

Notes from the Science Board Chair

Jennifer Boldt

Continuing its tradition of reducing its carbon footprint, the PICES Science Board (SB) convened its intersessional meeting (ISB) virtually from April 27 to 29, 2026. Ten SB members participated in the meeting, which was led by the new SB Chair, Jennifer Boldt. In addition, two Governing Council members, one Finance and Administration Committee member, one member from the Advisory Panel on Early Career Ocean Professionals (AP-ECOP), the former SB Chair, three national delegates from China, and two representatives from the PICES Secretariat attended the ISB. The SB welcomed four new Committee Chairs: Karen Hunter (HD), Kym Jacobsen (MONITOR), Toru Kobari (BIO), and Fangfang Wan (TCODE). Many thanks to the outgoing SB Chair, Sukyung Kang, and to the outgoing Committee Chairs: Mitsutaku Makino (HD), Sung Yong Kim (MONITOR), Akash Sastri (BIO), and Jeanette Gann (TCODE)!



Photo by Sonia Batten
Pelican and boat in the Sea of Cortez, Mexico

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The ISB meeting began with updates from the Scientific Steering Committee (SSC) of the PICES Science Program—FUTURE, the [AP-UNDOS \(Advisory Panel on the UN Decade of Ocean Science\)](#), and [SmartNet \(Sustainability of Marine Ecosystem through Global Knowledge Networks\)](#). Collectively, these groups are working to expand and encourage networking and active contributions from researchers—including early career ocean professionals—to advance interdisciplinary ocean science and policy in support of sustainable ocean management. Get involved and stay connected!

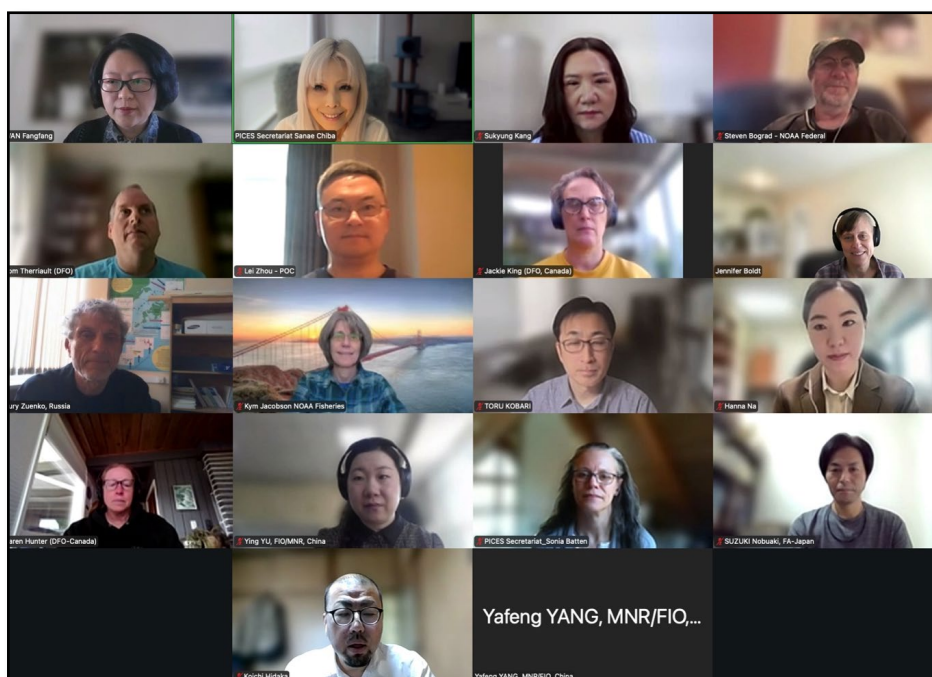
A PICES project, [Basin-scale Events and Coastal Impacts \(BECI\)](#), has also been actively networking with North Pacific Regional Fisheries Management Organizations, PICES Science Committees and Expert Groups, scientists, non-governmental organizations, and fisheries stakeholders. At the ISB meeting, participants learned that BECI temporarily suspended its activities in April 2026, as funding for the first phase concluded at the end of March 2026. This UNDOS-endorsed project is actively seeking alternate sources of funding to continue its important mission of building a North Pacific Ocean knowledge network that collates existing data, research, monitoring, management efforts, and operational tools into accessible products to support climate-resilient fisheries and conservation decisions. Some additional funding was awarded in May to continue engagement and to fund the writing of a proposal to be submitted later this summer.

The PICES/MAFF Special Project, [FishPhyto](#) (2023–2026), also ended this spring. The goal of this project, titled

“Creating a Phytoplankton-Fishery Observing Program for Sustaining Local Communities in Indonesian Coastal Waters,” was to establish, in collaboration with local fishers, research institutes, and universities, the capacity to develop and operate a phytoplankton-fishery observing program in the Lombok Island region of West Nusa Tenggara Province, Indonesia. A final report will be available soon.

At the ISB meeting, Chairs of the five Science Committees (BIO, FIS, HD, MEQ, POC) and two Technical Committees (MONITOR, TCODE) reported on the progress and planned activities of the expert groups that report to them. There was also an update from the Study Group on External Review Report Response (SG-ERRR), whose goal is to manage PICES’ response to the [External Review Report recommendations](#), beginning with identifying which recommendations are operational, strategic, or may be deferred. One outcome to date was the revision of the [PICES Mission statement](#) and the approval of [Working Group 58 \(WG58\)](#) to update PICES’ Strategic Plan and implement the revision. I’m looking forward to learning about the progress of WG58 at the PICES 2026 Annual Meeting.

SB members learned about PICES’ revised data-reporting protocol. All datasets produced through PICES expert group activities should be archived; an operational manual will be developed soon, and expert groups will receive guidance on how to submit data to the PICES Data Catalog. Publishing expert group data ensures transparency, accessibility, and the long-term preservation



Some of the Interseasonal Science Board participants.

of PICES knowledge. Recent publications showcasing PICES science includes 13 peer-reviewed papers, which are posted on the PICES Website [here](#).

Thank you to the SB members for their work and dedication to advancing and guiding PICES science activities. Thank you also to the PICES Secretariat, particularly Sanae Chiba, for their tireless efforts in preparing for and organizing the ISB, in addition to their many other roles that ensure the successful operation of an intergovernmental science organization—or family, as I like to call it!

PICES-2026 will be held from October 24 to 30, 2026, at the Vancouver Island Conference Centre in Nanaimo, BC, Canada, which is situated on lands that the Snuneymuxw First Nation people have been calling home since time immemorial. The opening ceremony will be followed by a keynote talk and presentations from last year's Zhu-Peterson Early Career Scientist and FUTURE Early Career Ocean Professional award winners. There will be 13 topic

sessions, five paper sessions, and 11 workshops focused on the meeting's main theme: providing actionable science for a changing ocean. Bring your raincoat and hiking shoes to explore Nanaimo and its beautiful surrounding areas. I'm looking forward to seeing you there!

Questions to the PICES Community:

Did you know that PICES presents six different types of awards? These awards recognize various contributions to the advancement of North Pacific marine science, including scientific contributions (Wooster), long-term monitoring, data management, innovative advances (POMA), contributions to data sharing (PODA), innovative research by an ECS (Zhu-Peterson ECS), sustained contributions to PICES (Chair), and recognition and application of the Socio-Ecological-Environmental System (SEES) framework by an ECOP (FUTURE ECOP). Many outstanding contributions go unrecognized, and someone you know, or a program of which you are aware, likely qualifies for one of these awards. Please take the short time needed to nominate the people or programs that made a difference this year (Nominations will be open November 1).

Does your PICES work highlight actionable information? Was your PICES science used in or linked to policy and/or management decisions? We want to know! Also, did you acknowledge your expert group in science products and publications? Acknowledging your PICES expert group and identifying linkages between PICES science and policy and management actions will enable PICES to showcase your valuable work, track its uptake, and continue to demonstrate the value of PICES.

Does your expert group have a Fact Sheet? Fact Sheets are easy to make using the handy [template](#) provided by PICES [AP-Science Communications](#). They are used to communicate with a wide variety of people and organizations and help others stay up to date about your group. Think of it as your group's business card!

Recently convened and upcoming events

Symposia, conferences, and capacity development events

1. The ICES/PICES/FAO *International Symposium on Small Pelagic Fish (SPF) 2026, Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries*, was held from May 4 to 8, 2026, in La Paz, Mexico. This symposium was organized by the Joint ICES/PICES Working Group on Small Pelagic Forage Communities (WG53), which convened a two-day business meeting after the symposium. The PICES Section on Climate Change Effects on Marine Ecosystems (S-CCME) also convened a business meeting just before the symposium.
2. NPAFC Workshop, *Interactions Between Salmon, Ecosystems and Climate: From Mechanisms to Predictive Models*, May 16–17, 2026, in Vancouver, Canada.
3. 2026 PICES Summer School on "Ocean Biologging," organized by AP-NPCOOS, September 14–18, 2026, at Hokkaido University, Hakodate, Hokkaido, Japan.
4. **ICES ASC 2026**, September 15–18, 2026, in Brest, France. PICES is co-convening Session E: Causes and Consequences of Extreme Temperature Events.
5. **Global Symposium on Fisheries Management in an Ecosystem Context (FIMEC)**, May 10–13, 2027, in Penang, Malaysia.
6. 5th ICES/PICES Early Career Scientists Conference (ECS) 2027 or 2028, with dates and location to be announced soon.
7. ECCWO6: 6th International Symposium on the Effects of Climate Change on the World's Ocean, with dates and location to be announced soon.



Dr. Jennifer Boldt is a Research Scientist with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, BC. Her research focuses on pelagic fish and the environment. She conducts research and monitoring to improve the understanding of factors affecting pelagic fish and to integrate ecosystem information into science advice for sustainable fisheries management. Within PICES she is a member of the Joint ICES/PICES Working Group on Sustainable Pelagic Forage Communities (WG53), MONITOR, FUTURE SSC, and Science Board Chair.

We All Take Care of the Harvest (WATCH)—a new chapter in collaborative seafood safety in coastal British Columbia, Canada

Svetlana Esenkulova

Coastal seafood systems, including traditional harvesting and aquaculture, are vital to food security and ecosystem health. They are among the most efficient food production systems, offering locally sourced, low-carbon nutrition. For coastal First Nations, this information is especially significant, as marine resources contribute a substantial portion of dietary intake. Today, shellfish harvesting in particular remains a cornerstone of local food systems, providing essential nutritional, cultural, and economic value.

Seafood safety systems are under increasing pressure from harmful algal blooms (HABs), marine biotoxins, and operational constraints within existing monitoring and regulatory frameworks. In Canada, shellfish safety is managed through the Canadian Shellfish Sanitation Program (CSSP), a federal system jointly administered by the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada (DFO), and Environment and Climate Change Canada (ECCC). While this centralized system is designed to ensure public safety, persistent gaps and barriers across infrastructure, knowledge, technical capacity, governance, and system design limit the full realization of sustainable and accessible seafood harvesting. These challenges are particularly significant for coastal First Nations, for whom shellfish harvesting is a foundational component of food systems, supporting nutrition, cultural continuity, and community well-being.

The We All Take Care of the Harvest (WATCH) initiative was established in 2020 by the First Nations Health Authority (FNHA) in response to growing community concerns about marine food safety, particularly shellfish contamination linked to marine biotoxins and changing ocean conditions. Between 2020 and 2025, WATCH operated as a pilot program co-developed with four First Nations communities across Vancouver Island and northern British Columbia. The pilot phase supported community-based monitoring, knowledge exchange, and collaborative approaches to HAB preparedness and seafood safety.

In 2025, governance of WATCH transitioned to the Island Marine Aquatic Working Group (IMAWG) <https://imawg.ca/>. This shift marks a move toward First Nations stewardship of seafood safety programming. Currently supported by the DFO Aboriginal Aquatic Resource and Oceans Management (AAROM) Innovation and Collaboration Fund (ICF), WATCH is now moving beyond its pilot phase toward a more structured and sustainable regional program model. A Steering Advisory Committee, including representatives from CFIA, DFO, BC Centre for Disease Control, FNHA, provincial government, and Vancouver Island University. Other organization representatives also provide technical and scientific guidance to support this transition. A central objective of this phase is to ensure that future expansion is intentional, adequately resourced, and guided by First Nations priorities.

The long-term objective of WATCH is to establish a stable, scientifically grounded program that can reliably support seafood safety and security in coastal communities. Bridging the gap between scientific systems and community needs is an ongoing and complex process that requires sustained partnerships, technical capacity, and long-term coordination. Under IMAWG leadership, WATCH is focused on building a program model designed for continuity and regional relevance, with the goal of supporting resilient marine food systems under increasingly variable ocean conditions and rising HAB risks. WATCH welcomes engagement from partners across science, government, and First Nations organizations interested in contributing expertise or participating in future advisory or collaborative activities.



Svetlana has been studying harmful algal blooms (HABs) since 2010, with research interests focused on HAB ecology and their impacts on marine ecosystems, particularly finfish and shellfish. She has contributed to several major international initiatives, including the International Year of the Salmon and the Salish Sea Marine Survival Project. Svetlana has participated in PICES meetings since 2012 and is an appointed member of the Section on Harmful Algal Blooms (S-HAB).

Science Communication: Sharing PICES Research Through Fact Sheets

Fact sheets: big ideas, bite-sized

A fact sheet is a short, visually attractive, and easy-to-read summary of your research that gives readers a quick sense of what your work is about and why it matters.

Rather than expecting readers to dig through lengthy reports, a fact sheet highlights the key findings, data, or ideas at a glance. It does not include a lot of scientific detail, but it does point readers to reports, papers, or other resources to connect and learn more. They are also easily updated to reflect the latest advancements as projects evolve.

How PICES Expert Groups can use fact sheets

For [PICES Expert Groups](#), fact sheets are a useful way to share research with a wide range of audiences, including the science community, policy makers, managers, and the public. They allow potential collaborators to see what each Expert Group is working on, identify groups that match their interests, and follow up for more information. They have already been used to share relevant PICES research with specific potential collaborators, partner organizations, and visiting national representatives and have been taken to conferences as handouts and posters.

Where to find them

Completed fact sheets are posted on the PICES website under the Products menu ("[Expert Group Fact Sheets](#)"). For optimal accessibility to external audiences, they can also be accessed through the homepage's quick link titled "[Research Snapshots](#)."

Read Expert Group fact sheets on the PICES website



<https://meetings.pices.int/publications/other/fact-sheets>

The PICES fact sheet template

PICES has created a one-page custom fact sheet template to help Expert Groups present key information in a clear, consistent, and concise format. Once completed, fact sheets will be posted on the PICES website, shared directly with target audiences, promoted on social media, and displayed at PICES events.

Download the template

To make a fact sheet for your Expert Group, download a template using the links below. Two templates are available:

- Use the **fixed format template** to simply enter your text into a fillable form. No formatting required!

[Fixed formatting Fact Sheet Template \(.pdf\)](#)

- Use the **flexible format template** if you would like to customize the layout to meet your needs.

[Flexible formatting Fact Sheet Template \(.ppt\)](#)

To submit a fact sheet or to request assistance creating one, please contact PICES Science Communication Officer at devon.warawa@pices.int.

Example completed by WG53

Example completed by WG53

Joint PICES/ICES Working Group on Sustainable Pelagic Forage Communities

Improving knowledge and management on the role and importance of small pelagic forage communities through global collaboration across ecosystems.

KEYWORDS

Ecosystem management
Climate variability
Predator-prey
Recruitment processes
Socio-economic impacts

WG-53 WEBSITE

[https://meetings.pices.int/working-groups/53](#)

SMALL PELAGIC FISH SYMPOSIUM

May 4-6, 2024 (La Jolla, CA, USA)

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Introduction

This Working Group will investigate and synthesize research and methods that can be used to better understand and manage forage species. This includes innovative technologies, such as genetics, acoustics, underwater imagery and isotopes, as well as emerging analysis techniques such as artificial intelligence, management strategy evaluation, and social network modeling. International collaboration on the development and application of these methods will be useful to develop strategies that lead to robust and sustainable management of forage species.

The Issues

Forage species are at the base of many marine food webs and are critical to the health of the ecosystem. They are also important to the health of the economy. The focus of this Working Group is to investigate the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish. The group will focus on the following issues:

- Understanding the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish.
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Current Work

- Foster collaboration among scientists within PICES, ICES, and other international organizations and programs to address research and management.
- Improve our ability to predict the outcomes (short and long term) of management actions on forage species. This includes biological interactions (e.g., how impact forage communities) and socio-economic interactions (e.g., how impact forage communities on the economy).
- Convene a joint PICES/ICES symposium on forage species, Mexico, that builds upon the 2017 and 2022 Small Pelagic Fish Symposium.

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Email:

Name:
Email:

PHOTO

Photo should be easily relatable to the Expert Group

Introduction

This area provides the information on who is in the group and what topics or disciplines they cover. This area is to establish the setting. For instance, the focus of this Working Group is to investigate the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish. The group will focus on the following issues:

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The Issues

This area is to state what issues this group is addressing. What problems and concerns are group members focused on?

For instance, this group is addressing the following: understanding the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish. The group will focus on the following issues:

- Understanding the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish.
- Understanding the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish.
- Understanding the current status of the Pacific Ocean pelagic zone with an emphasis on small pelagic fish.

Current Work

- The Current Work section is to highlight the actions of the Working Group, Committee, etc.
- What progress has been made in the current work? To make this information easy to read and digest, provide a 3-4 bullet points in concise statements.
- These statements should highlight the current key action - it is not to provide details on all the activities. Focus on what actions do you want your audience to remember? What stands out about your current work? What makes it unique?
- These action statements should be understood by wider audiences, be careful to not use terms that only other committee members would understand.

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PICES fact sheets were developed by PICES Advisory Panel on Science Communication. See their fact sheet [here!](#)

The Saroma Sea Ice School

Nadja Steiner



The Saroma Sea Ice School was held from February 28 to March 9, 2026, in Saroma, Japan, with the objective of building capacity for sustainable multidisciplinary science focused on the interactions among the Ocean-Ice-Snow-Atmosphere (OISA) system. The school was designed to equally represent ocean, sea ice, and atmospheric science components through lectures, field, and laboratory components and modeling exercises. A key goal was for Early Career Scientists to build a foundational understanding of the various components of this interdisciplinary field at an early career stage and to promote future cross-disciplinary collaboration. This collaboration is especially important because OISA processes remain insufficiently understood and poorly parameterized in climate models, partly as a result of the historical separation of the disciplines involved. In addition to the scientific focus on OISA systems, the program incorporated complementary training components to support the professional development and career advancement of early-career researchers. Accordingly, the school featured lectures and workshops on Indigenous traditional knowledge, knowledge co-production and two-eyed seeing, science communication, time management, and publication strategies.

Twenty-nine early career researchers participated in the school, and their feedback was extremely positive. Several students had not seen or set foot on sea ice before, making this an exceptionally memorable experience.

The school was co-organized by Biogeochemical Exchange Processes at Sea Ice Interfaces (BEPSII) and Cryosphere and Atmospheric Chemistry (CATCH), who consolidated their efforts in the Scientific Committee on Ocean Research (SCOR) working group Cice2Clouds, which focuses on synthesizing and advancing OISA research and capacity. The school was the final element of the working group's terms of reference, and the school was closed off by the Cice2Clouds hybrid meeting in Shiretoku, Japan. Several Saroma school students attended the meeting and participated in discussions of future collaboration within the OISA community.

In advance of the school, a 200+ page textbook was created, largely building on an OISA tutorial paper that is currently being finalized by the Cice2Clouds working group. The school received 208 applications from 45 countries. The selection was extremely difficult due to so many deserving candidates. In the end 30 students were selected from 17



countries. The extensive educational program was held by 19 lecturers, with field support from 8 students out of the host institution in Japan (Daiki Nomura, Hokkaido University). The program consisted of 17 hours of lectures on 11 topics, 16 hours in the field, 15 hours in the lab, and 11 hours of poster sessions and networking (including karaoke!). Participants were divided into 5 groups, which were each supported by a mentor. Each group prepared a final presentation on one of the 5 larger topics. As a special event, participants had a live call with colleagues on RV Polarstern in the Weddell Sea, which was particularly engaging as the senior researchers in the field talked about the same measurements in the field as the students were learning in the school.

Primary organizers of the event included Daiki Nomura, Bruno Delille, Jessie Creaman, Odile Crabeck, and Letizia Tedesco, who drove the local planning, general coordination, budget allocation, student selection, communication with sponsors, etc., along with support from many more to help with details and funding applications. In addition to reporting to our sponsors, a peer-reviewed report is in preparation for "Ocean Education" in Oceanography. A communications expert, Yann Ilunga from KoineComm, captured dozens of hours of recordings, which are currently being turned into tutorial videos. Students and lectures were also being treated to occasional video summaries, which were then posted through various communication channels.

In the name of BEPSII, CATCH and Cice2Clouds, the organizers, lecturers, and students are extremely grateful to all sponsors: Hokkaido University, Arctic Challenge for Sustainability, European Geophysical Union, European Polar Board, Green Feedback, International Arctic Science Committee, International Glaciological Society, International Association of Cryospheric Sciences, European Union, Kakenhi, International Union of Geodesy and Geophysics, Meopar, North Pacific Marine Science Organization (PICES), Scientific Committee on Oceanic Research, Scientific Committee on Antarctic Research, and Surface Ocean Lower Atmosphere Study.

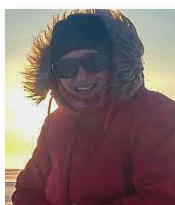
Thank you Sponsors!



*On ice activity for ice coring for sea ice physics.
Photo credit: Sea Ice School*



*Dissolved oxygen analysis by titration method.
Photo credit: Daiki Nomura*



Nadja Steiner (Nadja.Steiner@dfo-mpo.gc.ca) is a research scientist at Fisheries and Oceans Canada specializing in modeling Arctic and North Pacific marine ecosystems and biogeochemical cycles. Her work focuses on the impacts of climate change, including sea-ice change, acidification, and the marine sulfur cycle. She collaborates on Earth system modeling and leads assessments for Arctic adaptation under national and international programs. She is Co-chair for SCOR Working Group 163 - Coupling of ocean-ice-atmosphere processes: from sea-ice biogeochemistry to aerosols and Clouds (Cice2Clouds) as well as Co-chair for PICES Advisory Panel on the Arctic Ocean and the Pacific Gateways (AP-ARC).

ECOPs Participate in the North Pacific Anadromous Fish Commission Workshop on Interactions Between Salmon, Ecosystems, and Climate: From Mechanisms to Predictive Models

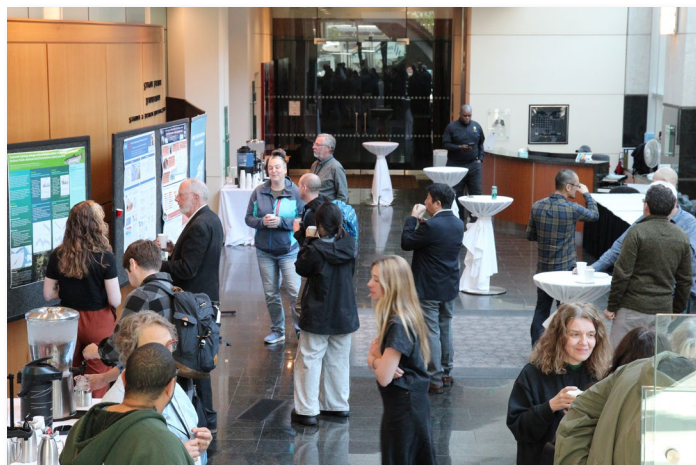
William Stanbury and Boem-Sik Kim

Introduction

The North Pacific Anadromous Fish Commission (NPAFC) hosted a 2-day hybrid workshop on *Interactions Between Salmon, Ecosystems, and Climate: From Mechanisms to Predictive Models*, co-sponsored by the North Pacific Marine Science Organization (PICES). The workshop was held in Vancouver, Canada, from May 16–17, 2026, and included a variety of oral, virtual, and poster presentations spanning three topic sessions: (1) Linking climate-ocean variability to salmon population dynamics, (2) Data integration frameworks: harmonizing oceanographic, ecological, and fisheries datasets (tools, standards, and case studies for cross-disciplinary synthesis), and (3) Identifying critical knowledge gaps and prioritizing research to forecast salmon responses under future climate scenarios. Through these topic sessions, we envisioned that participants would help advance mechanistic understanding of climate-driven changes in Pacific salmon abundance and distribution, improve synthesis and interoperability of multidisciplinary data for a North Pacific Ocean Knowledge Network, and identify critical knowledge gaps and prioritize research to forecast salmon responses under future climate scenarios.

This was the second hybrid workshop held by the NPAFC, which has allowed for wider participation from the salmon research community. The total virtual and in-person participants consisted of 80 scientists, researchers, and industry experts from Canada, England, Ireland, Japan, Korea, Russia, Scotland, and the United States. Virtual presentations were made from Alaska, central Canada, and as far away as Moscow, Russia. One presentation was given in a hybrid format—a first for an NPAFC workshop. For their presentation on Capabilities Required from a Digital Twin of a Salmon's Life, Scott Akenhead (in-person) and Colin Bull (remote from Scotland) jointly presented and encouraged audience participation through the use of live polls (using QR codes), which generated some interesting discussions. As participants become more comfortable with hybrid formats, it is exciting to see presenters find creative ways to engage with audiences and encourage meaningful discussion.

This workshop also marks the first time NPAFC has dedicated a topic session to discuss data standardization and emerging tools for data synthesis. With the lessons learned from the International Year of the Salmon program, it became



Participants having coffee and speaking with poster presenters during the first poster session.



A selection of workshop posters, including one on enhanced biological pumping at submesoscale edge fronts by ECOP Huizi Dong.

clear that salmon datasets exist in disparate formats, with inconsistent metadata, spatial/temporal resolutions, and access protocols. This fragmentation hinders the ability to (a) conduct comprehensive, basin-scale analyses of climate-salmon interactions, (b) validate mechanistic models linking environmental change to salmon productivity, and (c) support timely, science-based decision-making under climate uncertainty. To this end, workshop participants were treated to presentations on a practical semantic framework for integrating salmon data across programs and jurisdictions, refining high seas Pacific salmon distributions through machine learning, and the aforementioned presentation on creating a digital twin of a salmon's life.

In another first, PICES provided travel support for two Early Career Ocean Professionals (ECOPs) to present at this NPAFC Workshop. Boem-Sik Kim is a researcher from Kangwon National University who traveled from Korea to present his research on climate-driven migration route shifts in northwest Pacific chum salmon. Huizi Dong, a postdoctoral researcher at the University of California, traveled from Los Angeles to give a poster presentation on enhanced biological pumping at submesoscale edge fronts.



Photo by Marco Tjokro on Unsplash
Sockeye Salmon in Salmon Arm, BC, Canada

Navigating the Trailing Edge: An ECOP's Perspective on Climate, Life History, and a Collaborative Future at the NPAFC Workshop

By Boem-Sik Kim

More than Science: Building a Cross-Border Community

Attending the North Pacific Anadromous Fish Commission (NPAFC) Workshop in Vancouver was a defining experience in my journey as an Early Career Ocean Professional (ECOP). Navigating the complexities of salmonid ecology in a rapidly changing climate is a daunting task, but the environment fostered by the NPAFC was incredibly encouraging. Beyond the high caliber of scientific discourse, my highlight was the genuine spirit of mentorship and community. Engaging in open dialogues with seasoned experts and fellow ECOPs from across the North Pacific rim underscored a shared understanding: basin-scale ecological challenges cannot be addressed in isolation. The cross-border networking provided a profound sense of solidarity, transforming distant academic names into accessible mentors and potential collaborators.

Science Highlights: Life History and Resilience

The breadth of research presented was remarkable, but the detailed investigations into salmonid life history strategies stood out as a major scientific highlight. The presentations utilizing otolith microchemistry—specifically laser ablation ICP-MS to track strontium levels and pinpoint estuarine entry times—were particularly illuminating. It was fascinating to learn how fry and parr outmigrants navigate the marine environment with vastly different survival rates, yet early-migrating fry can still constitute a significant portion of older, larger returning adults. This insight powerfully reiterated that evaluating the true resilience and reproductive potential of a population requires looking beyond sheer outmigration numbers and simple survival metrics, demanding a closer look at the age and size dynamics of returning adults under varying environmental pressures.

Applications to Research: Scaling up to Spatial Models

The insights into fine-scale life history strategies perfectly complement my macro-scale research focus. My work investigates the trailing edge of chum salmon distribution, focusing on how rapidly warming marginal seas—such as

the waters between Korea and Japan—act as sentinels for broader climate impacts. At the workshop, I shared conceptual frameworks regarding potential climate-driven migration route shifts and the emerging role of dynamic “thermal gates” in altering traditional migration corridors.

While my specific statistical models are currently undergoing peer review, the core message I brought to the workshop—and the feedback I received—centers on the necessity of integrating spatial modeling with biological realities. I plan to integrate the life-history variability concepts discussed at the event into my ongoing efforts to delineate marine climate zones using high-resolution oceanographic datasets. Understanding how macro-level warming trends disproportionately stress specific outmigrant strategies at the southern distribution limits will critically enhance the predictive power of my models.

Future Directions: A Multinational Imperative

Looking toward the next five years, the intersection of fine-scale biological tracking (like genetic stock identification) with high-resolution physical oceanography will become the absolute frontier of anadromous fish research. As shifting marine climate boundaries continue to redraw the ecological map, localized studies will no longer suffice. I envision a future where multinational data harmonization and collaborative field validation—spanning corridors from the waters around Korea and Japan to the Okhotsk Sea—become the standard. Establishing predictive tools

and early-warning systems for climate-driven route shifts will require seamless cooperation across borders. The perspectives gained at this NPAFC workshop have deeply reinforced my commitment to this interdisciplinary approach, and I am eager to contribute to the robust, collaborative networks necessary to safeguard North Pacific ecosystems.



William Stanbury was born in Vancouver, British Columbia, and graduated from both the University of British Columbia with a BA in History and from the British Columbia Institute of Technology with a Technical Diploma in Fish, Wildlife, and Recreation. After finishing school, William worked as a seasonal hydroacoustics technician with the Pacific Salmon Commission (PSC) and joined the North Pacific Anadromous Fish Commission (NPAFC) in 2019 as the Web/Publication Manager. He is currently the IT/Data Officer and Acting Deputy Director at the NPAFC. In his spare time, William enjoys running, hiking, and spending time with his wife and two young children.

