



## **2024 Intersessional Science Board Meeting**

### **Report**

**Held online: May 7-9 (North America) May 8-10 (Asia)**

(With GC decision to SB recommendation as of June 30)

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## Agenda Item 1: Welcome, adoption of agenda

Science Board (hereafter SB) Chair, Dr. Sukyung Kang, reviewed video meeting etiquette and protocol, called the meeting to order, welcomed participants, and made introductions.

### List of Participants

<b>Science Board</b>	
Sukyung Kang	Science Board Chair
Jeanette Gann	Science Board Vice-Chair, TCODE Chair
Steven Bograd	FUTURE SSC Co-Chair
Hanna Na	FUTURE SSC Co-Chair
Akash Sastri	BIO Chair
Jackie King	FIS Chair
Mitsutaku Makino	HD Chair
Thomas Therriault	MEQ Chair
Lei Zhou	POC Chair
Sung Yong Kim	MONITOR Chair
Yury Zuenko	Representing Russia
<b>*Governing Council</b>	
Enrique Curchitser	PICES Chair
Tetsuo Fujii	PICES Vice-Chair
Se-Jong Ju	GC member
<b>PICES Secretariat</b>	
Sonia Batten	Executive Secretary
Sanae Chiba	Deputy Executive Secretary
Alexander Bychkov	ex-officio
<b>Guests</b>	
Yutaka Hiroe	F&A member
Tatsuki Oshima	F&A member
Katsuyoshi Ishikawa	MOFA Japan
Natsumi Okawa	MOFA Japan
Hana Matsubara	AP-ECOP
Hannah Lachance	AP-ECOP
Raphael Roman	AP-ECOP
Oleg Katugin	FUTURE, HD
Toru Kobari	BIO
Kathryn Berry	BECI

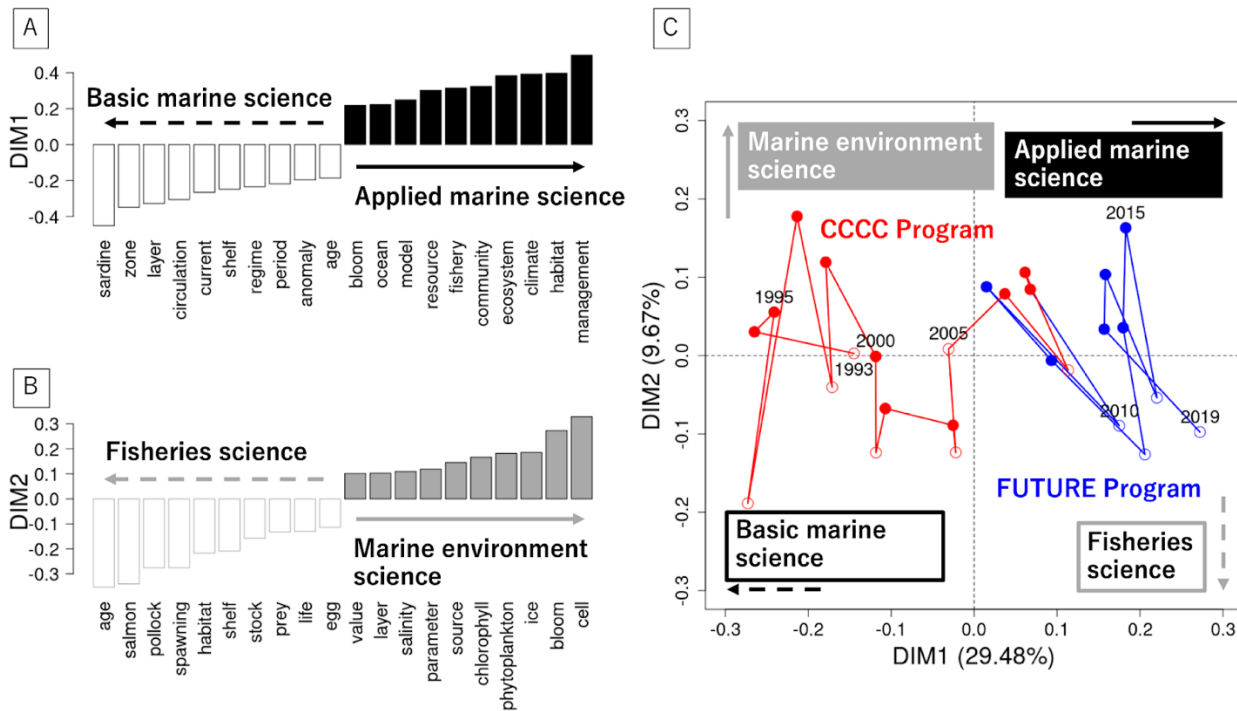
\*Note : GC members are regularly invited to participate in the Intersessional SB Meeting.

## Agenda Item 2: FUTURE-SSC Report

FUTURE SSC co-chairs, Drs. Steven Bograd and Hanna Na presented updated FUTURE activities and their planning in 2024 as discussed at the FUTURE SSC Business meeting held on May 7/8.

### 1. Progress of FUTURE synthesis paper

“Climate Variability and Ecosystem Resilience in the North Pacific: Lessons Learned from the PICES FUTURE Program” Takemura et al. to be submitted to ICES Journal of Marine Science (TBD). The paper was conducted to explore progress and shifts in emphasis facilitated by FUTURE Program, and overview FUTURE Program based on outcomes as summarized in FUTURE Product Matrix.



Transformation of PICES Science from CCC to FUTURE (Takemura et al, in preparation).

### 2. FUTURE symposium during PICES-2024

Planning of the FUTURE symposium to be held on Monday, October 28th, following the Opening Ceremony.

(Symposium Description) PICES has provided leadership in developing a more thorough understanding of the structure, function, and changes of North Pacific marine ecosystems with the support of its flagship scientific programs. The current scientific program on ‘Forecasting and Understanding Trends, Uncertainty, and Responses of North Pacific Marine Ecosystems’ (FUTURE) has been promoting investigations of North Pacific ecosystems with an emphasis on the synergy of social, ecological, and environmental systems (SEES) and processes. Within this SEES framework, FUTURE is focused on developing a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services, and marine-dependent social systems. The FUTURE symposium plans to review its past, assess the present, and discuss the future of FUTURE to better observations, improved awareness of mechanisms of change, and ultimately science for sustainability along with the United Nations Decade of Ocean Science for Sustainable Development and the mission of developing “the science we need for the ocean we want”.

### 3. FUTURE Phase III Priorities

The Phase III priorities include engaging ECOPs in FUTURE SSC, facilitating cross-pollination across FUTURE, AP-UNDOS, AP-ECOP and AP-SciCom, focusing on science-based solutions & operational products. FUTURE plans to develop new PICES Science Program to address emergent themes identified in UNDOS for 2025-2027.

### Agenda Item 3: SmartNet/AP-UNDOS Report

SmartNet co-chair and AP-UNDOS co-chair Dr. Bograd, updated [SmartNet](#) activities since PICES-2023 and planning for 2024 and forward. SmartNet keeps seeking the appointment of UNDOS intern to support facilitating and coordinating programme activities.

#### 1. Publication plan update

- 1.1. “Advancing Solutions for the Climate-Fisheries Nexus in the UN Decade of Ocean Science for Sustainable Development”
  - Based on the outcome of the cross-Programme Workshop we held at ECCWO in April 2023, aiming to evaluate the status of Decade Actions around the ‘climate-fisheries nexus’, describe our collective goals and capacities, identify key gaps, and provide recommendations for new Actions.
  - The UNDOS Programmes involved: [SUPREME](#), [GEOS](#), [FishSCORE](#), [ML2030](#), [BFF](#), [OBON](#)
  - Submitted to ICES Journal of Marine Science (in review as of June 30).
- 1.2. “Ocean sustainability through collaboration: SmartNet, Small Island Developing States (SIDS), Least Developed Countries (LDCs), Early Career Ocean Professionals (ECOPs) (title TBC)”
  - Developed from the outcome of [PICES-2023 Workshop 2](#) “Sharing Capacity and Promoting Solutions for Marine Ecosystem Sustainability within the UN Decade of Ocean Science”
  - Submitted to The Oceanography Society (TOS) Special Issue of Oceanography on ‘A Vision for Capacity Sharing in the Ocean Sciences’ (in review as of June 30)

#### 2. Report of the UNDOS Conference in Barcelona (April 2024)

\* see [PICES Press 2024 summer issue](#) for details

- 2.1. Prof Makino and his group organised a side event “What is the ocean we want?: Global Survey to Understand Perspectives on Ocean Decade Outcomes: 182”. “The Ocean We Want Global Survey” research is supported by SmartNet. Two PICES ECOPs Juri Hori and Naya Sena joined the event with travel support from PICES.
- 2.2. SmartNet and Global ECOP co-organized two sides events:
  - The inclusivity we need for the ocean we want: **244**
  - Networking satellite event “Building Ocean Leadership: Fostering Networking, Creativity and Resilience: **224**

An ECOP, Khush Jugroo, and SmartNet Co-Chair, Steven Bograd join the events with travel support from PICES.



(Left) One of the illustrations created at the “What is the ocean we want?” satellite event (Illustration by artist Bass Kohler. (Right) PICES members at the UNDOCS Barcelona conference (not shown: Juri Hori and Naya Sena).

## Agenda Item 4: Special Project Updates

### 4. 1. FishPhyO

The Project Science Team co-chair, Dr. Mitsutaku Makino, updated the progress of the PICES/MAFF Project: Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters (FishPhyO). Due to the sudden budgetary cut by the project sponsor, the Ministry of Agriculture, Forestry and Fisheries (MAFF) Japan, in early 2024, FishPhyO program is currently facing a significant threat to its continuation. Dr. Makino reported the attempts to identify alternative sponsors had been unsuccessful but the team would seek alternative funding sources to keep the project alive.

#### Background

FishPhyO was launched in June 2023 as the third in a series of collaborative projects with Indonesia following the previous PICES-MAFF projects [FishGIS \(2017–2020\)](#) and [Ciguatera \(2020–2023\)](#). Project Science Team co-chair, Dr. Makino, introduced the objectives and planning of FishPhyO, and reported the project kick-off meeting, the PICES/MAFF Indonesian workshop, held on July 2-8, 2023 in Banten and Lombok (see the [Scientific Progress Report](#) on FishPhyO webpage).

#### Objective

To establish, in collaboration with local fishermen and research institutes and universities, a phytoplankton-fishery observing program in coastal Indonesia by integrating the FishGIS application, developed and refined during the previous two PICES/MAFF projects (2017–2023) with existing automated technologies for detection of toxic benthic Harmful Algal Bloom (HAB) species. The longer-term goal is to provide local communities with the capacity and knowledge to sustainably manage their fisheries resources and ensure seafood safety. The project also aims to identify potential research needs for deploying the FishGIS application in PICES member countries.

### 4. 2. Basin Events to Coastal Impacts (BECI) Report

BECI Science Director, Dr. Kathryn Berry, introduced herself to SB, and presented the updates and planning up to 2025 of BECI (Basin-Scale Events to Coastal Impacts: An Ocean Intelligence System for a Changing World). Dr. Berry answered to SB members’ questions on the feasibility of ocean observation components and data mobilisation of BECI, the progress and timeline of the implementation plan, and prospects for securing funding. SB

members recommended BECI engage more Western North Pacific experts with current leadership being dominated by North American experts.

**Background:** The BECI project (Basin-Scale Events to Coastal Impacts: An Ocean Intelligence System for a Changing World) was endorsed by the United Nations Decade of Ocean Science and Sustainable Development (UNDOS) in 2021. BECI has continued to make progress towards developing a high-level Science and Implementation Plan through a series of international workshops in 2022, 2023 and 2024.

**The objective of BECI is** to develop an international ocean intelligence system for the North Pacific Ocean that will use enhanced high-tech observations, ocean modeling, data infrastructure and artificial intelligence (AI) to provide timely and targeted information on the impacts of current and future climate events on ocean ecosystems and people. Using salmon as an exemplar species, BECI will ultimately take a modular approach to include all species of interest in the North Pacific Ocean to further develop cross-cutting marine research, modeling, and data synthesis to allow for more effective predictions on marine productivity for key species in the North Pacific Ocean.

**Update:** ([https://beci.info/funding\\_announcement/](https://beci.info/funding_announcement/)).

At the 2023 NPAFC Annual Meeting, the NPAFC adopted their new five-year science plan (2023 – 2027) which will complement BECI research and collaboration. BECI will build off the success of the International Year of the Salmon initiative's (2018 – 2022) High Seas Expeditions, which studied the winter ecology of salmon in the North Pacific Ocean. BECI Receives \$1.1M in Funding from the B.C. Salmon Restoration and Innovation Fund (BCSRIF). The funding enables the establishment of a project office and the recruitment of key personnel such as a BECI Science Director, Kathryn Berry, to complete the science and implementation plans.

## Agenda Item 5: PICES External Review

PICES Deputy Executive Secretary, Dr. Sanae Chiba reported the progress and publication timeline of the External Review Panel Report.

**Background:** External Review of PICES ([SG-ER](#)) was established with the consideration of GC on the need to commission a review of PICES to ensure that it is evolving in line with global marine science priorities and to give confidence to Contracting Parties that their resources are effectively used (2021/A/10). PICES External Review Committee members nominated by SG-ER were invited to PICES-2023 to review the scientific activities and function of the annual meeting. In January 2024, The Committee members visited the Secretariat in Sidney, Canada, to conduct a further survey on its organizational structure and current and future perspectives of PICES. The Review will be completed and available for the PICES Community during the summer of 2024.

## Agenda Item 6: Collaborative Frameworks with Partner Organizations

### 6.1. IPHC-PICES MoU Renewal

The Memorandum of Understanding (MoU) between the International Pacific Halibut Commission (IPHC) and PICES needed to be renewed upon completion of the previous MoU term as of January 14, 2024. FIS Committee has reviewed the revision and agreed to seek SB recommendation on the renewed MoU. SB recommended Governing Council (hereafter GC) approve the new MoU. *GC approved the new MoU (IGC2024/S/4)* (see [PICES website link](#)).

### 6.2. PICES-NPFC Collaboration Framework renewal plan

Dr. Chiba reported the planning for the renewal of the current collaboration framework between the North Pacific Fisheries Commission (NPFC) and PICES, whose 5-year term will end at PICES-2024 (see [PICES website link](#)). NPFC Scientific Committee (contact: Alex Zavolokin, Science Manager) and relevant PICES Committees (FIS and BIO, contacted through Secretariat, March 27, 2024) shall work together on the revision of the framework to seek SB recommendation/GC approval at PICES-2024 and approval of NPFC Commission in close proximity.

## Agenda Item 7: PICES 2024 and 2025

### 7.1. PICES 2024 Update and PICES-2025 Planning

#### 7.1.1 PICES-2024 General Schedule

Dr. Chiba updated the basic schedule of PICES-2024.

Date: Oct 26-Nov 3, 2024,

Venue and Location: Hawaii Convention Center, Honolulu, HI, USA

\*Abstract submission opened on March 15 and will be closed on June 15 (\*extended to June 30)

Pre-meeting timeline (tentative)	
– June 15	Confirmation of Invited speakers, Abstract submission & Financial support application
July - August	Confirmation of speakers, Finalization of Sessions / Workshop schedule
By late-Sept	<b>Online</b> EG Business meetings to prepare; Activity Reports & Requests for SB-2024
By mid-Oct	<b>Online</b> Committee/FUTURE business meeting to review; EGs Activity Reports & Requests for SB-2024

PICES-2024				
Oct 26 (Sat)	Day	3 Parallel Workshops	in-person EG business meetings (up to 4)	
	Evening		Committee Business Meetings x 3 or 4 (hybrid)	
Oct 27 (Sun)	Day	3 Parallel Workshops	in-person EG business meetings (up to 4)	
	Evening		Committee Business Meetings x 3 or 4 (hybrid)	
Oct 28 (Mon)	AM	Opening Ceremony		
	1030-	FUTURE Symposium		
	Evening	Welcome reception (TBD)		
Oct 29 (Tue)	Day	4 Parallel Topic Sessions	in-person EG business meetings (1-2 per day)	
Oct 30 (Wed)	Day	4 Parallel Topic / Paper Sessions	F&A meeting Day 1&2 (0.5 day) on Oct 24	
Oct 31 (Thu)	Day	4 Parallel Topic Sessions	and 25	
	Evening	Poster Session	(hybrid)	
Nov 1 (Fri)	AM	Special Panel: PICES Science in the Next Decade		
	Noon	Closing Ceremony		
	PM			SB Meeting Day 1 (hybrid)
	Evening	Chair's reception		
Nov. 2 (Sat)	Day		SB Meeting Day 2, GC Meeting Day 1 (hybrid)	
Nov. 3 (Sun)	Day		GC Meeting Day 2 (hybrid)	



### 7.1.2. PICES-2024 In-person Business Meeting request

SB reviewed the proposed in-person business meetings from Expert Groups (hereafter EG) and recommended GC for approval (see the table). *GC approved for the EGs listed to hold an in-person business meeting during PICES-2024 (IGC2024/S/1)*

\* All EGs and Committees are recommended to have at least one online business meeting to discuss items to request/propose to SB/GC approval before PICES-2024. Expert Groups can additionally request an in-person meeting during PICES-2024.

EG	Duration (Max 1.0 day)	Note
FUTURE	0.5	
AP-CREAMS	0.5	
AP-ECOP	0.5	
AP-NIS	1	
AP-UNDOS	0.5	
S-CCME	0.5	To help reinforce collaborations across S-CCME members and identify activities for the upcoming year. We are flexible on the time and day.
AP-NPCOOS	0.5	
S-HAB	0.5	
S-MBM	0.5	
SG-GREEN	0.5	The major objective is to finalize our report, discuss a proposal for the next SG on Carbon Credits, and plan the way forward.
WG45	0.5	Confirm the progress of WG45 activities and determine the final report type.
WG46	1	*Upon approval of new WG
WG47	0.5	Request to hold a 2-hr meeting on either Oct 29, 30, 31. or Nov. 1
WG49	1	To review progress of research activities associated with the proposal initiated by co-chairs to achieve multiple TORs and discuss gaps in TOR 3 and 5.
FishPhytO	1	
WGSPF	1	*upon approval of new WG

### 7.1.3. Update of Workshop plan

Dr. Chiba updated the approved workshop plans listed below, and SB acknowledged the updates.

**Workshop 2:** Applying social-ecological frameworks to explore actionable solutions for climate extreme events across the North Pacific (supported by FUTURE/HD/MONITOR).

The Workshop was postponed to PICES-2025 due to the difficulty of holding it at PICES-2024.

**Workshop 8:** "Science Jam" - Bridging the gap between science and social media to communicate PICES accomplishments with the world (supported by FUTURE/TCODE).

The workshop was initially planned as a 3-day lunchtime session. However, due to the restriction of ordering affordable lunches for participants, the convenors modified its plan to fit 4 days (Mon to Thurs) of mini-sessions during coffee breaks. The duration of the coffee break will be adjusted to 20 to 30 min to accommodate the plan.

**AP-CREAMS Intersessional Workshop** (funding support approved by GC2023/S/12)

CREAMS 30th Anniversary and **CSK-II** Joint Workshop, "Promoting international collaboration for science of East Asian Marginal Seas in a changing climate: from circulation, biogeochemistry, ecosystem and socio-economic

researches. \*CSK: Cooperative Study of the Kuroshio and Adjacent Regions.

Date: July 25, 26, 2024

Location: Seoul, Korea

Host: Seoul National University

Expected participants: 80

#### 7.1.4. PICES-2025 Update

Dr. Chiba updated the planning of PICES-2025, and SB acknowledged the updates. Japan has confirmed to host PICES-2025. Meeting details will be updated in due course. (GC2023/A/10: GC approved the proposal by Japan to hold the PICES-2025 Annual Meeting from November 7-16, 2025 in Yokohama)

### 7.2. Protocol of PICES-2025 Session/Workshop Proposal Selections

Dr. Kang reviewed the new protocol for PICES-2025 Session/Workshop Proposal selections which were suggested and agreed upon at GC-2023. SB members have already made intensive email-based discussions about the pros and cons of the suggested new protocol over winter and generally reached an agreement at ISB-2024 to apply it as a trial.

