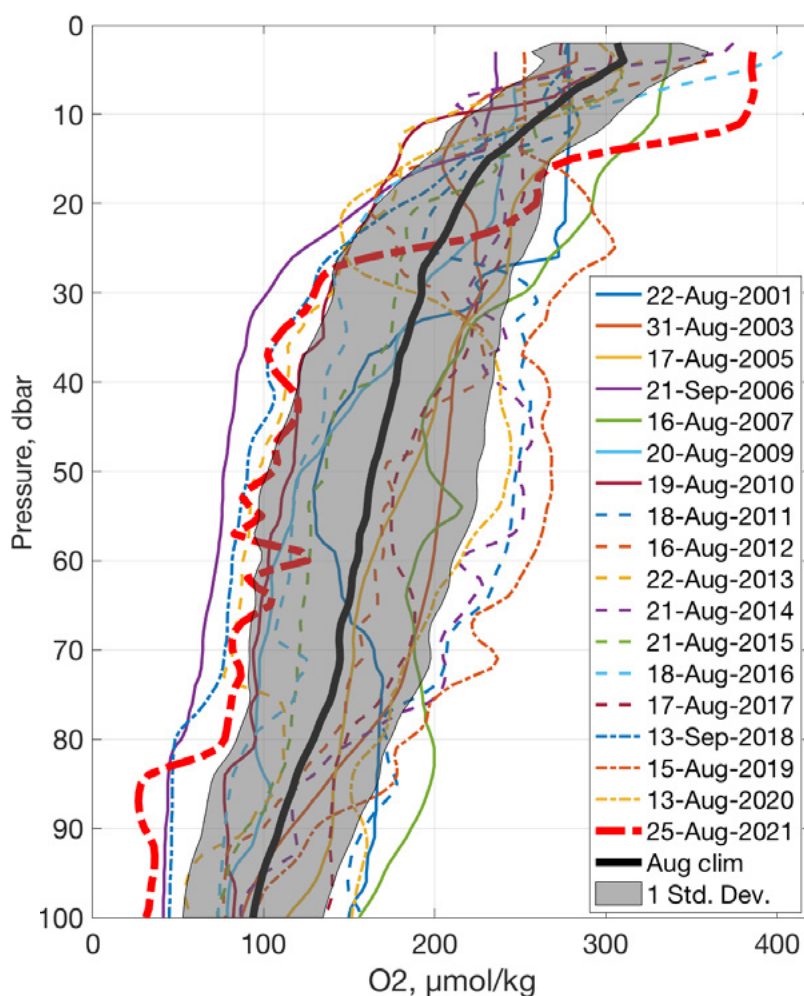


Figure 6. Vertical profiles of dissolved oxygen ($\mu\text{mol kg}^{-1}$) collected at station P02 (Figure 5) during late summer cruises (August and September) as part of DFO's Line P monitoring program. Gray shading indicates one standard deviation from the climatological (2001-2021) summer mean. In 2021 (red thick dot-dash line), the bottom oxygen was the lowest observed in two decades and one of only two recent years where bottom waters reached hypoxic levels at this location.

The seasonal low-oxygen bottom waters in the Northeast Pacific coastal areas are typically linked to upwelling, both driven by the sinking and decomposition of primary production fueled by upwelled nutrients (Connolly et al 2010) or sometimes upwelled low oxygen waters. The separation of the coastal hypoxic waters from deep

hypoxic water in the offshore in a glider transect collected near the OOI bottom platform (Figure 2) suggests that increased coastal productivity was responsible for the low oxygen on the Washington shelf in July 2021. An early onset of upwelling may be responsible for this productivity, though it could also be caused by an increase

in stratification trapping phytoplankton nearer the surface, as they may be light limited earlier in the growing season due to deeper mixing (Thomson and Fine 2003).

Initially, the hypoxic area was south of the Canada-USA border, but in late summer it expanded north onto the Vancouver Island shelf (Figure 3). In May, oxygen concentrations were lower than the climatological value off Vancouver Island at the P01 (observations not shown), but they were not yet hypoxic. The NOAA West Coast Ocean Acidification Cruise in late June/early July found hypoxic waters offshore of Washington, but not off Vancouver Island (Figure 4). Oxygen data from a sensor near the bottom (96 m) at Ocean Network Canada's Folger Deep mooring (Figure 5; black star in Figure 3) had some data loss in 2021, but suggests that hypoxic bottom water was present close to shore on the Vancouver Island starting in mid-July. By late summer, Fisheries and Oceans Canada (DFO)'s routine summer surveys observed hypoxic bottom waters over much of the Vancouver Island shelf (Figure 3), including a Line P station (P02) where the bottom oxygen was lower than ever observed before (Figure 6; see also Crawford and Peña, 2013).