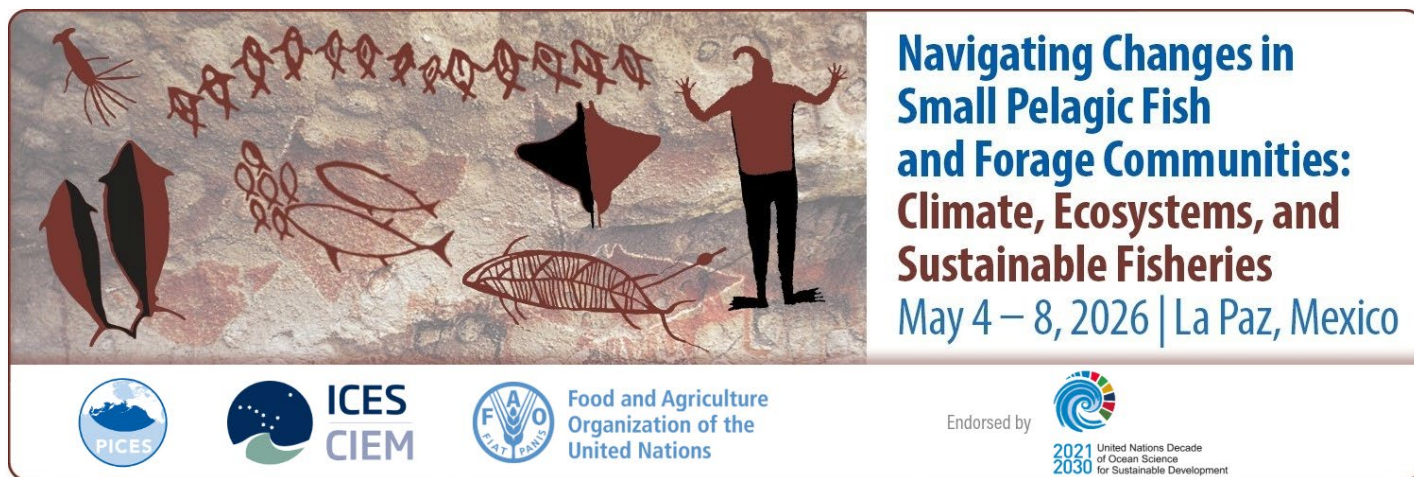


Boem-Sik Kim is a researcher from Kangwon National University in Korea.



Salmon fishing boat in Southeast Alaska, USA

SMALL PELAGIC FISH INTERNATIONAL SYMPOSIUM



Symposium in La Paz, Mexico Reunites the Global Scientific Community to Discuss the Central Role of Small Pelagic Fish and Forage Fish in Climate, Ecosystem, and Food Security Challenges

Rebecca Asch, Susana Garrido, Salvador Lluch-Cota, Ruben Rodriguez-Sanchez, Chris Rooper, Motomitsu Takahashi, and Marcelo Vasconcellos

The international symposium “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries (SPF-2026)” was held May 4–8, 2026, in La Paz, Mexico, and represented another major milestone for the international small pelagic fish (SPF) community, reuniting scientists, managers, and stakeholders dedicated to advancing the ecological understanding, sustainable management, and future resilience of these critical marine resources. Building on the strong legacy of previous symposia held in Victoria (SPF-2017) and Lisbon (SPF-2022), this symposium once again highlighted the importance of global collaboration in addressing the rapidly evolving challenges facing small pelagic and forage fish populations in a changing ocean.

Research on SPF and forage species continues to flourish, driven by increasingly interdisciplinary approaches comparing ecosystems and fisheries across regions of the world. SPF-2026 provided a unique opportunity to strengthen international cooperation and scientific

exchange at a time when climate-driven ecosystem changes, marine heatwaves, shifting species distributions, and food security concerns are becoming increasingly prominent. The meeting reinforced the central role that forage fish play not only in marine food webs, but also in supporting fisheries, coastal livelihoods, and global food systems.

La Paz proved to be an exceptional setting for the symposium. Situated on the coast of the biologically-rich Gulf of California (Sea of Cortez), the city offered participants a vivid reminder of the ecological and socioeconomic importance of small pelagic resources. The local culture, cuisine, artisanal fisheries, and strong regional connection to the sea created an inspiring backdrop for discussions on the future of forage fish science and management.

The symposium brought together a highly diverse and interdisciplinary community of participants from around the world (more than 200 attendees from 31 countries and 6 continents), including experts in fisheries biology,

oceanography, climate science, trophic ecology, ecosystem modeling, socioeconomics, and fisheries management. SPF-2026 also continued the strong commitment to fostering international scientific partnerships across institutions and regions and supporting early career ocean professionals.

The main part of the symposium (May 5–8) was held at the International Convention Center (ICC) of La Paz, located approximately 10 km north of downtown. The Government of the State of Baja California Sur graciously made this venue available to the organizers at no cost, demonstrating its commitment to international scientific collaboration and support of sustainable fisheries. In addition to providing conference rooms, the ICC offered spectacular views of the Sea of Cortez, which served as a source of inspiration for symposium participants during conversations over lunch and coffee breaks.

The symposium scientific program was composed of eight half-day workshops selected from the proposals submitted by the scientific community (workshop summaries are outlined in this issue of PICES Press) and nine theme sessions on a wide range of topics addressing the science and management of forage fish. Morning plenary sessions on May 5–7 provided overarching keynote presentations and introduced topics for the concurrent sessions that were convened on those days:

- S1: Bridging the Gap: From Ecological Data and Models to Fisheries Decision-Making
- S2: New Approaches for Assessment of Human Impacts Beyond Fisheries
- S3: Life History Variation Across Space, Time, and Ontogeny: Implications for Populations, Ecosystems, and Fisheries
- S4: Forage Fish and Food Webs: Trophic Dynamics of Small Pelagic Fish, from Freshwater to the Open Ocean
- S5: Spatiotemporal Dynamics of Small Pelagic Fishes in a Changing Ocean
- S6: Managing Small-Pelagic Fisheries within an Ecosystem Approach: Lessons, Challenges, and Outlook
- S7: Integrating Social Metrics into Economic Growth Strategies for Small Pelagic Fisheries
- S8: Maximizing Value and Sustainability in Small Pelagic Fisheries: Markets, Nutrition, and the Post-Harvest Sector
- S9: Modeling Human Choices Regarding Harvest and Management of Small Pelagic Stocks

In total, there were 230 presentations at the symposium: 15 plenary, 12 invited and 147 contributed talks, and 56 posters, which were discussed thoroughly during an evening poster-viewing session. Below, we offer a summary of the key research themes discussed, including recommendations for future work.



A group photo of symposium participants outside the International Convention Center (ICC) of La Paz.



**Andy Bakun
(1939-2025)**

**A life's
celebration**





**Joel Kyle Llopiz
our friend and colleague
passed away on 19 January 2026 at the age of 48**

2000	B.S. Marine Science - Eckerd College, St. Petersburg, FL
2007	La Paz, Mexico (1 st CLITOP meeting – poster)
2008	PhD University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL
2010	Post-doc positions in Miami and Woods Hole Oceanographic Institution (WHOI)
2012	Joined WHOI staff and was a tenured scientist in 2023
2008-15	CLITOP Early Life History working group lead
2018-21	CLITOP co-chair

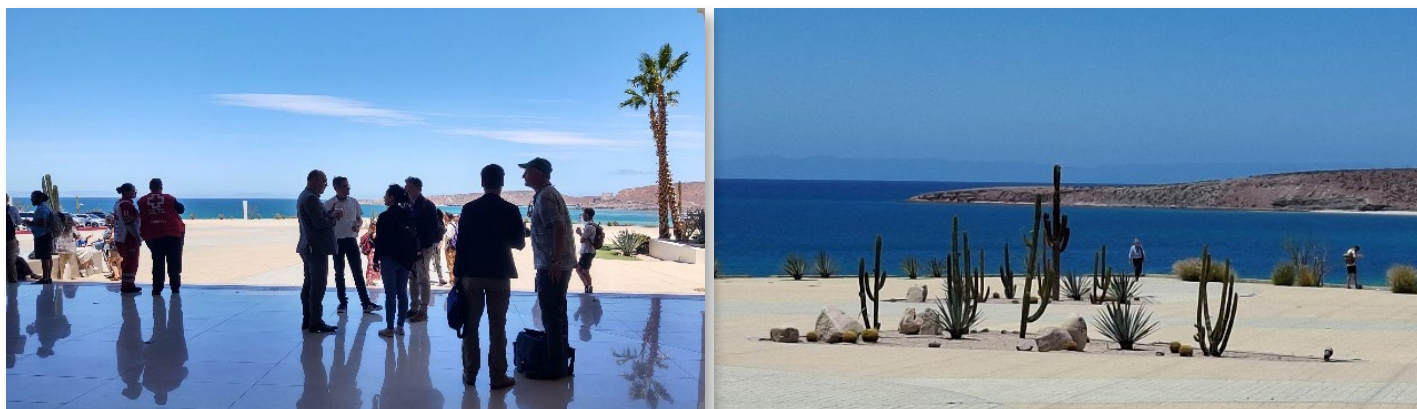
Integrated Marine Biosphere Research (IMBR)
Climate Impacts on Oceanic Top Predators (CLITOP)

Paying tributes to Andy Bakun (left) and Joel Llopiz (right) during the Opening Session. Cisco Werner (middle) recognized Andy Bakun, while Myron Peck (photo not available) honored Joel Llopiz, both offering heartfelt thoughts and reflections on their scientific contributions.

Environmental conditions (including climate change) and environmental variability are the dominant drivers of small pelagic community dynamics. The symposium featured numerous studies that examined the relationships between climate, oceanography, and population dynamics. Shelf seas, boundary currents, hyper-local circulation and El Niño-Southern Oscillation (ENSO) dynamics were all shown to shape recruitment synchrony, larval dispersal and population connectivity. Other contributions highlighted the impacts of long-term climate forcing, upwelling variability, basin warming, and boundary-current dynamics on abundance changes and distribution shifts for different species. Biological processes, such as predation and density-dependence, were also the focus of several works, as they can act in concert, or independently, with changes in physical oceanography to determine key life history traits (e.g., growth rates or survival). SPF-2026 focused mostly on small pelagic fish, but several works centered on other forage fish, particularly mesopelagics, their distribution, dynamics and trophic interactions. A topic that has been under-appreciated but received more focus at this symposium, is how the environmentally-driven changes in small pelagic fishes can translate into socioeconomic impacts. Small pelagic species ecology is closely linked to the physical environment in which they live, the

productivity of their ecosystems and the mortality induced by higher trophic level predators, and all of these processes impact human interactions with these species.

A key theme of the symposium was turning ecological knowledge into actionable management advice. This theme was the focus of studies presented across many of the sessions, but highlighted particularly in Sessions 1, 2, 3 and 6. These studies tended to use analytical tools as pathways to bring ecological research into decision-supporting frameworks. For example, management strategy evaluation (MSE) frameworks and simulation testing using the natural range of variability in both process and observation error were shown to be critical bridges to robust decision making. Data integration across multiple platforms and knowledge systems can improve detection of changes, and thus responsiveness of management to the need for precaution. Some of the key ecological challenges to managing small pelagic communities were observed to be time-varying natural mortality, non-stationarity of relationships with the environment, and accounting for changing ecosystem interactions. These are challenges to the traditional approaches of fisheries science and management, requiring the development of innovative and robust analytical approaches and risk assessments, including substantial focus on ecosystem



Symposium participants are enjoying spectacular views of the Sea of Cortez during a coffee break.

approaches to fisheries and fisheries management (EAF–Ecosystem Approach to Fisheries/EBFM–Ecosystem-Based Fisheries Management). Clearly, our ecosystems are changing faster than we can improve models and management systems. It was noted that ecosystem approaches are no longer an option, but are instead an obligation for providing management advice on small pelagic fisheries that accounts for ecosystem interactions and supports the evaluation of trade-offs among fisheries production, ecosystem functions, food security, and other socioeconomic objectives.

Communication between scientists, managers, and other stakeholders was highlighted as a key theme in multiple sessions. In particular, the trade-offs between complexity (ecological realism), statistical robustness, and our ability to communicate to non-scientists is a continuing challenge. In multiple sessions there was discussion of the emphasis on quantifying uncertainty to the detriment of focusing on patterns and trends that are robust for providing advice. A vibrant message on the importance of uncertainty relative to unambiguous patterns is needed. Clear communication is key to both informing policy makers and the public, but it is often challenging given the scale and pace of climate driven change. In this context, speakers highlighted that there is no single pathway to EAF/EBFM implementation, however, there are several common criteria that have proven useful, such as participatory governance (e.g. stakeholder involvement), regional cooperation (for transboundary stocks), clear management objectives, risk and trade-off evaluation, stronger science–policy integration, and stronger governance systems. Each of these requires clear communication of science, uncertainty and potential outcomes for small pelagic species.

Another key theme at the symposium was improving the integration between fisheries management, science, and socioeconomic understanding. The trend in the use of small pelagics by humans is towards a growth in direct human consumption over the last 20 years, although fishmeal and fish oil production (and increasingly their byproducts) still constitute the majority of small pelagic fisheries markets. Fishing access arrangements between industrial fishing nations and developing countries are increasingly part of the economic landscape for small pelagic fisheries. However, these arrangements are often between unequal partners and can negatively impact local stocks, fisherpeople and access of local communities to nutrition. Thus, many studies showed examples of how fisheries and governance need to work for fishers and the people who rely on the industry for their livelihoods. Despite

their importance, social aspects in fisheries often remain underrepresented in policies and management systems. Thus, decent work should be treated as a core component of fisheries sustainability. In line with EAF/EBFM, sustainable fisheries require not only healthy ecosystems, but also secure livelihoods, safe work conditions, and inclusive institutions. Small pelagic fisheries science can contribute to this by developing social indicators for integration into fisheries management and conducting more studies that attempt to model/address the socioeconomic impacts of changing fisheries stocks and sustainability.

Novel and developing technologies and their use in studying and managing small pelagics was also a key theme throughout all the symposium sessions. Developing techniques, such as eDNA methods and whole genome sequencing, are improving our ability to map the distribution, contribute to abundance estimates and provide more certainty on stock structure, and population linkages for small pelagic species. Some examples were seen in studies that linked population genetics to oceanographic features to provide mechanistic explanations for maintenance or modification of stock structure. Stable isotopes as tools for investigating migration and trophic relationships were used in multiple works. One of the most encouraging themes found in many contributions was the increasing ability of researchers to integrate new and underutilized data streams into small pelagic science. For example, new modeling techniques can allow for integration of existing or newly collected acoustic data from fisheries-dependent sources to complement fisheries-independent surveys, enhancing both the spatial and temporal coverage of small pelagic populations. Examples of new technologies include uncrewed surface vehicles (USV's) and egg and larval identification and enumeration through artificial intelligence algorithms. Archeogenomic techniques (both existing and novel extensions) are a powerful tool for investigating historical patterns of population diversity and dynamics. These technologies are developing rapidly with associated reductions in cost and expertise that will make them key to future assessment and management of small pelagic species.

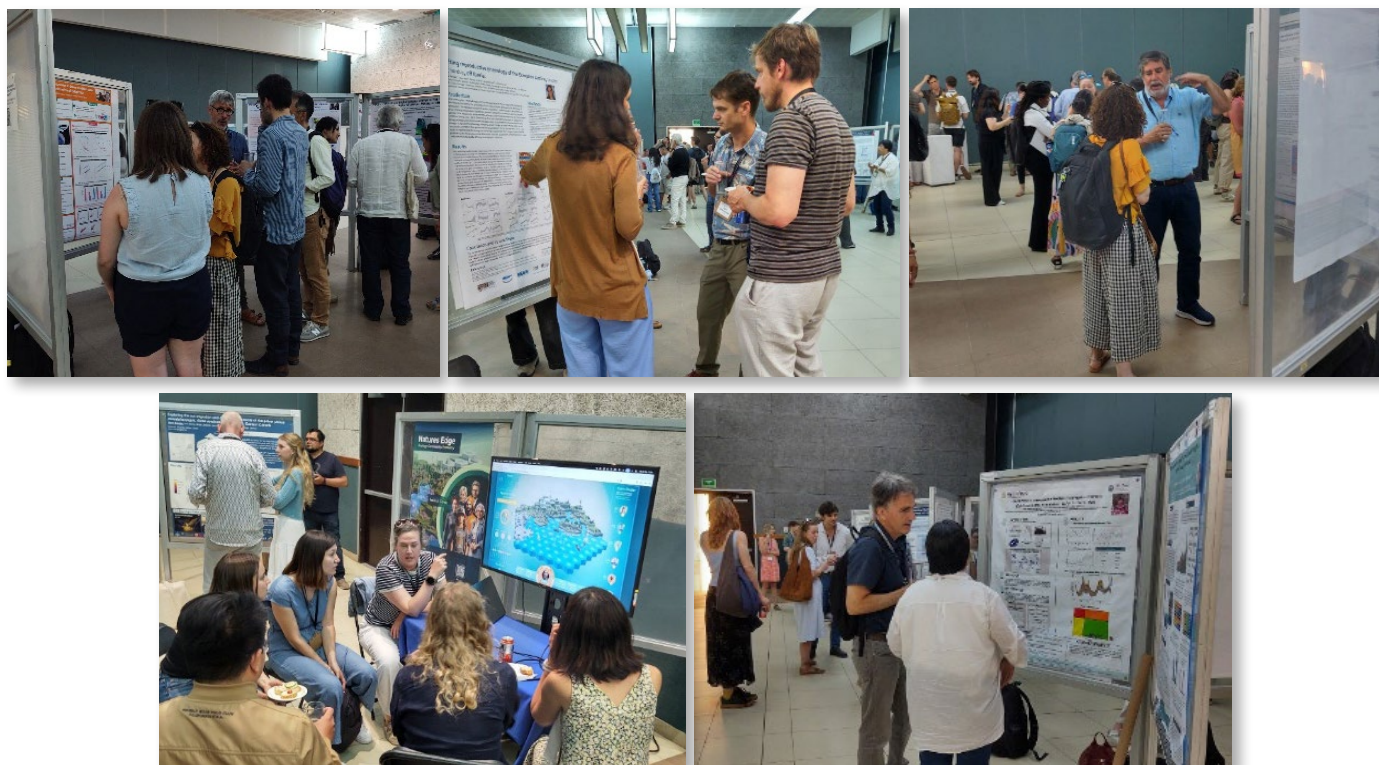
One of the most exciting outcomes of the symposium was the number of presentations that integrated studies from across the globe to develop important trends, test widely-held hypotheses or simply identify similar or contrasting characteristics of small pelagic forage species in multiple ecosystems. This is a key outcome of not only the symposium, but also of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities ([WG53/WGSPF](#))

and its predecessor the PICES/ICES Working Group on Small Pelagic Fish ([WG43/WGSPF](#)), which have created a venue for cross-system collaborations among scientists from around the world studying small pelagics. During the symposium, many plenary speakers, as well as speakers within sessions, presented work that stretched across national boundaries and multiple ecosystems. Much of this research grew out of ideas and collaborations initiated during SPF-2022 in Lisbon or through WGSPF. For example, growth studies were featured that synthesized life history of multiple small pelagic fish species occurring in the world's oceans for both laboratory and field studies to determine root causes for global patterns in reductions of size at age and fish condition. Multiple sessions identified additional areas for collaborative research using common methods across global ecosystems for future work. This avenue for global collaboration is one of the key strengths of the symposium, and we anticipate further progress on global syntheses over the coming years and a future small pelagic communities symposium (tentatively planned for 2030).

The previous SPF symposia generated two publications in primary journals each: SPF-2017 – the special issue of *Deep-Sea Research II* on “Drivers of Dynamics of Small Pelagic Fish Resources: Environmental Control of Long-term Changes” (2019, Vol. 159, pp. 1-182) and the [Theme Section No.58](#) on “Drivers of Dynamics of Small Pelagic Fish Resources: Biology, Management and Human Factors” in *Marine Ecology Progress Series* (MEPS, 2019, Vol. 617-618, pp. 1-376), and SPF-2022 – the [Theme Section No. 67](#) on “Small Pelagic Fish: New Research Frontiers” in MEPS (2024, Vol. 741, pp. 1-330) and the special issue of *Canadian Journal of Fisheries and Aquatic Sciences* on “Small Pelagic Fishes: New Frontiers in Science and Sustainable Management” (CJFAS, 2024, Vol.81, No. 8, pp. 984-1173). It is expected that two special issues resulting from SPF-2026 will be also published in MEPS (sessions 3-6 and workshops 1-2 and 5-7) and CJFAS (sessions 1-2 and 7-9 and workshops 3, 4 and 8).



A mentoring event for early career scientists held May 5 included discussion groups structured around techniques, topics and regions of interest vital to SPF science and management.



Symposium participants gathered during the poster session to socialize and discuss the latest advancements in SPF science and management, including a collaborative game for EBM of small pelagic fisheries (bottom left).



The Closing Plenary Session: attentive session audience (top left); symposium convenor Dr. Chris Rooper (PICES) presenting a summary of the scientific sessions and workshops (top right); and panel moderator Dr. Cisco Werner (USA) announcing discussion questions to panel members Dr. Oshima (Japan), Dr. William Griffin (FAO), Dr. Niels Hintzen (Denmark), Dr. Renato Salvattech (Germany/Peru), Dr. Eleni Petrou (USA), and Dr. Seleni Cruz (USA) (bottom).

The symposium was a memorable event not only due to excellent science but also because of great networking and the welcoming and friendly atmosphere. Evening social networking began with a Welcome Reception on May 4 at beautiful La Ceiba Jardín, located just one block from the Malecón (waterfront boardwalk), where participants enjoyed live music and informal discussions. A Poster Session/Reception took place at the ICC on May 6 and was design to allow participants to roam around the displays and chat with presenters while appreciating hot and cold Mexican snacks. A visit to Mexico would not be complete without enjoyment of a mariachi band, one of Mexico's most iconic cultural traditions, characterized by energetic rhythms, rich vocal harmonies, and the distinctive sound of trumpets, violins, and guitars. At the symposium dinner held May 7 at the ocean-view garden of Hotel La Posada, we were all treated to an evening of fine dining and the mariachi performance, which offered participants an authentic experience of Mexican culture and hospitality. At the dinner special recognition was given to Alex Bychkov for his longstanding contributions. He received two tributes: an acknowledgement by the symposium convenors, and an appreciation from the Mexican scientific community in the form of commissioned artwork.

A substantial portion of the attendees (46%) identified themselves as early career ocean professionals (ECOPs). The generous support from the symposium sponsors facilitated the participation of many of these early career scientists from around the world. A mentoring session on May 6 was an important and exciting networking event. During this event, structured around techniques, topics and regions of interest vital to forage fish science



Participants socializing at the Welcome Reception at La Ceiba Jardín.

Symposium dinner at Hotel La Posada. Top: Participants socializing and enjoying the beautiful setting, middle: Mariachi band performance, and bottom: Special recognition to Alex Bychkov with symposium convenors.

and management, ECOPs had the opportunity to interact with mentors (members of the symposium's organizing and scientific steering committees, plenary and invited speakers, and topic session and workshop conveners) who have expertise across diverse geographic regions, research disciplines, and career-related areas. During the closing ceremony, five awards were given to early-career scientists: four for best oral presentations – Stephanie Hopkins (USA), Jerry Ian Leonida (Philippines), Marina Puebla-Aparicio (Spain), and Sebastian Vasquez (Chile), and one for best poster – Susan Kenyon (UK). Honorable mentions included Sofia Gonzalez-Perez (Spain), Liz Loutrage (USA), Karlee Orvis (Canada), and Maria Iohara Quirino-Amador (UK).

Organizing SPF-2026 was a Term-of-Reference of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF), and a two-day (May 9–10) business meeting of this working group directly followed the symposium. This hybrid meeting, held at CICIMAR-IPN, brought together about 50 participants to discuss products closely aligned to symposium topics, such as the compilation of world-wide data sets, integrative analyses, and peer-reviewed manuscripts. The meeting also provided an opportunity to broaden the working group network by welcoming new members, including many early career scientists and scientists from outside the PICES and ICES regions.



A group photo of participants for the PICES/ICES Working Group on Sustainable Pelagic Forage Communities meeting outside of CICIMAR (May 9, 2026).



From left to right: Drs. Akinori Takasuka (Japan), Ruben Rodriguez (Mexico), Rebecca Asch (USA), Susana Garrido (Portugal), Motomitsu Takahashi (Japan), Chris Rooper (Canada), Ryan Rykaczewski (USA), Salvador Lluch (Mexico) taking a break from the PICES/ICES Working Group on Sustainable Pelagic Forage Communities meeting.

We want to take this opportunity to emphasize our gratitude to the symposium sponsors. In particular, the symposium would not have been possible without the dedication of CICIMAR and CIBNOR staff, the ICC staff, and the efforts of the PICES Secretariat. Finally, the local organizing committee and Dr. Alex Bychkov (PICES Special Projects Coordinator) were responsible for almost all of the organization and details of the meeting. Their leadership was critical to the success of the symposium and it could not have happened without their tireless effort.

Following the success of SPF-2026, the international SPF community is already looking ahead with enthusiasm and curiosity to the next symposium in 2030 to foster interdisciplinary dialogue and to further advance the science for sustainable management of small pelagic fish. Several potential host locations from around the globe are currently being discussed, reflecting both the world-wide importance of small pelagic fish research and the truly international spirit of this scientific community.



Our group of helpers from CIBNOR.



PICES Secretariat (missing from photo: Julia Yazvenko).

Thank you to our 2026 Small Pelagic Fish Symposium Sponsors

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Sistema Productivo de Acuicultura

MAZ SARDINA



Dr. Rebecca Asch (aschr16@ecu.edu) is an Associate Professor in the Department of Biology at East Carolina University in Greenville, North Carolina, USA. Rebecca is a fisheries oceanographer whose research combines fieldwork, time series analysis, and ecosystem modeling. Her early career research primarily investigated whether climate change could lead to increased seasonal mismatches between trophic levels, with a particular focus on small pelagic fishes. While changing phenology continues to be a research interest, current projects in the Asch Lab examine a greater diversity of topics, including tradeoffs between fish species shifting their geographic distribution vs. phenology in response to climate change, use of DNA barcoding to identify fish spawning habitat in the South Atlantic Bight, climate-related shifts in spawning habitat of species that form transient spawning aggregations, assessment of the effects of saltwater intrusion on the community composition of estuarine fishes, and impacts of ship-channel dredging on larval fish biodiversity. Rebecca is an ICES Co-Chair of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF).



Dr. Susana Garrido (susana.garrido@ipma.pt) is a Senior Researcher at the Portuguese Institute for Sea and Atmosphere (IPMA) in Lisbon, Portugal, where she leads the Research Group on Coastal Pelagic Fish and the Trophic Ecology Laboratory. Her research mainly focuses on marine trophic webs, larval physiology and survival, and understanding the impact of environmental variability on SPF population dynamics, aiming at developing indicators to improve management advice. Additional research interests include zooplankton ecology and parental effects. She is also responsible for the stock assessment of the European anchovy in Portugal. Susana is a member of several ICES Working Groups and an ICES Co-Chair of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF).



Dr. Salvador Lluch-Cota is a Fisheries Oceanographer at the Northwest Biological Research Center (CIBNOR) in La Paz, Mexico. Salvador has been actively involved in PICES activities since the Beyond ENSO Conference in 2000 and has helped organize several PICES events, including a modeling workshop and three international conferences hosted in La Paz. His research examines the effects of climate variability and climate change on marine organisms, populations, and ecosystems, with an emphasis on linking physiological responses to ecological and fisheries dynamics.



Dr. Rubén Rodríguez-Sánchez (rrodrig@ipn.mx) is currently a Senior Researcher at the Interdisciplinary Center of Marine Sciences (Centro Interdisciplinario de Ciencias Marinas – Instituto Politécnico Nacional; CICIMAR-IPN) in La Paz, Baja California Sur, Mexico. He has built his entire academic and professional career at this institution since 1977, completing here both his undergraduate and graduate studies and serving in various academic and administrative leadership roles. Rubén's research has focused on small pelagic fishes from multidisciplinary perspectives. Throughout his career, he has collaborated with leading international researchers on topics such as the taxonomy of sardines and anchovies in the Eastern Central Pacific, reproductive cycles, genetics, functional morphology, and the influence of environmental variability across spatial and temporal scales on the distribution and abundance of small pelagic fishes. Over the past decade, Rubén has also contributed to international collaborative projects involving satellite-tagging migration studies and captive research on large pelagic fish species, such as mahi-mahi. As a professor at CICIMAR-IPN, he has combined frontier research with teaching, mentoring master and PhD students, as well as early-career researchers from local, national, and international universities.



Dr. Chris Rooper (chris.rooper@dfo-mpo.gc.ca) is a Research Scientist with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, British Columbia, Canada. Chris's research is focused on developing and applying new methods for estimating fish and invertebrate abundance, distribution and habitat use. For the last 22 years he has been working with colleagues in Canada, Alaska, and the U.S. West Coast to apply advanced technologies to conducting *in situ* research on small pelagic fishes, deep-sea corals and sponges and rockfishes. More recently, Chris has been working with international colleagues at the North Pacific Fisheries Commission on fisheries beyond national jurisdictions. Chris is a PICES Co-Chair of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF).



Dr. Motomitsu Takahashi (takahashi_motomitu30@fra.go.jp) is a Research Scientist with the Japan Fisheries Research and Education Agency at the Fisheries Resources Institute in Nagasaki, Japan. Moto's research is mainly on mechanisms for population dynamics of small pelagic fishes in relation to environmental variables. His initial work has focused on the early life survival for anchovies and sardines in the eastern and the western North Pacific. Currently, Moto has been working on life history traits of small pelagic fishes, including chub mackerel and jack mackerel for the stock assessments, and he is trying to understand their migration patterns and population structures around Japan. Moto is a PICES Co-Chair of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF).