**Background:** At GC-2023, GC reviewed the proposed workshops, sessions and draft schedule for PICES-2024. There was discussion on balancing the length of the annual meeting (and the associated travel burden for member countries) while allowing sufficient time for the discussion and development of emerging ideas to be developed as session/workshop proposals for the following year. Council proposed a **modified schedule of session/workshop proposals for PICES-2025** to be reviewed/selected in 2024 and adjusted the schedule of PICES-2024 to reflect this.

GC Decision 2023/S/14. Annual meeting session and workshop planning. Council approved a new process for 2024 whereby the Session and Workshop proposal deadline be set two weeks after the end of the PICES annual meeting. Committees will work inter-sessionally/by correspondence to review, rank and report to SB by the end of November. SB will review and provide to GC in early December for approval before year-end.

#### **New Protocol for PICES-2025 Session/Workshop Selection**

Sept 2024: Session/Workshop Proposal application open

Mid-Nov: Session/Workshop Proposal application close (after 2 weeks from the end of PICES-2024)

Mid-Late Nov: Committees to review/rank the proposals through virtual meeting/review sheet

Early Dec: SB to hold a virtual meeting to make recommendations for the proposals

Year-end: GC to approve the SB recommendation.

### 7.3. Special Panel “PICES Science in the Next Decade” Planning

SB brainstormed ideas on the structure and topics of the Special Panel “PICES Science in the Next Decade” scheduled on November 1<sup>st</sup> during the PICES-2024 (see Background information below). PICES Review Panel member(s), ECOP representatives, and FUTURE SSC were listed among possible speakers and panellists. However, as the possible topics could be too broad to deal with, SB felt it difficult to start productive discussions until the Review Panel report becomes available this summer. SB decided to have one (or more) virtual meeting(s) to prioritise the topics, develop the structures and identify expected outcomes of the Special Panel during the summer of 2024 upon the issue of the Review Panel Report. With the other major event “FUTURE Symposium” at the opening of PICES-2024 (Oct 28), SB unanimously stressed the importance of synergy in the designs and

outcomes of the FUTURE Symposium and the Special Panel. FUTURE SSC and SB will closely communicate over the summer to co-design each other's event.

**Background:** At the PICES-2023, GC requested to hold a 0.5-day panel to discuss future science priorities for PICES before the closing ceremony of PICES-2024 (tentative title "PICES science in the next decade" scheduled at 900-1200, November 1<sup>st</sup>). Expected deliverables of the Special Panel include the recommendation for the direction of PICES Science in the next decade. GC suggested;

- include panel members who are outside PICES, more "stakeholders" from other organizations and communities that may receive PICES science products and so aim for a better balance of people inside and outside of PICES.
- make sure that there is sufficient opportunity to receive feedback on the External Review Panel (ERP) recommendations.
- higher representation of ECOP in the Panel as it will be "their decade" the Panel will be discussing.
- wait until the report from the ERP has been released in order to better plan the session, and the Deputy Executive Secretary confirmed that SB also expressed a desire to see the report first and would have a virtual meeting later in the summer to discuss.

The Chair suggested that he and the Executive Secretary would discuss after the IGC meeting a way for SB and GC to work closely on this planning and would follow up with GC members for specific ideas for Panel members. GC members can join SB discussions and should therefore plan to join SB's discussion later in the summer.

### **Agenda Item 8: Scientific and Technical Mid-Year Reports**

SB, FUTURE and Committees report scientific achievements and progress of TOR of the respective Children Expert Groups since PICES 2023. The details of each EG report will be published online as a part of the [PICES-2024 Annual Report](#).

### **Agenda Item 9: PICES New Data Policy**

TCODE Chair, Jeanette Gann, presented the proposal of PICES New Data Policy (see next page) and sought an SB recommendation to adapt the new data policy at ISB-2024. SB agreed on the necessity of a data policy update and recommended GC approve the proposed PICES New Data Management Policy. *GC postponed its decision on this recommendation until its next ad hoc meeting (nominally in September) to allow GC members more time to review the details.*

**Background:** To apply FAIR (Findable, Accessible, Interoperable and Reusable) data standard, which is widely recognised among the ocean science community, to the PICES data policy, SG-DATA proposed the update of the current [PICES Data Management Policy](#) (2018/A/6) in its final product ([PICES Technical Report No. 2](#)) at PICES-2023. TCODE and WG52: Data management reviewed and revised the draft proposal to be submitted at ISB-2024.

# PICES Draft Data Policy – Proposal

## **Section 1. Preamble**

As stated in Article III of the Convention for the North Pacific Marine Science Organization (PICES) the Organization is to promote the collection and exchange of information and data related to marine scientific research in the North Pacific Ocean and its adjacent seas. The PICES strategy on capacity development identifies TCODE as the committee responsible for the development of communication networks for the exchange of data and information.

PICES is strongly committed to the open and free sharing and exchange of data and information between member countries and beyond. Thus, PICES also highlights the importance of sharing data as stated within the IOC data policy. “The timely, open and unrestricted international sharing, in both real-time and delayed mode of ocean metadata, data and products is essential for a wide variety of purposes and benefits including scientific research, innovation and decision making, the prediction of weather and climate, the operational forecasting of the marine environment, the preservation of life, economic welfare, safety and security of society, the mitigation of human-induced changes in the marine and coastal environment, as well as for the advancement of scientific understanding that makes this possible. Metadata, data and products should be accessible, interoperable and openly shared with minimum delay and minimum restrictions.” (IOC Oceanographic Data Exchange Policy, 2023). For any data provided to or shared with PICES, PICES will respect the ownership rights and any restrictions placed on these data by the data provider.

## **Section 2. FAIR and CARE Principles**

Data, metadata and products compiled and produced by PICES expert groups and programs should meet the FAIR Guiding Principles (Findable, Accessible, Interoperable and Reusable, Wilkinson et al., 2016) and in the case of indigenous data and information, data should meet the CARE principles (Collective Benefit, Authority to Control, Responsibility, Ethics) to the greatest extent practicable. Data and metadata should be freely and openly shared with minimum delay and restrictions. PICES strongly encourages the cross-country sharing of data between PICES member countries when and where possible. Such open sharing of data in both real-time and delayed mode facilitates scientific research and innovation that benefits all PICES countries and the world.

## **Section 3. Data Repositories and the IOC ocean data and information system (ODIS)**

Data gathered as a result of PICES activities will be responsibly managed to guard against loss and to ensure continued discovery and accessibility into the future. The management of data using external data management systems is preferred to using internal PICES resources. Data should be quality controlled, accompanied by metadata and, when possible, it is to be stored in an openly accessible data repository and made accessible and discoverable through a web interface and machine-to-machine access protocols. PICES members shall, where possible, use IODE-approved data centers (National Oceanographic Data Centres, Associate Data Units and Associate Information Units), the World Data Service for Oceanography of the World Data System, or other openly accessible data centers including those linked to the IOC Ocean Data and Information System (ODIS) as repositories for oceanographic data and associated metadata (example list of repository options are listed in the “Open Data Repositories document”). In special cases where a suitable open-access data repository is unavailable, PICES expert groups will work with TCODE to find an alternative solution.

## **Section 4. Definitions and Abbreviations**

**‘Data’** include data, data products, information, services, and model outputs related to PICES activities. Metadata are data about data.

**‘End users’** include a person, organization, group (including PICES expert groups) using data.

**‘Data providers’** include a person, organization, group (including PICES expert groups) providing data.

**‘Data inventory’** refers to data for which PICES has primary responsibility.

'**IODE**' Intergovernmental Oceanographic Data and Information Exchange

'**IOC**' Intergovernmental Oceanographic Commission

'**ODISCat**' Ocean Data Information System Catalog of Services

### **Section 5. Data Produced by PICES**

All data produced by PICES through various expert groups, summer schools, and research projects are considered to be publicly available unless explicitly specified otherwise.

Results, conclusions, or recommendations derived from the data associated with PICES do not imply endorsement from PICES.

Contributions of data from PICES expert groups will adhere to the expert groups' Terms of Reference and be submitted to TCODE for inventory while the group is active.

All data including metadata should be archived using standard codes, formats, and protocols. The quality control and quality assurance of data is the responsibility of the data producer.

In the event that PICES becomes aware there may be quality issues in the data, PICES will inform the data providers as soon as practical.

Data providers should inform the PICES secretariat of any policies that may place special conditions on use and redistribution of data.

End users are responsible for the proper use of the data and metadata provided.

PICES may reformat data or metadata for inclusion in data products but will never change the data provider's original data record without consent.

Data use must be acknowledged, preferably using a formal citation (e.g., Creative Commons).

### **Section 6. Citations**

Data citations should facilitate giving scholarly credit and normative and legal attribution to all contributors to the data, recognizing that a single style or mechanism of attribution may not be applicable to all data.

Where DOIs exist (Digital Object Identifier) they should be included in the citation.

### **Section 7. References**

Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* **3**, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

IOC Oceanographic Data Exchange Policy, 2023. <https://new.iode.org/data-policy/>  
[CARE Principles for Indigenous Data Governance https://www.gida-global.org/care](https://www.gida-global.org/care)

#### **Open Data Repositories**

**(Information Only: not to be added to the website information of PICES New Data Policy)**

Japan Oceanographic Data Center

<https://www.jodc.go.jp/jodcweb/>

United States National Centers for Environmental Information

<https://www.ncei.noaa.gov/>

Canadian Integrated Ocean Observing System

<https://cioos.ca>

Korea Coastal Big Data Platform

<https://www.bigdata-coast.kr/>

IOC Ocean Data and Information System Catalog of Sources

<https://catalogue.odis.org/>

IODE World Oceanographic Database <http://wod.iode.org/SELECT/dbsearch/dbsearch.html>

Korea Oceanographic Data Center

<https://www.nifs.go.kr/kodc/eng/index.kodc>

National Marine Data and Information Service

<https://www.nmdis.org.cn/english/nmdiss-mission/>

Marine Environmental Data Section (MEDS)

<https://www.isdm.gc.ca/isdm-gdsi/index-eng.html>

All-Russian Research Institute Hydrographic Information – World Data Center, Obninsk (RIHMI-WDC)

<http://www.meteo.ru/nodc/index.html>

Sea Scientific Open Data Publications

[www.seanoe.org](http://www.seanoe.org)

## Agenda Item 10: New Award “PICES Open Data Excellence Award”

TCODE Chair, Gann presented the revised proposal of the new PICES Award “PICES Open Data Excellence Award (PODA)”(see next page) to promote data sharing among PICES communities. Ms. Gann explained the difference in the criteria of POMA and the new Data award (see below) and the rationale why the new award focusing on data in addition to POMA should be needed. SB regarded the establishment of the new award as beneficial for PICES science and agreed that the roles, selection criteria and processes of POMA and PODA are distinguished in the presented proposal. SB recommended GC to approve the new PICES Award “PODA”. *GC postponed its decision on this recommendation until its next ad hoc meeting (nominally in September) to allow GC members more time to review the details.*

### Background:

At SB-2023, TCODE proposed the establishment of the PICES new award “Open Data Excellence Award”. Motivated by the fact that projects with excellent data management and sharing standards have often been ranked low in the POMA award selection process, the idea was raised and discussed by SG-DATA and TCODE members. While understanding the motivation, SB members agreed that the submitted proposal did not fully clarify the overlap in criteria between the two awards and that the selection protocol for the new award would likely require modifications to the current POMA award selection process. SB members suggested that TCODE and MONITOR discuss the rationales and new selection protocols of POMA and the new Data award, and if agreed, submit the revised proposal at ISB-2024 or later.

### Clarification of difference from PICES Ocean Monitoring Award (POMA)

For POMA, long-term monitoring programs have often been more highly regarded by those ranking the proposed recipients, over databases and data dissemination groups. In the newly proposed protocol, POMA keeps the requirement for a monitoring program to freely share their data but restricts the award to monitoring programs and utilization of new innovative technology/tools only (i.e. eliminate awards to technical groups solely involved in data management and dissemination). Doing these would help clearly separate the POMA vs the Open Data Excellence Awards and help to achieve SG-DATA’s goal of providing incentives for data sharing.

“Current ([POMA Eligibility](#)) *The award is given for significant contributions to the progress of marine science in the North Pacific through long-term monitoring operations, management of data associated with ocean conditions and marine bio-resources in the region, development of advanced and innovative technologies for ocean monitoring or all categories. Recipients may include, for example, research vessels, research or administrative institutes or portions thereof, or technical groups involved in monitoring, data management and dissemination, or the development of tools or technologies that have been shown to enhance ocean monitoring, or a combination of these activities. Outstanding individual efforts may also be recognized.*”

**Draft Proposal for the  
PICES Open Data Excellence Award**  
*in honor of Igor Shevchenko*

**Overview**

The **PICES Open Data Excellence Award** is an annual award presented to individuals, groups, or organizations who have demonstrated exceptional innovation in the field of open science, data sharing, and FAIR data principles (Findable, Accessible, Interoperable, Reusable; Wilkinson et al., 2016) in support of the PICES community. This prestigious award recognizes individuals or groups who have made outstanding contributions to the practice of data stewardship, with a particular focus on its applications in marine research and oceanography, and as relevant to the PICES mission and data policies, as outlined in the organization's Convention.

The Open Data Excellence Award is bestowed in honor of the respected Dr. Igor Shevchenko, who for many years was deeply involved in national and international data sharing activities. Dr. Shevchenko's pioneering work in differential games and artificial intelligence, along with his extensive involvement in data sharing and metadata initiatives, has left an indelible mark on the PICES community in the field of marine science. In particular, his tireless work in helping to create and maintain an extensive resource for metadata and data records via the technical committee on data exchange (TCODE) metadata catalog, will be a PICES legacy upon which we continue to build. As an Advisor to the Head of the Pacific branch of the Russian Institute of Fisheries and Oceanography, his leadership and expertise have played a pivotal role in advancing scientific knowledge and promoting international collaborative approaches. Additionally, his dedication to teaching and mentoring students majoring in mathematics and programming has inspired countless young minds to pursue careers in data science and its applications. In recognition of his remarkable achievements and contributions, the PICES Open Data Excellence Award stands as a testament to Dr. Igor Shevchenko's legacy and the enduring impact of his work.



This award honors an individual or group within PICES who exemplifies the spirit of excellence in data stewardship, open data sharing and international collaboration. The award celebrates the spirit of collaboration, transparency, and progress in marine science research through open data sharing and access equity. By recognizing outstanding individuals or groups who embrace these principles, the award aims to inspire further advancements in the field and foster a community committed to innovation in open data and sharing for the betterment of our marine ecosystems and the greatest societal good.

**Rationale/Purpose of the Award**

The purpose of the PICES Open Data Excellence Award is to honor those who have excelled in promoting and coordinating marine scientific research by actively and openly sharing and exchanging information and data originating within the PICES region or relevant to the PICES community. The award highlights the importance of open data and its role in driving scientific progress and addressing global challenges, including weather and climate change impacts on marine ecosystems and human activities.

**Nomination and Selection Process**

The PICES Open Data Excellence Award invites annual nominations from the PICES community, aiming to acknowledge significant contributors to advancing open data, data sharing, and data



stewardship in marine-related disciplines. While the award may not be granted annually, its purpose is to honor individuals or groups who have made substantial strides in promoting and advancing a culture of open data principles and practices in alignment with PICES' mission and objectives. This includes advancing open data principles from research to application and particularly within the realm of marine and ocean related work. Priority will be granted to nominees who have demonstrated exceptional dedication to integrating diverse marine science disciplines within their open data initiatives.

### **Eligibility**

Criteria for selection include outstanding and inspiring contributions to advancing data sharing and management throughout the data management lifecycle including application, development or unification of data and metadata standards, large-scale data integrations from disparate sources in support of decision support or modelling, archival of critical datasets to prevent loss, quality control and improvement of critical datasets, impactful community building around the practice of open data and data stewardship, and development of critical cyber infrastructure to support open data sharing and stewardship. The criteria also include contributions such as: developing open data software; catalyzing interoperability of data/metadata; building open data communities developing novel training and mentoring around data science; sharing data, algorithms, code, and protocols. Only one award will be conferred each year.

### **Nomination and Selection**

Nominations from individuals or groups residing in PICES member countries should be submitted, along with the requested supporting documentation, to the Executive Secretary (Sonia.Batten@pices.int) by the deadline specified in the Call for Nominations. Nominees who have actively participated in PICES activities or research projects within the organization's purview will receive preferential consideration. The Technical Committee on Data Exchange (TCODE) will independently assess the documents accompanying each nomination and recommend some or all nominations for consideration by the Science Board. The Selection Committee, represented by the PICES Science Board, will evaluate all nominations and identify the most deserving recipient. Those who have been nominated but not selected for the PICES Open Data Excellence Award will remain eligible for re-nomination in subsequent years. If re-nominating, please provide updated nomination documents to ensure an accurate representation of the candidate's open data accomplishments. To maintain a substantial pool of potential candidates, the Science Board will retain any excess recommendations for review over two consecutive years, and these recommendations will be reactivated with the nominator's approval.\*\* Government and/or large public organizations that have data sharing requirements are not eligible for consideration of this award. However, individuals or groups within these organizations that go above and beyond their agency requirements for data sharing may be considered for the award.

### **Award Presentation and Benefits**

The Award Presentation Ceremony takes place during the Opening Session of the PICES Annual Meeting. The successful nominee will be provided with a certificate of recognition to attend the ceremony. No financial support from PICES will be provided to the recipient to attend the Annual Meeting where the award is given. Should any representative be unable to attend the Annual Meeting, a delegate from the recipient's country will be asked to accept the award on behalf of the recipient. The award itself symbolizes recognition of the recipient's commitment to open data principles and their contributions to advancing marine scientific research through data sharing.

## Agenda Item 11: PICES Awards

The Award Selection Committee (consisting of SB members and PICES Chair) chose the recipients of the Wooster Award and POMA Award for PICES-2024. The awardees will be recognized during the awards ceremony to take place during the opening ceremony of PICES-2024. Information on the awardees is confidential until PICES-2024. Given that there were no nominations for Zhu-Peterson Award, the Committee suggested Secretariat re-open the nomination and encourage the community to send the nomination package of the qualified nominees to the PICES Executive Secretary by June 15, 2024. *GC acknowledged, and the application deadline was extended to June 30.*

## Agenda Item 12: EG Proposals for SB Recommendation with Funding Request

Dr. Chiba with the respective Parent Committees Chairs reported EGs' proposals seeking SB recommendations.

### 12.1. Proposal for Travel Support

SB reviewed and ranked the priority of the travel support proposals for PICES ECOPs to participate in international symposia and a capacity development workshop organized by PICES Strategic Partners, IMBeR, SOLAS and APN. SB recommended GC approve the requests considering the priority scores given by SB. *GC approved the travel supports as requested with consideration of priority scores provided by SB (IGC2024/S/5)*

Requests From Partner Organizations (See Agenda item 15 or 16 for the event details)			
Conference title / Date / Location	Recipient name / contact	Amount and rational of fund request	SB priority score (1: Low ~ 3: High)
<a href="#">IMBeR IMBIZO 7</a> 22-24 Sept 2024, Morocco	A few ECOPs from PICES countries	(reference only: CA\$ 6000) PICES and IMBeR regularly support participations of ECOPs to each other's organizing international meetings. <i>*the meeting was cancelled due to the logistics issues</i>	2.4
<a href="#">9th SOLAS Open Science Conference</a> 10-14 November, Goa, India	A few ECOPs from PICES countries	(reference only: CA\$ 6000) PICES and SOLAS regularly support participations of ECOPs to each other's organizing International meetings.	2.2
<a href="#">APN Proposal Development Training Workshop</a> Uva, Fiji, 26-30 August 2024.	1 or 2 ECOP from PICES/APN countries	(Amount will be determined later) Canada is non-APN countries, and not eligible. Open call inf for APN sponsorship was shared to PICES community, this is for the possible additional participation with PICES funds.	1.9

## Agenda Item 13: EG Proposals for SB Recommendation without Funding Request

Dr. Chiba with respective Parent Committees Chairs reported EGs' proposals seeking for SB acknowledgement or recommendations.