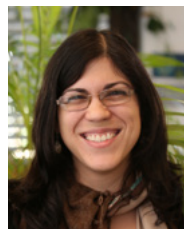
By mid-October, the bottom waters on the Vancouver Island shelf had returned to normal (oxic) oxygen levels, as observed by an ocean glider (diamond symbols in Figure 3).

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Dr. Tetjana Ross is a Research Scientist at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in Sidney, BC. She is an ocean physicist who develops new ways to observe the ocean – from observing ocean mixing using sound to taking photographs of zooplankton in turbulence. Nowadays, she rarely goes to sea, sending robots out to do the work for her: both gliders and Argo floats (i.e., she currently leads the Pacific component of DFO's Argo and glider programs). In PICES she is member of the Technical Committee on Monitoring and the Working Group on Mesoscale and Submesoscale Processes (WG-38).



Ana C. Franco is a postdoc at the Earth, Ocean and Atmospheric Sciences department at the University of British Columbia. She focuses on marine inorganic carbon and oxygen dynamics, specifically on the drivers of deoxygenation and ocean acidification at different time scales with the combined use of long-term observations and computational tools. Currently, she is working on estimating the potential impact of future climate change scenarios on oxygen and suitable habitat availability for Pacific halibut in the Northeast Pacific.



Dr. Jack Barth is a Professor of oceanography in Oregon State University's College of Earth, Ocean, and Atmospheric Sciences and the Executive Director of OSU's Marine Studies Initiative. He received a Ph.D in Oceanography from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution Joint Program in Oceanography. His research seeks to understand how coastal ocean circulation and water properties shape and influence coastal marine ecosystems. He has led a number of research, technology development, and ocean observing system projects off Oregon and around the world. He presently Co-Chairs the Oregon Ocean Acidification and Hypoxia Coordinating Council. He is a Fellow of The Oceanography Society and the American Meteorological Society. In PICES, he is a member of Governing Council, AP-NPCOOS, MONITOR, and SG-SciCom.



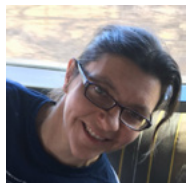
Dr. Akash Sastri is an oceanographer with Fisheries and Oceans Canada at the Institute of Ocean Sciences in Sidney, British Columbia, Canada, where he leads the Plankton Ecology program. He has a background in biological oceanography with a focus on the roles of marine plankton communities in changing environments. His Ph.D. (2007) thesis at the University of Victoria focused on the development and application of novel ways to measure zooplankton productivity routinely at sea. In PICES he is the Chair of the Biological Oceanography Committee, co-chairs the Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions (WG 37), and is a member of the Advisory Panel on North Pacific Coastal Ocean Observing Systems.



Marie Robert is an oceanographer with the Institute of Ocean Sciences of Fisheries and Oceans Canada, and co-ordinates the Line P program. She leads three cruises per year sampling the Line-P long-term observation program, and in between these cruises she coordinates products and future research of this program.



Richard Dewey is the Ocean Networks Canada Associate Director, Science. Richard is responsible for coordinating and assisting all scientists and researchers using the observatories, from planning to publication. He works with the Staff Scientists to support the science community. He has a B.Sc. in Physics from UVic and a Ph.D. in Oceanography from UBC. His research interests are coastal flows, mixing, turbulence, waves, and tides. He has conducted research throughout the Pacific from Japan to California, and along the B.C., Alaskan, and Arctic coasts. He has used a variety of profilers and ROVs, and deployed more than 150 moorings on over 100 oceanographic expeditions. He is author of the Mooring Design and Dynamics MATLAB package, and specializes in time series analysis.



Debby Ianson is an interdisciplinary oceanographer who works in the field and develops numerical models focused on climate change issues. She is a federal research scientist at the Institute of Ocean Sciences in Sidney BC and an Adjunct Professor at the University of British Columbia, Simon Fraser University and the University of Victoria. Debby was also a member of the West Coast Ocean Acidification and Hypoxia Panel convened by the California Ocean Science Trust.



Dr. Charles Hannah is a senior Research Scientist for Fisheries and Oceans Canada based at the Institute of Ocean Sciences in Sidney, BC. His research program is focused on the oceanography of the central and north coast of British Columbia and he is currently leading a program of moored observations along the British Columbia continental shelf. Within PICES he is member of the Advisory Panel on North Pacific Coastal Ocean Observing Systems (AP-NPCOOS).