Dr. Marcelo Vasconcellos (marcelo.vasconcellos@fao.org) is a Fishery Resources Officer at the Food and Agriculture Organization of the United Nations (FAO), where he leads capacity development projects on fisheries assessment and the ecosystem approach to fisheries (EAF) in different parts of the world. He holds a PhD in Resource Management and Environmental Studies and worked as a researcher and professor at the University of Rio Grande, Brazil, before joining FAO in 2015. Marcelo's research focuses on supporting the sustainable management of capture fisheries under multiple objectives and challenges, including the impacts of climate change. He has worked closely with governments and stakeholders to strengthen the management of both small-scale and industrial fisheries, including several small pelagic fisheries that are critical for food security, livelihoods and national economies in developing countries.



SPF-2026 Early Career Ocean Professional (ECOP) Outstanding Presentation Awards



Session 01 - Oral Presentation

STEPHANIE HOPKINS

University of California, Santa Cruz, USA

Using species distribution models to develop movement scenarios for management strategy evaluation: A Pacific sardine case study



Session 05 - Oral Presentation

MARINA PUEBLA-APARICIO

Molecular Ecology and Biotechnology, AZTI, Spain

Multiple chromosomal inversions reveal the evolutionary history of lineage divergence and admixture in the European sardine



Session 03 - Oral Presentation

SEBASTIÁN VÁSQUEZ

Instituto de Investigación Pesquera, Chile

Integrating physiology, environment, and adaptation in anchovy (*Engraulis ringens*): Insights from a Dynamic Energy Budget model in the southern Humboldt ecosystem



Session 06 - Oral Presentation

JERRY IAN LEONIDA

University of the Philippines Visayas

Assessing the lilang fishery of Miagao, Iloilo, Philippines: Ecosystem-based insights on catch dynamics and sustainable fisheries management



Session 03 - Poster Presentation

SUSAN KENYON

Centre for Environment, Fisheries and Aquaculture Science (Cefas), UK

Temporal variability in life-history parameters and body condition of sardine (*Sardina pilchardus*) in the English Channel



Honorable Mention Presentations

Honorable Mention (Session 3)

KARLEE A. ORVIS

University of Northern British Columbia, Canada

Energetics of “the savior fish”: the phenology of Eulachon (*Thaleichthys pacificus*) energy reserves and potential survival bottlenecks in British Columbia marine and freshwater systems

Honorable Mention (Session 4)

LIZ LOUTRAGE

University of California, San Diego, USA

Use of trait-based approaches to reveal the complexity of trophic ecology in deep-pelagic fishes

Honorable Mention (Session 9)

MARIA IOHARA QUIRINO-AMADOR

University of the Highlands and Islands, UK

Drivers in the selection of fishing areas by the Scottish Pelagic Fleet

Honorable Mention (Workshop 6)

SOFÍA GONZÁLEZ-PÉREZ

Instituto Español de Oceanografía (IEO-CSIC), Spain

IBM models for simulating the Early Life Stages of small pelagic: a generic code approach

Jürgen Alheit Receives the Inaugural Small Pelagic Fish Career Contribution Award

The Small Pelagic Fish (SPF) Career Contribution Award aims to honour outstanding individuals (researchers, fisheries managers, and other practitioners) who, throughout their careers, have made a substantial and sustained contribution to the understanding and management of SPF or other forage species, with an emphasis on those who have stimulated international collaboration in this arena. In particular, active participation and contributions to the joint ICES-PICES Working Group on Sustainable Pelagic Forage Communities and its precursors are an important qualification for award nominees. This award was established in 2026 and presented for the first time at the international symposium “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries (SPF-2026)” held May 4–8, 2026, in La Paz, Mexico. Dr. Jürgen Alheit, a retired Senior Scientist from the Leibniz Institute for Baltic Sea Research in Warnemünde, Germany, is the inaugural recipient of this award.

Dr. Alheit began his career by obtaining a B.Sc. in Marine Biology from the University of Liverpool in England, which was followed by a Ph.D. in Fisheries from Kiel

University (or Christian-Albrechts-Universität) in Germany. His early publications focused on a diversity of topics in biological oceanography, including the behavioral basis for intertidal zonation (Alheit & Naylor 1976), the role of benthic harpacticoid copepods in fish diet (Alheit & Scheibel 1982), and the transport of sediment by fishes (Alheit 1983). However, starting in the early 1980s, his research began to focus on the ecology of SPF, a topic that would ultimately become the focus of Dr. Alheit’s most impactful work. Dr. Alheit is best known for his paradigm-forming contributions addressing the connections between SPF and climate dynamics, as well as examining whether SPF exhibit synchronous variation across ocean basins. He has led numerous highly cited publications documenting climate-related regime shifts affecting SPF in ecosystems as diverse as the North Sea, Baltic Sea, and Humboldt Current (Alheit & Hagen 1997; Alheit & Ñiquen 2004; Alheit *et al.* 2005; Petitgas *et al.* 2012). Furthermore, Dr. Alheit was a key contributor to Schwartzlose *et al.* (1999), which was the publication that first synthesized data on SPF populations globally and identified similar patterns of decadal-scale, boom-bust variability in stocks across many regions. This paper was highly influential and has motivated multiple hypotheses and decades of work to explain the observed phenomenon.

Dr. Alheit’s career also exemplifies the SPF Career Contribution Award’s emphasis on fostering international scientific collaboration. In 1983, he took part in the international symposium “The Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources” organized by the Food and Agriculture Organization (FAO) of the United Nations and the Intergovernmental Oceanographic Commission (IOC) of UNESCO in San José, Costa Rica, which provided the first impetus for globally coordinated research on SPF. This positioned Dr. Alheit as a leader of IOC’s Sardine-Anchovy Recruitment Project (SARP), which examined within-year variation in survival of these fish stocks while also comparing data across several upwelling regions (e.g., Kuroshio Current System, California Current System, Humboldt Current System) (Bakun *et al.* 1991). In the 1990s and 2000s, Dr. Alheit undertook multiple leadership roles in the Global Ocean Ecosystem Dynamics (GLOBEC) Program, which was the IOC’s first international program to investigate how climate change could impact marine ecosystems. He was the lead investigator of the GLOBEC



Dr. Jürgen Alheit

Germany program from 2000 to 2007 and served on the GLOBEC International Scientific Steering Committee throughout its entire duration. For 16 years, he also led the Small Pelagic Fish and Climate Change (SPACC) Initiative launched by GLOBEC in 1994. The culmination of SPACC's research was an edited volume entitled *Climate Change and Small Pelagic Fish* (Checkley et al. 2009), which documented trends in SPF stocks across regions and synthesized knowledge of SPF habitat use, trophodynamics, scales of variability (decadal to millennial), connections to oceanic and climate dynamics, sustainable fisheries management, and the human dimensions of SPF fisheries. This volume has become a touchstone for SPF researchers around the world.

Following the completion of SPACC, there was a hiatus in globally coordinated SPF research that lasted nearly a decade. To rejuvenate this field, Dr. Alheit encouraged PICES and ICES to initiate the SPF Symposium series and served as the co-convenor for the first SPF Symposium that took place in March 2017 in Victoria, Canada (Alheit & Peck 2019; Alheit et al. 2019). Attended by researchers from 31 countries, this symposium provided the impetus to establish the [joint ICES-PICES Working Group on Small Pelagic Fish](#) in 2018, followed by the [joint ICES-PICES Working Group on Sustainable Pelagic Forage Communities](#) in 2024. Dr. Alheit was also an invited plenary speaker at the second SPF Symposium occurring in November 2022 in Lisbon, Portugal, but was unable to attend due to health reasons. During this period, he co-authored a publication assessing how themes in publications on SPF changed between the SPACC era and the following years up to the time of the first SPF Symposium (Peck et al., 2021).

Beyond his work on the linkages between SPF, teleconnections, and climate variability, Dr. Alheit has

also published extensively on SPF mortality rates (Smith et al. 1989), reproductive biology (Goldberg et al. 1984; Alheit 1988; Alheit 1989), cannibalism (Alheit 1987), egg predation (Alheit 1987), and paleoecology (MacKenzie et al. 2002; Struck et al. 2002; Finney et al. 2010). He was a key contributor to the development of the daily egg production method (DEPM), which has been adopted globally to estimate SPF spawning stock biomass to aid in stock assessment (Alheit 1993). In addition to his SPF-focused research, he has edited the definitive book on hake biology (Alheit & Pitcher 1995), served as a co-author of the 2014 Intergovernmental Panel on Climate Change (IPCC) report (Pörtner et al. 2014), and led the ECODRIVE program from 2009–2012, which brought together multidisciplinary researchers to model historical and future changes in trophodynamics of the North Sea.

Dr. Alheit was nominated for this award by a global set of scientists who indicated that he contributed to their professional and intellectual development as an informal mentor *via* his focus on scientific rigor combined with engaging hospitality. Below are selected quotes from these nominators that are intended to illustrate these aspects of Dr. Alheit's personality and his influence on the SPF research community:

"What strikes me most about Jürgen is his unwavering commitment to scientific rigor—his willingness to dig into the details of hypotheses and confront captivating ideas with actual data rather than accepting them at face value. This approach has been both inspiring and instructive for me and many other researchers in our field...He has served as an informal mentor to me and countless other researchers, always ready to engage in thoughtful debate about mechanisms underlying climate-fish interactions."

– Ryan Rykaczewski, Supervisory Marine Scientist, US NOAA Pacific Islands Fisheries Science Center



Dr. Jürgen Alheit at SPF-2017 in Victoria, Canada: opening the symposium (left) and receiving appreciation from Dr. Chul Park (PICES Chairman) and Dr. Cornelius Hammer (ICES President) (right).

“His style of organizing the event, summing-up of discussion, and connecting the participants had a huge impact on me, an early career scientist at that time, getting involved in international activities. Since then, Jürgen has been a mentor in international activities to me. Likewise, it is easy to assume that his warm personality and friendly and focused scientific advice encouraged many other early career scientists at numerous meetings, symposia, and workshops...The current development of the international groups would be impossible without the leadership and enthusiasm of Dr. Jürgen Alheit.”

– Akinori Takasuka, Professor, University of Tokyo

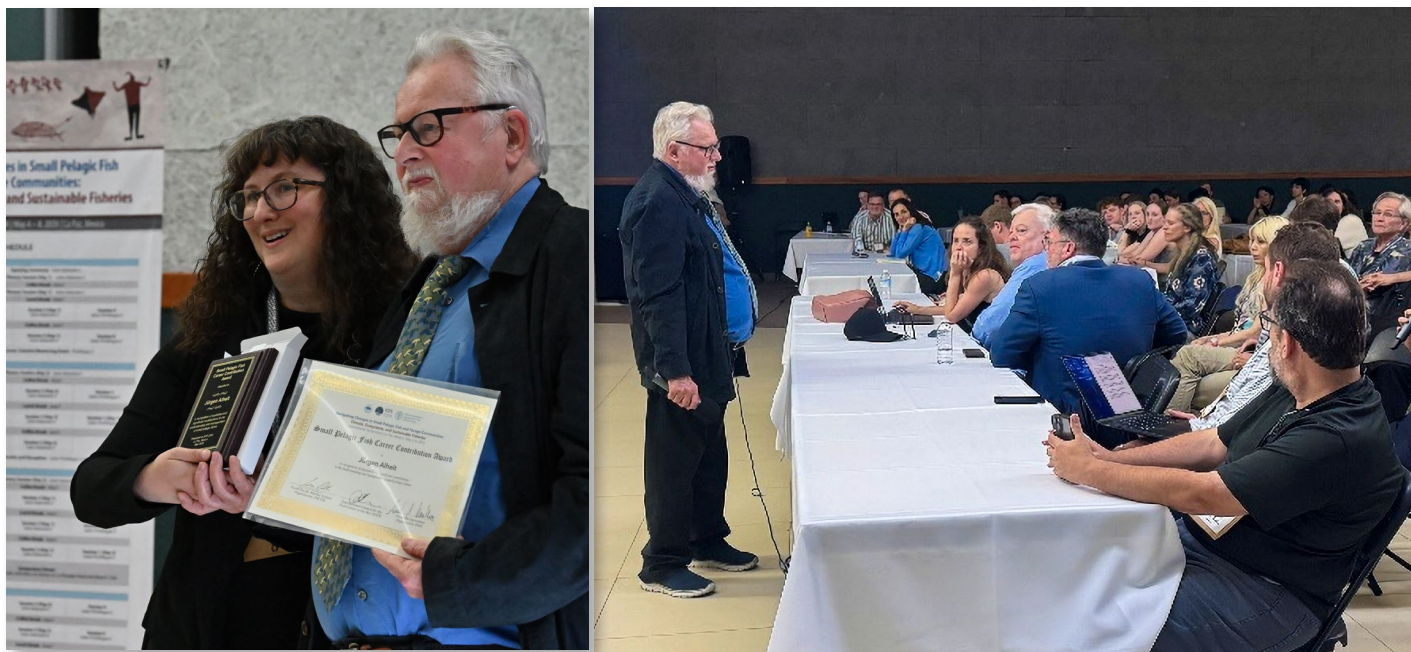
“For more than four decades, Dr. Alheit has made outstanding contributions to the understanding of small pelagic fish and fisheries. He has excelled as both a scientist—producing groundbreaking knowledge—and as a leader and active participant in international research groups and programs...On a personal note, Dr. Alheit has been a constant source of inspiration throughout my professional life...He has mentored many of us—formally and informally—through his scientific rigor, meticulous attention to detail, patience, and, above all, his commitment to transdisciplinary, multiregional, and multicultural collaboration.”

– Salvador Lluch Cota, Researcher, CIBNOR, Mexico

“Across several continents, Jürgen has helped build and maintain strong, international bridges through his professional and personal relationships with colleagues working on SPF. Not only is he a rigorous scientist that is never afraid to “get into the weeds” on specific subjects (particularly reproductive biology of SPF and climate variability), but he also is a consummate host. I recall many Riesling wine tastings where I was introduced to international colleagues (his friends) in a warm, welcoming setting. In my opinion, this mixture of formal and informal leadership is a recipe for success for international collaboration. As a community, we are still reaping the benefits of the professional network and long-term friendships that he created many years ago.”

– Myron Peck, Head of Department, Coastal Systems, Royal Netherlands Institute for Sea Research (NIOZ).

The award presentation ceremony took place at the SPF-2026 final plenary session on May 8, and was conducted by Dr. Rebecca Asch, Chair of the Symposium’s Awards Committee. The ceremony was followed by Dr. Alheit’s talk describing the history of the “boom and bust” cycles for a number of important small pelagic fisheries stocks from around the world and how these historical variations in SPF fisheries impacted the livelihoods of coastal communities.



Dr. Jürgen Alheit at SPF-2026 in La Paz, Mexico: accepting the Small Pelagic Fish Career Contribution Award from Dr. Rebecca Asch, Chair of the Symposium’s Awards Committee (left) and answering questions after his plenary presentation “Rise and fall of big small pelagic fisheries: The human dimension” (right).

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Early-career experiences at the 2026 Small Pelagic Fish Symposium in La Paz

Soeon Ahn, Lane Atmore, Wesley Greentree, Éamonn-Joeín Mac Donnachá, Alexanra B. Regalado, Hallie Repeta, Raquel Ruiz-Diaz, Nathanael Tabert, Madeleine Thomson, and Ziqin Wang

Introduction

Small pelagic fish (SPF) are pivotal in marine food webs, acting as a key pathway for the transfer of energy from plankton to predators. Recognizing the importance of SPF, researchers from across the globe met in La Paz, Baja California Sur, Mexico for the third ICES/PICES/FAO Small Pelagic Fish Symposium, titled “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries (SPF-2026),” held May 4–8, 2026. Kindly provided by the Baja California Sur government, the International Conference Centre of La Paz provided a stunning view of Bahía de La Paz. Frigate birds, brown pelicans, and terns were a common sight as we enjoyed lunch and coffee outside. Mottled pufferfish and bright sergeant majors patrolled the shores of the beautiful bay below the convention centre. Along the Malecón (waterfront) in downtown La Paz, schools of sardines were easily spotted from shore. Those of us who wandered beyond the city limits were met with incredible landscapes and species diversity, including hammerhead sharks, sperm whales, and mobula rays (Figure 1).

Over five days in this incredible environment a wide diversity of SPF research was discussed, covering ecology, fisheries assessment and management, economics, and social dimensions like human nutrition. More than 200 participants represented 31 countries, with 93 early career ocean professionals (ECOP) in attendance.

As ECOPs who received travel funding from the North Pacific Marine Science Organization (PICES), we wrote this article to share our experiences from the symposium and our time in La Paz.

Science Highlights

Lane Atmore

Events like the Small Pelagic Fish Symposium are incredible opportunities for researchers, as they bring together researchers whose work covers similar themes, such as fisheries management, marine ecology, and climate change, but often with dramatically different methodological perspectives. Bringing together diverse approaches to similar issues highlights the ways in

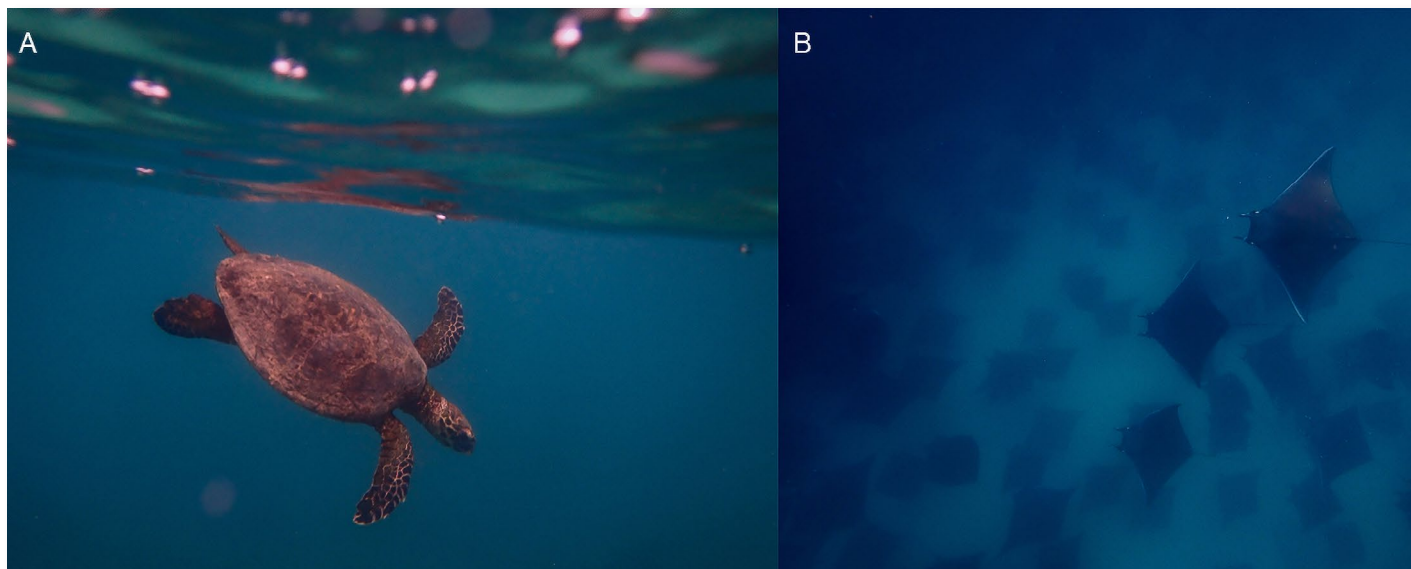


Figure 1. (a) A sea turtle descends after taking a breath at the surface in Cabo Pulmo National Park, a marine protected area that was established through ground-up efforts by fishers. (b) A school of mobula rays near La Ventana. Photos: Wesley Greentree.

which science has converged on some topics and ways in which our disciplines may be subject to blind spots. The keynote talks discussing major themes in fisheries science and policy were all thought-provoking—from the applications of genomics to understand fisheries ecology to the question of whether we have done enough science and now need to focus on the policy side of the equation.

One of the science highlights for me was a contributed talk in [Session 9](#), "Modeling Human Choices Regarding Harvest and Management of Small Pelagic Stocks". The talk, given by Eros Quesada at the Swedish University of Agricultural Sciences, explored the concept of the Newcomb-Benford Law, a mathematical rule that can be used to assess anomalies in numerical datasets. What struck me the most about this presentation was the underlying philosophy of science themes brought to the room—what do we think we know and how do we know it? Perhaps a simple question, but one that merits constant reflection when working in fields such as marine ecology and fisheries science, where we frequently rely on opportunistic—and perhaps less-than-perfect—datasets. Data are (ostensibly) the foundations of the policy we aim to advise; ensuring trust in our data is crucial for research and for management.

Soeon Ahn

Participating in SPF 2026 helped me understand small pelagic fish from a broader global perspective. Species such as anchovies and sardines are not only ecologically important as the foundation of marine food webs but also economically and socially significant resources that connect capture fisheries, direct human consumption, fishmeal and fish oil production, aquaculture feed, international trade, and food security.

One of the most important lessons I learned was that the value of small pelagic fish cannot be assessed solely by catch volume or ecosystem impact. Their significance varies depending on how they are used: as food for people, as raw material for marine ingredients, or as part of circular systems through by-product utilization. [Session 8](#) clearly showed that by-products are a cornerstone of fishmeal and fish oil production and that marine ingredients are now regarded as strategic components of high-quality aquafeeds rather than simple commodity inputs. The discussions also underscored the need for multidimensional evaluation frameworks that integrate nutritional quality and life-cycle assessment when assessing the sustainability and efficiency of marine resource utilization.



Figure 2. Brown pelicans in Punta Lobos. Photo: Lane Atmore.

I was also particularly interested in discussions showing that the use of small pelagic fish is shifting with increasing direct human consumption, rising demand for aquaculture feed, and growing price volatility in fishmeal and fish oil markets. These trends made me realize that sustainable management of small pelagic fisheries requires an integrated view of ecology, nutrition, markets, policy, and resource efficiency. The symposium ultimately underscored that discussions about small pelagic fisheries primarily revolve around the allocation of marine resources within future food systems.

Hallie Repeta

As an early-career researcher, one of the most valuable aspects of attending SPF-2026 was engaging in collaborative discussions with international researchers about shared climate-driven challenges to fisheries science and management and on how we can improve cross-system responses. Workshops 2 and 7 emphasized how climate change is altering historical environmental relationships traditionally used in fisheries science, with recruitment indicators and environmental proxies becoming increasingly dynamic and decoupled, resulting in challenges forecasting and managing under shifting baselines. One highlight for me was learning about novel approaches and tools for incorporating climate variability into management strategy evaluation frameworks, including the use of downscaled regional climate projections and “thresholds of robustness” to evaluate how resilient different management procedures may be under future environmental change.

I also valued learning more about how scientists can better communicate recommendations to managers

and practitioners under increasing uncertainty. Many discussions emphasized that the challenge is not necessarily building increasingly complex models but rather reframing how we interpret and communicate model outputs into management-relevant risk. There was strong emphasis on communicating trade-offs in socioeconomic terms, such as weighing the economic consequences of a potential fishery closure against a smaller reduction in yield. In terms of bridging the gap between science and management, using the appropriate level of model complexity to answer the right management questions was highlighted. Lastly, I appreciated hearing about knowledge co-production and the integration of Indigenous knowledge systems alongside western science, as it reinforced the importance of collaborative and adaptive approaches to fisheries management. The symposium provided an encouraging perspective on how fisheries science is evolving toward even more adaptive, collaborative, and climate-resilient management approaches.

More than Science

Alexandra Regalado

Building Community Across Systems and Disciplines

One of the most memorable aspects of attending the 2026 Small Pelagic Fish Symposium was the strong sense of community fostered by bringing together researchers from diverse geographic and disciplinary backgrounds. With participants representing forage fish systems from across the world, the meeting created meaningful opportunities to exchange ideas that extended far beyond formal presentations.

As an early-career researcher, I particularly appreciated the openness of discussions throughout the conference and the approachability of senior scientists. I was especially grateful that my advisor, Prof. Shin-ichi Ito, introduced us to many of his colleagues, which allowed me to connect with researchers whose work I had previously only encountered through publications. Conversations during poster sessions, coffee and lunch breaks, and informal gatherings often led to some of the most valuable insights. These interactions made the field feel highly collaborative, with researchers willing to share advice, discuss conceptual challenges, and offer perspectives shaped by their own regional systems. One of my personal highlights was seeing how researchers approached similar ecological questions through very different lenses, ranging from genomics and modeling to fishery observations and ecosystem-based management. This diversity of

perspectives was both inspiring and humbling, and it reinforced the importance of interdisciplinary approaches to understanding small pelagic dynamics.

Experiencing the symposium in La Paz, Mexico added another meaningful dimension to the event. The location served as a reminder of the close connection between marine science and coastal communities whose livelihoods depend on small pelagic fisheries. Beyond the conference venue, we had a boat day that became one of the most unforgettable highlights of the symposium. Seeing whales and dolphins in their natural habitat, swimming alongside sea lions, and experiencing local marine life up close made our shared interest in marine systems feel even more tangible (Figure 3). Sharing this experience also strengthened the friendships within our lab and made the symposium especially memorable.



Figure 3. A sea lion at Los Islotes, Espíritu Santo Island, a protected breeding habitat in La Paz, Mexico. Photo: Alexandra B. Regalado

Ziqin Wang

Attending SPF-2026 in La Paz, Mexico, was a truly memorable experience for me as an early-career researcher. Even before arriving at the conference venue, the journey had already become special: during our transfer in Mexico, we visited Teotihuacan, the famous archaeological site of Mesoamerican civilization, which felt like a meaningful beginning to the trip (Figure 4).

After arriving in La Paz, I was very happy to reunite with Florian Berg, who supervised my research stay in Norway from January to February this year. Meeting again at SPF helped strengthen our connection, both personally and academically. My supervisor, Prof. Shin-ichi Ito, also introduced me to many of his colleagues and friends. As a student, I sometimes felt that my words were still inexperienced when speaking with senior scientists, but listening to their discussions, questions, and perspectives gave me valuable knowledge and a broader view of small pelagic fish research.

Beyond the scientific sessions, I also enjoyed the atmosphere of the meeting and the people I met there. After the conference, I joined friends on a one-day boat tour to the islands north of La Paz. There, I saw whales for the first time in my life and later swam with sea lions. These experiences became precious memories for me, not only as part of SPF-2026, but also as part of my growth as a young scientist.



Figure 4. Group photo in Teotihuacan of ECOPs from the University of Tokyo, AORI. From right to left are Alexanra B. Regalado, Daisaku Suda, and Ziqin Wang. Photo: Ziqin Wang

Éamonn-Joeín Mac Donnachá

Among the many wonderful opportunities that SPF-2026 provided was the chance to hear some perspectives outside of research and the academic world. Some of the talks on small pelagics focused on a wider range of topics, including industry, fisher safety, economics, and management. This allowed people from many different fields to discuss and share the challenges that they each face. As an ECOP, this was extremely valuable as it offered perspectives on topics that intersect with small pelagic research that are often overlooked. SPF-2026 also gave me the chance to speak directly to many people from different fields to get career advice, as well as to hear about where they think small pelagic research is headed in the future. It was an insightful look into the challenges and the opportunities that we will face as ECOPs.

Participating as an ECOP in the Early Career Scientist Mentoring Event was extremely useful for me. During this event, participants could choose from several discussion groups to talk to mentors working in various fields, positions, and geographic locations. This event facilitated discussions about potential opportunities for ECOPs, and it allowed for conversations on how to navigate different fields and job perspectives within the small pelagic world. This helped me narrow in on the areas most relevant to me, as well as understand the challenges ECOPs will face in this field.

Wesley Greentree

The Small Pelagic Fish Symposium brought together many fantastic scientists. One of my favourite parts was finally meeting in-person with several collaborators after years of emails and Zoom calls. We have been working on a synthesis of SPF prey size data since 2022, so it was great to connect with co-authors whom I had not met in-person. I was also very happy to connect with colleagues with whom I previously had only minor interactions, as well as meet new people, including potential collaborators. For me, the next steps from this meeting are to continue to work with existing collaborators and begin to build partnerships with some of the researchers I met at the symposium.

The combination of great talks and getting to ask questions during coffee breaks and at the symposium dinner was very valuable. The symposium featured many great talks on the application of genomics to the ecology and sustainable management of SPF populations. Back in Canada, we are beginning our first DNA sequencing project. It was especially interesting to (a) see the

tools being applied in ways that I had not considered, (b) see novel approaches like low-coverage whole genome sequencing and archaeogenomics, and (c) ask basic questions (e.g., what does depth mean in DNA sequencing?). I'm thankful for these great experiences at the symposium, facilitated by PICES' travel support.

Applications

Madeleine Thomson

I was honoured to attend the 2026 Small Pelagic Fish Symposium with the support of a travel award from PICES. As my first international conference, the symposium was a valuable opportunity to learn from global experts and connect with researchers who share similar interests. In the Forage Fish and Food Webs session, I presented early results from my MSc research on predator-prey size ratios and forage fish consumption by juvenile salmon. The feedback and discussions that followed were highly informative, helping me think about new analytical frameworks and future directions for my work. It was especially rewarding to meet researchers whose work has helped shape my own and to discuss shared questions about marine food web ecology.

One of my biggest takeaways from the symposium was the importance of collaborative international meetings in exposing researchers to new ideas and perspectives. Throughout the week in La Paz, I heard about several topics directly relevant to my research, including trait-based approaches to diet analysis, best practices for stable isotope work, and methods for monitoring climate-driven shifts in trophic ecology. Listening to the discussions that followed presentations was equally informative, highlighting the diversity of perspectives on ecological problems and methods. I am grateful to have had the opportunity to participate in this event and develop new connections with researchers across the international small pelagic fish community.

Future Directions

Raquel Ruiz

One of the strongest themes I saw emerge from the Small Pelagic Fish Symposium was the growing recognition that future fisheries science must better integrate ecological complexity, climate variability, and human dimensions into management. From Session 1 and Workshops 2 and 7, Management Strategy Evaluation (MSE) frameworks stood out as particularly powerful tools for exploring environmental change, testing



Figure 5. Boats on the beach in La Paz. Photo: Sonia Batten.

trade-offs, and evaluating management options under uncertainty. Several presentations highlighted how spatial distributions of small pelagic fish are shifting in response to climate variability, while others linked environmental conditions to life-history processes such as growth and maturation. Talks also demonstrated the value of models of intermediate complexity in supporting operational fisheries management while remaining computationally feasible and interpretable.