### 13. 1 Membership Needs/Changes

SB acknowledged the membership requests of EGs and urged the national delegates to consider the appointment of new members at an appropriate time. *GC acknowledged the member needs and respective national delegates to appoint these members.*

EG (Parent)	Country	Names	Affiliation	e-mail
Carry over requests from PICES-2023				
FUTURE	Japan	1 ECOP members		NA
TCODE	Russia	1~2 members		NA
AP-NIS (MEQ)	Japan	Kenji Iwasaki	Nara University	iwasaki@daibutsu.nara-u.ac.jp
	USA	John Darling	US EPA	darling.john@epa.gov
AP-SciCom (SB)	Russia	1~2 members	NA	NA
AP-UNDOS (SB)	Russia	Evgenia Kostianaia	(IOC), ECOP leader in UNDOS	e.kostianaia@unesco.org
SG-GREEN (SB)	China	Ruoyu Guo	SIO	dinoflagellate@sio.org.cn
	S. Korea	Hyunggyu Lim	KIOST	hqlim@kiost.ac
WG48 (BIO)	China	Junbai Yue	Tsinghua U, ECOP	yuejb21@mails.tsinghua.edu.cn
WG50 (POC)	Russia	Nikita Aleksandrovich Chikanov	St. Petersburg State University	prants@poi.dvo.ru
WG50 (POC)	Russia	Sergey Prants	Pacific Oceanological Institute, Department of the Ocean and Atmosphere Physics	erjey_nik@mail.ru
WG52 (TCODE) (TCODE)	USA	Herman Garcia	NOAA	Hernan.Garcia@noaa.gov
	China	Wan Fangfang	National Marine Data and Information Service	fangfw15@sina.cn
	China	Han Chunhua	National Marine Data and Information Service	hanchunhua2008@126.com
	Korea	Cholyoung Lee	KIOST	cylee82@kiost.ac.kr
	Russia	1~2 members	NA	NA
New requests at ISB-2024 from here				
AP-SciCom (SB)	Canada	1 member (Amy Elvidge)	NA	NA
WG51	Russia	1 member		

### 13.2 Change of EG Chairs

SB recommended GC approve the change of the AP-CREAMS co-chairs. *GC approved changes of co-chairs of AP-CREAMS as listed.*

EG	Current Chair to replace	New Chair Name/Country/Organization
AP-CREAMS	Joji Ishizaka (Japan) Jae Hak Lee (Korea)	Jing Zhang (Japan), Toyama University SungHyun Nam (Korea), Seoul National University

### 13.x Addendum – Ex-officio member

SB recommended GC approve the appointment of an ex-officio member of [BECI project](#) (Basin-Scale Events to Coastal Impacts: An Ocean Intelligence System for a Changing World) in AP-UNDOS.

*- GC approved the addition of Kathryn Berry (BECI project) as an ex officio member of AP-UNDOS.*

EG	New ex-officio member: name and contact	Organization
AP-UNDOS	Kathryn Berry (Kathryn.Berry@pices.int)	Science Director, BECI

### 13.3 Change of Action Plan

Dr. King reported that FIS Committee revised its Action Plan (2022) for 2024 and SB endorsed the new plan (see [new Action Plan](#) on FIS webpage).

#### PICES Rule:

#### [Guidelines for Chairs and Convenors: III. Scientific and Technical Committees](#)

Chair of a Scientific/Technical Committee is responsible for;

- maintaining an up-to-date Action Plan to indicate how the Committee's activities are, or will, achieve goals under the [PICES Strategic Plan](#) (2016-);
- reviewing regularly the performance of the Committee with respect to its Action Plan;

### 13.4 Extension of WG term

SB reviewed the rationale of the extension needs of SG-GREEN and recommended GC approve the request, but clarified no further extension be approved after PICES-2024 - *GC approved the extension of SG-GREEN term to PICES 2024 to enable them to complete their TORs but noted this was the final extension.*

EG (Parent)	Duration	Rationale
SG-GREEN (SG)	Up to PICES-2024	To summarize the findings of the SG-GREEN survey and to prepare a presentation of results for PICES-2024. To put together a proposal for a new PICES SG on viable carbon credits and how to implement them for PICES. We also need to discuss the implementation of TOR 4, 5 (Exploration of PICES investment in climate-responsible industries. Provide recommendations for best practices in purchasing carbon offsets for members for face-to-face meetings, including suggestions for including offsets as part of the conference registration fees.) which have not yet been completed.

### 13. 5 New Expert Group Proposals

SB reviewed and evaluated the proposals listed, and recommended GC approve the new Expert Groups with suggested amendments shown below. *see the respective GC decision.*

Name of EG	Proposed Parent Committee	Background	SB suggestion
AP-ARC <i>Approved</i> (revised proposal: <a href="#">Appendix 1</a> )	SB	SB recommended it at PICES-2023, but GC requested to submit the revised proposal at ISB-2024.	Revise ToR to address broader scientific issues/disciplines to cover PICES scientific priorities. <i>SB recommended and GC approved the revised proposal (IGC2024/S/2)</i>
WG-SPF <i>Approved</i> (revised proposal: <a href="#">Appendix 2</a> )	FIS, BIO, HD	Based on the accomplishment of WG43.	Revise the proposed member list considering geographical balance and clarify the discipline of their expertise. <i>SB recommended and GC approved the revised proposal (IGC2024/S/2)</i>
WG ONCE-CN <i>Decision deferred (see the page 8).</i> (revised proposal: <a href="#">Appendix 3</a> )	POC, BIO	Based on the accomplishment of WG46. SB requested WG46 to revise the initial version proposal at PICES-2023.	Revise the goals and ToR to clarify its contribution and relevance to the North Pacific. <i>SB recommended but GC requested revision of ToR and deferred the decision until its next ad hoc meeting (nominally in September 2024). Council concurred with SB that the proposed WG is important and interesting but that there are some missing pieces of information and would like to see a revised version before approval.</i>

### Agenda Item 14: SB Chair-Elect Application

Dr. Kang noted the SB-Chair-Elect would be due to be elected at PICES-2024, and the application would be open during the summer of 2024. SB members were suggested to approach possible candidates and encourage them to apply for the position.

[\(GC06/A/11\)](#) In 2006, to facilitate the continuity of Science Board affairs, the Governing Council established a Science Board Chair-elect position to allow the election of the Science Board Chair 1 year before the official change of the chairmanship.

[\(PICES Rules and Procedures Rule 17\)](#) Qualified candidates nominated, or seeking, to be elected as Chair(-Elect) of the Science Board shall submit their credentials (*curriculum vitae* and letter of justification) in writing to the Executive Secretary at least 60 days prior to the start of an annual meeting at which said election will occur...  
\*The candidate must be a citizen of one of the Contracting Parties.

[\(PICES Rules and Procedures Rule 12\)](#) ... The Chair shall not concurrently be a Chair of another group nor be eligible for re-election for successive terms...

## Agenda Item 15: PICES Sponsored Conference/Symposia

Dr. Chiba updated information on PICES-Sponsored International Conferences and Symposia which took place or are upcoming from 2023 to 2027.

1. 7<sup>th</sup> International Zooplankton Production Symposium, **Mar 2024**, Hobart, Australia (report)
2. MSEAS: Marine Socio-Ecological Systems Symposium, **June 2024**, Yokoyama, Japan
3. ICES Annual Science Meeting, **Sept 2024**, Gateshead, UK
4. IMBeR IMBIZO 7, **September 2024**, Rabat, Morocco
5. SOLAS Open Science Conference, November 2024, Goa, India
6. International Symposium on Small Pelagic Fish, May **2026** with **SB recommendation**
7. 5<sup>th</sup> Early Career Scientists Conference, **2027**

### 15. 1. 7<sup>th</sup> ICES/PICES Zooplankton Production Symposium 2024



- Date & Location: March 16-21, 2024, Hobart, Australia
- Venue: [Hotel Grand Chancellor](#), Hobart
- Local organiser: University of Tasmania, CSIRO,

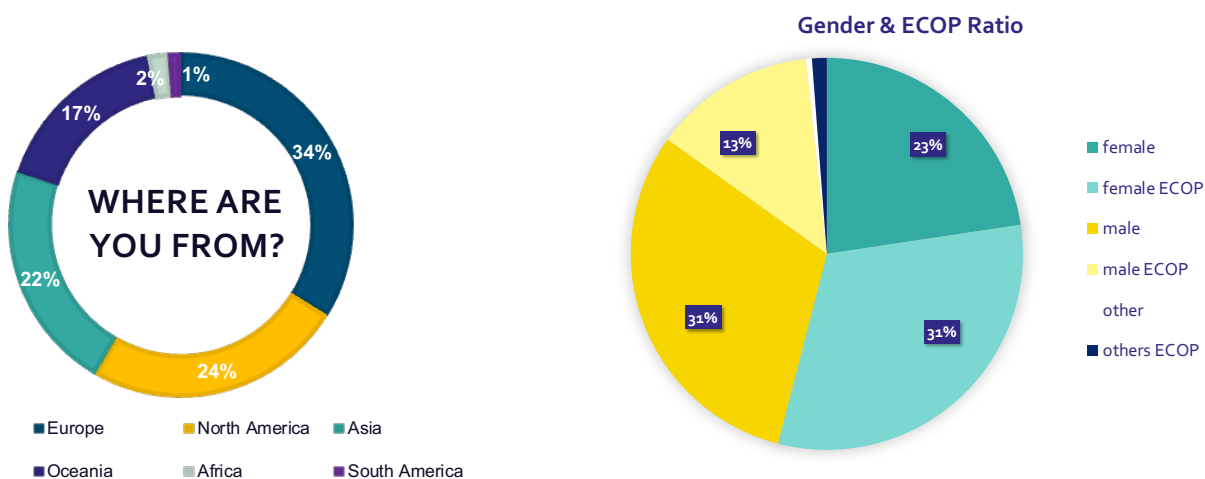
#### PICES Member involvement:

Organizing Committee: Batten, Chiba (Secretariat), Sastri (BIO)

SSC: Bi (WG48), Kobari (WG37),

ZPS7 was a highly successful meeting, and PICES received very positive feedback from participants. See the [PICES Press 2024 Summer issue](#) for the detailed report.

Participants stat: 16 Sessions, 5 Workshops, 315 attendees from 38 countries, 161 ECOPs.



## 15.2. 2<sup>nd</sup> [MSEAS](#) Symposium



Theme: Managing for Sustainable use of the Earth's marine and coastal system

\*Originally planned as MSEAS-2020 but postponed to 2024.

- Date & location: June 3-7, 2024, Yokohama, Japan
- Venue: [Pacifico Yokohama](#) North
- Primary Sponsors: PICES, ICES, NOAA Fisheries, FRA
- Local Organizer: FRA
- [Sessions](#), [Schedule](#)

See the [PICES Press 2024 Summer issue](#) for the detailed report.

### **PICES Member involvement:**

Symposium Convenor: Batten (Secretariat), Hasegawa (FUTURE)

Symposium Coordinators: Chiba (Secretariat)

Local Organizing Committee: Makino (HD), Fujii (PICES Vice-Chair)

## 15.3. [ICES Annual Science Conference 2024](#)

- Date/Location: Sept 9-12, 2024, Gateshead, UK
- Conference style: Hybrid
- Abstract Deadline: March 22, 2024

### **PICES co-convening Session:**

Session 20: Evaluating ecosystem-based management performance: examples of success.

Co-convenor, Xuelei Zhang (BIO, S-CCME, S-MBM, AP-NPCOOS)

Session 31: Climate impacts and adaptation responses in marine fishery systems

Co-convenor, Kirstin Holsman (S-CCME, AP-UNDOS)

## 15.4.: [IMBeR IMBIZO 7: Transitioning towards sustainable ocean governance by 2030: Commitments and challenge](#) *\*The meeting was cancelled due to logistics issues.*

See Agenda Item 12 for the travel support request

- Date: Sept 23-26, 2024
- Venue: Institut Agronomique et Veterinaire Hassan II (IAV), Rabat Morocco
- Abstract Deadline: Feb 29, 2024

Designed for 60-70 post-graduate students and early career researchers, and led by an interdisciplinary group of scientists which includes leaders in their respective fields.

3 Interactive workshops:

- Science based adaptive management and policy responses to the causes and consequences of eutrophication.
- A framework for the development of social-ecological models of transformative change for sustainable ocean management.
- Governance transformations for resilient fisheries and aquaculture: Progressions, challenges and opportunities.

ECOP event: IMBeR's Interdisciplinary Marine Early Career Network (IMECaN) is organising an event on 22 September, the day before the start of IMBIZO7. This event is open to all IMBIZO7 participants, not only students and early career researchers.

### 15.5. [SOLAS Open Science Conference 2024](#)

(See Agenda Item 12 for the travel support request )

- Date: November 10-14, 2024
- Venue: CSIR, National Institute of Oceanography, Goa, India
- Abstract Deadline: May 1, 2024

The Surface Ocean–Lower Atmosphere Study ([SOLAS](#)) is an international and interdisciplinary research project on biogeochemical-physical air-sea interactions and climate change. SOLAS Open Science Conference (OSC), is to bring together the oceanographic and atmospheric communities, and offers the ideal programme for scientists who wish to learn and exchange about cutting-edge research in the field. A special event dedicated to Early Career Scientists is being organised.

### 15.6. [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](#)

The symposium organizing team requested SB endorse the following supports for SPF-2026. SB recommended GC confirm 1) the PICES convenors as nominated and 2) funding support for the participation of early career scientists and logistics of the symposia. *GC approved the PICES convenors for SPF-2026 and funding support for SPF-2026 (IGC2024/S/6).*

1. To nominate/confirm PICES convenors for SPF-2026

Dr. Chris Rooper (Canada) and Dr. Motomitsu Takahashi (Japan), PICES Co-Chairs of the proposed joint ICES-PICES WG on Sustainable Pelagic Forage Communities have been recommended and are prepared to take on the task.

2. To ask GC for funding to support SPF-2026 (the amount of funds will be confirmed by GC in coming years)

PICES provided \$15,000 CAN for each of the previous two SPF symposia, SPF-2017 and SPF-2022. Funds to support the participation of Early Career Scientists from PICES member countries in these events came from the Trust Fund and funds to support the logistics of the symposia from the General Fund.

- Date: 4-8 May 2026
- Location: La Paz, Mexico
- FAO, ICES and PICES (IGC-2023) confirm their supports
- Local logistic support: CICIMAR, CIBNOR, CICESE, UABCS, etc.



- Local symposium convenor: Dr. Salvador Lluch-Cota (CIBNOR)
- ICES/PICES WG on SPF convened a 3-day workshop for preparation of SPF-2026 in La Paz, Feb 12-14, 2024

See **Appendix 4**: for the detailed proposal to host SPF-2026. *GC approved the PICES convenors for SPF-2026 and funding support for SPF-2026 (IGC2024/S/6)*

## 15.7. 5<sup>th</sup> ICES/PICES Early Career Scientists Conference (ECS) 2027

ICES and PICES played as the main organisers of ECS in turn. As the 4<sup>th</sup> ECS was organized by ICES and held in Newfoundland, Canada, PICES will host the 5<sup>th</sup> ECS in an Asian nation.

## Agenda Item 16: Capacity Development Events

Dr. Chiba updated information on Capacity Building Events proposed and/or organized by PICES EGs (16.1) and PICES partner organizations (16.2) upcoming from 2023 to 2025. SB reviewed the information and recommended GC approve the funds for the Mentorship Program proposed by AP-ECOP.

### 16.1. PICES Events

SB recommended GC approve the request of AP-ECOP for holding a mentorship program orientation during PICES-2024.

Event title / Date / Location	Date/Location	Amounts and rationale of requests
<b>Organizer: AP-ECOP (FUTURE)</b>		
International Open Science Training: Building effective international collaborations for ocean sustainability (some references <a href="https://www.openscapes.org/resources/">https://www.openscapes.org/resources/</a> )  co-sponsors (TBC): TCODE; AP-SciCom; ECOP Programme, HD, FUTURE	Spring/Summer 2024 Virtual	CA\$ 7000 support travel for 2 participants of this workshop to attend the PICES 2023 meeting to ensure that fruitful discussions and lessons learned can be shared and incorporated into other parts of PICES and that the training can continue through PICES 2023. <i>Information only (approved at GC-2022 but deferred to 2024)</i>
Introduction to PICES - Similar to the PICES 101 provided during the AP-ECOP Workshop during PICES 2022. The goal is to provide a brief overview of PICES and its committees/EGs to help introduce new ECOPs/new PICES members to the organization.	PICES-2024 (0.5 day, either on Oct 29, 30 or 31)	Funding: N/A Propose the event <u>every 2 years</u> during the core Annual meeting days given many ECOPs prioritize the weekday schedule when travelling due to the funding constraints. <i>Information only (approved at PICES-2022)</i>
Mentorship program orientation. Similar to the program conducted at PICES-2023.	PICES-2024 (2 hr x 2, Oct 29 & 31)	Funding: N/A During the core Annual meeting days <i>GC approved the Mentorship program.</i>
<b>Organizer: AP-NPCOOS (MONITOR)</b>		
Macro Coastal Oceanography summer school. 20 participants, Analysis of coastal observing data: ADCP, HF Radar, and other environmental variables	Autumn 2025 or Spring 2026 Hakodate, Japan	CA\$) TBD: travel, lodging, meals and administrative costs. <i>Information only</i>

## 16.2. Events of PICES Partner Organization

### 16.2.1 SCOR Capacity Development ([link](#))

Chiba, PICES Deputy Executive Secretary has acted as a SCOR CD Committee member (July 2021~)

Core Programmes:

- [Visiting Scholars Programme](#)
- [Fellowship Programme](#) (with POGO)
- [Travel support for Conference](#) (proposal must be submitted by organizations)  
Funded US\$ 6K for participants of Zooplankton Production Symposium (March 2024)  
Funded US\$ 6K for participants of MSEAS-2024 (June 2024)

**News:** Satoshi Nagai (AP-NIS, MEQ) was selected for a SCOR Visiting Scientist for 2024, with the topic on "Harmful Algal Bloom (HAB) genomics at Marine Science Institute, University of the Philippines.

### 16.2.2. APN Training Workshop

See [Agenda Item 12](#) for the travel support request

PICES received potential PICES-APN collaboration opportunities on their 26-30 August 2024 events at the University of the South Pacific in Fiji, including a 3-day [Proposal Development Training Workshop](#). PICES ECOPs are invited to join. See [Appendix 5](#) for details.

**The Proposal Development Training Workshop (PDTW)** aims to equip early-career professionals with the essential skills to formulate proposals for the APN call for proposals and other funding opportunities.

Topic(s) of the PDTW will be decided among the below:

- Global change and its impacts on ecosystems and livelihoods in the Pacific
- Climate adaptation, disaster risk reduction, displacement and relocation
- Climate variability and change, and their impacts in national and regional contexts
- Biodiversity and ecosystem conservation for human well-being and protection in the Pacific.