Dr. Angelica Peña is a Research Scientist at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in Sidney, BC. Her research focuses on processes influencing phytoplankton ecology and biogeochemical cycles. She develops circulation-biogeochemical models and uses long-term observations to study the impacts of natural variability and climate change on ocean productivity and biogeochemistry of the northeast Pacific. In PICES, she is a member of the Biological Oceanography Committee and the Section on Climate Change Effects on Marine Ecosystems.



Francis Chan is an ecologist in the Department of Integrative Biology at Oregon State University (OSU). His research is focused on the dynamics of ocean deoxygenation and ocean acidification in the coastal ocean. He is also the Director of the Cooperative Institute for Marine Ecosystem and Resources Studies (CIMERS). The Institute is a partnership between the United States National Oceanic and Atmospheric Administration (NOAA) and OSU to advance management-focused ocean science.



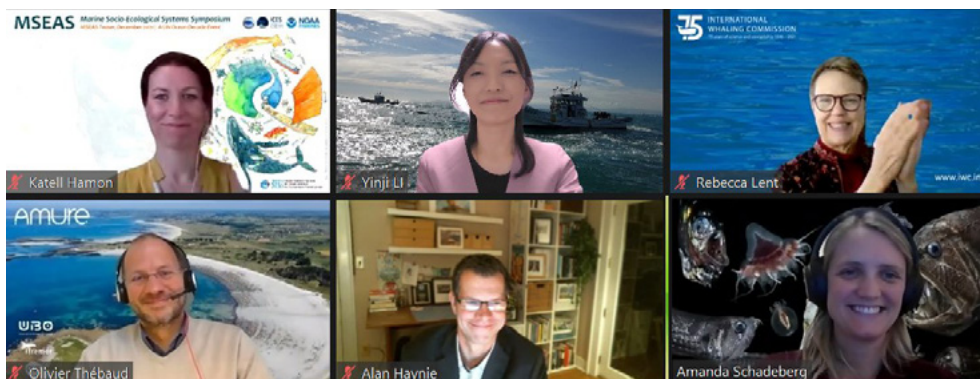
Dr. Richard Feely is the group leader of the Ocean Carbon Group at the NOAA Pacific Marine Environmental Laboratory in Seattle, WA. He has more than forty years of experience working with large-oceanographic data sets for the study of long-term changes in the ocean carbon system. He is the co-chair of the U.S. CLIVAR/CO₂ Repeat Hydrography Program, and has published more than 220 peer-reviewed publications on the carbon cycle in the oceans, including his most recent research on ocean acidification processes in the South Pacific, including the Southern Ocean.

Highlights from the MSEAS (Marine Socio-Ecological Systems) Teaser Event, Dec 8, 2021

MSEAS-SSC

MSEAS

Marine Socio-Ecological Systems Symposium
MSEAS Teaser, December 2021 | A UN Ocean Decade Event



The MSEAS Scientific Steering Committee held a "Teaser Event" on December 8, 2021, to whet the scientific appetites of MSEAS colleagues ahead of the International MSEAS Symposium delayed from 2020, and now being planned for Winter 2022. The event was attended live by 58 participants from 22 countries, with many more expected to view the [recorded session available here](#).

Rebecca Lent (Executive Secretary, [International Whaling Commission](#)) led off the presentations with an overview of the unique challenges faced in applying socio-economic frameworks to recover the critically-endangered vaquita porpoise in the northern Gulf of California. She was followed by Yinji Li ([Tokai University](#)) who focused on the need to understand how management and policy decisions can impact the viability of Japan's small scale fishing fleet. Providing an early career scientist perspective, Amanda Schadeberg ([Wageningen University](#)) discussed the need to understand our current preferences and biases and how they impact our development and utilization of future scenarios in formulating policy. Olivier Thébaud ([IFREMER](#)) wound up the talks with a reminder about the importance of governance and institutions, particularly in cross-sectoral uses of the oceans and coasts.

The speakers then engaged in a panel discussion moderated by Alan Haynie ([NOAA Fisheries](#)) and Katell Hamon ([Wageningen University](#)) which included responses to audience questions. The panel highlighted the many commonalities among the topics discussed in requiring greater understanding of the functioning of the socio-ecological system.

The conveners wish to get the MSEAS community together soon and are working hard to make the physical symposium happen, hopefully in the course of 2022.