At the same time, many discussions focused less on model development itself and more on the challenge of bridging the gap between science and decision-making. A recurring question was how to communicate uncertainty and model complexity in ways that are transparent, understandable, and actionable for managers and stakeholders. Ensemble and multimodel approaches were frequently highlighted as promising avenues for addressing uncertainty in both data and model structure. Collaboration with industry and stakeholders also emerged as a critical area requiring stronger engagement and co-development.

Another important takeaway was the need to better incorporate social dimensions into fisheries research. One keynote speaker noted that discussions often focus on “sustainable fisheries” without adequately considering the people and communities that depend on them, suggesting that the concept of “sustainable stocks” may sometimes dominate over broader sustainability goals. Although Session 5 addressed human dimensions, livelihoods, and governance, participation was comparatively limited, emphasizing that social considerations remain underrepresented in fisheries science and management. Over the next five years, integrating ecological, economic, and social objectives will likely become increasingly important for achieving truly sustainable small pelagic fisheries.

Nathanael Tabert

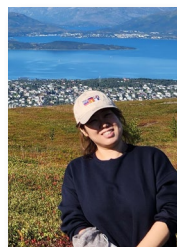
Local Results on an International Stage

With participants from 36 different countries, this meeting highlights the global importance of forage fish in marine systems. While similarities exist across systems, each has its own environmental, ecological, social, and political context that shapes the system itself as well as the research being done on it. As a result, at an international conference such as this, the implications of any given researcher’s work will likely not be fully understood by the audience, even in a room full of forage fish researchers. We cannot expect everyone to understand the ins and outs of every forage fish system in the world, but for

effective management to occur, each system must be thoroughly understood by someone. This understanding should be based in science. Methods and research implications that can be applied across systems are particularly valuable. For example, meta barcoding and otolith microchemistry analytical methods were shared in Session 5, “Spatiotemporal Dynamics of Small Pelagic Fishes in a Changing Ocean,” which can be used in a variety of settings even if results cannot be compared directly across systems. In contrast, the use of functional traits for characterizing food webs is an example of a methodology shared in Session 4 on Forage Fish and Food Webs that allows results to be compared across systems. Although research methods that facilitate comparisons across systems should be a priority on the international stage, certain contexts can only be fully understood by residing in and being connected to a specific location. Placed-based knowledge, whether through the personal connection of the researcher or through collaboration with local fishers and/or indigenous groups, was referenced often throughout the conference sessions. This connection to forage fish and the systems they are a part of helps to inform meaningful research by providing the local context that cannot be understood by scientific inquiry alone.

Conclusion

The 2026 Small Pelagic Fish Symposium brought together researchers from across the globe and different fields that share a core goal: to advance understanding and management of small pelagic fish. As early career scientists, we greatly benefited from our experiences attending this meeting. We connected with new and existing collaborators, broadened our horizons, thought carefully about our own research, and enjoyed beautiful La Paz. We are grateful to PICES’ support of our attendance at this meeting. See you at the next Small Pelagic Fish Symposium!



Soeon Ahn is a researcher at the Korea Institute of Ocean Science and Technology in Jeju, Republic of Korea. She received her Ph.D. from Jeju National University in February 2026. Her research focuses on marine spatial ecology, species distribution modeling, habitat suitability assessment, and sustainable marine resource utilization. She aims to better understand marine ecosystems by analyzing diverse environmental, ecological, fisheries-related, and biological datasets and applying data science and machine learning approaches. Outside of work, she enjoys spending time with her family and exchanging ideas with researchers from different fields.



Lane Atmore is a Banting Postdoctoral Fellow at the University of British Columbia in Vancouver, Canada. Her work addresses changes in marine management over time and how we can use ancient DNA to explore anthropogenic and climatic influences on key fish species, such as Pacific herring. Dr. Atmore's work is conducted in partnership with the Sitka Tribe of Alaska and funded in part by the National Geographic Society & the Lindblad Expeditions. Aside from science, Lane enjoys snorkeling, diving, piano, and hanging out in the woods with her dog.



Wesley Greentree is a PhD candidate at the University of Victoria on Vancouver Island, Canada. In partnership with the Pacific Salmon Foundation, he tracks the movements and diets of Chinook salmon around Vancouver Island. The importance of herring to salmon brought him into the small pelagic fish world, where he studies the role of small pelagic fish as both predators and prey. Outside of work, he enjoys fly fishing and crocheting sweaters.



Éamonn-Joeín Mac Donnachá is a PhD Candidate at Fisheries and Marine Institute of Memorial University Newfoundland. His research is on forage fish population dynamics, with a focus on developing an age-structured state-space population dynamics model for capelin off Newfoundland. In his spare time, he is an avid SCUBA diver, hiker, and saxophone player.



Alexanra Regalado is a PhD student at the Atmosphere and Ocean Research Institute (AORI), The University of Tokyo, Japan. Her research examines the life-history responses of small pelagic fishes to climate-driven range expansion across the Pacific through collaborative work spanning the Philippines and Australia. Using otolith-based approaches, stable isotope analysis, and environmental DNA (eDNA), she investigates growth, reproductive dynamics, migration, and phenotypic plasticity in rapidly changing marine environments. Outside the lab, she enjoys traveling, experiencing local food culture, and searching for good coffee in every place she visits.



Madeleine Thomson is a MSc student at the University of Victoria in British Columbia, Canada. Her research examines how variation in forage fish availability influences the feeding ecology and growth of juvenile Chinook salmon. She uses a combination of diet content and stable isotope analyses in collaboration with the Pacific Salmon Foundation. Outside of work, she enjoys playing volleyball and hiking with a good snack.



Hallie Repeta is a PhD candidate at the College of Marine Science of the University of South Florida in St. Petersburg, Florida, USA. Her research focuses on forage fish population dynamics and trophic connectivity on the West Florida Shelf, integrating ecosystem modeling and multivariate statistical approaches to quantify how bottom-up and top-down processes structure food web dynamics and influence the performance of candidate fisheries management procedures under climate-driven environmental variability. In her spare time, she enjoys scuba diving, cooking and traveling.



Nathanael Tabert is a MSc student in the Juanes Lab at the University of Victoria, British Columbia, Canada. His work focuses on the diets of adult Chinook and coho salmon in the coastal waters of southern British Columbia through the UVic Adult Salmon Diet Program (ASDP - THE JUANES LAB). His project has two main focuses: first, to look at long term trends in diets by comparing current data to historical records, and second, to characterize feeding patterns through spatiotemporal modeling. Nathanael enjoys diving, spearfishing, boating, and fish skeleton reconstruction outside of work.



Ziqin Wang is a third-year PhD student at the University of Tokyo and is expected to graduate in March 2027. His current research focuses on the dynamic assessment of fisheries resources using an individual-based model (IBM), with target species including Northwest Pacific chub mackerel. He is currently working on several research topics, including the effects of the Kuroshio Large Meander on fisheries resource dynamics, the bioaccumulation of microplastics, and changes in the spatial distribution of marine biological resources. He is also seeking postdoctoral or research scientist opportunities after his graduation in March 2027. If your team is looking for a modeler with experience in IBM or related approaches, please feel free to contact me at wangexcellent@gmail.com.



Raquel Ruiz-Diaz, University of Washington.

Workshop Summaries

SPF-2026 Workshop 1

Conceptualizing a Vulnerability Analysis for Anthropogenic Stressors on Small Pelagic Fish Communities

Rebecca Asch, Francis Juanes, Marta Moyano, and Patrick Polte

The impacts of fishing activities, climate change, and climate variation on small pelagic fishes (SPF) and other forage species have been long recognized, resulting in variations in stock size, recruitment, individual growth rates, and other population processes. However, the impacts of other anthropogenic activities on these fishes have not been studied as comprehensively, especially at broader spatial scales. These anthropogenic activities can be diverse, ranging from offshore energy production to coastal construction associated with beach renourishment, ship-channel dredging, and development of coastal infrastructure, such as jetties, breakwaters, and tsunami defences. Impacts of these activities and others can occur at the stages of planning, construction, operation, and decommissioning. Stressors produced by such anthropogenic activities can include sediment resuspension and deposition, alteration of benthic substrate, release of contaminants and nutrients, altered primary and secondary productivity, changes in dissolved oxygen concentration, increased noise levels, altered hydrodynamic flows, changes in light cues, introduction of invasive species, and direct entrainment of marine organisms.

Several of the authors have been asked by policymakers to provide expert input on how such activities could impact SPF, but often without adequate resources to thoroughly assess the risks to fish stocks. This experience motivated the development of this workshop on “Conceptualizing a Vulnerability Analysis for Anthropogenic Stressors on Small Pelagic Fish Communities” ([W1](#)), as well as the accompanying topic session on “New Approaches for Assessment of Human Impacts Beyond Fisheries” ([S2](#)), held at the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” ([SPF-2026](#)) in La Paz, Mexico. Both events are outputs of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF), which includes a sub-activity focused on non-fishing and non-climatic, anthropogenic impacts on SPF.

The half-day workshop was held on May 4 at the Interdisciplinary Center of Marine Sciences (Centro Interdisciplinario de Ciencias Marinas – Instituto Politécnico Nacional; CICIMAR-IPN) and attracted 18 participants from ten countries. This workshop was conceived as a first step towards developing a vulnerability analysis on anthropogenic impacts for SPF, which parallels the process of conducting a climate vulnerability analysis (CVA). Such analyses provide a mechanism to rapidly assess potential impacts on aquatic species, prioritize particularly vulnerable species for more intensive research, and identify key areas of uncertainty. A vulnerability analysis framework would need to include the following information: (1) different stressors and their modes of impact on SPF; (2) levels of exposure of SPF to these stressors and how this varies across life history stages and phases of project development; (3) cumulative impact of multiple stressors; and (4) the degree of uncertainty in both expert knowledge and the state of the science. A draft vulnerability analysis framework was developed by the



La Paz, Mexico

workshop convenors prior to the meeting, with the goal of using the workshop to obtain feedback and apply the framework to species representing different geographic regions. Our longer-term goals included the following: (1) distributing our vulnerability analysis framework to experts through a survey to assess differences in the vulnerability of SPF species with distinct life history traits, and (2) producing a multi-authored publication describing the survey results. Some of these longer-term goals were modified as described below due to workshop discussions.

The workshop participants were organized into three “regional” breakout groups, including the Eastern Atlantic, the Western Atlantic, and the North Pacific. For each region, participants were asked to review types of regional anthropogenic impacts that affect SPF, list stressors generated by those anthropogenic impacts, identify life history traits that influence SPF vulnerability, and recommend 2–3 species from their region to which the vulnerability analysis could be applied. Plenary discussions reviewed the topics presented by each group and developed recommendations for moving this project forward. Below we present a summary of these discussions.

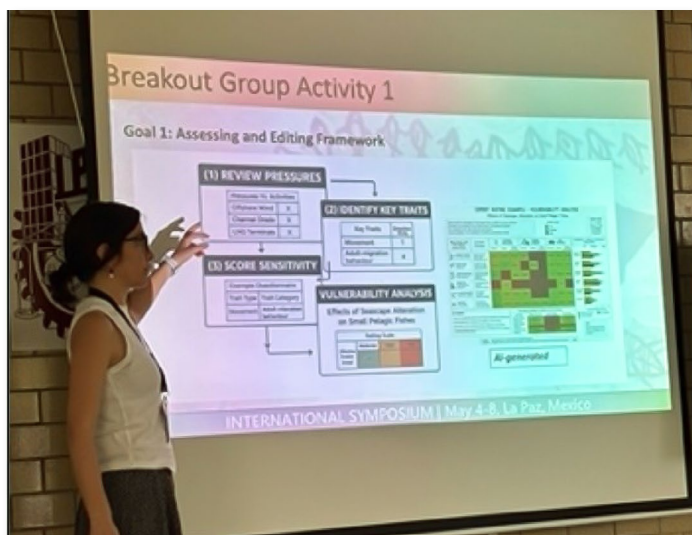
The breakout group focused on the North Pacific identified a number of anthropogenic impacts that were important in this region and were not listed among the initial impacts under consideration. These included the impacts of aquaculture, fish hatcheries, maritime shipping, deep-sea mining, desalinization, and the development of coastal barricades and dikes. They also discussed the need to consider additional stressors resulting from these activities, such as the role of light as an attractant for

marine organisms, changes in nutrient regimes as a result of hydrological alterations, and release of hormones as a potential chemical pollutant.

The breakout group for the Eastern Atlantic had an extensive discussion around the scope of proposed research activity and the extent to which the vulnerability assessment framework could be streamlined to allow participants to more easily complete a survey of expert opinion. Discussions addressed: (1) whether this activity should focus on solely SPF species or if it should include other forage species; (2) if impacts during different stages of planning and construction of offshore and coastal structures could be combined; (3) how to address the uncertainty related to decommissioning activities like offshore renewables; and (4) if the relevant spatial and temporal scales might differ between the planning and operational stages of projects.

The breakout group for the Western Atlantic focused on revising the list of species traits that may contribute to SPF vulnerability to anthropogenic activities. This group pointed out that (1) certain traits might vary across a species’ life history; (2) phenological coincidence between a species’ migration or reproductive season and an anthropogenic stressor could impact vulnerability; (3) a species’ position in the benthic or pelagic food web could affect their vulnerability; (4) sensitivity to chemical pollutants should be added as a trait not previously considered; and (5) plasticity in habitat use could increase a species’ resilience to anthropogenic impacts.

During the plenary session following the breakout groups, participants arrived at an agreement on next steps. Rather



Workshop 1 convenor Marta Moyano presents the topics to be discussed by participants during breakout groups (left) and workshop participants socialize during a coffee break (right).

than initially developing a widely distributed survey with a complex assessment of uncertainty, they decided that the first step would be to prepare a manuscript focused on presenting the rapid risk assessment framework and applying it to a few case studies using species with differing life history characteristics. This rapid assessment approach could be useful given the quick timeline often needed to make management decisions. Also, this framework might be useful for determining which risks could be mitigated to increase species' resilience to climate change. We proposed to develop separate case studies focused on land-based, coastal, and offshore anthropogenic activities. Also, we aim to have case studies that address mesopelagic, pelagic-spawning, benthic-spawning, and anadromous species in order to cover a diversity of life history characteristics observed among forage species.

The workshop outcomes were presented at both topic session 2 during SPF-2026 and the business meeting of WG53/WGSPF. Following these two presentations, audience members came forward to propose case studies on specific fishes, such as Peruvian anchoveta and Pacific sand lance. Work on finalizing the vulnerability assessment framework and compiling case studies will start soon. If you are interested in participating in this activity as a collaborator, please contact any of the workshop convenors.



Dr. Rebecca Asch (aschr16@ecu.edu) is an Associate Professor in the Department of Biology at East Carolina University in Greenville, North Carolina, USA. Rebecca is a fisheries oceanographer whose research combines fieldwork, time series analysis, and ecological modeling. Her early career research primarily investigated whether climate change could lead to increased seasonal mismatches between trophic levels, with a particular focus on small pelagic fishes. While changing phenology continues to be a research interest, current projects in the Asch Lab examine a greater diversity of topics, including tradeoffs between fish species shifting their geographic distribution vs. phenology in response to climate change, use of DNA barcoding to identify fish spawning habitat in the South Atlantic Bight, climate-related shifts in spawning habitat of species that form transient spawning aggregations, and impacts of ship-channel dredging on larval fish biodiversity. Rebecca is an ICES Co-Chair of the PICES/ICES Working Group on Sustainable Pelagic Forage Communities (WG53/WGSPF).



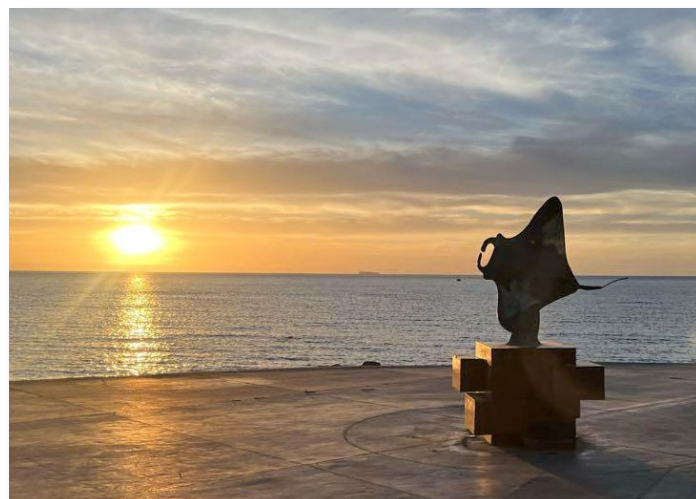
Dr. Francis Juanes (juanes@uvic.ca) is the Liber Ero Chair for Fisheries Research and a Professor of Biology at the University of Victoria, Canada. Francis' research interests lie at the intersection of behavior, ecology and conservation of fishes and marine invertebrates. His team studies underwater soundscapes with a focus on quantifying the effects of noise on fish, invertebrate and marine mammal behavior and communication, and also investigates the early life of Pacific salmon once they have entered the ocean.



Dr. Marta Moyano (marta.moyano@niva.no) is a Senior Researcher at the Norwegian Institute for Water Research (NIVA) and Adjunct Professor at the University of Agder (Norway). She investigates the effects of climate and anthropogenic activities on plankton and fish populations and works at the interface between marine ecology, ecophysiology, oceanography, and aquaculture, using a multifaceted approach (laboratory experiments, field sampling and numerical models). Her latest research focuses on the effects of offshore wind and coastal infrastructure (including nature-based solutions and nature-inclusive concepts) on marine ecosystems.



Dr. Patrick Polte (patrick.polte@thuenen.de) leads the working group for herring recruitment at the Thünen Institute for Baltic Sea Fisheries in Rostock, Germany. As a Senior Marine Ecologist his focus is on coastal fish nursery habitats and the environmental factors structuring their contribution to fish populations. Additionally, Patrick is responsible for the monitoring and extensive time series of Western Baltic herring recruitment feeding into the ICES stock assessments.



La Paz, Mexico.

SPF-2026 Workshop 2

Best Practices for Improving Assessment of Small Pelagic Fishes Using Environmental Indicators

Alexander Jensen, Jennifer Boldt, Kym Jacobson, Carryn de Moor, and Margaret Siple

Although environmental indicators are increasingly incorporated into stock assessments of marine fishes to inform demographic processes like recruitment, growth, and natural mortality, with the aim of improving model and management performance, their integration into assessments for small pelagic fishes (SPF) has lagged. There also are myriad ways in which environmental information can be leveraged in fishery assessments and management, with varying strengths and weaknesses. Data-rich assessments are rare for SPF worldwide, and the recommended methods for accounting for environmental variability depend on data and resource availability. Best practices for the integration of environmental information in assessments, as recommended by researchers and practitioners, can address these challenges and enhance SPF management.

The half-day workshop on “Best practices for improving assessment of small pelagic fishes using environmental indicators” (W2) was convened on May 4, 2026 as part of the ICES/PICES international symposium “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries (SPF-2026)” in La Paz, Mexico. The hybrid workshop had the following objectives: 1) identify commonalities, challenges, and opportunities in an effort to integrate environmental

conditions into single-species stock assessments and management of SPF, and 2) identify recommendations and best practices for future efforts. The workshop was attended by 69 in-person and 9 online participants who contributed diverse global expertise and roles in the fishery management process, including field biologists, ecologists, statisticians, stock assessors, and managers.

Following introductions and a workshop overview, Dr. Bocar Baldé and Dr. Alexander Jensen presented case studies on efforts to integrate environmental indices in assessments for SPF in the Canary Current Upwelling System and in the California Current Ecosystem, respectively, to highlight relevant advances (and challenges!). Participants then joined breakout groups to discuss additional case studies and synthesize findings and recommendations across fisheries. Each breakout group included at least one case study expert and one rapporteur to facilitate discussions and capture insights. To conclude the workshop, groups shared summary takeaways and recommendations with the broader audience.

Breakout groups discussed and synthesized the takeaways from a wide variety of case studies, including species of anchovy, herring, sardine, sardinella, and smelt from different regions of the Atlantic Ocean, Pacific Ocean, Baltic Sea, Mediterranean Sea, and North Sea. Recurring focal case studies included Pacific sardine (*Sardinops sagax*), Atlantic herring (*Clupea harengus*), and Pacific (chub) mackerel (*Scomber japonicus*). Comparisons across case studies led to general takeaways and recommendations to incorporate the environment into assessments.

First, there are numerous tradeoffs in selecting which life history processes to model as a function of environmental indicators. Recruitment typically receives the most focus in identifying environmental-demographic linkages for SPF given its outsized importance to population forecasting and fisheries management. However, identifying reliable relationships between the environment and recruitment has proven a consistent challenge. Modeling natural mortality as a function of the environment may provide



Workshop 2 case study presentation.

a more tractable alternative. Numerous SPF assessments either specify or are exploring the use of time-varying natural mortality, and recent research suggests estimated relationships between recruitment and the environment could be driven by underlying variation in natural mortality. Modeling linkages between movement and the environment has also proven effective, especially in fisheries with spatial management considerations. Linking environmental variation to other processes like growth may further improve assessments and management.

Participants also identified numerous persistent challenges to integrating environmental indicators into SPF assessments, including poorer model fits when ecologically important indicators are incorporated into stock assessments. This could be a result of spatial and temporal mismatches between the scale of environmental drivers and available biological data on SPF, as well as changes in the strength of the environmental influence on the stock. Other challenges included the difficulty of modeling highly variable recruitment and environmental complexity causing variation that is not entirely captured by the environmental indicator. In some cases, previously established environmental relationships did not persist when more years of data were included, demonstrating that even informative indicators, once established in assessments, can rapidly become unhelpful when unpredicted environmental changes occur.

Institutional and process-based barriers to incorporating environmental information into assessments also arose as a discussion theme. Assessments for some SPF stocks do not receive support for incorporating environmental relationships until a recruitment failure or other large-scale population event occurs. Others receive attention from scientists and decisionmakers but sufficient resources are not available to identify and incorporate new data streams. Developing and integrating useful data streams for environmental indicators may entail interdisciplinary collaborations between assessment scientists, oceanographers, ecosystem biologists, and other specialists, and institutional support for these coordination efforts would benefit the uptake of indicators into assessments.

Workshop participants identified several high-level recommendations for incorporating environmental information in the stock assessment and management process. They include: 1) supporting and enhancing interdisciplinary collaboration between stock assessment scientists and teams who collect ecosystem data; 2) developing standardized model diagnostics and metrics of success; 3) adopting a modular approach to

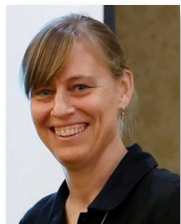
modeling, including participatory models that engage stakeholders and multiple assessment methods ranging from data-limited to data-rich; 4) adopting open science methodology to enhance data standardization and reproducibility; 5) exploring the feasibility of emerging technologies like environmental DNA to collect data at relevant scales; and 6) embracing advances in computing power, model complexity, and climate models. Workshop participants also acknowledged the value of incorporating environmental variables in other parts of the assessment and management process, including data standardization, risk tables, reference points, harvest guidelines, and simulation frameworks such as management strategy evaluation. There was broad agreement that original research to identify indicators, as well as model-based evaluations to test their utility in stock assessments, should be ongoing, as environmental shifts can render indicators more or less useful over time.



Workshop 2 breakout group (top) and plenary (bottom).



Dr. Alexander Jensen is a stock assessment scientist with the Fisheries Resources Division at the NOAA Fisheries' Southwest Fisheries Science Center. He conducts stock assessments and fisheries research for coastal pelagic species like Pacific mackerel and Pacific sardine and is broadly interested in incorporating new data sources (e.g., genomics, ecosystem information) to improve model performance and fishery management.



Dr. Jennifer Boldt is a Research Scientist with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, BC. Her research focuses on pelagic fish and the environment. She conducts research and monitoring to improve the understanding of factors affecting pelagic fish and to integrate ecosystem information into science advice for sustainable fisheries management. Within PICES she is a member of the Joint ICES/PICES Working Group on Sustainable Pelagic Forage Communities (WG53), MONITOR, FUTURE SSC, and Science Board Chair.



Dr. Kym Jacobson is a Supervisory Fisheries Biologist and the Program Manager for the Estuarine and Ocean Ecology program with NOAA Fisheries' Northwest Fisheries Science Center. The program includes long-term research and ecosystem monitoring projects, including the Juvenile Salmon Ocean and Ecosystem Survey, the Newport Hydrographic Line, and the Northern California Current Ecosystem Survey. She is a member of the Pacific Fisheries Management Council's Coastal Pelagic Species Management Team, and is the Chair of the PICES Technical Committee on Monitoring.



Dr. Carryn de Moor is a Chief Research Officer at the Marine Resource Assessment and Management (MARAM) Group, University of Cape Town, South Africa. Carryn's research focuses on the quantitative assessment of marine resources and sustainable fisheries management, with a particular interest in advancing best practices for Management Strategy Evaluation. Having been a member of the South African Department of Forestry, Fisheries and the Environment's Small Pelagic Scientific Working Group for more than two decades, she has also developed an interest in managing the fisheries of these highly dynamic species to account for spatial structure in the underlying populations, their key role in the ecosystem, and trade-offs in competing objectives.



Dr. Margaret Siple is a Research Fish Biologist in the Groundfish Assessment Program at NOAA's Alaska Fisheries Science Center (AFSC). Her research at AFSC addresses areas where ecosystem information can be incorporated into the assessment and management process, as well as how fisheries-independent survey designs can be improved to account for environmental variation. She earned her PhD from the School of Aquatic and Fishery Sciences at the University of Washington in 2017, where her research focused on accounting for ecological uncertainty in the management of small pelagic fish, and she has since worked on modeling risk in marine mammal bycatch management and ecosystem-based fisheries management. She is a member of the Joint ICES/PICES Working Group on Sustainable Pelagic Forage Communities (PICES WG53).



SPF-2026 Workshop 3

Addressing Knowledge Gaps and Future-proofing Monitoring of Small Pelagic Communities Using Novel Methods and Technologies

Chris Rooper, Maria Manuel Angelico, David McGowan, Heidi Pethybridge, Niels Hintzen, Brian Hunt, Benoit Berges, and Qiuyun Ma

A half-day hybrid workshop on “Addressing Knowledge Gaps and Future-proofing Monitoring of Small Pelagic Communities Using Novel Methods and Technologies” (W3) was convened on May 4, 2026, as part of the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) in La Paz, Mexico, and brought together experts involved in surveying small pelagic communities to explore case studies from around the world and discuss how emerging technologies and analytic methods can enhance or complement traditional survey approaches. About 35 people attended in person at the workshop, while another 5–10 participated online.

A series of short presentations that described case study surveys and applications started off the workshop. Each presentation highlighted the pros and cons of novel technologies or methods relative to traditional methods. A common theme across regions and disciplines was that future monitoring of small pelagic communities will increasingly rely on integrating traditional survey methods with complementary and emerging technologies such as eDNA, autonomous and multi-sensor platforms, machine learning, electronic reporting systems, and ecosystem modeling. Rather than replacing existing approaches, these technologies were generally viewed as tools that can address specific limitations of traditional surveys and improve the spatial, temporal, and taxonomic resolution of monitoring programs.

Four of the case studies communicated the integration of eDNA into traditional survey frameworks: 1) an ecosystem survey of international waters in the North Pacific that integrated eDNA sampling into an ecosystem survey using multiple gears to estimate biomass of squid and small pelagic fishes; 2) egg production surveys for sardine in Australia attempted to estimate species composition and egg and larval abundance using eDNA; 3) a comparison from South Africa of trawl-caught biomass and eDNA estimated abundance from an underway sampler in the net; and 4) a



Pelicans in La Paz, Mexico.

Bayesian joint linear model that combined an acoustic-trawl survey for anchovy and eDNA collections in the Bay of Biscay.

A fifth case study integrated an uncrewed surface vehicle (USV) into an acoustic-trawl survey conducted using a traditional research vessel and found that using the USV vastly increased efficiency and decreased the coefficient of variability around SPF biomass estimates in Norwegian fjords. This USV study showed a data processing method that allowed for automation of acoustic data scrutinization in the cloud to increase efficiencies and demonstrated the benefits of using artificial intelligence and machine learning for data processing and analyses. Another case study also highlighted the advantages of using machine learning techniques and ensemble models to link environmental conditions to aggregation of jack mackerel and its euphausiid prey, potentially addressing non-stationarity concerns that can confound survey abundance estimates.

The final two case studies both provided methods to incorporate more fisheries-dependent data into fish abundance estimation. The first presented a phone application that allowed fishers to input data in real time on fish species captured, catch weight, catch location, predator

interactions, and discards. The second demonstrated an electronic catch reporting system that allowed for a wider collection of non-catch data (i.e., search time) for a small and agile purse seine fleet that uses spotter planes to search and find SPF aggregations to target.

The final talk in the workshop presented a summary of metadata from small pelagic fish surveys from around the globe. This informal meta-database has been compiled since approximately 2020 and represents data from more than 60 SPF surveys that are routinely conducted around the world. Most of these surveys are carried out annually, in the spring and summer, with trawls, acoustics, and plankton nets. The surveys typically target adult and juvenile life history stages, with a smaller proportion aiming at larvae and eggs.

Following the case study presentations, there were two rounds of discussion. The first focused on the case studies themselves and highlighted a few key outcomes of the presented case studies. In general, eDNA complemented each of the surveys well, but standardization is key. For example, the comparability of the abundance of fish using eDNA collected by an underway sampler mounted inside a trawl to the overall survey catches was much better than the correlation between net-based estimates of egg and larval abundance and eDNA-based estimates collected by bottles in the same general area. This indicates the need for standardization of methods and calibration when incorporating new technologies into existing survey methods. It was also noted that eDNA data are typically assessed against net-collected data as the benchmark, but that these data are themselves subject to bias (e.g., avoidance and size selectivity). It is important to keep in mind the advantages and disadvantages of all methods being used and how they can complement each other.



La Paz waterfront.