## Agenda Item 17: Publication update

### 17.1. Peer-Reviewed Journal Papers (published)

The respective parent committees confirmed the publications listed are the outcomes of their children Expert Groups' activities. SB endorsed committees' evaluations and recommended GC approve these publications to be posted on the PICES website. *GC approved these publications to be posted on the PICES website (IGC2024/S/7).*

EG (Parent)	Citation	Comment
WG45 (FIS)	Lin Z., S. Ito, 2024, Fish weight reduction in response to intra- and interspecies competition under climate change. Fish and Fisheries, 25, 455-470. <a href="https://doi.org/10.1111/faf.12818">doi:10.1111/faf.12818</a>	
WG46 (POC, BIO)	Jiao, N., Luo, T., Chen, Q., Zhao, Z., Xiao, X., Liu, J., ... & Robinson, C. (2024). The microbial carbon pump and climate change. Nature Reviews Microbiology, 1-12. <a href="https://doi.org/10.1038/s41579-024-01018-0">doi: 10.1038/s41579-024-01018-0</a> .	
WG43 (FIS, HD)	<b>Journal Special Issues (2)</b> Marine Ecology Progress Series (MEPS) " <a href="#">Small Pelagic Fish: New Research Frontiers</a> ". The complete Theme Section will be published in May or early June 2024  Canadian Journal of Fisheries and Aquatic Sciences (CJFAS) " <a href="#">Small Pelagic Fish: New Frontiers in Science for Sustainable Management</a> " (also <a href="#">HERE</a> ). The complete issue will be published in May 2024	See 17.2. WG Final Reports
SeaTurtle (BIO)	Jang S-J, Jo K, Jang S, Nishizawa H, Kim M, Balazs G, Im J, Suk HY, Kim B-Y and Kim T (2024) Connectivity between sea turtles off Jeju Island on the Korean Peninsula, and other populations in the western Pacific. Front. Mar. Sci. 11:1281897. <a href="https://doi.org/10.3389/fmars.2024.1281897">doi: 10.3389/fmars.2024.1281897</a>	

### 17.2 WG Final Report

The respective parent committees reviewed and approved the documents listed as the final reports/products of their children EGs. SB endorsed committees' evaluations and recommended GC approve these publications as their Final Reports and disbandment of these EGs. *GC approved the publication of these final reports and disbandment of these EGs (IGC2024/S/7).*

EG (Parent)	Type of publication & Title	Note
WG39 (SB) <i>To be disbanded</i>	<b>PICES Scientific Report</b> Final Report of Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment for the Central Arctic Ocean (WG-39)	<b>Appendix 6</b>
SG-ARC (SB) <i>To be disbanded</i>	<b>SG Final Product</b> Final Report of Study Group on the Arctic Ocean and the Pacific Gateways	<b>Appendix 7</b> Recommendation of new EG, AP-ARC
WG-43 (FIS)(HD)	<b>Journal Special Issues (2)</b> Marine Ecology Progress Series (MEPS) " <a href="#">Small Pelagic Fish: New</a>	based on the papers

<b>To be disbanded</b>	<p><a href="#">Research Frontiers</a>". The complete Theme Section will be published in May or early June 2024</p> <p>Canadian Journal of Fisheries and Aquatic Sciences (CJFAS) "<a href="#">Small Pelagic Fish: New Frontiers in Science for Sustainable Management</a>" (also <a href="#">HERE</a>). The complete issue will be published in May 2024</p>	<p>submitted from SPF2022 Symposium, Lisbon, Portugal.</p> <p><b>Appendix 8</b> for the details and lists of papers</p>
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### 17.3. EG Final Report in Progress

Dr. Chiba reported the EG Final Reports in progress in various stages (1. In preparation, 2. Being reviewed by the parent Committee, 3. submitted to Secretariat, 4. previously approved by SB and nearly completed)

EG	Type of publication & Title	Stages	comments
WG35 (MONITOR /TCODE)	<b>PICES Special Publication <a href="#">NPESR III</a>:</b> online supplemental materials NPESR III Regional Reports (R11 – R24)	5. Published	All regional reports published online <b>Disbanded</b>
SG-DATA	<b>PICES Technical Report <a href="#">No. 2</a></b>	5. Published	<b>Disbanded</b>
WG36 (FUTURE)	<b>PICES Scientific Report <a href="#">No. 64</a></b> Common Ecosystem Reference Points across PICES Member Countries	5. Published	<b>Disbanded</b>
WG41 (HD/FUTURE)	<b>PICES Scientific Report</b> Marine Ecosystem Services	4. Approved, under final formatting by Secretariat	<b>Disbanded</b>
WG-42 (MEQ)	<b>PICES Scientific Report</b>	2. Being reviewed by parent Committee	
WG-44 (HD, FIS)	<b>PICES Scientific Report</b>	1. In preparation	
WG-46 (POC, BIO)	<b>PICES Scientific Report</b>	1. In preparation	

Note on the Protocol of WG Final Report Submission and the Timing of Disbandment of WG.  
(agreed at ISB-2022)

- WGs are due to submit their final reports to the Parent Committees upon the end of the term. SB members wish to gently remind EGs that final reports are expected – particularly for those groups where GC has already extended their terms in order to complete their reports.
- The format of the final report will be typically a PICES Science / Technical Report ([PICES Rule](#)) but also be in a various format such as Peer-reviewed Journal Special Issue, Peer-reviewed Journal Review Paper, etc.
- Definition: WG disbands upon the submission of its Final Report to Secretariat after review and approval of Parent Committee(s).  
[PICES Rule of Procedure 13](#): A WG shall be disbanded either after preparation of its final report, or as determined by the SB, for inadequate progress in achieving its tasks.

## Agenda Item 18: North Pacific Ecosystem Status Report IV

SB brainstormed the ideas for the next issue of the North Pacific Ecosystem Status Report (NPESR IV). Although there were challenges and lessons learnt through the implementation processes of NPESR III, SB evaluated NPESR as a useful product for the assessment of ecosystem variability in the North Pacific Ocean and stressed the need to develop a new Study Group for planning for NPESR IV without delay. SB members agreed to develop a proposal for the Study Group for NPESR IV to submit at PICES-2024 to seek GC approval. *GC Acknowledged SB's plan for NPESR IV*

Example idea: Develop an EG (SG?) to plan NPESR IV with a focus on the recent urgent topic, e.g. climate extremes, which are interests of member countries (see [Agenda Item 7.3 Special Panel at PICES-2024](#))

- End of the document -

## **Appendix 1**

### **AP-ARC Proposal**

**Proposal for**  
**PICES Advisory Panel on the Arctic Ocean and the Pacific Gateways**  
**(AP-ARC)**

**Acronym:** AP-ARC

**Potential Parent Committee:** Science Board (SB)

**Term:** May 2024 - TBD

**Background**

The Central Arctic Ocean (CAO), that is in between the North Pacific and North Atlantic, is in rapid transition, in interaction with and impacting these waters. It has become more accessible to a range of activities. For example, rapid loss of sea ice cover has opened up the CAO for potential fishing opportunities. In this context, the agreement to Prevent Unregulated High Seas Fisheries in the CAO has been signed and entered into force which will necessitate joint research and monitoring. The Pacific gateway to the CAO, i.e., the Northern Bering Sea-Chukchi Sea (NBS-CS) is also experiencing unprecedented warming and loss of sea ice as a result of climate change. Declines of seasonal sea ice and warming temperatures have been more prominent in the northern Bering and Chukchi seas than in the European Arctic. Continuous and abrupt changes in climate conditions in this Arctic gateway are clearly reshaping the system and its food-webs, and enlarging opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts.

PICES took on responsibilities in the CAO issues when it joined the WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)) by establishing WG39 in 2017. In 2019, PICES also established WG44 (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) in efforts to understand the Arctic system and its impacts to the sub-Arctic and mid-latitude North Pacific. An integrated ecosystem assessment (IEA) is a useful approach that is shared by these two Working Groups, and which is particularly relevant as substantial science and policy needs are emerging to ensure a sustainable Arctic. However, developing such an IEA is a substantial

task. This renders a coordinated IEA of the CAO and NBS-CS as a priority task. In addition, it is of particular significance to developing future approaches for The United Nations Decade of Ocean Science for Sustainable Development in the Arctic Ocean (UNDOS-Arctic), where science for resilience and sustainability is more important than anywhere else in the world oceans. Despite this continuing significance and unfinished commitment to WGICA and also WGIEANBS-CS, WG 39 ended their term with the closure of PICES 2022 and WG 44 ended their term with the closure of the PICES 2023 Annual Meeting. Subsequently, a new Study Group was established by PICES on the Arctic Ocean and the Pacific Gateways (SG-ARC) to develop a new EG on the Arctic Ocean and the Pacific Gateways. In this context, we propose PICES establish an AP-ARC to coordinate and integrate PICES scientific activities on the Arctic issues and to further advance the understanding of the Arctic system and linkages and impacts to the North Pacific.

#### **Proposed Terms of Reference (ToRs)**

1. Provide information and scientific expertise to the Science Board, and other scientific and technical committees (as needed), on the key physical, biogeochemical, ecological and societal effects of climate change and other anthropogenic-driven changes in the Pacific Arctic and its Gateways, with focus on how these changes are relevant for both the Arctic and mid-latitude marine environments and ecosystems in the PICES region;
2. Convene workshops/sessions and build knowledge networks, to discuss and exchange information on the strong influence of the Pacific Arctic including its Gateways on the Arctic and mid-latitude Oceans and its linkages to broader PICES activities;
3. Represent and coordinate responses of PICES concerning the Arctic Ocean and the connected waters in cooperation with PICES internal partners, institutions and organizations and other international organizations, including WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)), WGIEANBS-CS (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea);
4. Develop and support trans-disciplinary and collaborative approaches using co-production methods and inclusive of Indigenous knowledge systems to consider existing and future anthropogenically driven pressures, such as increased marine



traffic, harmful algal blooms, non-indigenous species, noise, contamination, litter, and microplastics in the Pacific Arctic and its Gateways in alignment with PICES activities;

5. Develop recommendations for PICES to better collaborate within PICES, and with Indigenous and international initiatives relevant to the Arctic Ocean including Arctic Council (and its WGs: AMAP, CAFF, PAME and SDWG), CAOFA, ESSAS, IASC, ICES, ICC, PAG, UNCCC, and UNDOS-Arctic;

#### **Potential Theme of Report/Workshop/Symposium**

- Review and prospect of national flag research on the Arctic Ocean and Pacific gateways
- Knowledge exchange session: Coordinate subject matter experts on the climate and anthropogenic-driven impacts and linkages across the Arctic Ocean, the Pacific Arctic including its Gateways, and mid-latitude ecosystem in PICES
- Coordinate observing and monitoring networks within the Arctic Ocean and Pacific gateways.
- Monitoring of Arctic Ocean and Pacific gateways using research ice breakers and other means
- Development of research plans for International Polar Year 2032/2033
- Improved coordination across scale and discipline in transboundary and transnational Arctic science
- Present and future pressures and human activities in the Arctic Ocean and Pacific Gateways

#### **Proposed Co-chairs (Two from west and two from east)**

Sei-Ichi Saitoh (SG-ARC, WG39) (Japan) - [ssaitoh@arc.hokudai.ac.jp](mailto:ssaitoh@arc.hokudai.ac.jp)

Hyoung Chul Shin (SG-ARC, WG39) (Korea) - [hcshin@kopri.re.kr](mailto:hcshin@kopri.re.kr)

Nadja Stefanie Steiner (WG44) (Canada) - [nadja.steiner@dfo-mpo.gc.ca](mailto:nadja.steiner@dfo-mpo.gc.ca)

Sarah Wise (WG44) (USA) - [Sarah.Wise@noaa.gov](mailto:Sarah.Wise@noaa.gov)

### **Proposed Membership**

Andrea Niemi (WG44) (Canada)

Nadja Stefanie Steiner (WG44) (Canada)

Zhongyong Gao (CC-S, SG-ARC, WG39, WG44) (China)

Guangshui Na (FUTURE-SSC, MEQ, SB, SG-ARC, WG35, WG39) (China)

Fang Zhang (SG-ARC, WG39) (China)

Hyoung Chul Shin (SG-ARC, WG39) (Korea)

Hyoung Sul La (SG-ARC, WG44) (Korea)

Sei-Ichi Saitoh (SG-ARC, WG39) (Japan)

Fujio Ohnishi (SG-ARC, WG39) (Japan)

Takafumi Hirata (SG-ARC, WG44) (Japan)

Shigeto Nishino (WG44) (Japan)

Yury I. Zuenko (CREAMS-AP, POC, S-CCME, SG-UNDOS, WG35, WG40, WG44) (Russia)

Kirill Kivva (WG44) (Russia)

Zack Oyafuso (SG-ARC)(USA)

Sarah Wise (WG44) (USA)

Elizabeth A. Logerwell (FIS, WG44) (USA)

Lisa B. Eisner (MONITOR, WG44) (USA)

David L. Fluharty (SG-ARC, WG39) (USA)

\*This membership is tentative and subject to changes.

### **References**

Skjoldal, H. R. (Ed.). 2022. Ecosystem assessment of the Central Arctic Ocean: Description of the ecosystem. ICES Cooperative Research Reports Vol. 355. 341 pp. <https://doi.org/10.17895/ices.pub.20191787>

## **Appendix 2**

### **WG-SPF Proposal**

**Working Group Title:** Working Group on Sustainable Pelagic Forage Communities (WGSPF)

**Proposed Reporting Committees:** BIO, FIS, HD

**Term (normally 3 years):** June 2024–October 2027

#### **Linkage(s) to Previous PICES and ICES Expert Groups or Activities**

- [PICES Working Group 3 on Dynamics of Small Pelagics in Coastal Ecosystems](#) (1992–1995)
- [ICES Working Group on Cephalopod Fisheries and Life History](#) (WGCEPH; 1994–now)
- [PICES Working Group 14 on Micronekton of the North Pacific](#) (1997–2004)
- [PICES Working Group 23 on Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim](#) (2007–2011)
- [PICES Section/ICES Strategic Initiative on Climate Change Effects on Marine Ecosystems](#) (S-CCME; 2011–now)
- [ICES/PICES Symposium on “Forage Fish Interactions: Creating the Tools for Ecosystem-based Management of Marine Resources”](#) (Nantes, France, November 12–14, 2012)
- [PICES/ICES Symposium on “Drivers of Dynamics of Small Pelagic Fish Resources”](#) (Victoria, Canada, March 6–11, 2017)
- [PICES/ICES Working Group 43 on Small Pelagic Fish](#) (2019–2023)
- [PICES/ICES Symposium on “Small Pelagic Fish: New Frontiers in Science and Sustainable Management”](#) (Lisbon, Portugal, November 7–11, 2022)

#### **Linkage(s) to Other Organizations and Programs**

- [GLOBEC Regional Program on Small Pelagic Fish and Climate Change](#) (SPACC; 1994–2009)
- [FAO General Fisheries Commission for the Mediterranean](#) (GFCM): Working Group on Stock Assessment of Small Pelagic Species
- [North Pacific Fisheries Commission](#) (NPFC): Technical Working Group on Pacific Saury Stock Assessment (TWG PSSA) and Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA)
- The mandate of this joint ICES/PICES activity is relevant to the objectives of [the UN Decade of Ocean Science for Sustainable Development](#) (e.g., Challenge 2 – Protect and restore ecosystems and biodiversity, Challenge 3 – Sustainably feed the global population, and Challenge 4 – Develop a sustainable and equitable ocean economy) and [UN Strategic Development Goals](#) (e.g., SDG 2 – Zero Hunger, SDG 12 – Responsible Consumption and Production, and SDG 14 – Life Below Water)

#### **Linkage/Contributions to the PICES and ICES Strategic Plans**

Forage species and communities typically exhibit high variability, part of which is associated with drivers including climate change, changing ecosystem structure, and fishing pressure. To understand their dynamics, a whole-ecosystem approach is required that includes knowledge about oceanography, biological and human interactions. The activities of the proposed joint working group will contribute primarily to the first three of the six goals identified in [the PICES Strategic Plan](#): (1) Foster collaboration among scientists within PICES and with other multinational organizations; (2) Understand the status and trends, vulnerability, and resilience of marine ecosystems; and (3) Understand and quantify how marine ecosystems respond to natural forcing and human activities. Goals 2 and 3 are similar to the two research themes in [the PICES FUTURE \(Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems\) integrative scientific program](#).

The activities of this joint Working Group also align with at least five of the seven science priorities set in [the ICES Strategic Plan](#), including: (1) Ecosystem science, (2) Impacts of human activities, (3) Observation and exploration, (4) Seafood production and (5) Conservation and management science.

## Motivation and Goals/Objectives

Forage species are critical ecosystem components, occupying mid-trophic levels with the potential to impact most commercially important piscivorous fish species, marine birds and mammals. Additionally, directed commercial fishing on forage species accounts for more than 30% by weight of the total landings of fisheries globally. These landings are used both for human consumption and as protein for aquaculture and agriculture operations around the world. Many forage species are also culturally important and support local and indigenous communities.

Examples of forage species and community members to be considered by the working group include small, schooling, low- or mid-trophic level, pelagic fishes that are planktivorous throughout their life history (*e.g.*, herring, anchovy, sardine), mesopelagic fishes (*e.g.*, myctophids), euphausiids, and squids. Forage species are difficult to manage sustainably. Historical populations have often oscillated through “boom and bust” cyclical dynamics attributed to both bottom-up processes (*e.g.*, regime shifts or changes in marine productivity due to climate variability) that are amplified by top-down impacts (*e.g.*, natural mortality due to increasing predators or overfishing). As a group, forage taxa have relatively short life spans, potential for high recruitment, depensatory mortality, and density-dependent dynamics, are sensitive to both climatic and anthropogenic impacts and may exhibit rapid responses to changing conditions. Climatic and anthropogenic impacts are likely to change marine and estuarine systems and their forage communities in unanticipated ways, which will require adaptive and flexible management systems to maintain both sustainable fisheries and the ecosystem services that forage species provide.

From 2019–2023, a joint ICES-PICES working group on Small Pelagic Fish (WGSPF/WG 43) focused on establishing a multidisciplinary and global community of researchers to compare and contrast ecosystem-level approaches to determining the cause of fluctuations in populations of forage species and synthesize mechanisms linking climate and ecosystem variability and the population dynamics. The Working Group then connected these dynamics to socio-ecological systems and best practices in ecosystem-based fisheries management. These efforts culminated in an international symposium on “Small Pelagic Fish: New Frontiers in Science and Sustainable Management” (November 7–11, 2022, Lisbon, Portugal), two peer-reviewed publications (a Special Issue in *Canadian Journal of Fisheries and Aquatic Sciences* and a Theme Section in *Marine Ecology Progress Series*) containing 28 original research papers, and a perspectives manuscript anticipated to be submitted to either *Reviews in Fish Biology and Fisheries* or *Progress in Oceanography*.

The synthesis of the WGSPF/WG 43 noted several areas of emerging technologies and methods that can be used to better manage and adapt to changing forage dynamics. These include innovative technologies such as genetics, acoustics, underwater imagery, predator-inferred distributions, and isotopes, as well as novel and emerging analysis techniques such as artificial intelligence, management strategy evaluation, social network modeling, and simulation testing methods. In particular, international collaboration on the development of novel technologies to survey and monitor forage fish populations, simulation testing of management in the face of climate changes, and inclusion of climate and other anthropogenic drivers into management would be useful on a global scale to develop strategies that could lead to robust and sustainable ecosystem approaches to management of forage species. To that end, we are proposing to build on and expand the work of WGSPF, with the establishment of a new joint ICES-PICES working group with a three-year term beginning in mid-2024 that will address the following terms of reference.

## Terms of Reference

1. Foster international and interdisciplinary collaboration to establish similar study frameworks and comparative analyses of forage species, their ecology, and fisheries.
2. Assess recent progress on understanding fluctuations of forage species (abundance, distribution, diversity, and characteristics) and their impacts on the structure and function of ecosystems, particularly upper trophic levels including marine birds and mammals.