Rebecca Lent,
International Whaling Commission (IWC)

Could socio-economics have saved the vaquita?



Yinji Li,
School of Marine Science & Technology, Tokai University, Japan

Is Small Still Beautiful? Japanese Small-Scale Fisheries Then, Now and the Future: Small Steps Toward A Great Big Sea



Amanda Schadeberg,
Environmental Economics & Natural Resources Group & Environmental Policy Group, Wageningen University, the Netherlands

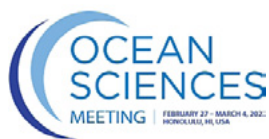
An early-career perspective on navigating uncertainty and complexity for marine futures



Olivier Thébaud,
French Research Institute for Exploitation of the Sea Ifremer

Governing marine socio-ecological systems: an economic perspective

PICES Events Calendar

**PICES-Sponsored Events**

- Ocean Sciences Meeting (OSM)
VIRTUAL, 27 February – 4 March, 2022
- ICES PICES Early Career Scientists Conference (ECS2022)
St. John's, Newfoundland, Canada, 9–12 May 2022
- PICES-2022
Busan, Korea, Sept 23–Oct 2
- International Year of the Salmon Symposium (IYS2022)
Vancouver, Canada, (Westin Bayshore) October 4-6, 2022
- ICES/PICES/FAO International Symposium on Small Pelagic Fish (SPFSymposium2)
Lisbon, Portugal Nov. 7-11, 2022
- MSEAS Marine Socio-Ecological Systems (MSEAS2022)
Yokohama, Japan. 2022 Date TBD
- Effects of Climate Change on the World's Ocean (ECCWO5)
Bergen, Norway, April 17-21, 2023
- PICES/ICES Joint Science Conference
Seattle, October 2023, TBC
- ICES/PICES Zooplankton Production Symposium (ZPS 2024)
Hobart, Australia, March 2024.

PICES Capacity Development Events

- PICES AP-NPCOOS Ocean Big Data Virtual Summer School 2022
VIRTUAL, August, 2022. Details TBA.
- SOLAS Virtual Summer School 2022
VIRTUAL, Dates TBA
- PICES AP-CREAMS Summer School on Ocean Turbulence
Qingdao, China, Dates TBD.

PICES Partner Events

- 2022 Alaska Marine Science Symposium
Jan 25–27, 2022

Your PICES Science Images - Call for images

People of PICES: do you have an interesting PICES science image to share in PICES Press? To have your image(s) considered, please email high-resolution .jpg or .tif files, along with a short caption and image credit to: Lori.Waters@pices.int

Thank you!

Open call for PICES Press submissions

PICES Press welcomes your articles. Please consider submitting articles on: research; conference or event highlights; programme news; and announcements. Please see our [Submission Guidelines](#). Previous issues are online at: <https://pices.int/publications/pices-press/> Deadlines are June 1st and December 1st for Summer and Winter volumes, respectively.

**PICES appreciates you sharing your work.
Thank you for your contributions!**



PICES Members, we hope to see you at PICES-2022, Sept 23–Oct 2, in Busan, Korea

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

In 2015, the United Nations (UN) General Assembly adopted the 2030 Agenda for sustainable development recognizing the peril humanity faces. The Intergovernmental Oceanographic Commission (IOC) of UNESCO announced the launch of the UN Decade of Ocean Science for sustainable development (hereafter, the Ocean-Decade) to support the 2030 Agenda for 2021-2030. The first batch of endorsed programs and contributions for the Ocean-Decade has been set in place in 2021 and will be followed by more Decade actions. It is about time to evaluate whether we have a good arsenal in line with the Ocean-Decade to transform ecosystems

in the North Pacific. While some areas of scientific knowledge are advancing well, certain aspects need to be enhanced to fulfill the transformative nature of the Ocean-Decade. For example, more extensive involvement of stakeholders and early career researchers/professionals. Also, inclusive action networks formed by all the stakeholders involved are crucial in harnessing the ocean knowledge to transform the ocean. In this meeting, we will review the major efforts in the PICES regions to meet with the Ocean-Decade objectives and challenges and steer the future directions by identifying gaps and setting the priorities.

About PICES Press: Published twice annually in July (Summer edition) and January (Winter edition), PICES Press is distributed globally to over 4500 PICES scientist members and institutions worldwide. Celebrating and highlighting the activities and achievements of PICES members - from participation in PICES-related programs and projects, to individual participation in PICES and PICES partner science symposia and other events - PICES Press is an important vehicle for sharing research and launching partnerships.

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