During the second round of discussion there were four small breakout groups and each was asked to bring forward significant issues with surveying pelagic fishes (e.g., high variability in biomass estimates, large response to environmental changes in terms of distributions and abundance, and non-stationarity of surveys), potential solutions to these issues, and also provide their thoughts on the future of SPF surveys. In addition to the examples above, some of the issues identified by breakout groups were changes to survey area/fish availability (e.g., implementation of marine protected areas, offshore wind farms, etc.); lethality of survey methods; selectivity of survey methods (e.g., mesh sizes that only capture adult fish, eDNA that does not discriminate among sizes or life stages); long-term trends in fish distribution; survey efficiency (in terms of cost efficiency); changes in phenology relative to the survey; seasonality of fish distribution and abundance; standardization of surveys; data integration; hyperstability of catch-per-unit-of-effort; transboundary stocks; unknown fish behavior; and a survey's ability to sample over the entire stock area.

Finally, the breakout groups discussed the different ways that advanced technology might provide solutions to some of the highlighted issues. Most of the solutions envisioned the use of uncrewed vehicles (e.g., gliders, sail drones, etc.) to increase the efficiency of surveys (thereby reducing costs), cover wider areas or better cover existing areas, reduce estimate variability, and cover seasons or times that are currently not sampled. Better use of fisheries and other data sources, through statistical techniques, additional reporting, or sensors, was also viewed as a solution to some of the coverage, timing, and efficiency issues. It was noted that net-mounted cameras, underway samplers, and other sensors were increasingly being implemented into existing surveys to supplement traditional data sources, and often these technologies were put in place to provide solutions to survey issues. Artificial intelligence (machine learning) was considered as a way to increase the efficiency of data processing and analysis. Advances in genetics, including both eDNA sampling and techniques like close-kin mark recapture, can also supplement the information from traditional surveys. Participants also highlighted the importance of full ecosystem and full life-cycle monitoring using survey platforms, which can inform species distributional changes and patterns in abundance and timing of species life history stages. Observation system simulation experiments (OSSE's), which use computer models to identify data needs and gaps and help to implement adaptive sampling strategies, were also brought up as a solution that has been used in climate and weather

forecasting to identify key data points or streams that need to be collected. Lastly, it was noted that full funding for surveys is essential to maintaining the monitoring of SPF populations, but technologies can often reduce costs. Avenues for developing technologies and efficiencies, such as joint efforts with start-up technology companies or linkages to technologies developed for the fishing industry, are often under-utilized, but hold promise for decreasing cost while increasing survey effectiveness.

To synthesize these discussions, Table 1 summarizes some of the major monitoring challenges identified by workshop participants and the emerging technologies and approaches that were viewed as promising tools for addressing them.

A key discussion point for the workshop was around the topic of surveys in the year 2050 and other points in the future (Fig. 1). In 1964, Alverson and Wilimovsky predicted that in “30 years we foresee fishing fleets and fish being brought together by a central computing and forecasting office. Supplied with information from a network of buoys and remote-controlled submersibles, this office would keep a constant watch on schools of fish and on physical conditions at sea”; however, this prediction has not been fully achieved (Alverson D.L., Wilimovsky N.J. 1964. Prospective developments in the harvesting of marine fisheries. In: Kristjonsson H., editor. Modern fishing gear of

the world. Part 3. Technical research. Fishing News (Books) Ltd; London. pp. 583–590). In the spirit of this quote, workshop participants were asked to think about what future surveys of small pelagic forage communities would look like. A few key ideas were common across breakout groups and discussions:

Enhanced ecosystem surveys. It was recognized that many SPF surveys conducted today still focus on single species. In the future, participants recognized the need, given both the strong impact of the environment and biology (e.g., predation) on small pelagic fishes, to conduct more holistic surveys of the ecosystem to obtain a comprehensive picture of processes and drivers of these populations.

Incorporation of new technologies. Most participants indicated that in the future technological advances and artificial intelligence would play a larger role in small pelagic surveys. However, there was a wide range of answers to whether new technologies would fully take over. For example, some participants indicated that existing methods, such as acoustic-trawl surveys, would continue but be supplemented by additional sampling using new technology (e.g., underway eDNA sampling). Others visualized a future where USVs, or gliders controlled via satellites, conducted entire surveys.

Table 1. Key monitoring challenges and emerging technologies that may help to address them identified during W3 workshop discussions.

Challenge	Promising technologies and approaches
Species composition in mixed schools	eDNA, broadband acoustics, optical systems (cameras), machine learning classification
Survey cost and efficiency	USVs, gliders, fisheries-dependent data, automated processing, electronic monitoring
Spatial coverage	Autonomous platforms, fisheries-dependent observations, multi-sensor platforms, habitat/ecosystem models
Temporal coverage	Moorings, fisheries data, multi-sensor autonomous platforms, eDNA, remote sensing
Distribution shifts and non-stationarity	Habitat/species distribution models, remote sensing, adaptive surveys, autonomous platforms
Natural mortality and ecosystem processes	Predator biologging, ecosystem models, diet studies, eDNA approaches
Fish behaviour and availability bias	Optics, tagging, biologging, combined acoustic-optical systems, broadband acoustics
Data integration and uncertainty	Multi-sensor platforms, integrated survey designs, data assimilation frameworks, ML and AI-assisted data fusion

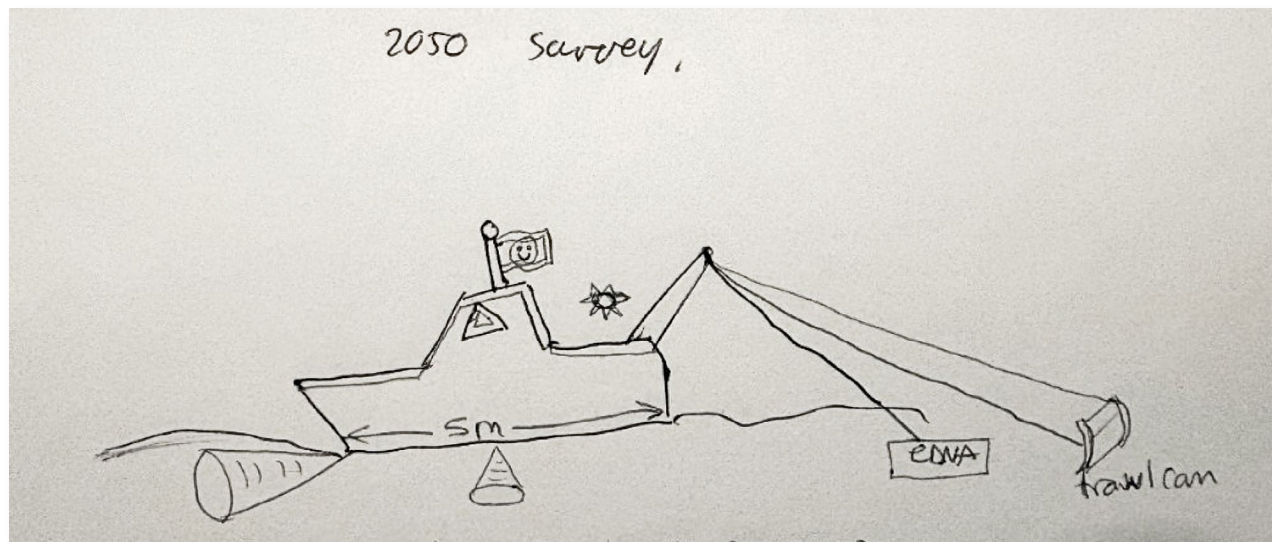


Figure 1. Participants' rendition of a small pelagic fisheries survey vessel in 2050 featuring underway eDNA samplers, a trawl outfitted with an open cod-end and a camera, and forward and downward looking sonars (image by Brian Hunt and Jennifer Boldt).

Incorporation of fisheries and other data. Participants also agreed that data collected by fishers and others, such as citizen-science programs, would have a role in future monitoring. Given the high cost of scientific surveys and the reductions in cost of technology (e.g., low-cost temperature sensors and underwater cameras), it is likely that we will see increased instrumentation of industry vessels to collect the types of data that we currently rely on scientific surveys to collect. Utilization of these data sources will allow for a much broader and larger view of small pelagic fish dynamics.

Adaptive survey designs. Participants recognized that future monitoring systems will need to respond to increasing non-stationarity associated with climate change. Distribution shifts, changes in phenology, novel species assemblages, and the emergence of transboundary stocks are already challenging traditional survey designs in many regions. Future survey systems will likely require greater adaptability, with increased use of autonomous platforms, habitat models, and integrated environmental observations to track changing ecosystem conditions and maintain survey relevance through time.

Integration of new data sources. All participants agreed that no matter what the future configuration of surveys would be, integrating new sources of data would be a characteristic of surveys in 2050.

A conclusion from the workshop was that no single emerging technology is likely to replace existing survey approaches. Rather, future monitoring systems will increasingly rely on integrating complementary data streams, including acoustics, optics, genetics, environmental

observations, and fisheries-dependent information. The challenge moving forward will be less about identifying a single optimal technology and more about developing efficient frameworks for combining diverse sources of information to address key uncertainties in abundance, species composition, ecosystem processes, and climate-driven change.

We anticipate compiling the case studies and discussions presented in the workshop to form the basis of a research paper that will be finalized in late-summer 2026. The initial draft of the paper has been completed, and it will include a systematic comparison of traditional and emerging survey tools and approaches based on key criteria (types of abundance proxies, scalability potential across different ecosystems and species, practical implementation considerations, survey costs, etc.). The aim is to offer practical guidance for researchers, managers, and agencies operating under diverse resource and operational constraints to survey small pelagic communities.

Acknowledgements

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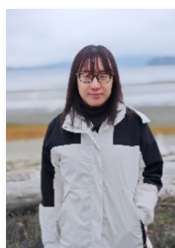
Dr. David W. McGowan (david.mcgowan@noaa.gov) is a Research Fish Biologist with the Midwater Assessment and Conservation Engineering (MACE) program at the National Oceanic and Atmospheric Administration (NOAA) Alaska Fisheries Science Center in Seattle, WA, USA. His current work involves conducting acoustic-trawl surveys for walleye pollock in Alaska and establishing best practices for using spatiotemporal mixed effects models to analyze acoustics survey data. His primary research interests include improving the design of acoustic-trawl and integrated ecosystem surveys using traditional and emerging sampling and analysis approaches, with a particular focus on improved monitoring of data poor species such as capelin and other small pelagic species.



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Dr. Heidi Pethybridge is a Senior Researcher at CSIRO, leading the Acoustic and Pelagic Ecosystem Team. She studies the trophic ecology and bioenergetics of oceanic species like sharks, squid, tunas, and pelagic fishes using diet analysis, biochemical tracers, and ecosystem models. Her work informs fisheries, nutrition, aquaculture, deep-sea mining, and conservation policy. She leads the [SEA-MES Project's](#) trophic component and her team manages the [IMOS Bioacoustics sub-facility](#), holding one of the largest mesopelagic datasets globally. Heidi also co-chairs [IMBeR-CLIoTOP](#), advancing research on climate impacts on oceanic top predators and their ecosystems.



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SPF-2026 Workshop 4

Identifying Management- and Industry-informed Research Priorities for Small Pelagic Fishes

Matthew Baker, Susana Garrido, Niels Hintzen, Minje Choi, and Asami Takahashi



Pelagic fishery vessels, Akutan Island, Aleutian Island Chain, Alaska, USA [photo credit: Matthew Baker]

A half-day workshop on “Identifying Management- and Industry-informed Research Priorities for Small Pelagic Fishes” (W4) was convened on May 4, 2026, as part of the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) in La Paz, Mexico, and brought together 28 fisheries scientists and fishing industry leads. Discussions focused on opportunities, challenges, and effective approaches to identify research priorities for fisheries science, which reflect the needs, interests, and insights of fisheries managers, fishers, and the fishing industry. The workshop’s objective was to outline strategies to initiate and coordinate further engagement of the fishing industry in setting priorities for research to inform fishery management through facilitated discussions with fisheries scientists, managers, and industry representatives. Industry is often motivated by particular objectives (e.g., maintain exploited stocks, improve gear, and access areas). Science is motivated by research questions and management objectives. The intent of this workshop was

to facilitate more productive exchange between these two sectors to inform management. Discussions aimed at determining effective means of translating objectives into research questions and priorities.

In advance of the workshop, the workshop convenors developed a survey translated into 6 languages and sent it to more than 200 fishing captains, industry leads, and representatives of pelagic fisheries. Participants were asked to identify management-informed and industry-informed research priorities in their region and outline existing mechanisms to solicit priorities within the existing fishery science and management structures. Survey results were compiled from 44 participants engaged in pelagic fisheries targeting 22 stocks in the Bering Sea, Gulf of Alaska, California Current, New England and Mid-Atlantic in North America, the Humboldt Current in South America, the North Sea, Celtic Sea, Bay of Biscay, and Iberian Coastal shelf in Europe, the Benguela and Agulhas currents in southern Africa, and in Korea and Japan (Figure 1).

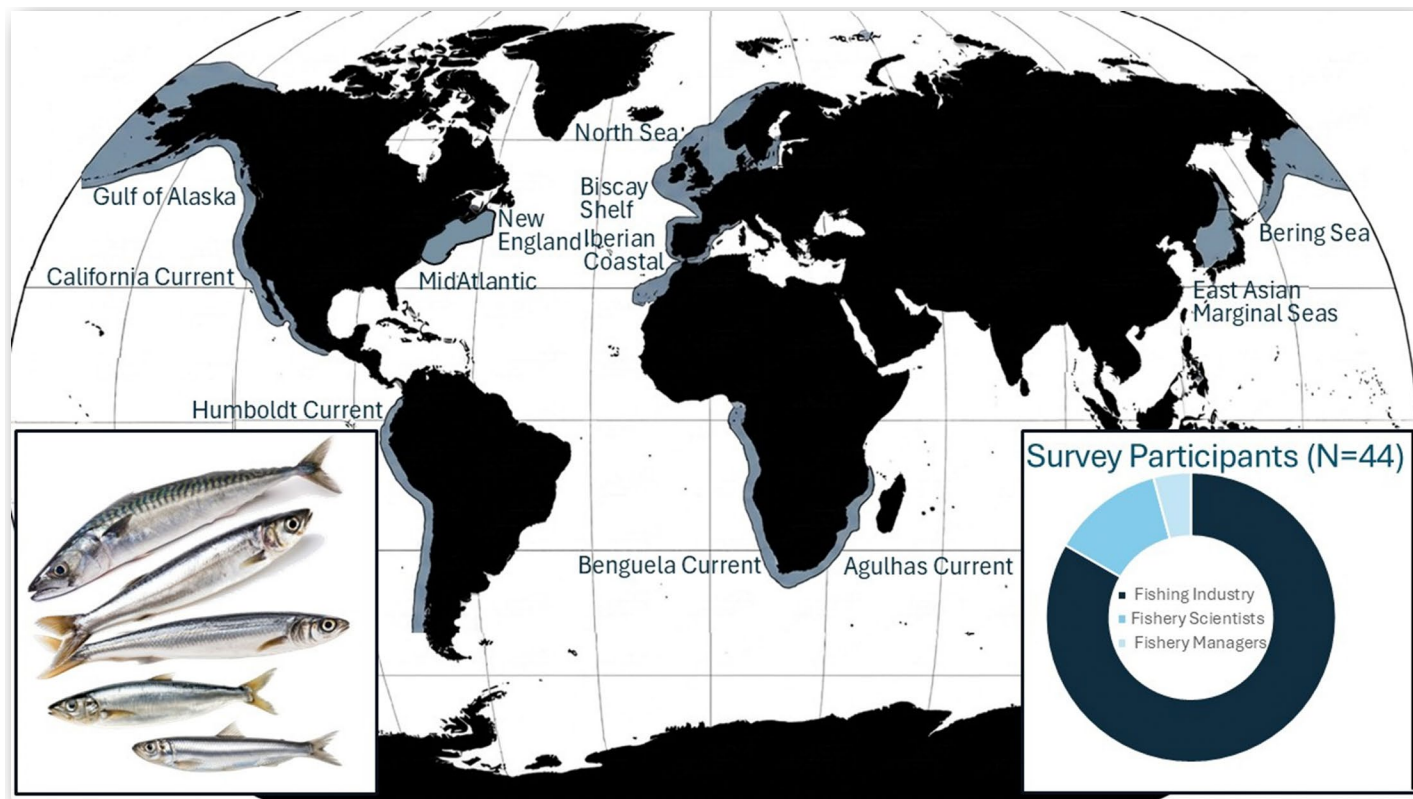


Figure 1. Surveys were provided to industry leaders, fisheries managers, and fishermen to solicit ideas on existing mechanisms and new approaches to identify needs and priorities for scientific research on small pelagic stocks and related issues informative to fisheries. Results were collected from 44 participants in 12 distinct large marine ecosystems (shaded areas), representing 22 distinct pelagic fisheries. The survey is available online at: <https://www.surveymonkey.com/r/FW8GF8F>.

The convenors opened the workshop and provided a summary of survey results:

- Primary research priorities for industry comprised: better information on stock availability, improved understanding of survival, biological condition, environmental variability, and behavioral data.
- Perceived benefits from setting priorities included: design for efficiency and bycatch reduction, diversification of fishing activities, gear modifications, environmental variability, and research that generates economic returns for the industry.
- Identified mechanisms and formats for industry engagement were: industry research foundations, processes within fishery cooperatives, discussions within industry associations, participation in Council meetings and directed committees, workshops, and one-on-one communication with fishermen and industry leaders. It is also conceded that “dialogue often lacks structure or fora for exchanging opinions” and that there was a “need for a holistic list or reference tool for communication across institutions.”
- Recognized opportunities for engagement included: word of mouth or established fora, quarterly meetings with fleet managers, disaster relief projects, expos, engagement with scientists, via gear manufacturers, and through integration of scientific and industry data repositories.
- Areas identified where industry data is underutilized encompassed: fishermen’s knowledge of ocean conditions and how species react to changes in weather, currents, seasons, acoustic and biological data collected by fishing vessels, leveraging information in logbooks, accessing data at processing plants, and the utility of fishery dependent data and data collection opportunities.
- Primary challenges and necessary conditions for successful research included: coordination regarding priority topics, mutual respect, communication, investment of time and resources, sharing data and results, relaying research and findings back to fishermen, and sharing data with fishermen. Participants noted that “nothing is linear, be open to learning other valuable lessons along the way.”

Positive examples of past engagement and paths forward were highlighted from the [2019 Wakefield Symposium on Cooperative Research](#) on strategies for integrating industry perspectives and insights in fisheries science, a recent [ICES workshops](#) to promote science-industry collaboration, and other examples published in the [Frontiers in Marine Science Special Issue](#) on challenges and lessons for integrating fishers' knowledge into marine science.

The workshop then featured several invited presentations:

- Salvador Peraltilla (Head of Oceanography and Fisheries Sustainability, Pesquera-Tecnologica de Alimentos, Peru) spoke on oceanographic platforms used in the fleet and implementation of sustainability practices in fishing activities, using fishermen's awareness and modern technology.
- Aquiles Sepulveda (Research Director at the Fisheries Research Institute, Chile) discussed scientific collaboration with industry and advances in biophysical modeling of jack mackerel.
- Rita Vasconcelos (Researcher at the Portuguese Institute of the Sea and Atmosphere and member of ICES working group on Commercial Catches) reviewed sampling programs for fisheries dependent data and frameworks used to produce scientific advice for management.
- Katie Brigden (Fisheries Scientist and expert in industry-science collaboration at University of the Highlands and Islands, Shetland, UK) presented on the Scottish pelagic industry and science data collection efforts and insights into industry priorities for research related to the herring, mackerel, and blue whiting fisheries, particularly through efforts of the Scottish Pelagic Fishermen's Association.
- HoGeun Jang (Professor of Marine and Fisheries Business and Economics, Pukyong National University, Korea) spoke on the complex relationship between resource management and industry, concentrating primarily on the Japanese anchovy and Japanese sardine fisheries. The talk highlighted ways to implement flexible total allowable catch systems to dynamically respond to stock fluctuations and means to empower local fishing communities by strengthening autonomous self-management capabilities.
- Jorge Abrantes and Sandra Farinha (ANOPCERCO – National Association of Purse Seine Fishing Producer Organizations, Portugal) reviewed the Iberian sardine fishery, highlighting the perspective of the purse seine fishing sector in Portugal and the importance of

dialogue between researchers and fishermen in the sustainable management of these resources.

Two pre-recorded interviews were also aired, provided by:

- Matt Alward, a herring and salmon fisherman and representative of the United Fishermen of Alaska, Pacific States Marine Fish Commission, and Seafood Harvesters of America; and
- Susie Zagorski, Intercoop Manager at United Catcher Boats and industry scientist engaged in collaborative research for the Alaska fisheries, focused on commercial fisheries bycatch, conservation engineering, and habitat protection.

Subsequent group discussions were held to detail existing or proposed models and frameworks and to identify challenges and next steps. The convenors directed debates to focus on (1) why and how to promote industry engagement in setting priorities for research and what mechanisms might be most effective and (2) what are the benefits of industry-informed research priorities, as well as best practices and/or lessons learned, and challenges, barriers, opportunities, and pathways. Finally, discussions delved into what the specific industry priorities for research are and what frameworks exist to solicit them, including the following:

- Research Set-Aside: a portion of the total allowable catch is auctioned to fund specific research;
- Scientific Quota: catches for scientific research are not subtracted from quota utilization;
- Cost Recovery: industry covers a portion of research costs;
- Grants: government or private investment in industry-motivated research; and
- Cooperative Research: established institutions/frameworks for co-investment in research.

In addition to presenting a workshop report to primary international organizers, it is anticipated that a peer-reviewed manuscript that builds on these discussions and survey results from industry representatives will be produced. Participants have been asked to further disseminate the questionnaire to solicit industry perspectives and priorities. The manuscript and associated efforts subsequent to the workshop will aim to:

- inventory processes to solicit industry input and identify information gaps and priorities;
- review fisheries management fora to synthesize industry testimony and input;
- survey fishery managers of small pelagic stocks;

- survey fishing industry representatives of small pelagic stocks;
- analyze and collate research priorities and needs;
- analyze and propose mechanisms to solicit industry priorities for science;
- share results and work with existing fisheries management structures—fishery management councils in the US, ICES (Europe), and similar management fora—to secure relevant data, determine existing processes, and inform future efforts.



Boatyard in La Paz, Mexico. Photo credit: Raul Aguirre Gomez



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Dr. Niels Hintzen (nhintzen@pelagicfish.eu) is the Chief Science Officer at the Pelagic Freezer Trawler Association, which represents 18 freezer trawler vessels that fish for herring, mackerel, horse mackerel, and blue whiting. Niels coordinates research onboard vessels and contributes to international efforts to improve knowledge of the marine environment and provide data to allow quantitative evaluation of fishing impacts.



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SPF-2026 Workshop 5

Revisiting the Potential of Sedimentary Records: New Answers to Old (and Emerging) Questions on Forage Fish Ecology versus Climate Variability

Renato Salvattecí, Dimitri Gutiérrez, David Field, and Salvador Lluch-Cota

Forage fishes such as sardines, anchovies, and herrings play a central role in marine food webs and support some of the world's most productive fisheries. Understanding how these species respond to climate variability remains a major scientific challenge, particularly as marine ecosystems face increasing pressures from climate change and fishing. A half-day workshop on “Revisiting the Potential of Sedimentary Records: New Answers to Old (and Emerging) Questions on Forage Fish Ecology versus Climate Variability” (W5) was organized during the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) in La Paz, Mexico, and brought together 12 researchers from the fields of paleoceanography, fisheries science, marine ecology, archaeology, and climate science. The program consisted of a keynote presentation, four contributed talks, and an open discussion focused on identifying opportunities to integrate paleo-records into fisheries science, ecosystem modeling, and climate adaptation strategies.

In his keynote presentation, Renato Salvattecí reviewed recent advances in paleoecological reconstructions of forage fish populations from eastern boundary upwelling systems, including Peru, California, Chile, Namibia, and British Columbia. He highlighted methodological innovations such as sedimentary ancient DNA (sedaDNA), isotopic approaches, and geochemical proxies that are expanding both the scope and resolution of paleoecological research (Figure. 1).

Several presentations demonstrated how emerging molecular techniques are transforming the field. New sedaDNA reconstructions from the northern Humboldt Current System illustrated how fish community composition can be tracked over the last millennium, while recent developments in marine archaeogenomics highlighted the potential of ancient DNA to reconstruct past population dynamics, genetic diversity, and stock responses to climate change. Additional contributions described analytical workflows for reconstructing long-term fish community structure and explored how sedimentary

archives can help explain historical fishery collapses, including the decline of the western Baltic herring fishery.

A central theme emerging from the discussions was how paleo-records can move beyond retrospective reconstructions and contribute directly to forecasting and climate adaptation. Participants emphasized that sedimentary archives document ecosystem responses to climatic conditions that have no modern analogue, providing unique opportunities to test ecological hypotheses and improve ecosystem and climate models. Paleo-records were viewed not only as historical archives but also as potential training and validation datasets capable of extending ecological observations far beyond the instrumental period.



Shell-packed rock layer in La Paz, Mexico. Photo credit: June Dias

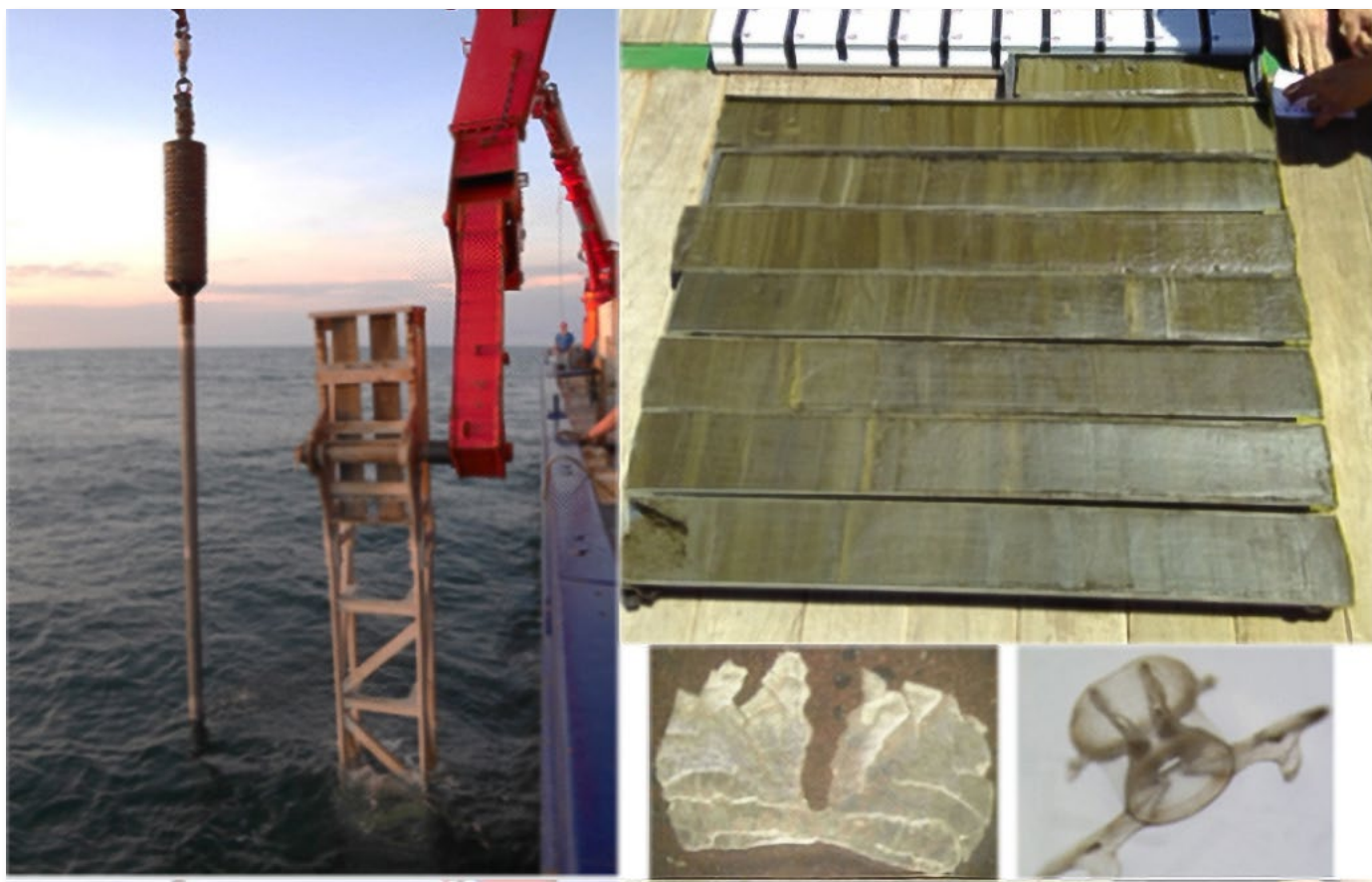


Figure 1. Sedimentary archives used to reconstruct long-term variability in forage fish populations and marine ecosystems. Left: deployment of a gravity corer to recover undisturbed sediment sequences from oxygen-depleted environments. Upper right: laminated marine sediments that preserve annual to decadal-scale records of environmental change. Lower right: fossil fish scales and vertebrae recovered from sediments and used as proxies for past forage fish abundance. Together, these archives provide unique insights into climate–ecosystem interactions over timescales extending far beyond direct observations.

Oxygen availability emerged as a key driver of forage fish variability across eastern boundary upwelling systems. Participants stressed the need for comparative studies among the Humboldt, California, Benguela, and other productive marine ecosystems to better understand how changes in oxygen influence habitat suitability, species distributions, and population fluctuations. Several participants suggested that oxygen may represent a common mechanism linking climate variability and forage fish dynamics across disparate upwelling systems.

The workshop also explored the types of information that paleo-records can provide to fisheries scientists and managers. Participants identified reconstructions of species abundance and diversity, estimates of rates of ecological change, detection of potential early warning signals, and identification of climatic refugia during past warm periods as particularly valuable contributions. These long-term records can complement modern observations and provide environmental scenarios beyond the range captured by contemporary monitoring programs.

Discussions highlighted the importance of integrating biological, molecular ecology, geochemical, and paleoceanographic proxies to better understand climate–ecosystem interactions. Participants also identified several priorities for future research, including cross-system comparisons among eastern boundary upwelling systems, the Baltic Sea, and other productive marine ecosystems; the development of standardized paleo-indicators relevant to fisheries management; and stronger collaboration among paleoecologists, fisheries scientists, and modelers.