3. Identify, prioritize, and recommend research most needed to advance our knowledge and capacity to forecast ecosystem responses to changes in forage species.
4. Recommend strategies for studying and monitoring socio-ecological systems to improve ecosystem-based management for the sustainable harvest of forage species.
5. Describe how climate change and other anthropogenic factors impact forage species and examine how these factors will affect economies, nutrition of human communities, aquaculture, fishery portfolios, and/or transboundary management among countries with different levels of development in fisheries, and recommend options for adaptation.
6. Organize a joint ICES/PICES/FAO symposium on forage species that builds upon the Small Pelagic Fish symposia held in 2017 (March 6–11, 2017, Victoria, Canada) and 2022 (November 7–11, 2022, Lisbon, Portugal). The symposium, tentatively scheduled for 2026, will showcase integrative analyses of this Working Group. Working Group members will also propose and convene topic sessions and/or workshops at the PICES Annual Meetings and ICES Annual Science Conferences, as well as at FAO-sponsored meetings focused on key questions and recent advances in the dynamics of forage species in ecosystems and the impact of forage species on higher trophic levels.
7. Complete the required PICES Scientific Report at the conclusion of the Working Group to summarize and disseminate the findings.

### **Deliverables**

A tentative timeline for deliverables is outlined below. The timeline with more specific deliverables will be developed during revisions to the terms of reference that will occur during the first meeting for the WG.

#### Year 1

- To foster collaboration among the international, scientific and fisheries management community around forage species research (TOR#1). Task Forces and Activities that were generated by the expired WG 43 will be reviewed and adjusted to best meet the TORs for the proposed Working. Some activities will be added and activities that are no longer relevant will be deleted.
- Convene a one-day topic session titled: *“Advances in observational, analytical, and modeling tools that lead to better observations and improved understanding of small pelagic fish”* at the 2024 PICES Annual Meeting in Honolulu, USA (TOR#3).
- Hold at least one in-person or hybrid meeting during Year 1 (TOR#1).

#### Year 2

- A series of manuscripts synthesizing existing knowledge on (1) spatial variability across life history stages of forage species, (2) best practices for coupling spatial distribution models with ecosystem models, (3) fleet and management response to spatiotemporal variability of forage species, and related socio-economic impacts, (4) inter- and intra-specific responses to environmental drivers, and (5) cross-system comparisons of internal and external forcing regulating growth is expected to be submitted to peer-reviewed journals (TOR#2). Targeted journals for these manuscript(s) include *Fish and Fisheries*, *Advances in Marine Biology*, *Marine Ecology Progress Series* or *ICES Journal of Marine Science*.
- Convene a joint ICES/PICES/FAO symposium on forage species that builds upon the 2017 and 2022 Small Pelagic Fish symposia. This symposium is tentatively scheduled for the spring 2026 in La Paz, Mexico (TOR#6).
- Propose and convene topic sessions at the PICES Annual Meeting and ICES Annual Science Conferences, as well as at FAO-sponsored meetings focused on key questions and recent advances in the dynamics of forage species in ecosystems and the impact of forage species on higher trophic levels (TOR#1, TOR#2, and TOR#3).
- Hold at least one in person or hybrid meeting during Year 2 (TOR#1).

#### Year 3

- Generate a manuscript (or a series of manuscripts) that synthesizes key research gaps and questions that are needed to forecast ecosystem responses to changes in forage communities (TOR#3) and recommend

approaches that will be robust to climate change and other anthropogenic factors (TOR#5) to improve ecosystem-based management of forage species (TOR#4).

- Publish studies emerging from the 2026 international symposium in special issues of scientific journals (with potential venues including *Marine Ecology Progress Series*, *Canadian Journal of Fisheries and Aquatic Sciences*, or *Deep-Sea Research Part II*). The timeline for completion of these volumes is tentatively 1–1.5 years following the symposium. This may be a suitable venue for publication of synthesis manuscript(s) highlighted in TOR#3, TOR#4, and TOR#5.
- Hold at least one in person or hybrid meeting during Year 3 (TOR#1) and complete the required PICES Scientific Report (TOR#7).

#### **Proposed Co-Chairs:**

Rebecca Asch (ICES, USA)  
Susana Garrido (ICES, Portugal)  
Chris Rooper (PICES, Canada)  
Motomitsu Takahashi (PICES, Japan)

#### **Proposed Membership:**

##### Canada

Jennifer Boldt (Fisheries and Oceans Canada; Jennifer.Boldt@dfo-mpo.gc.ca)  
*SPF ecology, ecosystem-based fisheries management, fisheries and the environment*

Jaclyn Cleary (Fisheries and Oceans Canada; Jaclyn.Cleary@dfo-mpo.gc.ca)  
*management strategy evaluation, stock assessment, SPF fisheries, First Nations fisheries/collaborations*

Brian Hunt (University of British Columbia; b.hunt@oceans.ubc.ca)  
*diet studies, Pacific salmon, predation, pelagic ecosystem function*

Francis Juanes (University of Victoria; juanes@uvic.ca)  
*predation studies, fisheries acoustics, fish behavior*

Hannah Murphy (Fisheries and Oceans Canada; hannah.murphy@dfo-mpo.gc.ca)  
*SPF early life history, spawning behavior distribution and phenology*

Chris Rooper (Fisheries and Oceans Canada; chris.rooper@dfo-mpo.gc.ca)  
*species distribution models, surveys and methods for small pelagics*

##### China

Yue Jin (Yellow Sea Fisheries Res. Inst., Chinese Academy of Fishery Sciences; jinyue@ysfri.ac.cn)  
*fish biology and ecology, such as age and growth, feeding ecology, migration, and habitat suitability*

Shuyang Ma (Ocean University of China, mashuyang1992@163.com)  
*fisheries oceanography, climate change, SPF recruitment, statistical modeling*

Yongjun Tian (Ocean University of China; yjtian@ouc.edu.cn)  
*fisheries oceanography, SPF recruitment, ecosystem dynamics, climate impacts*

Wei Yu (Shanghai Ocean University; wyu@shou.edu.cn)  
*fisheries oceanography, climate change, species distribution model, squid fisheries*

Hui Zhang (Institute of Oceanology, Chinese Academy of Sciences; zhanghui@qdio.ac.cn)  
*fish biodiversity, ichthyoplankton, fish eDNA, fish community, fishery assessment, fish variation*

Kui Zhang (South China Sea Fisheries Res. Inst., Chinese Academy of Fishery Sciences; zhangkui@scsfri.ac.cn)  
*SPF fish biology and fisheries, stock assessment, climate change*

## Japan

Sachihiko Itoh (*Atmosphere and Ocean Research Institute, University of Tokyo; itohsach@aori.u-tokyo.ac.jp*)  
*physical oceanography, biological oceanography, transport modelling*

Hiroomi Miyamoto (Fisheries Resources Institute, FRA; miyamoto\_hiroomi47@fra.go.jp)  
*biological oceanography, zooplankton biology, environmental analysis*

Tatsuya Sakamoto (Kyoto University; tatsfish@gmail.com)  
*fisheries oceanography, population dynamics, early life biology, migration analysis*

Motomitsu Takahashi (Fisheries Resources Institute, FRA; takahamt@fra.affrc.go.jp)  
*fisheries oceanography, population dynamics, early life biology*

Akinori Takasuka (University of Tokyo; atakasuka@mail.ecc.u-tokyo.ac.jp)  
*fisheries oceanography, population dynamics, early life biology, reproductive biology*

Mikio Watai (Fisheries Resources Institute, FRA; watai\_miko40@fra.go.jp)  
*fisheries oceanography, fishery-independent surveys, early life biology, reproductive biology*

## Korea

Hae Young Choi (National Institute of Fisheries Science; chy2021@korea.kr)  
*genetic science*

Minje Choi (National Institute of Fisheries Science; cmj543@korea.kr)  
*social science/human dimensions*

Hwansung Ji (National Institute of Fisheries Science; nise9@korea.kr)  
*ichthyoplankton*

Heejong KANG (National Institute of Fisheries Science; kanghj87@korea.kr)  
*stock assessment*

Dongwha Sohn (Pusan National University; sohndongwha@pusan.ac.kr)  
*fisheries oceanography, modeling*

## Russia

Dmitry Antonenko (Pacific Branch (TINRO), VNIRO; dmitrii.antonenko@tinro.vniro.ru)  
*stock dynamics, distribution, and biology of common pelagic fish in the North Pacific*

Nikita Dederer (Pacific Branch (TINRO), VNIRO; nikita.dederer@tinro.vniro.ru)  
*Pacific salmon, pelagic fish stock dynamics, pelagic ecosystem interactions*

Vladimir Radchenko (Pacific Branch (TINRO), VNIRO; vladimir.radchenko@tinro.vniro.ru)  
*North Pacific pelagic ecosystems, Pacific salmon, conservation biology, and fisheries management*

## USA

Matthew Baker (North Pacific Research Board; Matthew.Baker@nprb.org)  
*SPF ecology and distributions, arctic ecosystems, surveys and integrated modeling projects*

Noelle Bowlin (NOAA Southwest Fisheries Science Center; noelle.bowlin@noaa.gov)  
*CalCOFI, surveys and methods for small pelagics, larval ecology, plankton ecology*

Richard Brodeur (Oregon State University; ricbrodeur1@gmail.com)  
*SPF diets and trophic interactions, SPF and jellyfish ecology, survey methodology*

Tim Essington (University of Washington; essing@uw.edu)  
*SPF modeling and population dynamics, diets and trophic modeling, management strategy evaluation, global role of SPF for predators and fisheries*

Isaac Kaplan (NOAA Northwest Fisheries Science Center; isaac.kaplan@noaa.gov)  
*ecosystem modeling, trophic modeling, management strategy evaluation*



Barbara Muhling (NOAA Southwest Fisheries Science Center; barbara.muhling@noaa.gov)  
*species distribution modeling of SPF and their highly migratory predators, climate change*

Ryan Rykaczewski (NOAA Pacific Islands Fisheries Science Center; ryan.rykaczewski@noaa.gov)  
*fisheries oceanography, climate change, SPF ecology and population dynamics global ecosystems*

Margaret Siple (NOAA Alaska Fisheries Science center; margaret.siple@noaa.gov)  
*SPF management strategy evaluation, survey methodology*

Desiree Tommasi (NOAA Southwest Fisheries Science Center; desiree.tommasi@noaa.gov)  
*stock assessment of SPF and their predators, transboundary management, management strategy evaluation, seasonal forecasting, Pacific-wide analyses*

Robert Wildermuth (NOAA Southwest Fisheries Science Center; robert.wildermuth@noaa.gov)  
*SPF recruitment forecasting, management strategy evaluation, ecosystem modeling and stock assessment*

North Pacific Fisheries Commission (NPFC) – ex-officio membership

Toshihide Kitakado (Tokyo University of Marine Science and Technology; kitakado@kaiyodai.ac.jp)  
*fisheries management, population analysis, stock assessment methods*

Kazuhiro Oshima (Fisheries Resources Institute, FRA; oshima\_kazuhiro28@fra.go.jp)  
*fisheries management, population analysis, stock assessment methods*

## **Appendix 3**

### **WG ONCE-CN Proposal**

# Proposal for a new PICES Working Group on Ocean Carbon Negative Emissions for Carbon Neutralization (OCN)

**Group type:** Working Group

**Acronym:** WG OCN

**Parent Committees:** POC, BIO

**Term:** 2024-2027

**Chairs:** Nianzhi Jiao /China, Russell T. Hill /USA (TBC) or Michael Gonsior /USA (TBC)

## Background, Goals and Motivations

Facing the upcoming climate crisis, to achieve the goal of global carbon neutralization and the Paris Agreement for mitigation of global warming, actions were taken in the past decades. The previous PICES/ICES joint WG 33 on “Climate Change and Biologically-driven Ocean Carbon Sequestration” and the PICES/ICES joint WG 46 on “Ocean Carbon Negative Emissions (ONCE)” have finished its missions on identifying the knowledge gaps, exploring new ONCE approaches, and contributed to the foundation of the Global Ocean negative carbon emissions ([Global ONCE](#)) program which has been endorsed by the UN decade program. The North Pacific's significant environmental and economic importance makes it a key focus area of Global ONCE for fostering communication and collaboration among stakeholders. Based on the accomplishments of the previous WG-33 and WG-46, the newly proposed Working Group on “Ocean Carbon Negative Emissions for Carbon Neutralization (WG-OCN)” will promote collaborations and communications among the ONCE community across the North Pacific to achieve consensus regarding research strategy, technical protocols, and Monitoring, Reporting and Verification (MVR) framework to contribute to the goal of the global carbon neutralization for mitigating climate change and a sustainable future ocean. The engagement of the North Pacific community will be instrumental in fulfilling the global carbon removal requirements. WG-OCN can leverage the region's specific cases to improve public understanding and support for ocean carbon neutrality initiatives. Based on scientific knowledge, the working group aims to improve the communications between the scientific community, managers, policymakers, and the general public on the theme of oceanic carbon neutralization.

## Terms of Reference

The main objective of this WG is to link scientific theories with application techniques, engineering, and policies. The key scientific topics will be:

- Develop an international network of communication in the PICES region for collaboration for Ocean Carbon Neutralization science and technology;
- Integrate theoretical mechanisms of carbon cycles in the ocean, and climate change impacts on oceanic carbon pump under anthropologic impacts;
- Co-design research strategies and technical protocols for OCN;
- Assess Ocean Negative Carbon Emission (ONCE) approaches for sustainable eco-engineering, and the feasibility of applying them to North Pacific regions.
- Facilitate OCN capacity development, equitable policy, governance, and societal understanding.

## Expected Deliverables

- Framework for co-design of research strategies and technical protocols for OCN
- Assessment report of ONCE approaches in the North Pacific.
- Communication materials for capacity building, policy and literacy
- Working Group final report to summarize its accomplishments and recommendations.

## Tentative Members

**Nianzhi Jiao** /China (Ocean Negative Carbon Emissions)

**Russell T. Hill** /USA (Marine microbiology)

**Michael Gonsior** /USA (Photochemistry, Dissolved Organic Matter Diversity)

**Curtis Suttle** /Canada (Marine Viruses and Ecology)

**Boris Wang** / Canada (Trade and Application of Marine Carbon Neutral Technologies)

**Lei Zhou** /China (Marine Observation and Remote Sensing)

**Yanli Lei** /China (Biodiversity and Global Change)

**Yongyu Zhang** / China (Macroalgae Culture)

**Shigeru Tabeta** /Japan (Clean Energy Engineering)

**Moriaki Yasuhara** /Japan (Micropaleontology and Climate Change)

**Jung-Ho Hyun** /Korea (Sediment Biogeochemistry and Microbial Oceanography)

**Sun Young Kim** /Korea (Marine Genetic Ecology)

**Hongsheng Bi** /USA (Fisheries Oceanography and Imaging systems)

**Feng Chen** /USA (Marine Microalgae Ecology and Environmental Science)

**Jeremy Testa** /USA (Eutrophication and Ocean Acidification)

## **Appendix 4**

### **Proposal of SPF 2026**

## Third International Small Pelagic Fish Symposium (SPF-2026)

### Update for ISB-2024

The first international symposium in the Small Pelagic Fish (SPF) Symposium series, “[Drivers of Dynamics of Small Pelagic Fish Resources](#),” was held in March 2017 in Victoria, Canada (SPF-2017). The second symposium, “[Small Pelagic Fish: New Frontiers in Science and Sustainable Management](#),” took place in November 2022 in Lisbon, Portugal (SPF-2022).

At the 2023 inter-sessional meeting (ISB-2023; May 8–10, 2023), the PICES Science Board evaluated the proposal from Mexico and recommended to the Governing Council (GC) to approve holding the next symposium in this series in the spring of 2026 in La Paz, Mexico. This recommendation was considered and approved at the 2023 inter-sessional GC meeting (IGC-2023; May 30, 2023), and here is a formal decision:

**Decision 2023/S/8: Symposium sponsorship.** Council reviewed the proposal for a 3<sup>rd</sup> Symposium in the Small Pelagic Fish Symposium series, recommended by Science Board, and approved the joint co-convening of the Symposium with ICES and FAO in spring 2026 (dates to be determined) in La Paz, Mexico. Council deferred a financial commitment pending a specific request.

The SPF-2026 Local Organizing Committee has been formed and includes scientists from the institutions located in the Baja California region and the Mexican Institute for Research in Sustainable Fisheries and Aquaculture (Instituto Mexicano de Investigación en Pesca y Acuicultura Sustentables; IMIPAS) in Mexico City. Dr. Salvador Lluch-Cota (CIBNOR) was nominated as a symposium convenor representing the host country.

A letter inviting FAO to join PICES and ICES as a primary international organizer for SPF-2026 was sent on June 19, 2023. In response (dated October 25, 2023) to this invitation, FAO confirmed their involvement as a co-organizer and co-sponsor of the symposium, collaborating alongside PICES and ICES. FAO committed to provide from \$10,000 to \$30,000 USD to support the participation of experts from developing countries in this event, appointed Dr. Marcelo Vasconcellos (FAO Fisheries and Aquaculture Division) as a symposium convenor, and indicated an interest in nominating another person to serve on the Scientific Steering Committee (SSC).

Substantial time on planning for SPF-2026 was spent at a 3-day workshop convened by [the ICES-PICES WG on Small Pelagic Fish](#) (February 12–14, 2024, La Paz, Mexico):

- The symposium scope was drafted (see Appendix).
- The symposium duration and structure were confirmed to be the same as for SPF-2022: 1 day (Day 1) for concurrent workshops to be proposed by the scientific community and 4 days (Days 2-5) for topic sessions to be developed by the SSC. Days 2-4 will consist of morning plenary sessions to provide overarching keynote presentations and to introduce topics of the concurrent sessions to be convened on the same day (up to 3 sessions daily). On Day 5, the concurrent topic sessions will be held in the morning, followed by an afternoon summary plenary session. An evening poster session will be scheduled for Day 3.
- The symposium dates, May 4–8, were selected, taking into account information on federal/local holidays in Mexico/Baja California Sur, weather in La Paz, other relevant meetings, university spring breaks, etc.
- Drs. Rebecca Asch (ICES, USA), Susana Garrido (ICES, Portugal), Chris Rooper (PICES, Canada) and Motomitsu Takahashi (PICES, Japan) were recommended to play a double role – to serve not only as Co-Chairs of the proposed ICES-PICES WG on Sustainable Pelagic Forage Communities, but also as symposium convenors. The ICES-PICES WG on Sustainable Pelagic Forage Communities is a new working group currently undergoing review by ICES and PICES poised to expand on the activities undertaken by the WG on Small Pelagic Fishes. Organizing a joint ICES/PICES/FAO symposium on forage species that builds on the previous two SPF symposia is one of the Terms of Reference (TOR#6) for the WG on Sustainable Pelagic Forage Communities. These arrangements are similar to SPF-2022, when Co-Chairs of the ICES-PICES WG on Small Pelagic Fish, Drs.

Myron Peck (ICES, Netherlands), Ignacio Catalan (ICES, Spain), Ryan Rykaszewski (PICES, USA) and Akinori Takasuka (PICES, Japan) also served as symposium convenors.

In March 2024, the ICES Science Committee approved the Resolution stating that ICES will co-sponsor SPF-2026, and Drs. Rebecca Asch (USA) and Susana Garrido (Portugal), ICES Co-Chairs of the proposed joint ICES-PICES WG on Sustainable Pelagic Forage Communities, will serve as symposium convenors and Dr. Sarah Millar (ICES Advice Department Professional Officer) as a symposium coordinator. ICES co-sponsorship includes allocating 10,000 EUR to support participation of Early Career Scientists from ICES member countries.

#### Requests to Science Board:

- **To nominate/confirm PICES convenors for SPF-2026**

Dr. Chris Rooper (Canada) and Dr. Motomitsu Takahashi (Japan), PICES Co-Chairs of the proposed joint ICES-PICES WG on Sustainable Pelagic Forage Communities have been recommended and are prepared to take on the task.

- **To make a specific funding request to Council to support SPF-2026**

PICES provided \$15,000 CAN for each of the previous two SPF symposia, SPF-2017 and SPF-2022. Funds to support the participation of Early Career Scientists from PICES member countries in these events came from the Trust Fund and funds to support logistics of the symposia from the General Fund.

## **Appendix**

PICES/ICES/FAO International Symposium  
Navigating Changes in Small Pelagic Fish and Forage Communities:  
Climate, Ecosystems, and Sustainable Fisheries  
May 4–8, 2026, La Paz, Mexico

Small pelagic fish (SPF) constitute over 30% of the total catch in global fisheries, making them a pivotal component for sustaining food security worldwide. Together with other forage species (*e.g.*, squid, myctophids), their significance extends beyond mere sustenance, since forage species are key for energy transfer within food webs. Consequently, understanding the intricacies governing their population dynamics and ecological roles remains imperative for fostering robust management practices. Over the past five decades, concerted global research endeavors have shed light on these aspects for SPF, revealing important insights and identifying critical knowledge gaps. In particular, less research has focused on the dynamics of forage species beyond SPF.

One noteworthy revelation from global analyses is the oscillatory nature of SPF productivity, often attributed to climate variability spanning seasonal to multi-decadal scales. Such fluctuations, in line with other forage species, have profound ecological and socioeconomic ramifications, underscoring the interconnectedness of forage species dynamics with broader environmental processes. Leveraging comparative studies across diverse geographical regions offers invaluable perspectives for refining management strategies.

Scientific advancement in comprehending forage community dynamics is ongoing, utilizing an array of tools and methodologies. Integration of numerical models with extensive monitoring data and stock assessments enhances our ability to explore hypotheses regarding population variability. Furthermore, innovations such as eDNA analysis, machine learning, and genomic studies present promising avenues for unveiling nuanced aspects of forage species ecology. Collaborative efforts involving stakeholders from various sectors are instrumental in devising effective regional management approaches tailored to specific social-ecological contexts.

The upcoming international symposium, “Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries” aims to showcase recent advancements in SPF and forage communities research. By delving into topics encompassing ecology, population dynamics, climate and oceanic impacts, social-ecological systems, and sustainable management practices, the symposium promises to foster interdisciplinary dialogue and pave the way for informed decision-making in forage species conservation and utilization.



## **Appendix 5**

### **APN Training Workshop Information**

## **APN Proposal Development Training Workshop (PDTW)**

**Suva, Fiji, 26-30 August 2024**

### **Call for Participation of Early Career Professionals in the Pacific**

Main theme of the workshop

#### **Global Change Research in the Pacific**

#### **Introduction**

The Asia-Pacific Network for Global Change Research (APN) Proposal Development Training Workshops (PDTW) offer a unique and valuable opportunity for early career professionals (ECPs) in the Pacific to develop the skills needed to write competitive scientific research proposals for funding. This strategic initiative aims to provide participants with a comprehensive and interactive platform that equips them with the skills and capacity to access multi-stage and regionally-scoped grant award opportunities. One of the key strengths of the PDTW is that it serves as a valuable space for ECPs in the Pacific to connect and collaborate on regional research proposals of shared interest. This networking opportunity will enable participants to build lasting relationships with colleagues from different countries and disciplines. Through collaboration, participants will be better equipped to tackle the complex global change sustainability challenges facing the region and the world.

The main theme of the Pacific PDTW aligns with APN's strategic research interests on global change in the Pacific region. The workshop will address a range of global change topics concerning the Pacific region and its Small Island Developing States, and will provide participants with an opportunity to learn from experienced APN project leaders, past and present, and fellow researchers with regional expertise. Through a combination of presentations, group discussions and practical exercises, participants will gain a critical understanding of the field's complex challenges and opportunities. They will learn how to identify research gaps, develop research questions, design methodologies and create compelling narratives for their proposals.

With additional mentoring post-PDTW, participants will be encouraged to submit their competitive regional research proposals to APN's upcoming 2024 Call for Proposals, to be launched in November 2024 for funding from October 2025.

#### **Global Change in the Pacific region**

Encompassing 15% of the Earth's surface and an approximate population of 13 million people (World Bank, 2024; Pacific Data Hub, 2024), the Pacific Island Developing States evidence a great diversity of cultural identity, sea and landscapes, and traditional ways of life in each archipelago (UNESCO, 2017). While sharing commonalities in indigeneity and heritage, the region confronts distinctive and disproportionate challenges in livelihoods and development due to their

geographical positioning, climate vulnerability and heightened susceptibility to natural disasters (World Bank, 2022).

Recent assessments from global environmental conventions, research institutions and regional hubs reveal a multitude of external environmental challenges and threats faced by the Pacific region, with both tangible and intangible impacts on its resources, livelihoods and environmental quality (UNESCO, 2017). The IPCC's Special Report on the Ocean and Cryosphere in a Changing Climate (2019a) underscores the severity of these impacts with high confidence, emphasising the vulnerability of Small Island Developing States to sea level rise and cross-cutting impacts from climate-related ocean changes and adverse effects from human activities on ocean and land. Moreover, small islands exhibit high sensitivity and reactivity to change and climatic stressors, leading to knock-on effects on livelihoods through increasing coastal salinity, cyclones, mass coral bleaching and mortality, and wave-induced flooding (IPCC, 2019b).

Among the most urgent issues facing Pacific Island Developing States is the management of biological diversity within their shores and inland ecosystems. The 5th Global Biodiversity Outlook (CBD, 2020) presents alarming statistics, indicating the region's rich ecosystems are under siege due to habitat destruction, overexploitation and non-anthropogenic climate stressors. Since 1970, the Asia and Pacific region has witnessed up to a 55% decline in species abundance (World Wildlife Fund, 2022), with 305 native terrestrial and plant species in the Pacific Island Developing States threatened by climate change and severe weather (IUCN, 2018). Despite these challenges, the Pacific region's ecosystems benefit from significant protections, including the establishment of large marine protected areas such as the Marae Moana Marine Park in the Cook Islands (1.97 million km<sup>2</sup>) in 2017 and the expansion of the Papahānaumokuākea Marine National Monument in the Hawaiian Islands (1.5 million km<sup>2</sup>) (CBD, 2020). Spatial planning and protected areas governance, sustainable food industries, and harmonising indigenous and local cultural knowledge all play crucial roles in mitigating and adapting to future climate scenario risks in the Pacific (IPCC, 2019b).

In conclusion, addressing the challenges posed by global change impacts in the Pacific region necessitates ambitious and sustained efforts in mitigation, adaptation and resilience-building in climate action pathways, aligned with the United Nations Sustainable Development Goals. The integration of locality-specific research and earth observations offers promising avenues for bridging data gaps and implementing targeted policies to tackle these issues effectively (IPCC, 2019b). Recognising the diverse resources and capacities across Pacific islands underscores the importance of tailored approaches to integrated planning and adaptation, as emphasised by global change research. With high confidence, the IPCC (2019a) indicates that locally appropriate strategies, including decision analysis and public participation, can effectively manage the complexity of global change risks, paving the way for a more resilient and sustainable future in the Pacific and beyond.

## A. MAIN THEME

The main theme of the workshop is **Global Change Research in the Pacific**. Proposals developed with engagement of (1) indigenous, local, or traditional knowledge, community participation, and co-design, or (2) Big Earth Data, are welcomed and encouraged at the Pacific PDTW. The following sub-themes will be addressed in the proposal development activities:

- I. Management of Pacific island and ocean ecosystem services, resources, and circular ecological economy

*Addressing protected land and seascapes, biodiversity and habitat loss, coastal development, sustainable fisheries, food and water security, One Health initiatives, waste pollution such as microplastic debris, and CEE.*

- II. Enhancement of climate and disaster risk reduction, resilience and adaptation in Pacific ecosystems and livelihoods

*Identifying vulnerabilities and developing adaptive strategies against climate change, with the utilisation of science, and indigenous (IK) and local knowledge (LK) to enhance the adaptive capacities for the Pacific islands. Possible proposals may consider relocation and displacement, and climate-related sea-level rise.*

- III. Pacific climate variability and downscaling observation, assessment, and innovation in global change research

*Incorporating innovative technologies and methodologies, such as Big Earth Data, the monitoring and observation of earth systems, and citizen science to address Pacific climate variability.*

## B. STRUCTURE OF THE WORKSHOP

The training workshop and other networking activities will be for five full days, with the tentative schedule outlined in the table below.

### Timetable

Day 1: Monday, 26 August 2024	<ul style="list-style-type: none"> <li>● Introduction to APN, the PDTW, and the APN Call for Proposals</li> <li>● Discussion session and presentation on the key thematic areas</li> </ul>
Day 2: Tuesday, 27 August 2024	<ul style="list-style-type: none"> <li>● Official opening of Pacific PDTW</li> <li>● Project management essentials and proposal writing launch</li> </ul>
Day 3: Wednesday, 28 August 2024	<ul style="list-style-type: none"> <li>● Experience-sharing on proposal development and project implementation in the Pacific</li> <li>● Group Presentations, review and APNIS submission</li> </ul>
Day 4: Thursday, 29 August 2024	<ul style="list-style-type: none"> <li>● Proposal review process and presentations</li> <li>● Way forward in proposal development and submission</li> <li>● Award ceremony, workshop evaluation and closing</li> </ul>
Day 5: Friday, 30 August 2024	<p><b>All Day:</b> Field Trip, departing from Suva and ending in Nadi <i>PDTW concludes after the field trip.</i></p>

### C. PARTICIPATION

The PDTW is open to early career professionals from the Pacific and working in the areas related to the workshop's main theme. For this reason, applicants requiring funding support will ONLY be accepted from early career professionals who are from, living and working in APN Pacific member and approved countries.

### D. ELIGIBILITY and PROCEDURES

1. Applicants must be early career scientists/practitioners of 40 years of age and under as of the application deadline. Applicants must be one of the following:
  - a. An undergraduate degree holder with five years of related working experience;
  - b. A postgraduate student working towards a PhD or Master's degree (final year);
  - c. A Master's degree holder with three years of related work experience;
  - d. A PhD degree holder with at least one year of working experience, or received their highest postgraduate degree within the previous ten years.
2. Applicants should be working in areas of, or have academic experience related to, the workshop's main theme.
3. Applicants must have a good working knowledge of the English language.
4. Successful applicants will be selected on a **first-come, first-served** basis.
5. Applicants **seeking funding support** will only be accepted from early career professionals who are from, residing in, and working in the APN [Pacific member and approved countries](#). Limited funds are available for participants from APN Pacific member countries that are considered as developed: Australia, New Zealand and the United States of America.
6. Applicants applying on a **self-funded** basis can be within or outside the subregion, but their area of work must be related to the theme of the workshop and the geographical scope of work must be in the Pacific. The applicant must be from one of APN's member/approved countries.

### E. APPLICATION PROCESS

Interested persons should complete the **mandatory** four steps outlined below.

1. Complete and submit the application form provided with this announcement for the Pacific PDTW on the [Asia-Pacific Network Information System \(APNIS\)](#).
2. Submit resume/CV (maximum 2 pages) with minimum details: Full name, Nationality Date of Birth, Gender, Current Affiliation, Education/Employment History.
3. Submit a **short motivation essay (300-400 words)**. The best essay will address the following questions in a narrative style:
  - a) How will this training workshop be important in your career development and what are the expected impacts?
  - b) What is your research interest(s)?
  - c) What is your motivation for undertaking regional-based Global Change research?
  - d) Indicate which of the 3 sub-themes you are interested in (place in order of preference).

4. Submit a **letter of recommendation** from your supervisor indicating:
  - a. Endorsement to attend the workshop.
  - b. How will the training workshop benefit the trainee's research career?
  - c. Commitment and consent as the supervisor of the trainee to encourage the trainee to submit regional-based proposals (to APN or other funding bodies) and/or become engaged in regional-based Global Change research.

#### **F. SPONSORSHIP**

1. A maximum of 25 early career professionals will be selected for the training workshop. Financial support for sponsorship is available from APN, contingent on funding availability.
2. From each sub-regional member country and approved country (Pacific Island Countries), a minimum of two early-career professionals will be selected as recipients of APN financial support.
3. Sponsorship for successful applicants will cover the cost of an economy-class air ticket, accommodation, meals and local transportation.
4. There is no registration fee to participate in this workshop.

#### **G. APPLICATION DEADLINE: 30 April 2024, 23:59 (JST) on the APNIS interface.**

##### Additional information

- Participants of the workshop will be provided with breakfast and lunch during the event.
- Participants who have previously attended APN PDTWs are ineligible to apply for this training workshop.
- Participants are required to commit to attending the full five days of events to gain the maximum benefit from the programme.

For additional queries, please contact the APN Secretariat via email to Dr Nafesa Ismail ([nismail@apn-gcr.org](mailto:nismail@apn-gcr.org)) and Ms Naomi Young ([nyoung@apn-gcr.org](mailto:nyoung@apn-gcr.org)).

## **Appendix 6**

### **WG39 Final Report**

**Final Report of  
Joint PICES/ICES/PAME Working Group on an Integrated  
Ecosystem Assessment for the Central Arctic Ocean  
(WG-39)**

**April, 2024**



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## **1 Introduction**

Ecological monitoring of the Pacific Arctic conducted over the past ten years has shed light on the impacts of recent warming and reduced sea-ice conditions to Arctic marine ecosystems. In the period of 1974-2014, the date of sea ice retreat has occurred earlier in the year at a rate approximately -0.7 d/yr (Serreze et al., 2016). The years 2017-2019 were anomalously warm in the Northern Bering and Chukchi seas and further characterized by substantial winter sea ice loss (Huntington et al., 2020). Additional physical changes in the Pacific Arctic include increased transport of Pacific water through the Bering Strait increased storm activity in the High Arctic (prefaced by Moore and Stabeno 2015). These physical conditions underlie many ecological impacts that span the entire range of the Arctic ecosystem from phytoplankton and marine bacteria to marine mammals and ultimately impact Arctic native communities that rely on the marine ecosystem for sustenance and cultural value (Moore et al. 2018).

PICES took upon responsibilities concerning the CAO issues when it joined the WGICA (Joint ICES/PICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)) by establishing WG39 (Joint PICES/ICES/PAME Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean) in 2017. In 2019, PICES also established WG44 (Joint ICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) in efforts to understand the Arctic system and its impacts to the sub-Arctic and mid-latitude North Pacific. An integrated ecosystem assessment (IEA) is a useful approach that is shared by these two Working Groups, particularly relevant with substantial science and policy needs emerging for the sustainable Arctic.

### **1.1 WGICA**

The Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean (WGICA) was established jointly by ICES and PAME in 2016. The goal of this working group is to conduct an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO), a needed step to provide scientific advice on issues such as the prospect for future fisheries in the Arctic Ocean and sensitivity and vulnerability of marine ecosystems in relation to human activities (including shipping, fisheries, tourism). WGICA links human activities, pressures and ecosystem vulnerability into a semi-quantitative risk analysis by assessing the spatial and temporal overlap using best available data. The first WGICA meeting was held in May 24-26, 2016, at the ICES headquarters in Copenhagen, Denmark. PICES joined WGICA in 2017 and WGICA became the Joint ICES/PICES/PAME working group for the CAO IEA.

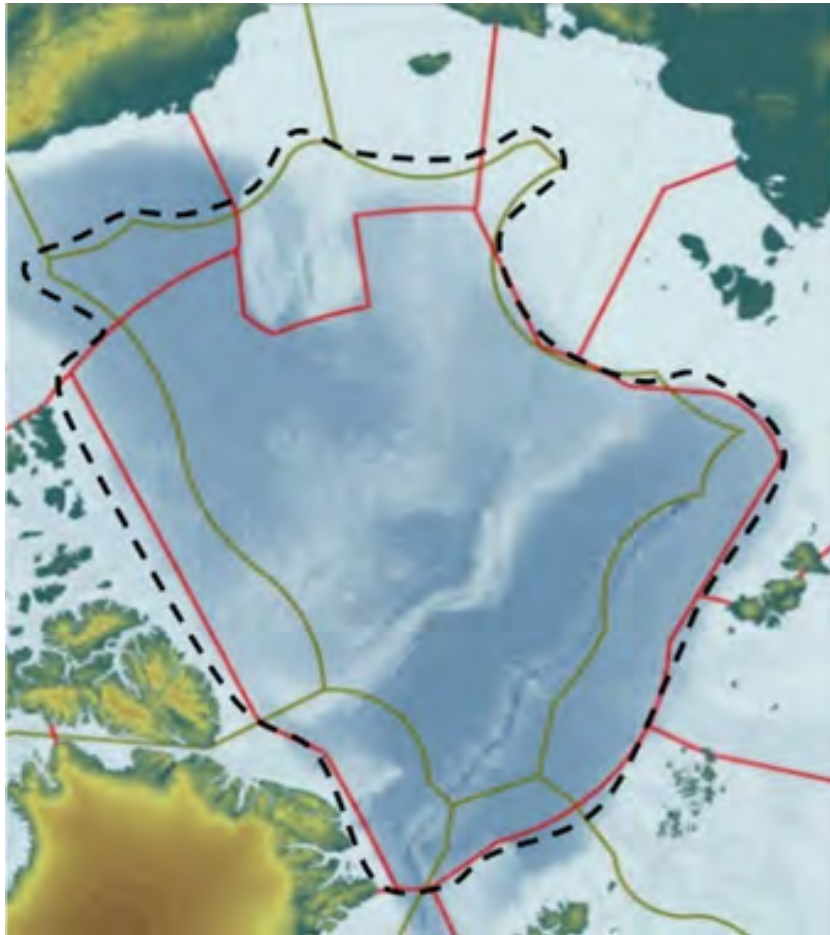


Figure 1. The Central Arctic Ocean study area (black broken line; CAO) with the Large Marine Ecosystems (red lines) as defined by PAME (Protection of the Arctic Marine Environment), one of the working groups in the Arctic Council, the borders of the five National Economic Zones (green), and the High Seas being the center area outside the 200 nautical miles of the five bordering nations.

Fifth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean (FiSCAO) was held in October 24-26, 2017, Ottawa, Canada. At that time, PICES sent WG39 co-chair Sei-Ichi Saitoh to this meeting and firstly WGICA three co-chairs met each other and start to communicate on the promotion of WGICA (Figure 2).

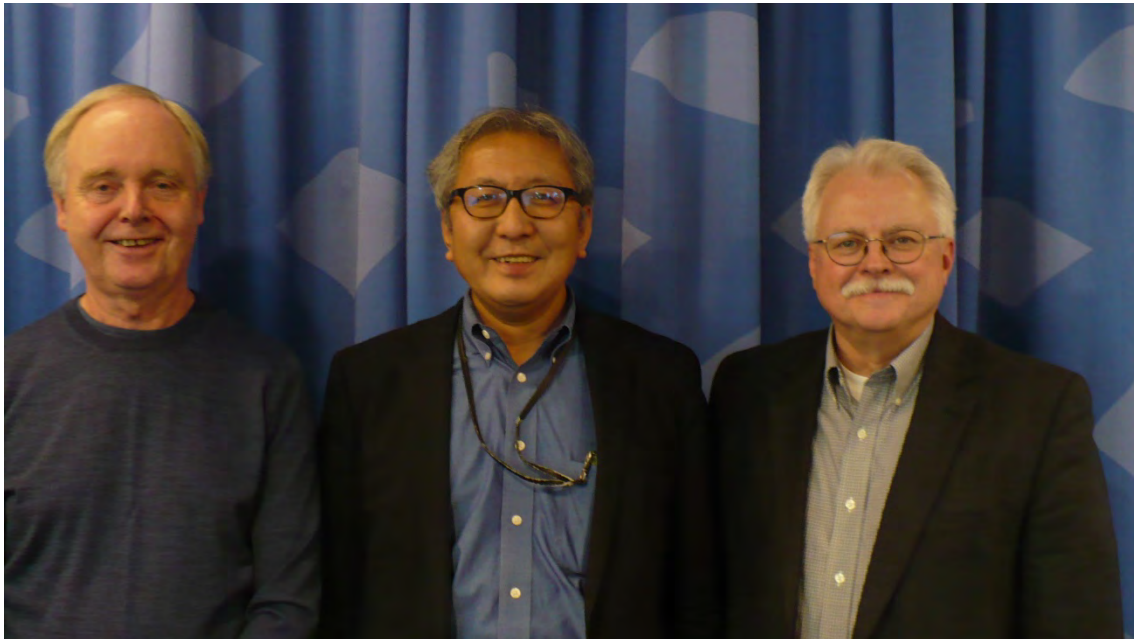


Figure 2. First three co-chairs of WGICA met in 5<sup>th</sup> FiSCAO meeting. From left, Hein Rune Skjoldahl (PAME), Sei-Ichi Saitoh (PICES), and John Bengtson (ICES).