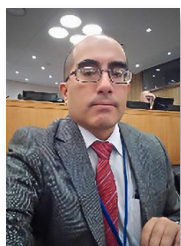
The convenors plan to continue these discussions through the development of a white paper summarizing key insights, methodological advances, and future research priorities. Participants also expressed interest in developing collaborative research proposals focused on climate–forage fish dynamics, expanding paleoecological investigations to new regions, and integrating paleo-records into ecosystem forecasting frameworks.



Dr. Renato Salvattecchi (renato.salvattecchi@ifg.uni-kiel.de) is a fisheries scientist and paleoceanographer at the Center for Ocean and Society, Kiel University, Germany. His research combines paleoceanography, marine ecology, and fisheries science to investigate how climate variability influences marine ecosystems and forage fish populations over long timescales. Renato develops and applies innovative approaches based on fish scales, bones, geochemical proxies, and sedimentary archives to reconstruct past ecosystem change. His current work focuses on the Humboldt Current System and on using paleoecological records to improve understanding of future climate impacts on marine resources and fisheries.



Dr. Salvador Lluch-Cota (slluch@cibnor.mx) is a Fisheries Oceanographer at the Northwest Biological Research Center (CIBNOR) in La Paz, Mexico. Salvador has been actively involved in PICES activities since the Beyond ENSO Conference in 2000 and has helped organize several PICES events, including a modeling workshop and three international conferences hosted in La Paz. His research examines the effects of climate variability and climate change on marine organisms, populations, and ecosystems, with an emphasis on linking physiological responses to ecological and fisheries dynamics.



Dr. Dimitri Gutiérrez (dgutierrez@imarpe.gob.pe) is a biological oceanographer at the Peruvian Institute of Marine Research (IMARPE). He received his PhD in Oceanography from the University of Concepción, Chile, in 2000. His research focuses on the effects of climate variability on marine productivity, subsurface oxygenation, and upwelling dynamics in the coastal southeastern Pacific, integrating paleoceanographic records with modern observations. Dimitri has also conducted extensive research on benthic responses to natural and human-induced hypoxia and has contributed to climate adaptation initiatives for Peruvian fisheries and coastal ecosystems.



Dr. David Field (dfield@hpu.edu) is an Associate Professor of marine sciences at Hawaii Pacific University, USA. He received his PhD from the Scripps Institution of Oceanography and has conducted extensive research on climate variability, marine ecosystems, and fisheries in the California Current and other productive ocean regions. David's work integrates modern observations, historical records, and geological archives to investigate ocean-climate interactions across ecological and geological timescales. His research has focused on paleoceanography, plankton ecology, and long-term variability in small pelagic fish populations, using sedimentary records, fossil assemblages, and geochemical proxies to better understand natural ecosystem variability and the impacts of environmental change.



Photos from around downtown La Paz, Mexico. Photo credit: Sanae Chiba and Sonia Batten

SPF-2026 Workshop 6

Advancing Spatio-Temporal Species Distribution Models for Fish: Challenges, Methodologies, and Collaborative Solutions

Daniela Silva, Luis A. Cubillos, and Shota Nishijima

A half-day workshop on “Advancing Spatio-Temporal Species Distribution Models for Fish: Challenges, Methodologies, and Collaborative Solutions” (W6) was convened on May 4, 2026, as part of the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) held in La Paz, Mexico. Chaired by Daniela Silva (Portuguese Institute for the Sea and Atmosphere, Portugal), Luis A. Cubillos (University of Concepción, Chile), and Shota Nishijima (Japan Fisheries Research and Education Agency, Japan), the workshop was designed to foster dialogue across disciplines in spatio-temporal modeling for understanding small pelagic fish (SPF) dynamics, addressing key data challenges, and discussing modern species distribution model (SDM) frameworks and applications. The workshop attracted 27 participants worldwide.

Understanding the spatial and temporal dynamics of SPF populations has become increasingly important under accelerating climate variability and ecosystem change. Species distributions are inherently dynamic and reflect environmental gradients, migration processes, habitat connectivity, aggregation behavior, fishing activities, and

observation processes. At the same time, the growing availability of ecological and fisheries datasets has created new opportunities to advance SDMs, while also introducing substantial methodological challenges related to sampling design, observational bias, missing data, and complex spatial dependencies. In this context, the workshop highlighted the importance of combining ecological understanding with robust statistical and process-based approaches to improve inference and support ecosystem-based fisheries management.

The workshop objectives were to (1) explore the role of spatial and spatio-temporal statistics in understanding SPF population dynamics through the introduction of key concepts in spatial statistics; (2) identify major data challenges affecting SDMs, including zero-inflated data and sampling issues; and (3) introduce, compare, and discuss recent developments in spatial and spatio-temporal SDMs, such as hierarchical, Bayesian, and joint modeling approaches, with emphasis on their applicability to SPF systems. The workshop structure combined different formats to encourage both methodological discussion and participant interaction. Activities included an introductory overview by the convenors, contributed



Participants of the SPF-2026 W6 workshop on “Advancing Spatio-Temporal Species Distribution Models for Fish: Challenges, Methodologies, and Collaborative Solutions”, held May 4, 2026, at CICIMAR, La Paz, Mexico.

talks, breakout group discussions, and a final plenary discussion integrating the main outcomes across sessions.

The introductory session, led by Daniela Silva, focused on the spatial and spatio-temporal nature of SPF distributions and on the importance of explicitly accounting for spatial structure in ecological analyses. The presentation emphasized that SPF distributions are shaped by multiple interacting processes, including environmental gradients, aggregation behavior, migration dynamics, habitat connectivity, fishing activities, and observation systems, leading to strong spatial and temporal dependence in fisheries data. Using examples from fisheries-dependent and fisheries-independent surveys, the participants discussed how different response variables—such as occurrence, abundance, and biomass—require distinct statistical approaches and ecological interpretations. Particular attention was given to the challenges associated with analyzing spatial ecological data, including presence-only observations, excess zeros, preferential sampling, physical barriers, migration processes, and spatially misaligned datasets. The session also highlighted how hierarchical and spatio-temporal modeling frameworks can help separate ecological and observation processes, improve inference, and provide more realistic representations of SPF spatial dynamics.

The contributed talks illustrated the diversity of spatial and spatio-temporal approaches currently used in SPF research and highlighted the growing integration of ecological, oceanographic, and statistical perspectives in fisheries science.

Luis A. Cubillos presented “Spawning of two small pelagic fishes exhibits a shared progressive spatiotemporal structure in central-southern Chile,” a hierarchical Bayesian spatio-temporal analysis of anchovy and common sardine spawning dynamics. The study showed that both species share a persistent and progressive spawning structure over time, suggesting common responses to environmental forcing and strong spatial connectivity in their reproductive dynamics, likely mediated by adult spawning fidelity.

Luz M. García-García gave a talk titled “Numerical modeling of early life stages of small pelagics in the Atlantic Iberian Margin and the Mediterranean Sea for fish stock assessment,” focusing on the application of Individual-Based Models (IBMs) within the OpenDrift framework to simulate the early life stages of sardine and anchovy. The work highlighted how hydrodynamic and biogeochemical processes influence egg and larval transport, retention patterns, and potential recruitment areas across the

Atlantic Iberian Margin and the Mediterranean Sea, reinforcing the importance of coupling biological and physical oceanographic processes in fisheries research.

Yuga Kisara’s work on “Impact of fishery research survey reduction on stock assessment indices: jack mackerel stock as an example” discussed the consequences of reduced fisheries surveys on stock assessment reliability for Japanese jack mackerel. Using spatio-temporal modeling approaches applied to long-term egg survey datasets, the study demonstrated that missing surveys may bias spawning biomass indices, emphasizing the importance of maintaining consistent monitoring programs for robust fisheries management.

Sofía González-Pérez presented “IBM models for simulating the early life stages of small pelagics: a generic code approach,” discussing the development of a generic IBM framework for simulating early life stages of multiple marine species within the OpenDrift platform. She emphasized how differences in hydrodynamic forcing, egg buoyancy, and larval behavior can strongly influence dispersal and spatial connectivity patterns, highlighting the importance of interdisciplinary approaches for improving ecological realism in marine spatial analyses.

During the breakout group discussions, participants were divided into thematic groups to explore major methodological, ecological, and collaborative challenges associated with spatial analyses of SPF systems. Each group focused on:

1. Comparative modeling approaches, including statistical SDMs, Individual-Based Models (IBMs), SEAPODYM, and machine-learning approaches. Discussions emphasized that these frameworks should be viewed as complementary rather than competing tools, as each captures different ecological or observational processes.
2. Data and observation challenges, including zero inflation, preferential sampling, missing data, spatial barriers, non-stationarity in observation systems, and changing catchability. Participants discussed both the ecological implications of these issues and practical methodological approaches used to address them.
3. Data integration and collaboration highlight the importance of combining multiple data sources, improving interoperability, standardizing protocols, and strengthening regional and international cooperation.

The workshop concluded with a plenary discussion integrating the main outcomes from the breakout groups. Participants agreed that robust spatial and

spatio-temporal analyses require balancing ecological understanding, data availability, and methodological complexity. A recurring theme throughout the workshop was that no single modeling framework can fully capture the complexity of SPF systems, reinforcing the need for complementary approaches and interdisciplinary collaboration. Participants also emphasized that improving ecological inference depends not only on methodological advances but also on refining sampling strategies, data integration, and collaborative research networks. Strengthening collaborative research networks and advancing spatial modeling capacity will be essential for supporting more reliable ecosystem-based fisheries management amid increasing environmental variability and climate change.

Moving forward requires strengthening collaborative research networks, maintaining long-term observation programs, and promoting the development and application of advanced spatial modeling approaches. Future workshops and collaborative initiatives should continue fostering methodological exchange, interdisciplinary dialogue, and regional cooperation to address emerging challenges in SPF research and management. Expected outcomes from the workshop include conducting a post-workshop survey to identify collaboration interests, expertise, and datasets to participate in future initiatives; creating a shared communication and resource platform for exchanging workshop materials, references, and modeling approaches; and developing a collaborative review paper on species distribution data challenges and the methodological strategies with the emphasis on case studies in SPF systems for *Marine Ecology Progress Series* (MEPS).



Daniela Silva (daniela.dasilva@ipma.pt) is a Research Scientist at the Portuguese Institute for the Sea and Atmosphere (IPMA) and an integrated researcher at the Centre of Mathematics of the University of Minho. Her research focuses on the spatial and temporal dynamics of small pelagic fish (SPF) in response to biological and environmental drivers, spatio-temporal modelling of species distribution, and the integration of multiple data sources. She also works on the identification and analysis of purse seine vessel fishing operations.



Dr. Luis A. Cubillos (lucubillos@udec.cl) is an Associate Professor at the Department of Oceanography, Faculty of Natural Science and Oceanography, University of Concepción, Chile. In addition, he is an associated researcher at the Center for Oceanographic Research in the eastern South Pacific (COPAS-COASTAL). His research focuses on the dynamics of small pelagic fish and climatic drivers across multiple temporal and spatial scales, including stock assessment modeling and spawning biomass estimation for SPF, particularly sardine and anchovy in central-southern Chile.



Dr. Shota Nishijima (nishijima_shota02@fra.go.jp) is a Senior Scientist at the Japan Fisheries Research and Education Agency. His research focuses on modeling the population and spatio-temporal dynamics of small pelagic fish (SPF) around Japan, with a particular emphasis on their non-stationary and non-linear dynamics. His work aims to improve stock assessment and contribute to sustainable fisheries management of SPF by applying modern statistical and quantitative approaches.



Conference attendees enjoying the symposium dinner at La Posada Hotel and Beach Club.

SPF-2026 Workshop 7

Operationalizing Ecosystem-Based Management of Forage Species using Management Strategy Evaluation

Rebecca Scott and Ashley Wilson

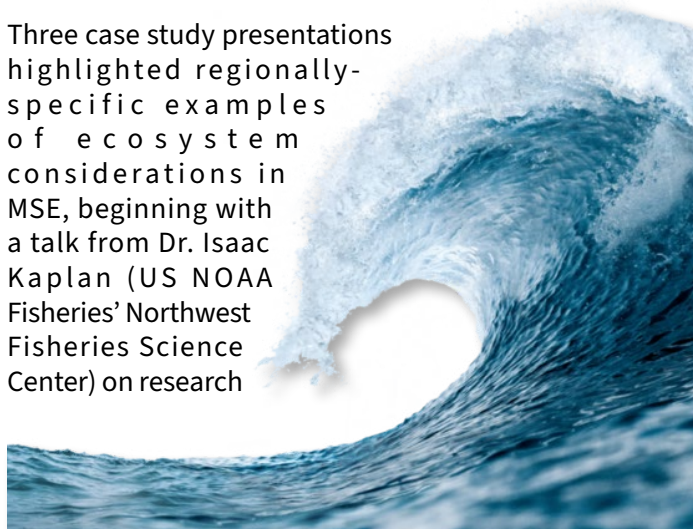
A half-day workshop on “Operationalizing Ecosystem-Based Management of Forage Species using Management Strategy Evaluation” (W7) was convened by [The Ocean Foundation](#) and [The Pew Charitable Trusts](#) on May 4, 2026, as part of the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) held in La Paz, Mexico. The workshop drew 25 attendees, including experts in management strategy evaluation (MSE), ecosystem-based fisheries management (EBFM), and the intersection between the two. The goal of the workshop was to progress the operationalization of EBFM in forage fisheries using MSE-tested management procedures, also known as harvest strategies, by highlighting successful MSE case studies and resources, identifying relevant ecosystem indicators for forage species, discussing critical barriers, and inspiring future EBFM efforts. Forage species (e.g., sardine, anchovy, herring) provide a crucial ecosystem service as key prey items in the marine food web, yet their abundance in space and time is highly dependent on environmental conditions. Effective management of these species has been a challenge as patterns in recruitment and biomass are often driven by multiple ecosystem factors, the individual impacts of which can be difficult to tease apart and simulate, and perceived relationships between the environment and forage fish population dynamics often break down over time. This leads to high uncertainty in estimating recruitment and natural mortality using traditional stock assessment methods and difficulty projecting future population levels. MSE is therefore an ideal tool for management of these species, as MSE frameworks can be built to capture a range of hypothetical ecosystem impacts and other uncertainties, allowing managers to adopt management procedures for forage species that are robust under changing environmental and/or ecosystem conditions.

In six presentations delivered by experts in the field, this workshop showcased existing research initiatives, case studies, and emerging tools that use MSE to incorporate ecosystem considerations in developing robust

management approaches for forage species (Figure. 1).

Dr. Chris Lynam (ICES) presented on the ICES experience with operationalizing ecosystem-based management for forage species including the development of the ICES Framework for Ecosystem-Informed Science and Advice (FEISA), which aims to explicitly incorporate environmental and ecological information into advice frameworks. Dr. Carryn de Moor (University of Cape Town) provided a synthesis of methodologies for explicitly incorporating EBFM into MSE, with a focus on small pelagics. Different approaches presented included: using ecosystem models as MSE operating models; unidirectionally coupling operating models with ecosystem considerations; considering predation mortality when defining natural mortality; the use of ecosystem-related thresholds in MSE performance metrics; incorporating ecosystem considerations in the parameterization of harvest control rules (HCRs); and accounting for ecosystem effects in reference points. Dr. Tom Carruthers ([Blue Matter Science](#)) showcased multiple emerging MSE tools relevant to the intersection of EBFM and MSE for forage species, including software packages within the openMSE modeling framework to test climate-resilient management procedures (‘ClimateTest’), conduct multi-stock MSE (‘EcoTest’), and implement MSE for short-lived species (‘sIMSE’).

Three case study presentations highlighted regionally-specific examples of ecosystem considerations in MSE, beginning with a talk from Dr. Isaac Kaplan (US NOAA Fisheries’ Northwest Fisheries Science Center) on research



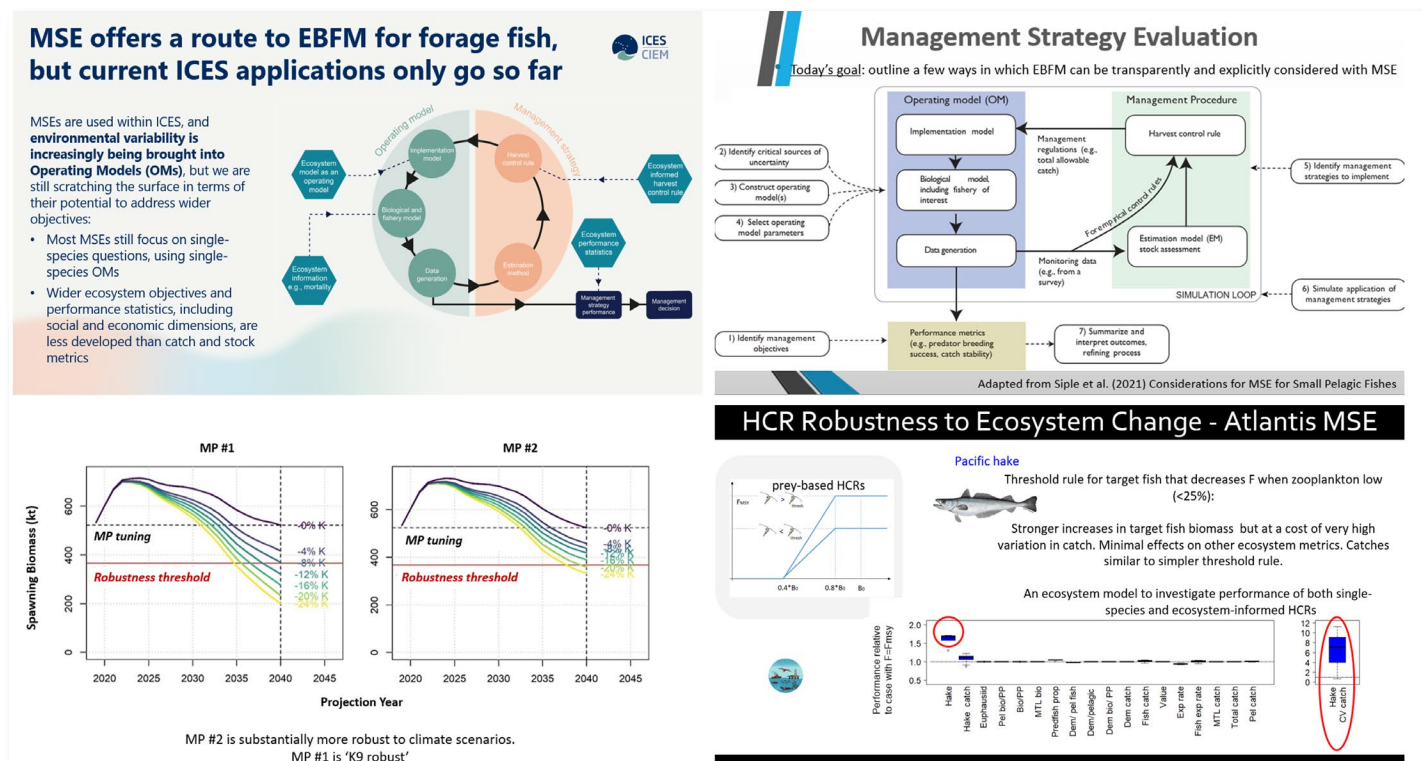


Figure 1. Slides from Workshop 7 presentations.

Top left: A slide from a presentation by Drs. Chris Lynam and Jacob Bentley “Operationalising Ecosystem-Based Management for forage species through ICES Experience,” which considered ICES progress towards developing ecosystem-informed MSEs and the ICES Framework for Ecosystem-Informed Science and Advice (FEISA).

Top right: A slide from Dr. Carryn de Moor’s presentation “Explicitly Incorporating Ecosystem-Based Fisheries Management (EBFM) into Management Strategy Evaluation (MSE),” demonstrating potential pathways for considering EBFM in MSE frameworks.

Bottom left: A slide from Dr. Tom Carruthers’s presentation “New MSE Tools,” highlighting the emerging Climate Test tool within the openMSE software package to test the climate-resilience of management procedures.

Bottom right: A slide from Dr. Isaac Kaplan’s presentation “Management Strategy Evaluation under shifting forage fish productivity and distributions in the California Current,” describing a case study of ecosystem-based HCRs that consider prey abundance.

the Future Seas project in the California Current system. This included: (1) a single-species MSE for Pacific sardine (*Sardinops sagax*) that assessed the robustness of HCRs that are responsive to environmentally-driven changes in recruitment, (2) an ecosystem MSE using an Atlantis ecosystem model as the operating model and multispecies HCRs that consider predator-prey relationships, and (3) an MSE framework for sardine that used a suite of process-based models (including distribution, recruitment, and predation mortality) to inform operating models. Dr. Ricardo Oliveros-Ramos (UMR MARBEC, France) showcased how environmental variability has been integrated into MSE frameworks in the Eastern South Pacific Ocean through the design of an MSE for jumbo squid (*Dosidicus gigas*). This research highlighted the need for tools capable of realistically reproducing short-term environmental variability, such as El Niño and the Southern Oscillation (ENSO) events, particularly as they relate to the productivity and distribution of short-

lived species, as well as methodological challenges such as downscaling, bias-correction, and scenario realism. Jaclyn Cleary (Fisheries and Oceans Canada) presented on knowledge co-production in the Pacific herring (*Clupea pallasii*) MSE process, where indigenous knowledge of key predators was utilized to develop consumption rates for Pacific herring predators. These were used to drive historical patterns of natural mortality in an operating model and allowed for the validation of a density-dependent mortality approach used for operating model projections. The talk emphasized the benefits of engagement and capacity building with First Nations and other stakeholders early in the MSE process.

Participants were then divided into breakout groups by region of expertise where they discussed region- and stock-specific considerations for operationalizing EBFM, including identifying key drivers of variability, potential ecosystem indicators, critical data needs (including for

building MSE frameworks), and the remaining hurdles to bridge science and management. The regional and stock-specific examples that were explored included the Pacific/California current sardine, Gulf of Mexico menhaden, Bay of Biscay anchovy, Iberian sardine, and North Sea and Central Baltic herring. One commonly identified challenge to incorporating ecosystem considerations into management across the example stocks was the need to better understand the mechanistic links between the environment and biology, and several stocks shared key environmental and ecosystem drivers (e.g., upwelling and predation). Interestingly, possible or existing approaches for incorporating ecosystem information into management (including MSE frameworks) varied across example stocks/systems. A final workshop report will synthesize the shared challenges, key drivers, and feasible ecosystem indicators for MSE; highlight common data and implementation needs; and identify opportunities for collaboration on joint research across the regions and stocks explored. These findings may have relevance to operationalizing EBFM for a wider range of forage fish (prey) species globally using MSE approaches.



Dr. Rebecca Scott (rscott@oceanfdn.org) is a Program Officer with The Ocean Foundation's International Fisheries Conservation Program, where she serves as the technical lead for the team's efforts to advance precautionary harvest strategies at regional fisheries management organizations (RFMOs). She has worked in quantitative fisheries science at both the U.S. federal and state government levels, with a strong focus on ecosystem-based fisheries management, pelagic food webs, and the use of ecosystem modeling tools. Rebecca holds a B.S. in Marine Biology from the University of Rhode Island, an M.S. in Biology from Georgia Southern University, and a Ph.D. in Marine Science from the University of South Florida.



Ashley Wilson (awilson@pewtrusts.org) works for Pew's international fisheries project, providing science and research support for the development and adoption of long-term sustainable harvest strategies. His focus includes the incorporation of precautionary management by regional fisheries management organizations, with additional considerations for ecosystem-based management in the northeast Atlantic. Ashley holds a B.S. in Marine Biology and Coastal Ecology from the University of Plymouth.



*Outside the main conference center in La Paz, Mexico
Photo credit: Sonia Batten*

SPF-2026 Workshop 8

Maximizing Nutrient Yield from Marine Ecosystems: Nutrition-sensitive Management Strategies Based on the Nutrient Composition of Small Pelagic Fish

Marian Kjellekvold, Maria Wik Markhus, James Robinson, and Alexandra Pounds

The growing recognition of aquatic foods as essential contributors to food and nutrition security has highlighted the need for nutrition-sensitive fisheries management. Such approaches consider not only biomass and economic value but also nutritional outcomes. The workshop on “Maximizing Nutrient Yield from Marine Ecosystems: Nutrition-sensitive Management Strategies Based on the Nutrient Composition of Small Pelagic Fish” (W8) was organized during the PICES/ICES/FAO Symposium on “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” (SPF-2026) in La Paz, Mexico, and brought together researchers and practitioners from fisheries science, nutrition, economics, policy, and food systems disciplines to explore how nutrient considerations can be more effectively integrated into the management of marine ecosystems. We were motivated by a central question: How can fisheries management contribute more directly to food and nutrition security through the sustainable production of nutrient-rich aquatic foods?

Small pelagic fish (SPF) such as sardines, anchovies, herring, and mackerel play a critical role in global food systems. In addition to supporting livelihoods and economies, these species provide essential micronutrients and fatty acids that contribute to healthy diets. Despite their nutritional importance, fisheries management frameworks rarely account explicitly for nutrient production when setting objectives, assessing trade-offs, or evaluating management strategies. The workshop explored opportunities and barriers (often through case studies) of where nutritional considerations created tensions or synergies with existing sustainability and economic objectives.

The workshop began with a series of short presentations designed to establish a common understanding across disciplines. Topics included: the concept of nutrition-sensitive fisheries management; nutrient composition in aquatic foods; the role of blue foods in supporting nutrition and food security (including culinary heritage and food culture); blue food trade dynamics and the resulting export/import of nutrients; and the role of governance and certification (Figure 1).



Figure 1. Presentations from workshop convenors and invited contributors (left to right): Marian Kjellekvold, Alexandra Pounds, and James Robinson (top row), Maria Wik Markhus, Andre Boustany, and Temiloluwa Akinoyemi (bottom row).

The group then moved into the main component of the workshop: an interactive food-systems mapping exercise (Figure 2). Participants worked with visual representations of the SPF value chain, spanning harvest and production, processing, trade, consumption, and nutrition outcomes. Using a combination of stickers and written notes, participants explored dynamics within the system where maximising nutrient-yield could affect decision-making and existing practices. We also identified points where implementation might face practical, social, economic, or governance challenges and synergies.

The systems-mapping activity revealed strong interest in applying nutrient-based information across multiple stages of the value chain. Participants identified opportunities for improving fisheries management objectives, informing processing and distribution decisions, supporting public health initiatives, and enhancing communication about the nutritional benefits of small pelagic fish. At the same time, they noted several challenges, including data limitations, governance constraints, competing management objectives, and the need to address equity considerations when prioritizing nutritional outcomes. Discussions emphasized the importance of recognizing that management and actor decisions can generate different nutritional outcomes.

Approximately two weeks after the symposium, the in-person workshop was replicated online for inclusive participation. We found that this enabled a significantly more diverse group of participants and generated a broader set of discussion points across disciplines.

As a follow-up to the in-person and online workshops, convenors and interested participants will collaborate on a synthesis manuscript that captures the key insights generated during the discussions. The workshops demonstrated substantial enthusiasm for strengthening connections among fisheries science, nutrition, and food-systems research and highlighted the value of bringing together diverse perspectives to address complex societal challenges.

By focusing on nutrient yield as an additional dimension of fisheries performance, this workshop (W8) contributed to ongoing discussions about how marine resource management can better support food and nutrition security while maintaining ecological sustainability. The ideas generated during the workshop will help inform future research and policy development aimed at maximizing the nutritional benefits derived from marine ecosystems.



Figure 2. Interactive food-systems mapping exercise with workshop participants. Each group discussed a conceptual diagram of small pelagic fish value chains, identifying opportunities and challenges for implementing nutrition-sensitive fisheries systems.



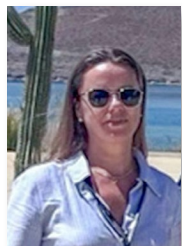
Figure 3. Workshop convenors and invited contributors (left to right): Maria Wik Markhus, James Robinson, Beth Woodhead, Marian Kjellekvold, Temiloluwa Akinyemi, Andre Boustany, and Alexandra Pounds.



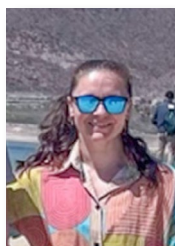
Dr. Marian Kjellekvold (marian.kjellekvold@hi.no) is a professor of nutrition at the Institute of Marine Research, Norway. Her main area of expertise is food security and nutrition, with focus on micronutrients in aquatic foods. She has extensive experience in dietary studies with seafood with special emphasis on the first thousand days (pregnancy and infants), and development and validation of food frequency questionnaires with biological marker.



Dr. James Robinson (james.robinson@lancaster.ac.uk) is a quantitative marine ecologist working on coral reefs, small-scale fisheries, and aquatic foods at Lancaster University, UK. His research programme investigates how pelagic ecosystems support coral reefs and small-scale fisheries. Using ecological and fisheries datasets, James examines how marine ecosystems respond to stressors, and how this impacts fisheries production and the supply of nutritious food around the world.



Dr. Maria Wik Markhus (maria.wik.markhus@hi.no) is a professor of nutrition at the Institute of Marine Research, Norway. Her education has been concentrated to the field of nutrition, but she has also attained experience in toxicology, risk assessment, and cognitive development/mental health. Lately, she has been focusing on the risk of low iodine during pregnancy and prior adolescence. She covers all aspects of the role of aquatic food and nutrition security, covering macro- and micronutrient needs for vulnerable groups, especially pregnant women, infants, and children. In addition, she is the secretariat of the UN Global Action Network for Sustainable Food from the Oceans and Inland Waters for Food Security and Nutrition on behalf of the Norwegian Ministry of Trade, Industry and Fisheries.



Dr. Alexandra Pounds (alexandra.pounds@thinkaqua.org) is Chief Scientist at ThinkAqua, an UK-registered charity focused on supporting the sustainable development of aquaculture globally, with a focus on smallholder production systems. Her work bridges the gap between science, sustainable aquaculture, and poverty reduction, with a primary interest and expertise on the role of fish in food system.