Following the first WGICA meeting at ICES headquarters in Copenhagen in May 24-26, 2016, the second meeting was held in Seattle in April 19-21, 2017.

The 3rd meeting was held in St. John's, Newfoundland, Canada, in April 24-26, 2018 (Figure 3). The three WGICA Co-chairs are John Bengtson, Sei-Ichi Saitoh, and Hein Rune Skjoldahl. At the third meeting, compiled material to be used in the IEA was presented and reviewed, and a plan for the further work to complete the IEA during 2018 was drawn up. This administrative meeting report provides a summary of the meeting and the agreed arrangements for completion of the IEA report.



Figure 3. Participants of the workshop 3rd WGICA at St. John's, Newfoundland, Canada, from left: John L. Bengtson (co-chairs of WGICA), Hein Rune Skjoldal (co-chairs of WGICA), 3rd from right: Sei-Ichi Saitoh (co-chairs of WGICA)

Forth meeting of WGICA was held in May 8-10, 2019, Sapporo, Japan (Figure 4). Under COVID-19, Fifth meeting of WGICA was held virtually in April 27-28, 2020, and Sixth meeting was held also virtually in October 12-14, 2021.

Seventh meeting of WGICA was held in person in ICES headquarters in October 11-13, 2022, Copenhagen, Denmark. Most recent meeting of WGICA was held in 20-23 October, 2023, Seattle, USA in connection with PICES 2023 Annual Meeting.

WGICA published comprehensive IEA Report No. 1 "Ecosystem assessment of the Central Arctic Ocean: Description of the ecosystem" (Skjoldal, 2022) and present co-chairs, Lis Lindal Jørgensen (PAME), Sei-Ichi Saitoh (PICES), and Martine van den Heuvel-Greve (ICES) continue to prepare IEA Report No. 2 "Human activities, pressures, and their impact on the ecosystems of the high seas and national waters of the Central Arctic Ocean (CAO) and existing management measures and knowledge gaps".

WGICA also published Ecosystem Overview of Central Arctic Ocean ecoregion in 2021 and revised in 2022 (See Appendix A) which is similar to PICES NPESR.

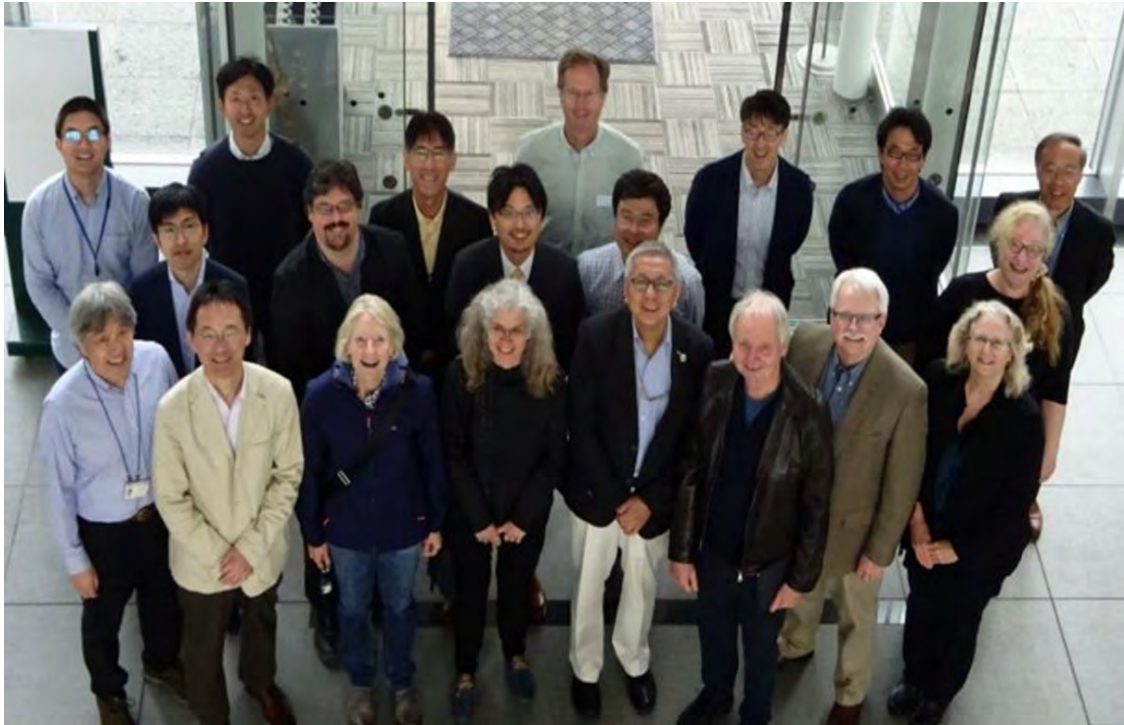


Figure 4. Group photo of 4<sup>th</sup> WGICA meeting held in May 8-10, 2019, Sapporo, Japan.



Figure 5. Present three co-chairs of WGICA. From left, Lis Lindal Jørgensen, Sei-Ichi Saitoh, and Martine van den Heuvel-Greve.

## **1.2 PICES WG39**

At PICES-2016, the ICES President requested that PICES join the existing Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean (WGICA), established jointly by ICES and PAME in 2016. This request was approved by Governing Council (Decision 2016/6/5). PICES joined as a co-sponsor of the group in 2017, making WG39, joint PICES/ICES/PAME Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean.

WG39 will consider approaches and methodologies for the IEA in the Central Arctic Ocean. In PICES, WG39 was established for supporting WGICA in 2017. Parent Committee and term of WG39 are as follows, and we have twice of extended term in 2018 and 2021.

Parent Committee: SB

Term: PICES-2016 – PICES-2022

Extended:

at PICES-2018 until PICES-2021 (GC decisions S/4 (vii))

at PICES-2021 until PICES-2022 (GC decisions S/10 (x))

We describe Terms of Reference in next section 2 and continue to describe the review of activities and achievements in section 3. Finally, we will conclude in section 4.

## **2. Terms of Reference**

The following are Terms of Reference of WG39 approved in July 2020.

1. Review and consider approaches and methodologies for conducting an IEA of the CAO ecosystem;
2. Review and report on ongoing and recent changes and events in the CAO ecosystem associated with changes such as in sea ice, oceanographic circulation, and hydrographic properties;
3. Continue to examine the effects of climate change on the CAO ecosystem by compiling and reviewing information on changes in response to the ongoing 'Great melt', and assess likely consequences to the CAO ecosystem of projected future changes associated with further loss of sea ice and other climate-related changes (i.e., a climate impact assessment);
4. Assess the consequences of recent and ongoing climatic and oceanographic changes on transport pathways (physical and biological) and potential effects of

- contaminants in the CAO ecosystem;
5. Review and report on new studies on fish as well as other biological components of the CAO ecosystem;
  6. Continue to identify priority research needs and monitor how identified knowledge gaps (needed to improve IEA and management effectiveness) are being addressed and filled;
  7. Prepare an Ecosystem Overview for the CAO ecosystem.

### **3. Review of Activities and Achievements**

The first WG39 business meeting was held on September 24, 2017, at PICES-2017 in Vladivostok, Russia (<http://meetings.pices.int/publications/Annual-Reports/2017/2017-WG-39.pdf>).

The first workshop of WG39 “PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment was held on March 22-23, 2018 at Hokkaido University, Sapporo, Japan. The major objectives of the first workshop in Sapporo were as follows:

- Synthesize past activities on observation and scientific research in CAO and adjacent ocean by PICES members including China, Korea and Japan.
- Assess the contribution of PICES WG39 to the 3rd WGICA and its report
- Discuss PICES’ potential contribution to monitoring and mapping efforts of CAO in future.

This workshop was co-chaired by Sei-Ichi Saitoh (Arctic Research Center, Hokkaido University), Hyoung-Chul Shin (KOPRI: Korean Polar Research Institute), and Fujio Ohnishi (Arctic Research Center, Hokkaido University).





Figure 6. Participants of the workshop on ““PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment “ was held on March 22-23, 2018 at Hokkaido University, Sapporo, Japan.

Since then, WG39 has been promoting workshops in subsequent PICES annual meetings and held joint workshops with WG44.

- PICES-2018: W2, PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment (Second)
- PICES-2019: W7, PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment (Third)
- PICES-2020: VW4, How does the Pacific Arctic gateway affect the marine system in the Central Arctic Ocean (WG39 and WG44 joint workshop)
- PICES-2022: W2, Integrated Ecosystem Assessment (IEA) to understand the present and future of the Central Arctic Ocean (CAO) and Northern Bering and Chukchi Seas (NBS-CS) (WG39 and WG44 joint workshop)

WG39 has been published several kinds of documents, including PICES Press, ICEA Interim Report, ICES Scientific Reports, and ICES Cooperative Research Reports with WGICA.

WG39 published two PICES Press as follows:

PICES Press Summer 2018, [Vol. 26, No. 2](#)

Activities of the joint PICES/ICES/PAME Working Group on an *Integrated Ecosystem Assessment for the Central Arctic Ocean*

PICES Press Winter 2023, [Vol. 31, No. 1](#)

PICES-2022 W2, Integrated Ecosystem Assessment (IEA) to understand the present and future of the Central Arctic Ocean (CAO) and Northern Bering and Chukchi Seas (NBS-CS)

WG39 published ICES Interim Reports, ICES Scientific Reports and ICES Cooperative Research Report as follows:

2017 Interim Report of the ICES/PICES/PAME Working Group on Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (WGICA)

- [Executive Summary](#)
- [Full Report](#)

2018 Interim Report of the Working Group for Integrated Eco-system Assessment of the Central Arctic Ocean (WGICA). 24-26 April 2018. St. John's, Newfoundland, Canada.

[WGICA 2018 Interim REPORT](#). ICES CM 2018/IEASG:11. 12 pp.

2019 Meeting report of [WGICA 4th Meeting](#), Sapporo, Hokkaido, Japan, May 8–10, 2019

2019 Interim Report of the ICES/PICES/PAME Working Group for Integrated Eco-system Assessment of the Central Arctic Ocean (WGICA).

[WGICA 2019 Interim REPORT](#). 8-10 May 2019. Sapporo, Japan. ICES CM 2019/IEASG:11. 18 pp

2019 Report of the Working Group for Integrated Eco-system Assessment of the Central Arctic Ocean (WGICA).

[Output from 2019 meeting](#). VOLUME 2 | ISSUE 33

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2022. ICES/PICES/PAME Working Group on Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (WGICA; outcomes from 2021 meeting). ICES Scientific Reports. 4:6. 34 pp. <http://doi.org/10.17895/ices.pub.9766>

2022. Ecosystem assessment of the Central Arctic Ocean: Description of the ecosystem. ICES Cooperative Research Reports Vol. 355. 341 pp. <https://doi.org/10.17895/ices.pub.20191787>

#### **4. Conclusion**

The variabilities of the Arctic Ocean strongly influence the global climate via atmosphere-ocean interactions and Arctic-subarctic freshwater and heat fluxes. The changing ocean has had both local and far-reaching effects on atmospheric circulation, including intensified storms and more frequent extreme weather conditions. Recent study shows that Arctic warming plays an important role in the increase in Northeast Pacific marine heatwave days during boreal summers (Song et al., 2023). PICES should understand the impacts of Arctic changes on its marine ecosystem and biodiversity and the linkage to sub-Arctic and mid-latitude oceans and contribute the development of IEA in CAO and NBS-CS through the joint PICES/ICES cooperation.

WG39 has been considering approaches and methodologies for the IEA in the Central Arctic Ocean. In PICES, WG39 was established for supporting WGICA in 2017. Parent Committee was SB and active term of WG39 was from 2017 to 2022, 6 years. During term of WG39, we contribute to promote WGICA activities and achievements including annual meetings, workshops and publications. The highlight is the publication of IEA Report No.1 “Ecosystem assessment of the Central Arctic Ocean: Description of the ecosystem” (ICES Cooperative Research Reports Vol. 355) with 341 pages, which is very comprehensive summary on ecosystem components in CAO. WG39 members and many PICES scientists participated for writing up this article.

From late 2022, WG39 activities are continuing through SG-ARC activities.

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## 6. Appendix

### A. Central Arctic Ocean ecoregion – Ecosystem Overview (separate file)

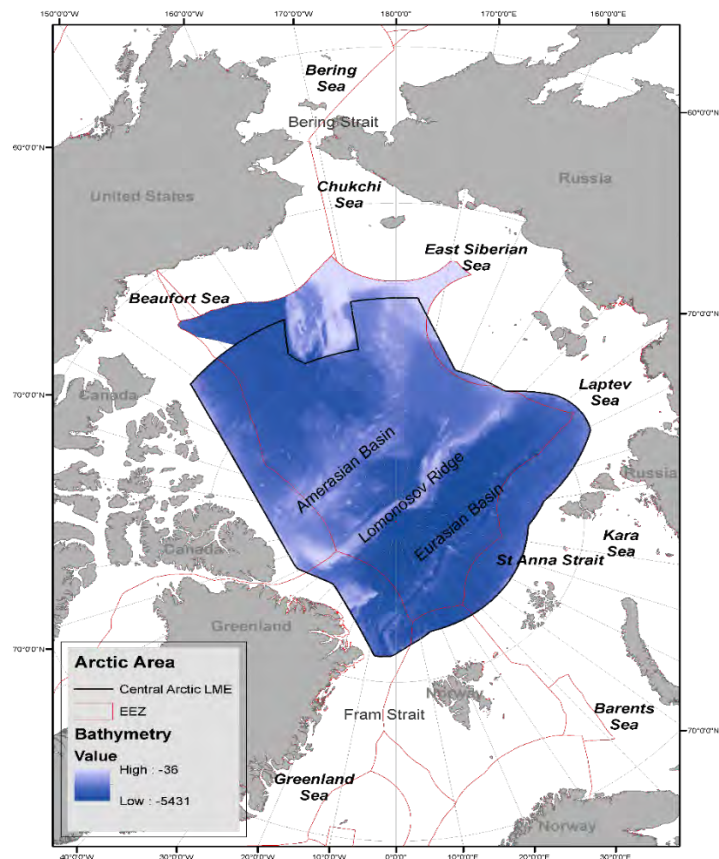
## 2.1 Central Arctic Ocean ecoregion – Ecosystem Overview

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### Ecoregion description

The Central Arctic Ocean ecoregion (Figure 1) mostly comprises high seas areas remote from any landmass, including deep basins and slopes up to depths of approximately 500 m, as well as some shallower shelf areas of the bordering Beaufort/Chukchi and East Siberian/Laptev seas. The boundary of the ecoregion follows the outer slopes on the Eurasian side from the Chukchi Sea to the Barents Sea, the shelf edge of north Greenland and the Canadian High Arctic, and runs along the 76°N parallel or the 200-mile Exclusive Economic Zones (EEZs) in the Beaufort/Chukchi seas.



**Figure 1** The Central Arctic Ocean ecoregion (in blue, with depth gradient), adjacent seas, and Exclusive Economic Zones (EEZs).

The Central Arctic Ocean ecoregion seabed consists of two large deep basins (between 3800 and 4500 m deep), the Eurasian Basin, and the Amerasian Basin, separated by the Lomonosov Ridge. This ~1300 m deep ridge consists of steep slopes rising about 3000 m above the seabed.

The Arctic Ocean is governed by the 1982 Law of the Sea Convention (UNCLOS). The areas within the EEZs and the continental shelves are under the jurisdiction of the coastal states: the Russian Federation, the United States, Canada, the Kingdom of Denmark (Greenland), and the Kingdom of Norway. There are pending claims made to the UN Continental Shelf Commission (CLCS) from coastal states regarding the outer limits of their continental shelves.

International governance of the Arctic Ocean under UNCLOS and other treaties (e.g. those concerning climate change) have been strengthened over the last decade through several regional agreements such as: the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013), the International Code for Ships Operating in Polar Waters (Polar Code; 2017), the Agreement on Enhancing International Arctic Scientific Cooperation (2017), and the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean (2018). Under the latter, the parties will not permit their vessels to engage in commercial fishing in the high seas of the ecoregion until 2037 at the earliest. This will depend on scientific assessments documenting commercial viability of resources yet to be discovered.

The Arctic states, consisting of the coastal states plus Finland, Iceland, and Sweden, carry the role of stewards of the region in the Arctic Council.

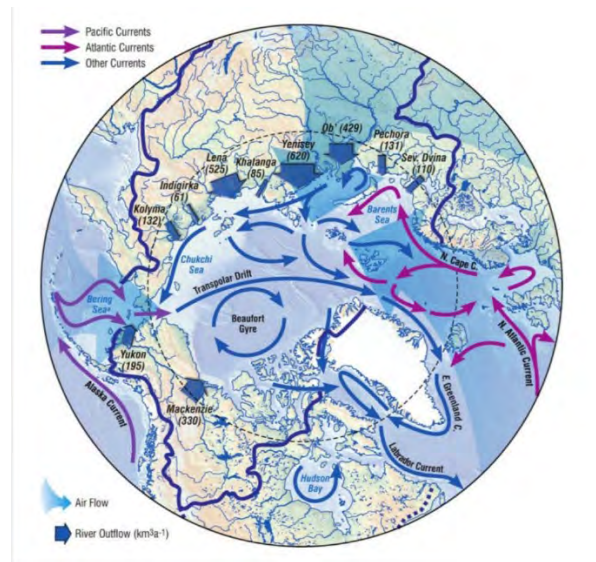
As the ecoregion is largely understudied, information from adjacent seas and nearby areas was used to inform this ecosystem overview.

### **Oceanography**

The key physical factors affecting hydrography of this ecoregion are the strong seasonal cycle, low temperatures, extensive permanent and seasonal ice cover, a large supply of freshwater from melting ice and rivers, and the input of heat and salt from adjacent oceans.

The main inflowing marine water comes through the Atlantic Gateway (via the Fram Strait and the Saint Anna Trough), and the Pacific Gateway (Bering Strait; Figure 2). The Lomonosov Ridge maintains a boundary between Atlantic and Pacific water masses. The circulation is anticyclonic within the Amerasian Basin (the Beaufort Gyre), and the Transpolar Drift from the northern border of the Russian Arctic shelf seas runs towards the Fram Strait.

The ecoregion receives about 10% of the world's freshwater discharge. The sea ice and river run-off cause a strong stratification, which is strongest in the Amerasian Basin. A major part of the suspended sediments discharged from these rivers is deposited on the seabed, forming sediment layers up to 1000 m thick.