REGIONAL REPORTS

Western North Pacific: Current Status and Developments

Sea surface temperature and sea ice in the Sea of Okhotsk in the 2025/2026 cold season

TOGAWA Hiroki

The western North Pacific was characterized by positive sea surface temperature (SST) anomalies over a wide area between 35°N and 45°N throughout the cold season (December 2025 – March 2026; Figure 1), as also observed since 2022. The magnitude of anomalies was generally smaller than those of the 2025 warm season. Record-high SSTs were also observed in the Sea between Japan and China in December and March. Meanwhile, negative SST anomalies were expanded in the area south of 35°N in March.

The winter maximum sea ice extent in the Sea of Okhotsk was 0.76 million km² in mid-February (around 68% of the 30-year average of 1.12 million km²), making it the second-lowest since 1971. The seasonal maximum exhibits a long-term decreasing trend of 0.059 million km² per decade, which corresponds to 3.7% of the Sea of Okhotsk's total area (Figure 2).

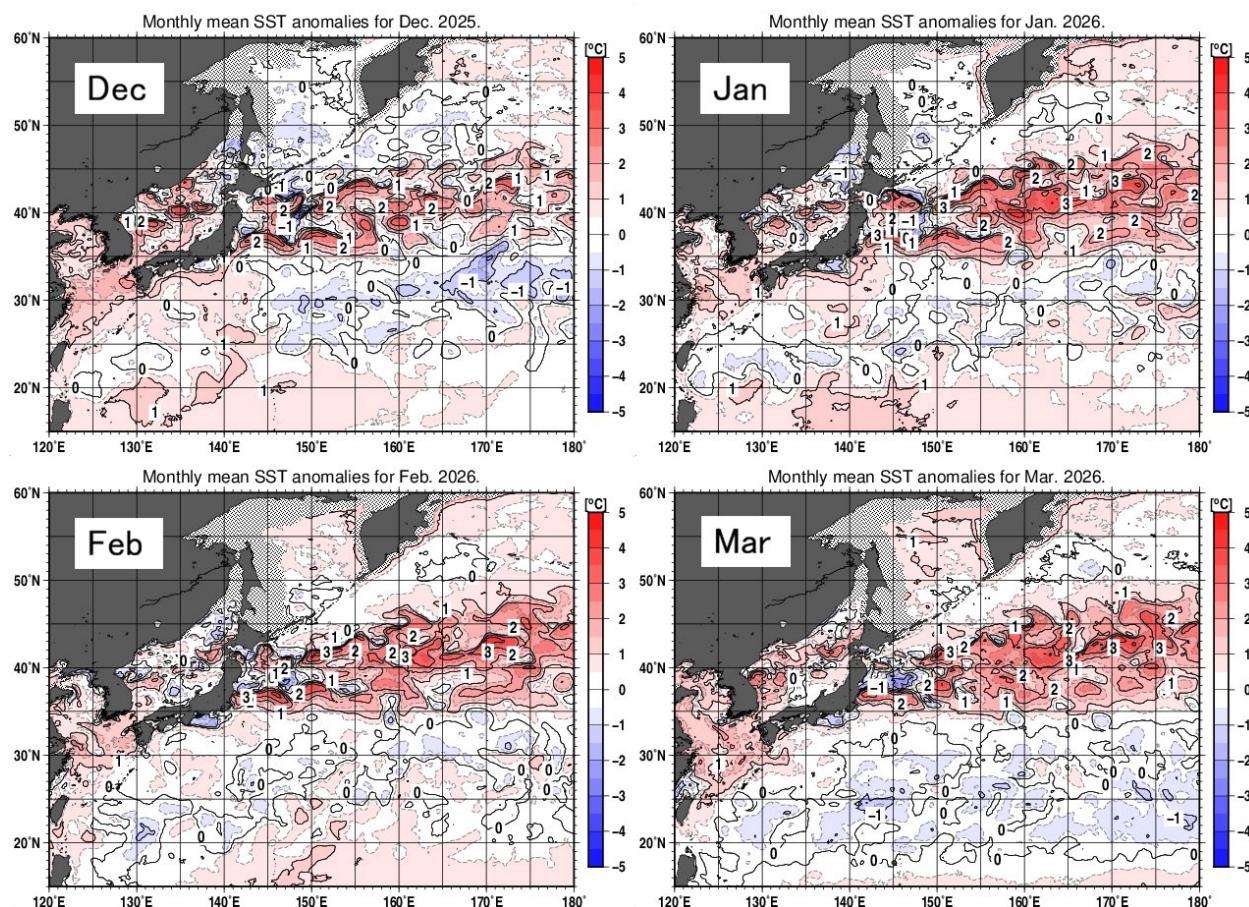


Figure 1. Monthly mean SST anomalies from December 2025 to March 2026 based on JMA HIMSST (High-resolution Merged Satellite and In-situ Data on Sea Surface Temperature). Anomalies are deviations from the 1991 – 2020 climatology.

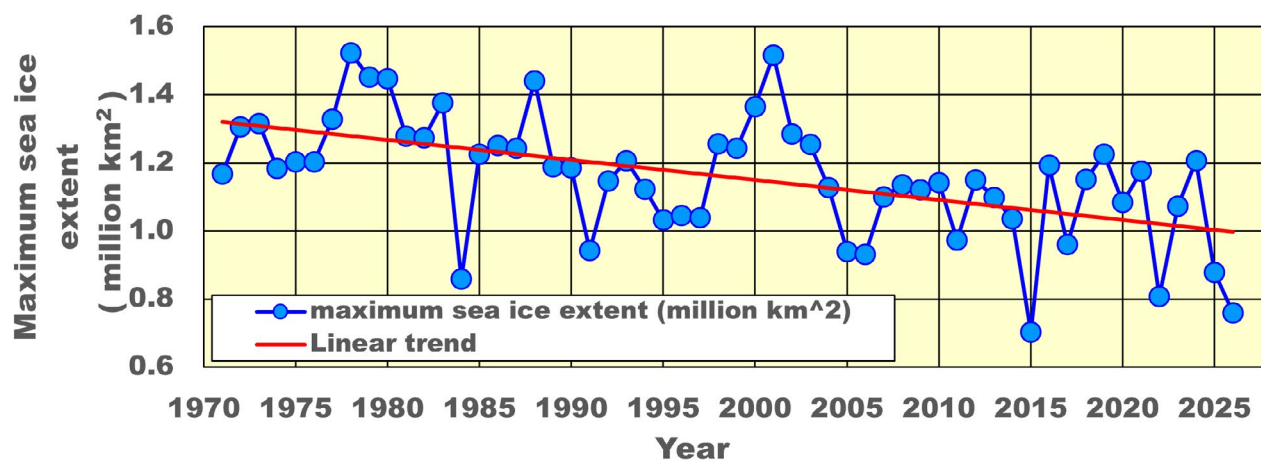
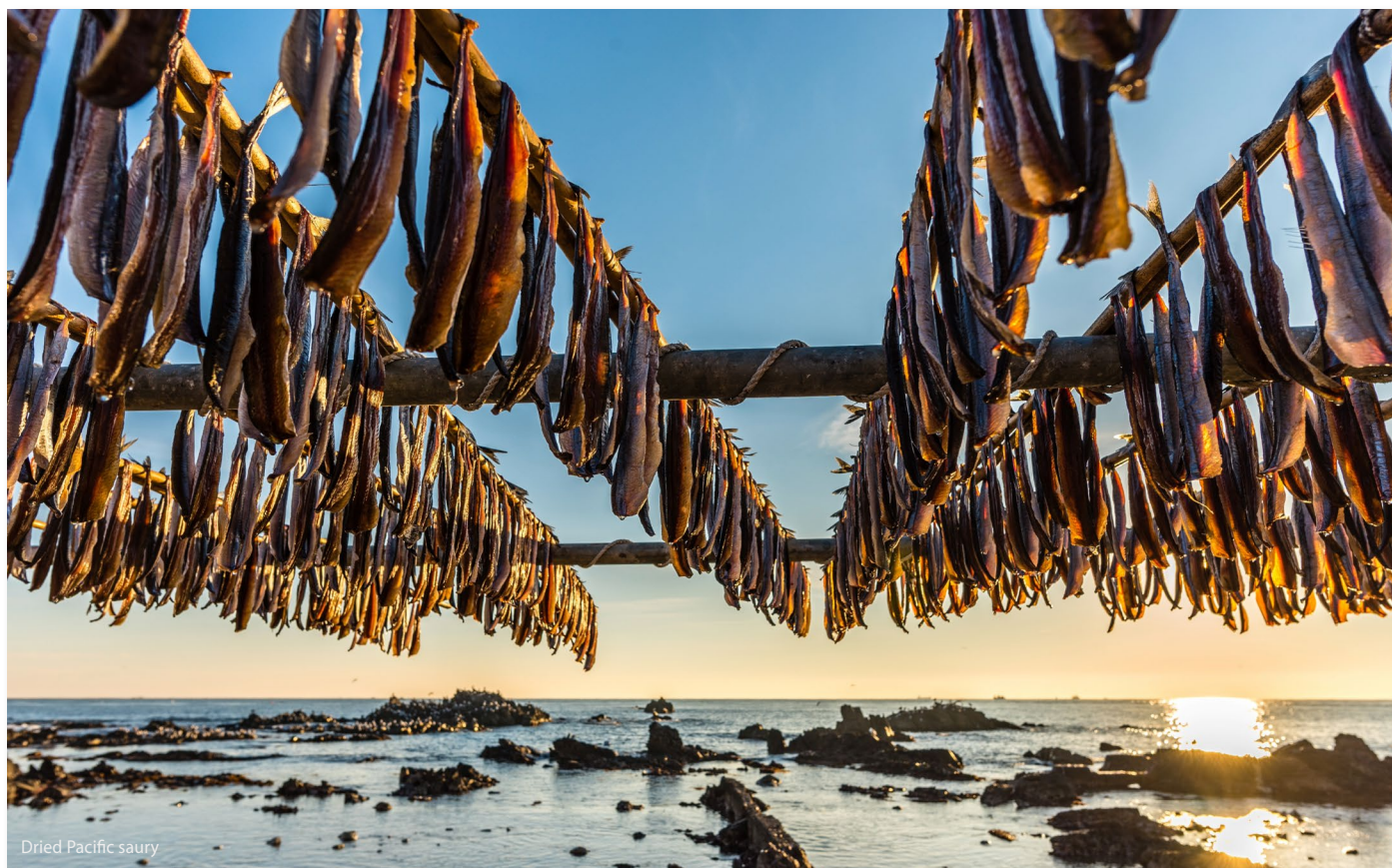


Figure 2. Time-series representation of winter maximum sea ice extents in the Sea of Okhotsk for 1971 – 2026. The red line denotes the long-term linear trend.



Mr. TOGAWA Hiroki is a senior forecaster at the Office of Marine Prediction of the Atmosphere and Ocean Department of the Japan Meteorological Agency, in Tokyo, Japan.



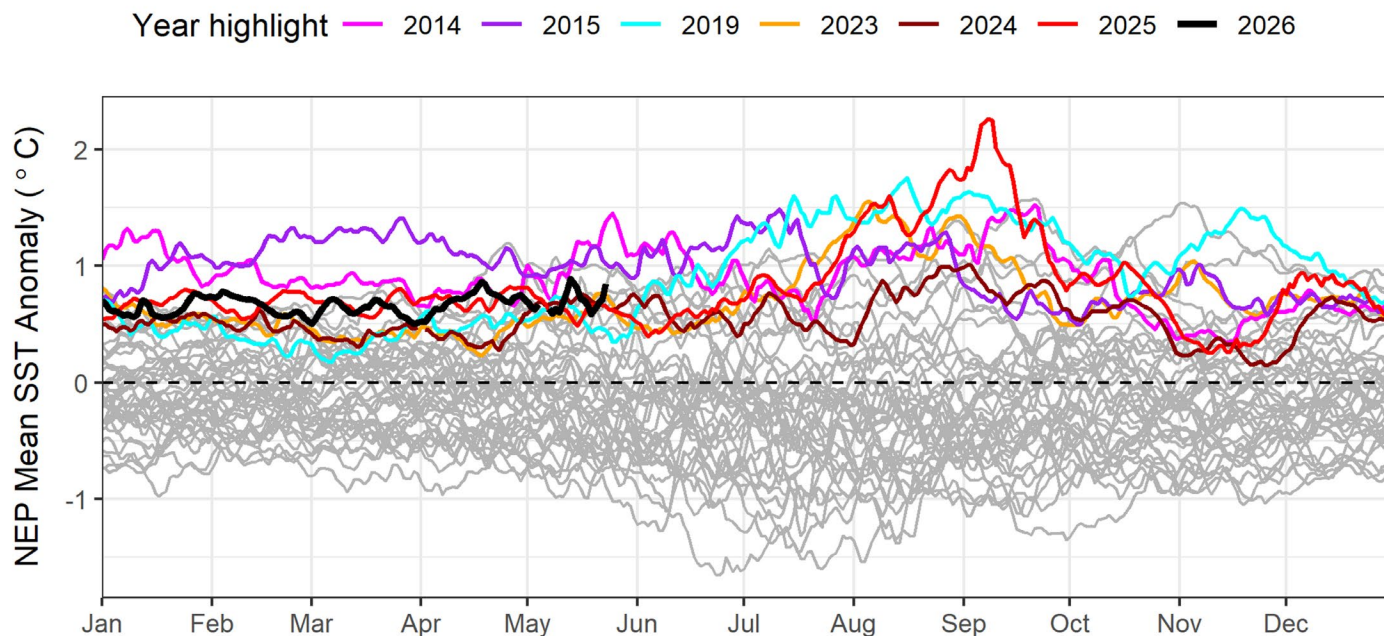
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The Northeast Pacific: Updates on Temperature and Marine Heatwave Status

Andrea Hilborn, Tetjana Ross, Charles Hannah, and Moira Galbraith

The global weather and climate news has been focused lately on the coming El Niño and how extreme its warm temperatures could be this summer and into the coming year. As Northern Hemisphere air temperatures heat up with the advance of spring, I have heard many people doing some quick mental math in my circles as they make summer plans: “Should I go camping in August, or will there be too much forest fire smoke?” “Should I buy a portable air conditioner in case there is another heat dome?” Recent news features have also highlighted the potential for an extra-strong “Super El Niño,” with a range of predicted effects like new global temperature records, deaths, droughts, and wildfires. Given the unceasing burning of fossil fuels, these predictions make intuitive sense to us, as much as they are not wanted. What is the outlook for ocean temperatures in the Northeast Pacific this summer and beyond, and is there anything that oceanography can teach us for facing this daunting, warmer future?

Typical El Niños peak late in the calendar year, as reflected in the name “El Niño” (Spanish for “the little boy”, which refers to the birth of Jesus at Christmas). Current long-term model predictions focusing on the Niño 3.4 region, a pre-defined equatorial region of the central Pacific used to delineate and monitor the El Niño-Southern Oscillation (ENSO) climate phenomenon, show sea surface temperatures (SSTs) crossing the threshold used to declare El Niño in May - July with > 80% certainty. SST anomalies are predicted to peak in October 2026 to January 2027. The NOAA Climate Prediction Centre states a nearly certain chance (96%) of El Niño status from December to February (Climate Prediction Centre/NCEP/NWS, 2026) and a 63% chance of a “very strong” El Niño during November to January. So far this year the SST in the Northeast Pacific (NEP) has been comparable to the last two years, with the mean anomaly hovering consistently slightly below +1°C for 2026 (Figure 1). January and February of 2026



Data source: <https://doi.org/10.25921/RE9P-PT57>

Data last updated: 2026-05-23

Plot last updated: 2026-05-25

Figure 1. The mean SST anomaly for the entire NEP, as observed in Optimum Interpolation Sea Surface Temperature data (OISST; 0.25 degree spatial resolution). All years since 1981 are shown in grey, with specific years highlighted in colour. The “Blob” years of 2014 and 2015 are shown in pink and purple, contrasted with 2019 in cyan, another year with large areas of the surface ocean in MHW status. The most recent three years are also shown. 2026, indicated in black, is comparable to the previous couple of years thus far. OISST data sourced from <https://doi.org/10.25921/RE9P-PT57> and analyzed by the authors. These plots update weekly at https://ios-osd-dpg.github.io/Pacific_SST_Monitoring_Site.

were the fourth-warmest months in the satellite record, dating back to 1981, with the “Blob” years of 2014 and 2015 taking first and second place and 2025 in third. March and April of 2026 were slightly cooler, at 6th and 5th place, respectively. 2025 was a La Niña year and was consistently warmer than 2026 thus far, which further emphasises the upward progression of ocean surface temperatures observed across the NEP. Given the strong influence of ENSO on the NEP, it is reasonable to expect 2026 to be warmer than 2025. Global predictions, accounting for the timing of El Niño, are expecting 2027 to be the next record-topping year (WMO, 2026). Consequently, we can expect MHWs with certainty. While we tend to focus on the ecological impacts of MHWs, their effects are also far-reaching socioeconomically across the world (Smith et al., 2021).

Below the surface, temperatures have remained warmer than normal for much of the year. Argo data optimally interpolated along the Line P monitoring line (Figure 2) show slightly cooler-than-normal temperatures have lingered off the shelf west of Vancouver Island. Further west, temperatures are generally warmer than baseline conditions, with significant warm anomalies in the upper 200 m of the water column during the winter. In March, warmth was more consistent throughout the water

column, with some cool anomalies emerging in the upper 100 m. When examining long-term conditions at Station Papa (located at 50°N, 145°W), warming throughout the upper 200 m of the water column offshore in the Northeast Pacific is clear (Figure 3). Simultaneously, over the last decade, fresher than average NEP surface waters (0 to 100 m depth) have been sustained for a much longer time than in previous decades. Combined with our knowledge of the coming El Niño, this adds to the concern for MHWs in the NEP over the coming year, as the fresher surface sets up more stratified conditions that restricts mixing with cooler waters down deep, thus amplifying the warming in the near-surface waters. Fresher than usual conditions were also present before the onset of the “Blob” MHW event that began in 2014.

Data collected on Fisheries and Oceans Canada (DFO) surveys off the west coast of Vancouver Island indicate this warming is contributing to shifts in zooplankton. More species of southern zooplankton were observed during cruises off the west coast of Vancouver Island in March and early May 2026, which may signal the start of the typical transition to poorer quality food for key species, including marine birds, mammals, and fish, that occurs during El Niños. During the La Perouse survey in March 2026, the offshore species *Veleva veleva* was observed on the shelf

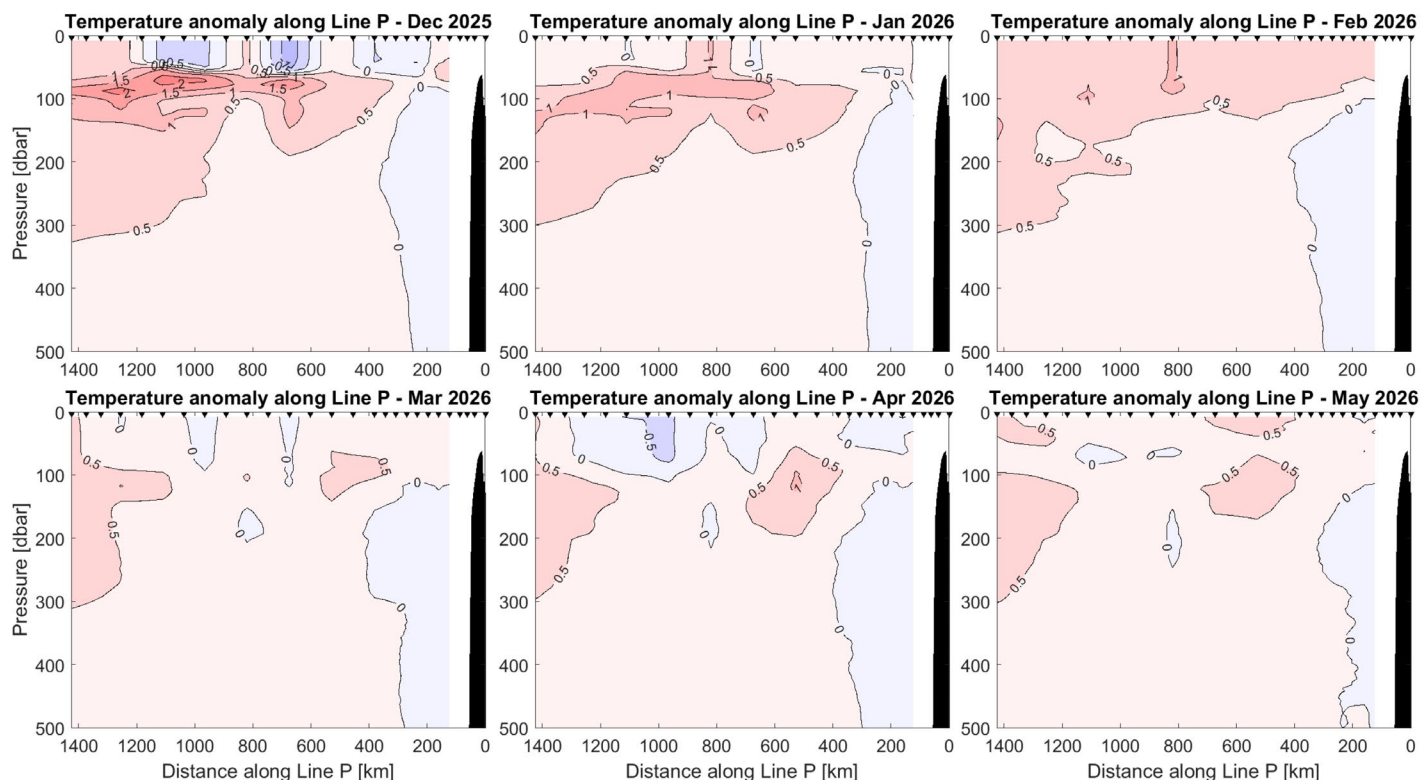


Figure 2. Monthly temperature anomalies for December, January, and February (top row), March, April, and May (bottom row), assembled from Argo data, for the upper 500 m of the Line P survey line. Data from https://data-argo.ifremer.fr/geo/pacific_ocean.

and in nearshore waters off the south and west coast of Vancouver Island. During the May survey, diolioids were observed in offshore and nearshore waters. Because these species are largely transported by water, the zooplankton observations suggest surface waters moved southwest to northeast in March and more south-to-north in May, carrying warm- and temperate-water species northward. Dolioids were observed as far north as Brooks Peninsula but not yet further north. Surveys in the coming months will continue monitoring zooplankton species composition with the onset of El Niño.

The outlook for the coming year can be alarming when a potentially very strong El Niño is expected. However, research on the resilience of marine ecosystems shows that we are not helpless in the face of climate change. Accurate and timely MHW predictions, combined with forward-looking management and ecological restoration plans, are an integral part of facing the warming climate

(Smith et al., 2021). Key to forward-looking management are marine protected areas, or MPAs, with more being established globally to protect marine species and habitats (and many countries on track to protect 30% of the ocean in some degree by 2030). This may sound surprising; how can protecting an area prevent planetary-scale heating from affecting local marine communities? It can't, but scientific efforts have shown that MPAs play an important role in reducing devastating synergistic effects of multiple stressors (Zentner et al., 2023) and promoting resilience of communities inside the MPA (e.g., Kumagai et al., 2024). For the case of the combined stressors of fishing and MHWs, MPAs reduce loss of trophic diversity in fish communities caused by large MHWs and may hasten recovery afterwards compared to non-MPA sites where fishing was permitted (Ziegler et al., 2023). MPAs can be more effective if combined with other ocean management measures, and the future will need to make use of all tools available.

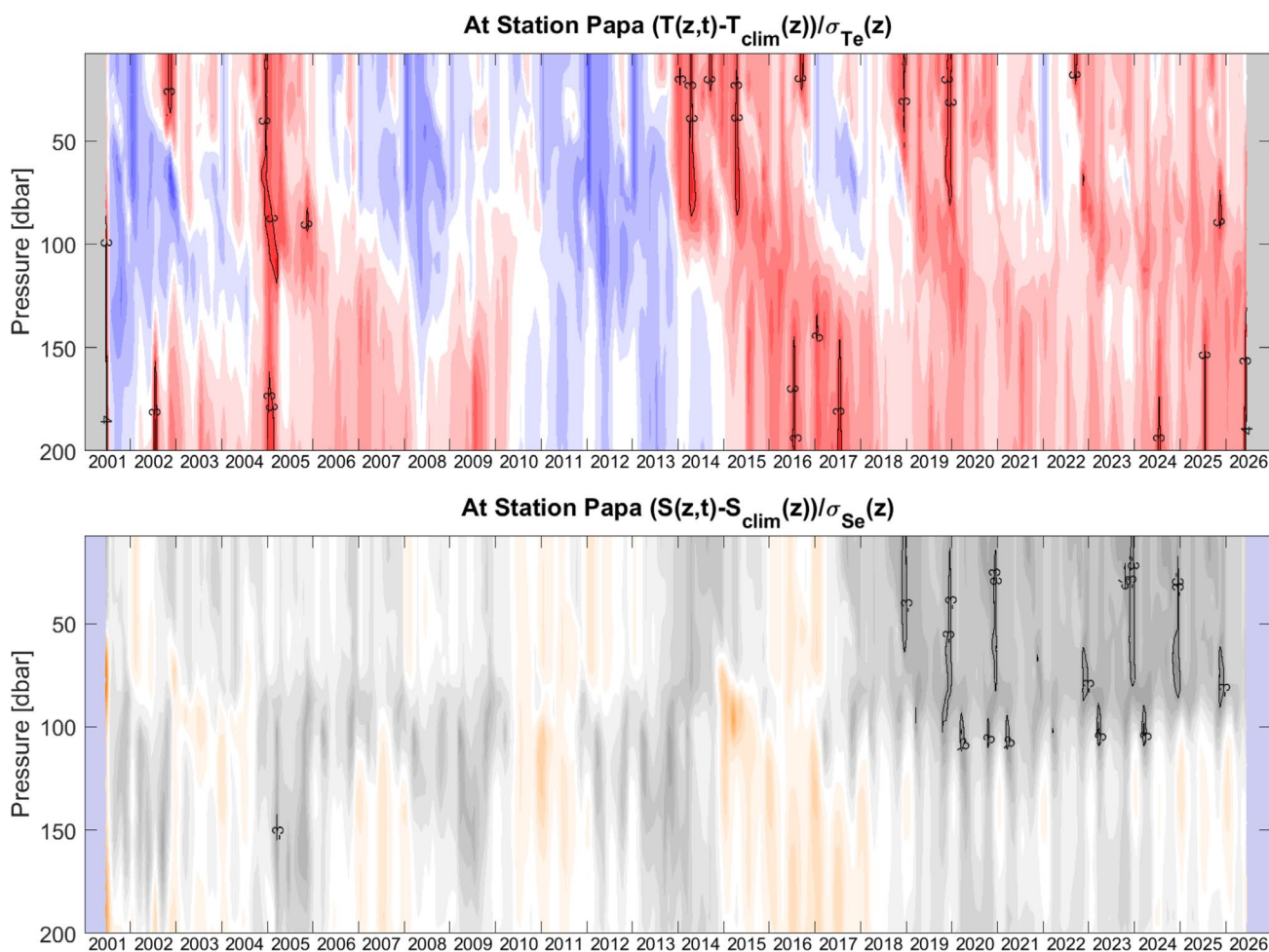


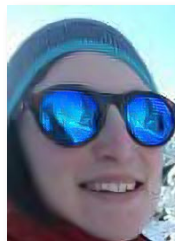
Figure 3. Normalized temperature anomaly (top row, blue is cooler than climatology and red is warmer) and normalized salinity anomaly (bottom row, grey is fresher than climatology and orange is saltier) at Station Papa, the terminus of the Line P survey line. Data from https://data-argo.ifremer.fr/geo/pacific_ocean.

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Humpback whale in Knight Inlet, Vancouver Island, Canada



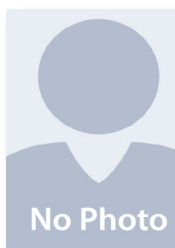
Ms. Andrea Hilborn is a remote sensing specialist who has been working for Fisheries and Oceans Canada at the Institute of Ocean Sciences in Sidney, BC. She is currently working on projects monitoring sea surface temperature, marine heatwaves, and ocean colour in the Northeast Pacific, with a focus on Marine Protected Areas.



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 Submesoscale Processes and Marine Ecosystems.



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).



Moira Galbraith is a Zooplankton Biologist at Fisheries and Oceans Canada at the Institute of Ocean Sciences in Sidney, BC.

The Bering Sea: Current Status and Recent Trends

Edited by Emily Lemagie and Elizabeth Siddon

Climate and Sea Surface Temperature

The most striking feature in the Bering Sea this year has arguably been the rapid expansion and contraction of southerly sea ice extent in March and April. In autumn 2025, sea surface temperatures (SST) were warmer than typical over most of the Bering Sea (Figure 1a). Despite continued warm open-water surface temperature anomalies over the basin and shelf, sea-ice extent remained close to the historical mean throughout the winter. In March 2026, anomalous winds from the north moved cool air and sea ice southward and drove upwelling onto the shelf (Figure 1c). This rapid expansion of ice over relatively warm water was likely associated with thin ice and enabled the rapid ice retreat in April. Meanwhile, to the west, 1-2°C surface ocean temperature anomalies persisted over the western Bering Sea shelf and basin (Figure 1). Sea ice extent was below average in the western Bering Sea, even as the southern extent reached the Aleutian Islands (Figure 1c).

El Niño conditions are developing in the tropical Pacific. A weak Aleutian low pressure this winter was consistent with what is typical during the transition to an El Niño. Near-surface air temperatures over Russia warmed to above average, while most of Alaska experienced cooler than average temperatures (not shown). Looking ahead, the latest National Multi-Model Ensemble (NMME) forecast shows warm SST anomalies of 1-2°C persisting over the Bering Sea basin into the autumn, matched by warm temperatures over much of the North Pacific (Figure 2). While there may be more impacts associated with the developing El Niño this winter and into next spring, the latest measurements and seasonal forecasts place ocean temperatures and species distributions across the Bering Sea generally near the climatological averages.

Atmospheric Conditions

The Aleutian Low is the dominant feature of the atmospheric pressure system in the northern North Pacific during winter (Dec-Mar). Variability in the strength and the position of the Low is important to the Alaska marine ecosystem through its impact on circulation, surface heat fluxes, mixed layer depth, and the extent of sea ice cover over the Bering Sea, all of which influence the rich biological resources of the sea

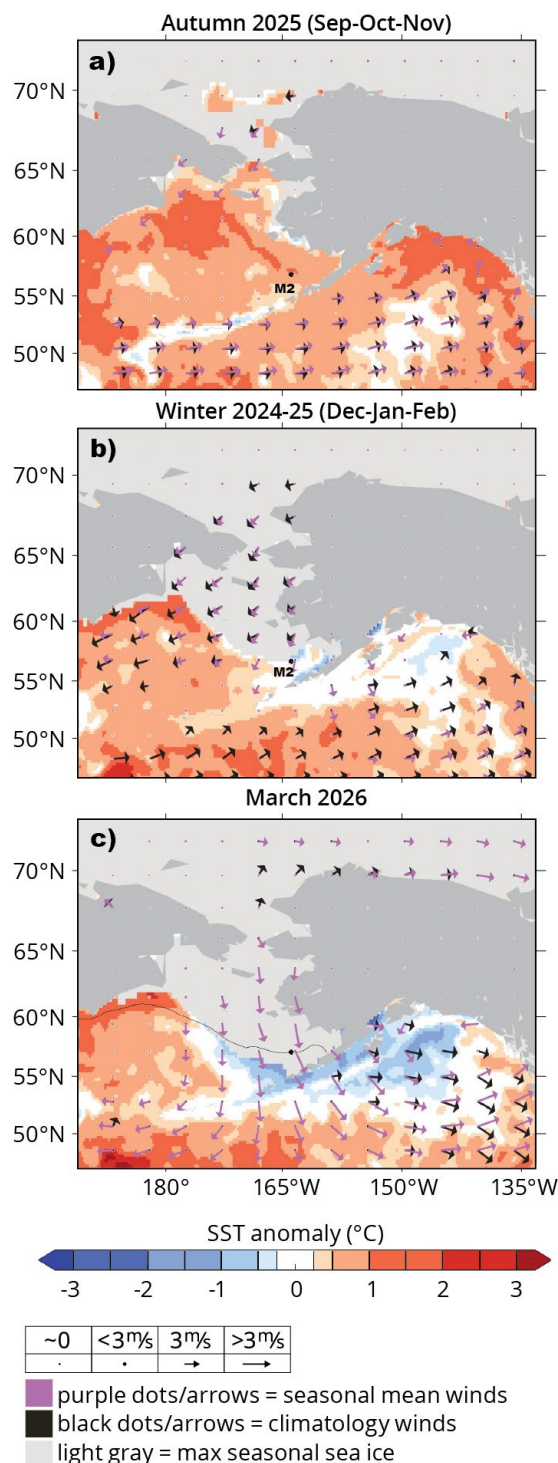


Figure 1. Mean SST anomalies (°C) and 10-m wind vectors for autumn (September–November 2025) through winter (December 2025–February 2026) and March 2026. The thin black line in panel c marks the 1991–2020 mean extent of >15% sea ice coverage.

(Rodionov and Overland, 2005; Wooster and Hollowed, 1995). In general, the intensity and position of the Aleutian Low can significantly influence storm tracks, ocean circulation, and weather patterns across the North Pacific, impacting North America. A stronger Aleutian low means the Bering Sea tends to be warm, stormy, and to have less ice.

Motivated by work from Rodionov and Overland (2005), we defined the Aleutian Low Index (ALI) as the area where sea level pressure (SLP) is less than or equal to 1000 hPa in the North Pacific region (40°N-60°N and 160°E-160°W). The Aleutian Low is a statistical low, which exists in winter only. The ALI was slightly above the normal in 2025, but it is very small in 2026, indicating an extremely weak Aleutian low system in the winter of 2026 (Figure 3). This is further

confirmed by the minimum SLP values in the region as shown in Figure 4. The minimum SLP value was 994 hPa in 2025, slightly below the climatology. It reached 1003 hPa in the 2026 winter, tying the value set 20 years ago in 2006. This is the weakest ALI in the last 50 years, the third weakest in the entire reanalysis record since 1950.

Comparing the NNR and ERA5 reanalysis, we found that the two datasets agree closely throughout the overlapping period in the representation of wintertime Aleutian Low variability (Figure 4). The minimum winter SLP fluctuates substantially from year to year, generally ranging between about 984 and 1005 hPa. Periods of lower minimum SLP correspond to stronger Aleutian Low conditions, while higher values indicate a weaker winter low-pressure system. The Aleutian low was relatively weak until 1977, when a minimum value of 984 hPa was reached. Then the Aleutian low was relatively stable for the next few decades, until 2015, when another minimum SLP record was reached, reflecting exceptionally intense cyclonic activity over the Bering Sea region.

This last winter, atmospheric pressure anomalies and wind patterns (Figure 5) contributed to cold temperatures over Alaska and the eastern Bering Sea shelf. The long-term time series of the monthly surface air temperature (SAT) anomalies at St. Paul Island show the evolution of surface temperatures over several decades (Figure 6). It is highlighting substantial interannual and decadal variability together with a clear warming trend. In the last 47 years (1980-2026), positive anomalies have become more frequent, persistent, and dominate the signal since September 2013 (Figure 6).

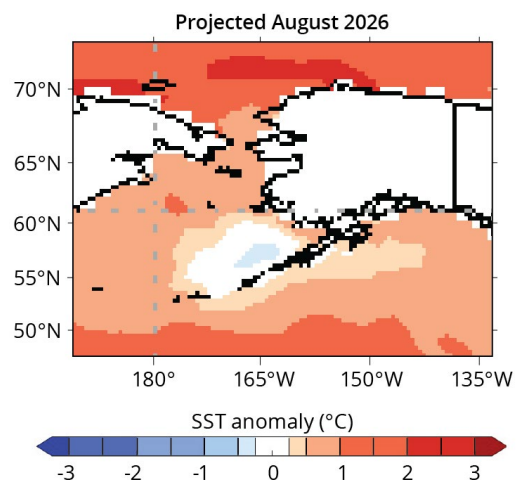


Figure 2. August 2026 NMME SST anomaly projections.

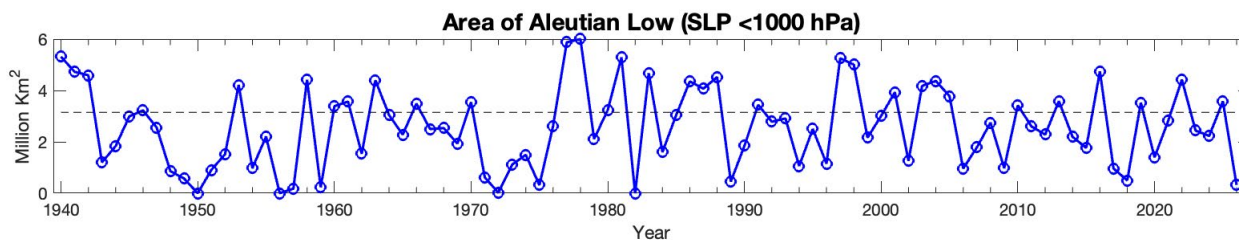


Figure 3. Winter (Jan-Feb) Aleutian Low index which is defined as the area occupied by sea level pressure less than or equal to 1000 hPa in the North Pacific Region from 40°N-60°N and 160°E - 160°W (see Figure 5). Figure courtesy of Muyin Wang, NOAA-PMEL.

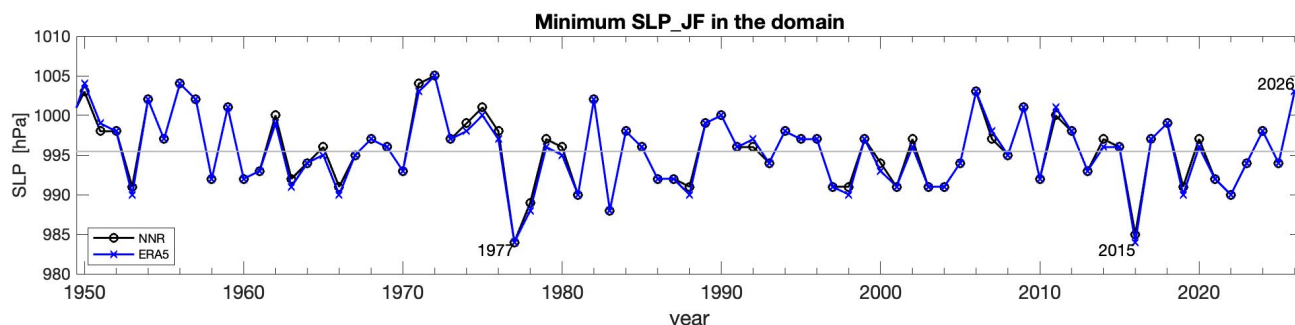


Figure 4. Minimum sea-level pressure (SLP) in the Bering Sea domain (40°N-60°N and 160°E-160°W) for each winter (the mean SLP of January and February) since 1950 based on ERA5 reanalysis. Figure courtesy of Muyin Wang, NOAA-PMEL.

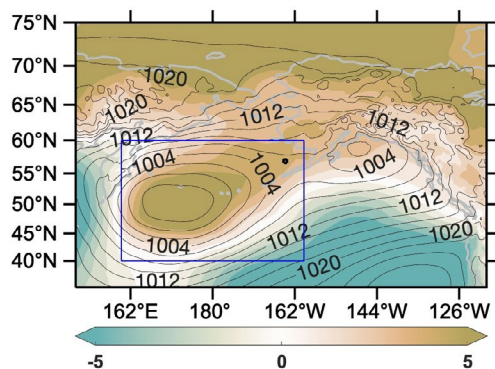


Figure 5. Winter (Jan-Feb) 2026 SLP (contours) and SLP anomaly (hPa). The black dot is the location of the NOAA M2 mooring and the blue box is the region where the ALI is calculated.

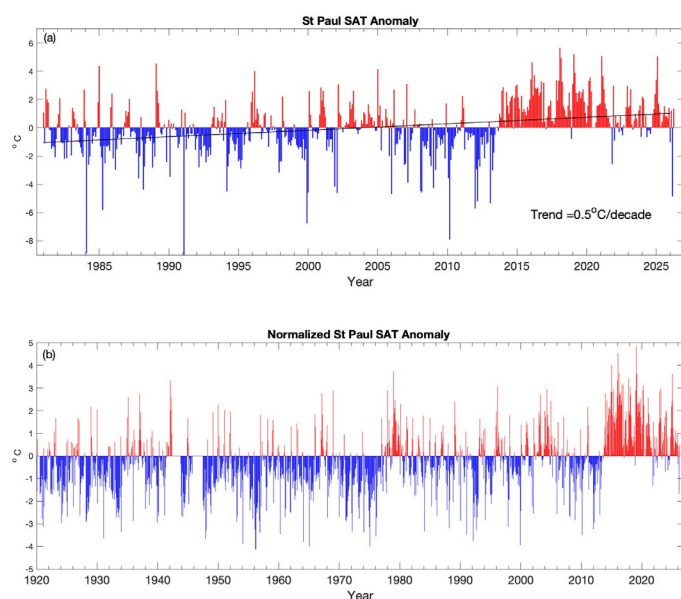


Figure 6. Monthly surface air temperature anomaly at St Paul Island. The anomalies are computed relative to the 1991-2010 period mean. The linear trend from 1981 on is significant at the 99% confidence level ($\pm 0.15^\circ\text{C}/\text{decade}$). Panel (a) shows the monthly time series since 1980, and panel (b) shows the normalized monthly time series since 1920. Figure courtesy of Myuin Wang, NOAA-PMEL.

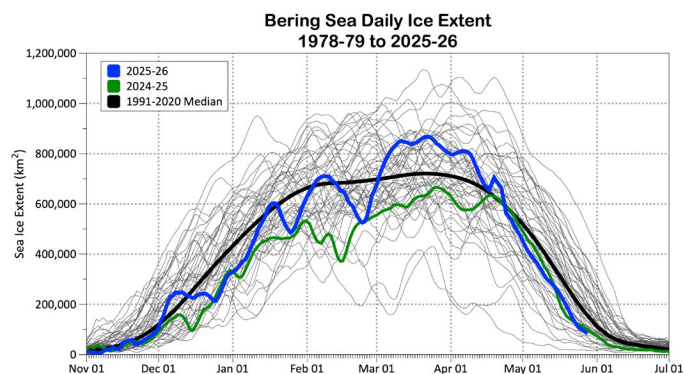


Figure 7. Daily estimates of sea-ice extent in the Bering Sea. Winter 2025/2026 updated to May 28th is shown in blue. Data from National Snow and Ice Data Center. Figure courtesy of Rick Thoman, UAF/ACCAP.

Compared with the warm conditions in 2025, 2026 started with a cold anomaly in January (-1.04°C), followed by a cold spell of -4.85°C in March, which is close to negative two standard deviations (Figure 6b) below normal (1991-2020). A linear trend of $0.50^\circ\text{C}/\text{decade}$ for the 1981-2026 period has been identified. This trend is about the same as found in the past several years.

Sea Ice Extent

Sea ice extent in the Bering Sea overall was near to below normal from the onset of the freeze season in autumn through February, with significant week-to-week variability due to changes in the prevailing storm track (Figure 7). In early March sea ice expanded dramatically in the southeastern Bering Sea due to sustained north to northeast winds. Late in March sea ice covered all of Bristol Bay and extended southwest along the Alaska Peninsula to the north shore of Unimak Island, and this was the most extensive ice in the eastern Bering Sea since 2012. A change in the weather pattern the second week in April rapidly melted most of the ice in the southeast Bering Sea, and by May, ice extent was lower than the 1991-2020 median.

Depth-averaged ocean temperatures at NOAA mooring M2 on the southeastern Bering Sea middle shelf have been above the long-term mean since 2013, with only brief periods of cool temperatures (Figure 8). Each period of cool temperature is associated with sea ice extent that reaches the mooring location. In early 2026, sea ice at M2 helped to cool the water column, with temperatures cooler than have been observed since before 2013. This impact was present across much of the eastern Bering Sea shelf, where the 2°C cold pool extent was above average in early 2026.

Species Distribution Models

NOAA's Alaska Fisheries Science Center hosted the annual Preview of Ecosystem and Economic Conditions meeting on May 26-28, 2026. The goal of the meeting is to exchange information on the early physical, biological, and economic conditions to inform the upcoming federal fisheries assessment cycle for crab and groundfish. Previously developed Species Distribution Models (SDMs) linking EBS groundfish and crab presence/absence and biomass to cold pool extent, bottom temperature, pH, and oxygen (Goodman et al., 2025) were re-fit to hindcasted conditions and used to predict on a persistence forecast from the MOM6 oceanographic model for the NOAA AFSC Spring PEEC. On average across the EBS, April 30th temperature ($\sim -0.3^\circ\text{C}$), oxygen ($\sim 3 \text{ mmol/m}^3$), and de-trended pH (~ 0.006) anomalies were small, and corresponding July forecast

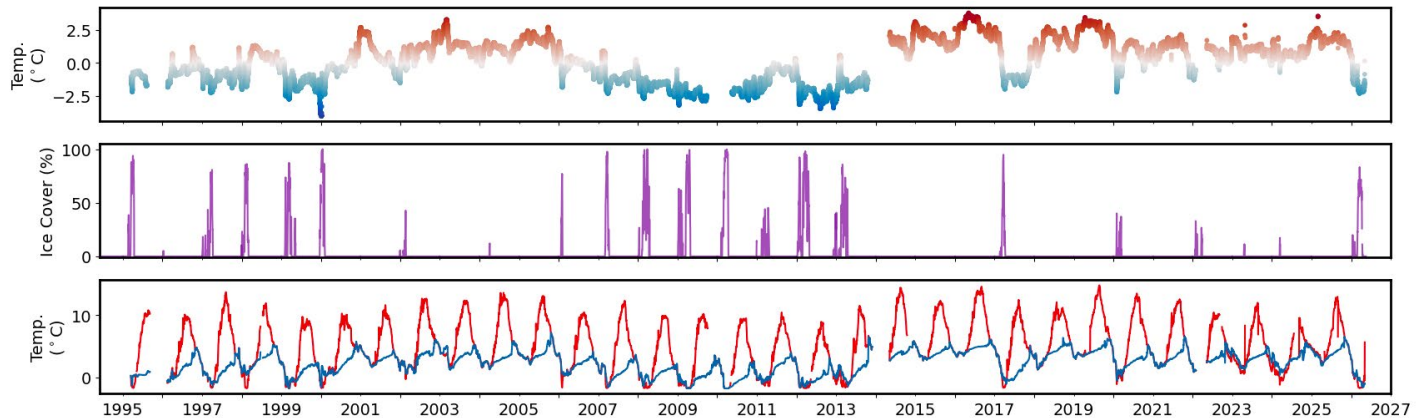


Figure 8. Depth-integrated ocean temperatures, ice coverage (purple), near-surface ocean temperature (red), and near-bottom ocean temperature (blue) from NOAA mooring M2 (Figure 1). Figure courtesy of Phyllis Stabeno, NOAA-PMEL.

conditions were near the 1993-2022 climatology. Among all species, life stages, and model types (presence/absence and biomass), there is a greater than 96% agreement between climatological mean distributions and July forecasted distributions. The range of predicted anomalies in species area occupied and both latitudinal / longitudinal centres of gravity includes zero in nearly all cases, indicating that aggregate properties of forecasted species distributions are consistent with the climatology as well (Figure 9).

Modest shifts are predicted for some species, however: a greater proportion of snow crab biomass is expected to be distributed in the NBS near St. Lawrence Island and in the middle southern domain than is typical, owing to a slightly larger than typical 2°C cold pool but ~1°C warmer than normal bottom temperatures north of St. Matthew Island (Fig. 10). Arrowtooth flounder are strongly avoidant of the cold pool, and models therefore predict flounder redistribution away from the middle domain and toward the outer shelf. Red king crab distributions are expected to shift east, with greater than typical habitat suitability in the inner domain of the EBS from Norton Sound down through Bristol Bay and the Alaskan Peninsula but with substantial disagreement among models (figure not shown).

Select NOAA 2026 Surveys in the Aleutian Islands, Eastern Bering Sea, and Arctic Ocean

- NOAA Alaska Fisheries Science Center (AFSC)/Pacific Marine Environmental Lab (PMEL) Spring mooring survey, R/V *Oscar Dyson*, 1 - 22 May 2026.
- NOAA-AFSC Eastern Bering Sea summer groundfish and crab bottom trawl survey, chartered vessel, 27 May - 1 August 2026.

- NOAA-AFSC Eastern Bering Sea pollock acoustic trawl survey, R/V *Oscar Dyson*, 28 May - 10 August 2026.
- NOAA-AFSC Aleutian Island summer groundfish and crab bottom trawl survey, chartered vessel, 31 May - 8 August 2026.
- NOAA-AFSC Gulf of Alaska & Eastern Bering Sea & Aleutian Islands Longline survey, chartered vessel, 1 June - 5 July 2026.
- NOAA Marine Mammal Lab (MML) Aleutian Island Steller sea lion survey, chartered vessel, 20 June - 5 July 2026.
- NOAA MML Northern Fur Seal abundance trend monitoring, land-based surveys, 1 July - 30 September 2026.
- NOAA-AFSC Northern Bering Sea summer groundfish and crab bottom trawl survey, chartered vessel, 1 - 16 August 2026
- NOAA PMEL and AFSC Fall mooring survey, R/V *Shimada*, 5 August - 1 September 2026.
- NOAA-AFSC Eastern Bering Sea juvenile fish surface trawl survey, R/V *Oscar Dyson*, 22 August - 14 September 2026.
- NOAA-AFSC Northern Bering Sea juvenile fish surface trawl survey, chartered vessel, 24 August - 23 September 2026
- NOAA MML Arctic Moorings survey, R/V *Fairweather*, 6 - 21 September 2026.

Acknowledgments

Many thanks to the scientists who helped create this report: Dr. Muyin Wang at UW-CICOES and NOAA-PMEL provided information on atmospheric conditions; Dr. Rick Thoman at the International Arctic Research Center and University of Alaska Fairbanks provided the sea ice summary; Dr. Phyllis Stabeno at NOAA-PMEL provided M2 mooring data; Dr. Maurice Goodman at NOAA-AFSC provided information for species distribution models.

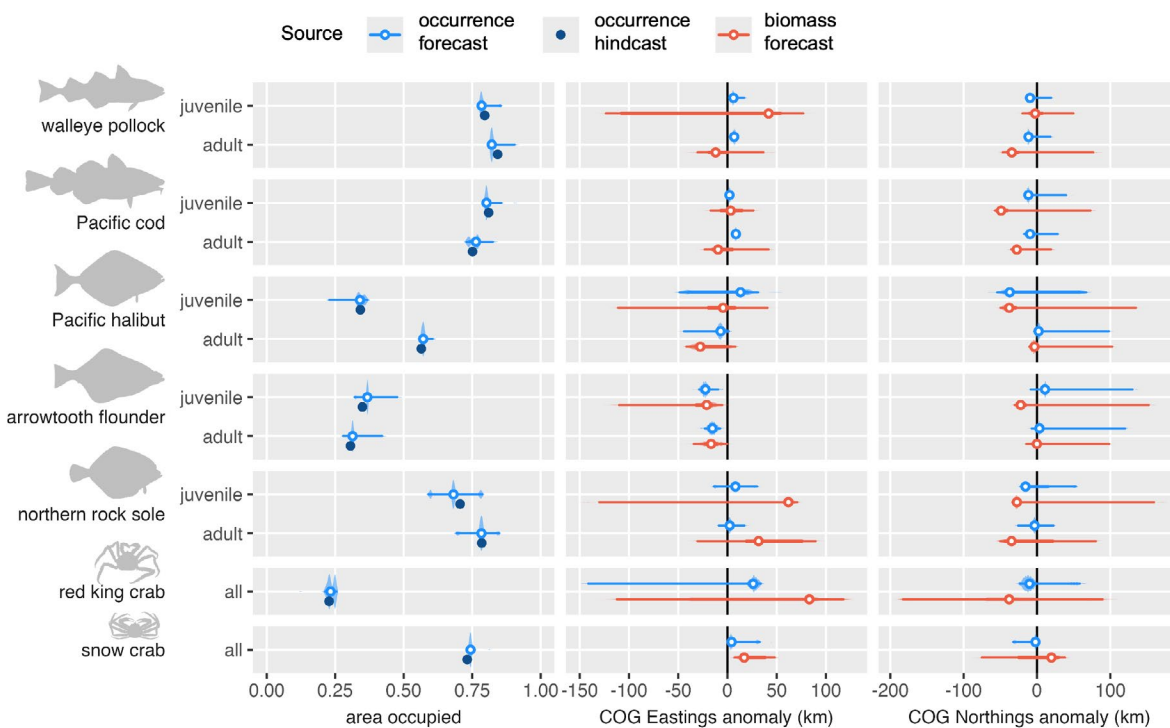


Figure 9. Derived quantities from species distribution model ensemble. Left: expected (open circles) and among-model range of estimates (density / line ranges) proportion of the EBS survey domain occupied by each species / life stage (rows), compared with climatological average (1993-2022). Right: deviation in distribution center of gravity eastings and northings from climatological average, as estimated by models for occurrence (blue) and biomass (red). Figure courtesy of Maurice Goodman, NOAA-AFSC.

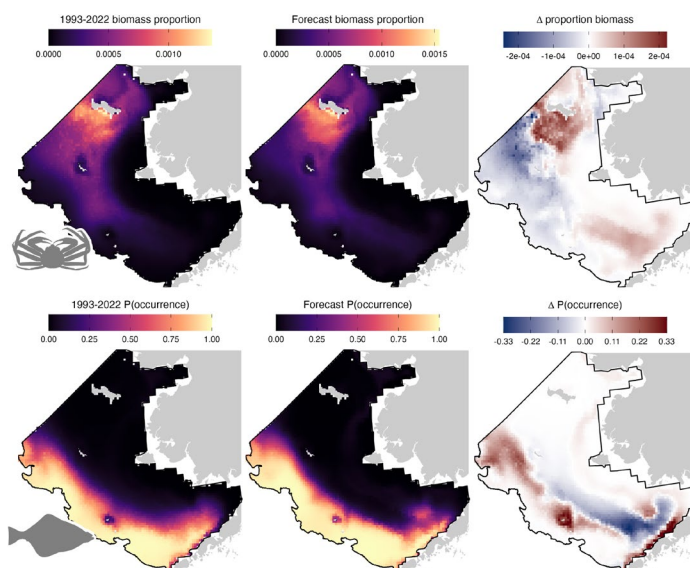


Figure 10. Maps of snow crab biomass distribution (top) and arrowtooth flounder probability of occurrence distribution (bottom) under climatological mean (left) and July forecast (center), with forecast anomalies (right) showing regions where relative biomass or probability of occurrence are expected to differ from climatology. Figure courtesy of Maurice Goodman, NOAA-AFSC.

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PICES UPDATES AND EVENTS

Event Schedule

PICES Summer School 2026

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September 14-18, 2026

Hakodate, Japan

[Information Package](#)



ICES Annual Science Conference

September 15-18, 2026

Brest, France

More information: [ASC 2026 Website](#)

Annual
Science
Conference

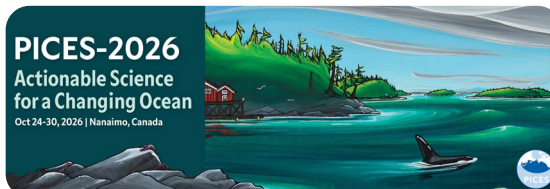
PICES-2026 Annual Meeting

Actionable Science for a Changing Ocean

October 24-30, 2026

Nanaimo, BC, Canada

More information: [PICES-2026 Website](#)



FIMEC-2027

Global Symposium on Fisheries Management in an Ecosystem Context

May 10-13, 2027

Penang, Malaysia

More information: [FIMEC-2027 Website](#)



PICES 2026 Annual Meeting

Actionable Science for a Changing Ocean

24-30 October 2026 | Nanaimo, Canada



We look forward to welcoming the PICES Community to PICES-2026 in Nanaimo, British Columbia, Canada!

For this year's theme, "Actionable Science for a Changing Ocean," we will unite ocean professionals, Indigenous partners, scientists, communities, and policymakers to share the latest research on climate-driven marine change and ways to bridge the science/policy interface by developing actionable science and improving communication to policy and decision makers. This includes interdisciplinary and transboundary research, the inclusion of human dimensions in research and management, and the inclusion of policy and regulatory decision makers in science processes. Recent advancements in research and monitoring tools, artificial intelligence, as well as social and economic

-oriented investigations show promise in improving our understanding of marine ecosystems and our ability to resolve socioeconomic and environmental conflicts. The scientific program includes 11 workshops, 13 Topic Sessions, and an evening poster session.

While the PICES Community is 'serious' about science, PICES Annual Meetings are a friendly, inclusive, and collaborative environment to discuss and share ideas. We welcome and celebrate our broad community, from Early Career Ocean Professionals (ECOPs) to Senior Scientists, breaking barriers for interdisciplinary research, and representation from numerous countries and cultures. Our annual meetings are a perfect opportunity for members to build relationships, get new perspectives, and develop collaborations in their work.



Venue location: *Vancouver Island Conference Centre*

More information

Registration and more details on the PICES-2026 meeting website [here](https://meetings.pices.int/meetings/annual/2026/PICES/scope).

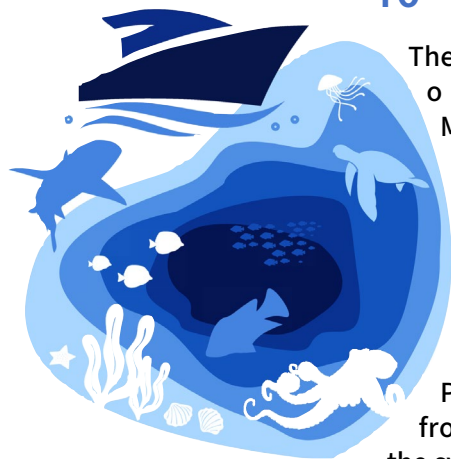


<https://meetings.pices.int/meetings/annual/2026/PICES/scope>

FIMEC 2027

Fisheries Management in an Ecosystem Context

10–13 May 2027 | Penang, Malaysia



The Global Symposium on Fisheries Management in an Ecosystem Context (FIMEC 2027) is now open for abstract submissions and registration!

Taking place in Penang, Malaysia from 10–13 May 2027, the symposium will bring

together fisheries scientists, managers, practitioners, and stakeholders from around the world to reflect on more than two decades of progress in ecosystem-oriented fisheries management and to help shape the next phase of action.

More than 25 years after the Ecosystem Approach to Fisheries became an explicit international framework, FIMEC 2027 offers a timely opportunity to take stock. What has ecosystem-oriented fisheries management delivered in practice? Where has implementation stalled? And what must change over the next two decades?

The symposium will consider fisheries as complex social-ecological systems, including the interactions between fisheries and ecosystems, the wider seascapes in which they take place, and the ecological, social, cultural, economic, and governance conditions that shape management decisions.

These systems exist across every region of the world, often where data, capacity, and resources are limited. The symposium aims to focus particularly on how Ecosystem Approaches to Fisheries (EAF) and Ecosystem-Based Fisheries Management (EBFM) can be made practical and credible in these real-world conditions as well as to provide a forum to discuss how to implement this approach in broader international agendas.

The symposium invites the global EAF and EBFM community to exchange knowledge, experiences, and perspectives across countries, cultures, and disciplines. Join us in Penang next spring to help shape the future of fisheries science and management for the decades ahead.

Registration is open!

September 30th is the deadline for:

- Early registration
- Abstract submissions
- Financial support applications

Topic Sessions

Morning Plenary Sessions

Session 1 – Governance, policy, and people: Enabling conditions for fisheries management in an ecosystem context

Session 2 – Global change and fisheries: Incorporating uncertainty into scientific advice and management

Session 3 – Practical implementation of fisheries management in the ecosystem context: Scalable approaches and overcoming operational challenges

Session 4 – Emerging approaches to fisheries management in an ecosystem context

Closing Plenary – Synthesis of fisheries management in an ecosystem context and charting a path forward for the next 20+ years

More information

Learn more, register, or submit an abstract on the symposium website [here](https://meetings.pices.int/meetings/international/2027/FIMEC/scope).



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