**Figure 2** The major air and ocean currents towards and in the Arctic Ocean, as well as the dominant river inflow.

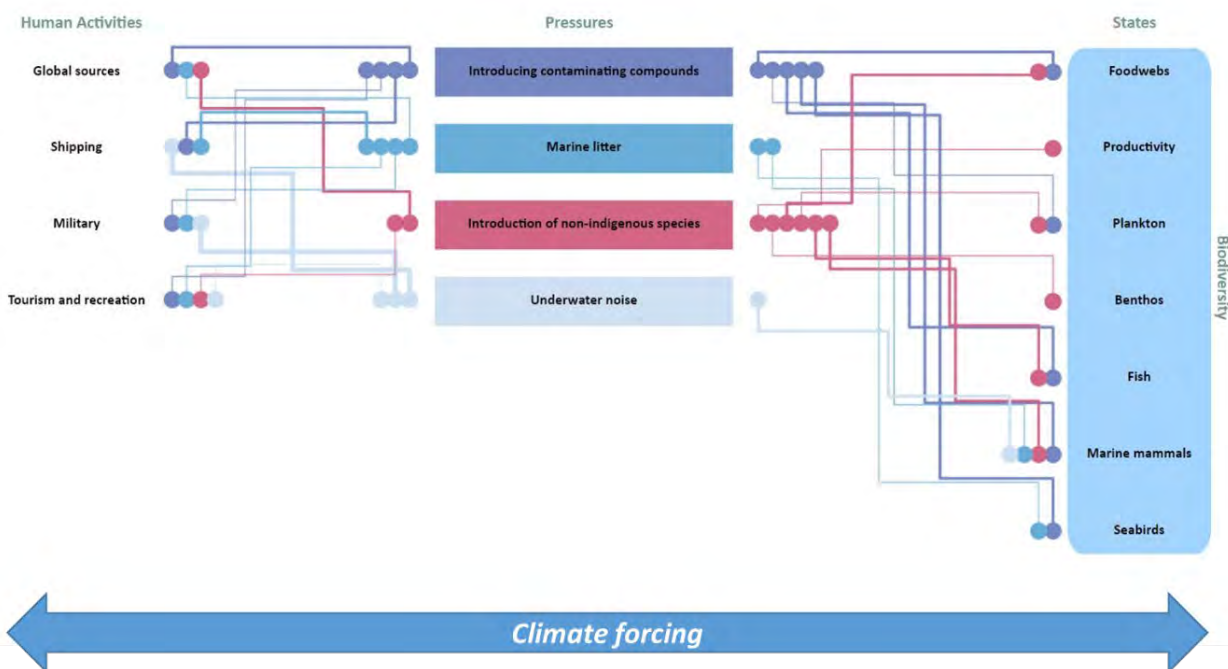
**Key signals**

- Climate change is the dominant and overarching driver in the ecoregion. Observed climate-related changes include decreases in sea ice extent and thickness, changes in salinity and freshwater content that affect water column stratification, the relative contributions/mixing of North Atlantic and North Pacific water masses in the ecoregion, and subregional increases in seawater temperature.
- The summer minimum sea ice extent decreased by a third in 2007–2020 relative to the 1979–2000 period. Old sea ice (> five years) decreased from 30% to 2% between 1979 and 2018. Mean sea ice thickness declined by 65% between 1975 and 2012.
- Receding sea ice has led to changes in both the range and abundance of species from primary producers to top predators. Examples include an increase in phytoplankton biomass, a reduction in the diversity and biomass of ice-associated algae and the expansion of the feeding migration of young ringed seals (*Pusa hispida*) into the ecoregion.
- Climate-related changes in both the ecoregion and adjacent seas are playing a key role in facilitating long-distance species exchange, population mixing, and pathogen transfer between the Pacific and Atlantic oceans.
- Ice-dependent fish and marine mammals are experiencing increased competition with boreal species for habitat and food throughout the ecoregion.
- The ecoregion has fewer human activities than other ecoregions and is a sink for contaminants and litter transported from global sources via ocean currents, rivers, and air.
- Climate change is affecting contaminant pathways and loading to the ecoregion and adjacent seas.
- Future perspective: sea ice loss is creating opportunities for the development and expansion of human activities in the ecoregion. However, the potential fish abundance is expected to remain far below levels that can sustain a viable fishery because of the low productivity of the ecoregion.

## Pressures

The Central Arctic Ocean ecoregion currently and historically has fewer human activities than other ecoregions. This is due to the ice cover, the depth of the ocean, the harsh climate and remote location, and the absence of land and human settlements.

The main human pressures affecting the ecoregion are the introduction of contaminating compounds, marine litter, the introduction of non-indigenous species and underwater noise. Some of the activities causing these are scientific icebreakers, tourism, and military shipping.



**Figure 3** Overview of the major regional pressures, human activities, and ecosystem state components for the Central Arctic Ocean. The width of lines indicates the relative importance of the main individual links. The scaled strength of the pressures should be understood as a relative strength between the human activities listed, and not as an assessment of the intensity of the pressure on the ecosystem. Due to the difference of scales, climate change is not represented as a regional pressure, but climate change affects human activities, the intensity of the pressures, and some aspects of state, as well as the links between these. As the ecoregion is largely understudied, information from adjacent seas and nearby areas was used to inform the assessment of regional human activities and associated pressures.

### Introduction of contaminating compounds

The areas in and around the ecoregion are a sink for pollutants transported from lower latitudes. Pollution is carried north by ocean currents, rivers, and atmospheric air masses. The accumulation of contaminating compounds in the deep Arctic Ocean is facilitated by the surface transport and subsequent cooling (and sinking) of warm Atlantic water into the Arctic and the wind-driven clockwise circulation in the Beaufort Gyre, which accumulates and sinks surface water down into the water column. Chemical compounds that bioaccumulate in foodwebs, such as mercury and persistent organic pollutants (POPs), are currently the main concern. High levels of mercury and polychlorinated biphenyls (PCBs) are found in seabirds and top predators in Arctic areas adjacent to the ecoregion, and these have population effects on marine mammals such as polar bears (*Ursus maritimus*). Additional pollutants of concern include flame retardants, pesticides, per- and polyfluoroalkyl substances (PFAS) are also of concern.



Pollution from local sources is increasing with a growing number of human activities. Oil spills from activities on the continental shelves may also affect ecosystem components in the ecoregion.

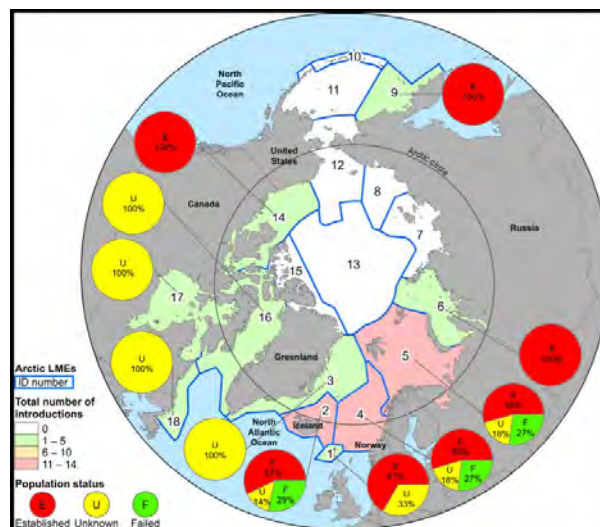
### Marine litter

Macro- and microplastic are transported by rivers, ocean currents and air masses into the ecoregion. Plastics have been found in sea ice, which may act as an important transport vector across the ocean surface and down the water column. There is evidence of the occurrence of microplastics in marine sediments in the ecoregion. Microplastics have also been reported on ice floes from the Fram Strait, snow samples from Baffin Bay, and in surface water, zooplankton, and sediment from the Canadian Arctic, providing evidence of atmospheric transport as suggested by simulations. Litter density on the seabed of the Atlantic Gateway has increased between 2002 and 2014.

Information on marine litter in the ecoregion is currently limited, but research efforts are ongoing to examine litter in the water column and sediment. In adjacent areas, plastics have been found ingested by Arctic wildlife such as seabirds and polar cod (*Boreogadus saida*), and seabirds and marine mammals were seen entangled in fisheries debris off northern Svalbard.

### Introduction of non-indigenous species (NIS)

There are currently no reports of the presence of NIS in the ecoregion, although there also has been no dedicated NIS monitoring. At least 34 NIS have been observed in adjacent Arctic marine waters (Figure 4), as well as numerous cryptogenic species (having uncertain origin due to poor baseline data in the Arctic and/or poorly studied biogeography and taxonomy of microscopic marine species). Ship biofouling and natural currents are the most likely mechanisms for the introduction of NIS to the ecoregion. Receding sea ice and warmer waters are expected to increase and facilitate both the transport and establishment of NIS in the ecoregion.



**Figure 4** Map illustrating the large marine ecosystems (LMEs) of the Arctic as defined by the Arctic Council's Protection of the Arctic Marine Environment Working Group (PAME, 2013; Chan *et al.*, 2019). ID numbers: 1 = Faroe Islands, 2 = Iceland Shelf, 3 = Greenland Sea East-Greenland, 4 = Norwegian Sea, 5 = Barents Sea, 6 = Kara Sea, 7 = Laptev Sea, 8 = East Siberian Sea, 9 = East Bering Sea, 10 = Aleutian Islands, 11 = West Bering Sea, 12 = Northern Bering Chukchi Sea, 13 = Central Arctic Ocean, 14 = Beaufort Sea, 15 = Canadian High Arctic-North Greenland, 16 = Canadian East Arctic-West Greenland, 17 = Hudson Bay, and 18 = Labrador-Newfoundland. Also shown are the total number of introduction events (n = 54) and the population status of NIS in each introduced region.

## Underwater noise

The main human sources of underwater noise in the ecoregion are ship traffic and the seismic surveys used in oil and gas exploration; these often propagate noise into the ecoregion from adjacent areas. Powerful military sonars operate in Arctic waters although their use is not publicly documented. These sonars are known to cause extensive disturbance to many species of deep-diving whale and have led to mass strandings.

Sound propagates very well in Arctic waters, and the effects (e.g. behavioural disturbance and the masking of other ecologically important sounds) of such sound can occur many hundreds of kilometres away. There has been limited measurement of the natural ambient sound in the ecoregion, but evidence from adjacent areas indicates a range of ambient noise levels – from very quiet under fast ice to naturally very noisy in areas with either very active ice or high biological activity (e.g. large numbers of calling marine mammals).

## Climate change impacts

Observed climate-related changes include decreases in sea ice extent and thickness, salinity and freshwater content affecting water column stratification, and the relative contributions/mixing of North Atlantic and North Pacific water masses in the ecoregion, as well as subregional increases in seawater temperature. These come with associated changes in the distribution and abundance of species, with implications for foodweb structure and dynamics.

A reduction in the extent and thickness of sea ice is the prevailing climate change signal in the ecoregion. Sea ice extent has dramatically diminished in the past decades, leading to an increase in the seasonal duration of open water in the ecoregion (Figure 5). The mean summer minimum of sea ice extent in 2007–2020 was much lower than in 1979–2000 ( $4.6 \pm 0.5 \times 10^6$  km<sup>2</sup> and  $6.9 \pm 0.5 \times 10^6$  km<sup>2</sup>, respectively [figures 5 and 6]). Old sea ice (> five years) decreased from 30% to 2%, while first-year ice increased from 40% to 70% between 1979 and 2018. Mean sea ice thickness declined by 65% (from 3.59 to 1.25 m) between 1975 and 2012.

Receding ice has already led to significant changes in both the range and abundance of species in and around the ecoregion, from primary producers to top predators. Primary productivity has increased in areas associated with the loss of summer sea ice. A reduction in multiyear ice and increase of first-year ice has led to a decline in sympagic algal diversity. Models suggest future increase in sympagic algal productivity because of the thinning of sea ice and enhanced light availability but also limitations by nutrients and ice as a substrate. Sea ice reduction and increasing water temperature were suggested to negatively influence polar cod recruitment in the adjacent Barents Sea. Seabirds and marine mammals that depend on sea ice for habitat and/or food are negatively affected for key processes like reproduction and rearing. The feeding migration of young ringed seals has expanded into the ecoregion over the past decades, concurrent with the sea ice retreat. As sea ice cover heavily influences ambient noise levels both directly (e.g. cracking and vibration) and indirectly (e.g. by limiting shipping activity), the rapid changes in ice conditions also have implications for ambient noise levels.

Since 2000, the stratification in the Eurasian Basin has been reduced, potentially altering nutrient fluxes and primary production. In the Amerasian basin, a stronger influx of Pacific waters has increased heat and freshwater content in the Beaufort Gyre and facilitated the expansion of Pacific species into the ecoregion. The increased seasonal duration of open water is expected to enhance primary production around the basin with subregional differences caused by changes in stratification that affect nutrient availability.

As a potential Arctic refuge, the ecoregion may experience at least short-term increases in the occurrence and abundance of both Arctic and boreal species that are capable of long-range dispersal. Some pelagic fish that occur in adjacent areas like beaked redfish (*Sebastes mentella*), Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), and Atlantic Capelin (*Mallotus villosus*) may eventually extend their summer feeding migrations into the ecoregion. Ice-dependent fish and marine mammals are experiencing increased competition from boreal species in and around the ecoregion. There is evidence of the occurrence of unusually large abundances of Atlantic cod (*Gadus morhua*) and other boreal species in the adjacent area (the Atlantic Gateway), which has likely contributed to the decline of polar cod and other Arctic fish species. The long-term

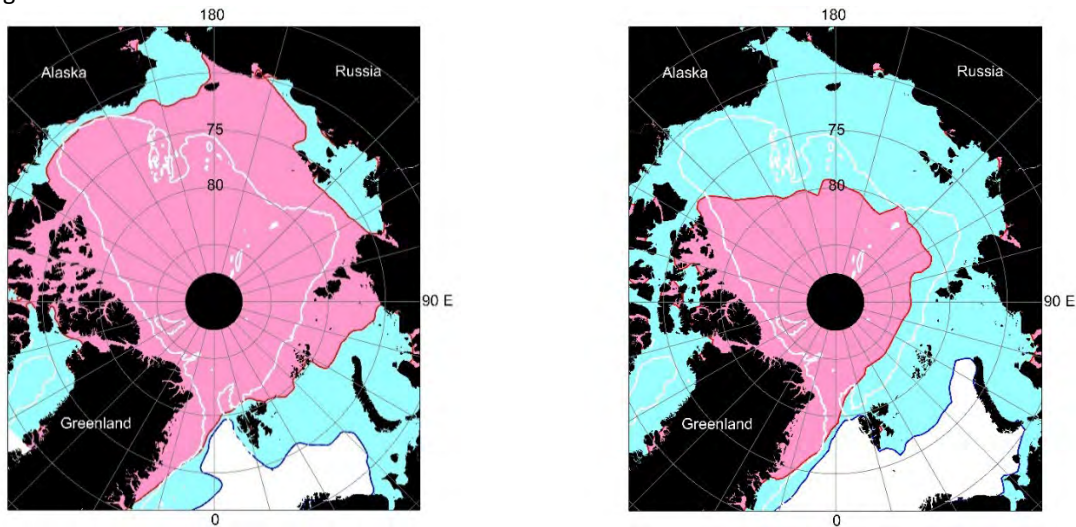
success of species' northward migration strategy will depend on the continued availability of key habitat, nutrients, and prey. For example, the distribution, behaviour, and fitness of sympagic species, such as the ivory gull (*Pagophila eburnea*), are strongly affected by declines in sea ice and associated prey. Bioenergetic modelling suggests that 24 Arctic-breeding seabird species may shift to year-round High Arctic residency.

Increasing freshwater input also leads to the enhanced delivery of terrestrial materials – including carbon, hazardous chemicals, methane, viruses, and bacteria – into the Arctic seas. Permafrost thaw is an important, warming-induced pathway for contaminants such as POPs and mercury into the Arctic Ocean.

Climate change is creating opportunities for the development and expansion of various human activities in the ecoregion. Ship traffic is currently very limited and largely restricted to scientific expeditions and icebreaker activities. In peripheral waters on the Russian side of the ecoregion and the Pacific gateway, however, ship traffic is increasing due to liquid natural gas (LNG<sup>1</sup>) and crude oil transport, as well as trans-Arctic cargo shipping along the Northern Sea Route (NSR). Geoengineering surveys also occur in the adjacent Kara Sea. Increasing shipping will increase underwater noise and marine litter, as well as the risk of the accidental release of hazardous materials and the introduction of NIS.

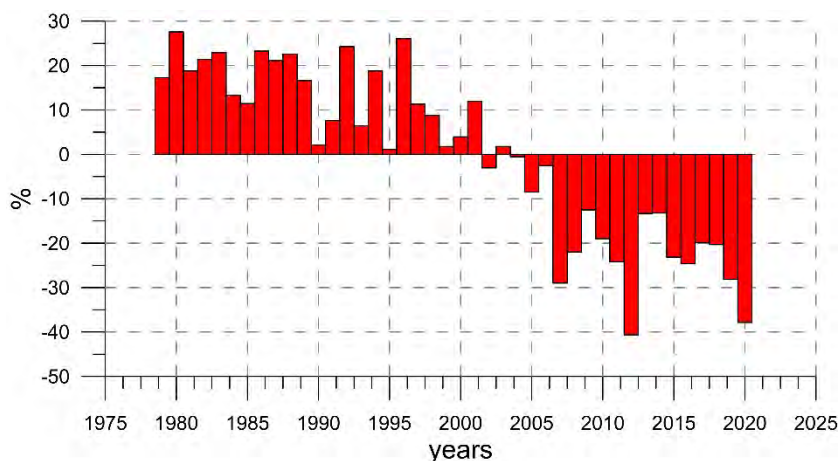
At present, there are no indications that commercially exploitable fishery resources exist in the ecoregion. With receding ice, exploratory fishing is expected to occur in accessible slope and shelf waters inside the EEZs of the coastal states.

To date, ocean mining interests have primarily focused on areas outside the ecoregion, but may expand further into the Arctic. Similarly, oil extraction is ongoing in adjacent seas, and interest exists for oil exploration in many of the shelf areas surrounding the ecoregion.



**Figure 5** Sea ice extent (the border of 15% ice concentration) in the Arctic Ocean in 1979–2000 (left panel), and in 2012 (right panel). The pink area corresponds to the seasonal minimum in September. The blue area corresponds to the seasonal maximum in March. The white line denotes an isobath of 1000 m, which may be considered a rough approximation of the border of the Central Arctic Ocean.

<sup>1</sup> "Liquid natural gas" is originally extracted as a natural gas (CH<sub>4</sub>), processed into liquid form by the Yamal LNG Factory (Novatek) in Yamal Peninsula, and transported by liquid natural gas tankers.



**Figure 6** Anomaly of the minimum distribution of the Arctic sea ice extent (the border of ice concentration less than 15%) in September (%) relative to the average for the period of satellite observations (1979–2020).

## State of the ecosystem

### Habitats (substratum) and foodwebs

Sea ice is a key habitat feature of the ecoregion. Sea ice coverage and associated ice algal production is a determinant of foodweb structure and functioning in the Central Arctic Ocean. There are ongoing disruptive changes in ice-associated habitats and their biogeochemical processes, with increased productivity on the shelves supporting the growth of pelagic zooplankton species over sympagic invertebrates and a mismatch between primary producers and consumers in the basins affecting trophic and passive carbon flux. These changes are anticipated to have negative impacts for sympagic species and biodiversity.

Benthic habitats are diverse and include extensive abyssal plains, shallower shelf areas, soft sediments, and glacial drop stones as well as seamounts, ridges, and active vent fields. Limited time-series information is available to assess the status of benthic habitats in the ecoregion. Most are generally unaffected by local human activity but may serve as a sink for pollution from global sources.

### Primary productivity

The ecoregion is an oligotrophic system with a strong seasonal variation in primary production. The average total annual primary production of the ecoregion basins is low, about  $13 \text{ gC m}^{-2} \text{ y}^{-1}$ , with the sympagic algae accounting for about half of this production. The nutrient rich shelves have higher productivity ( $> 70 \text{ gC m}^{-2} \text{ y}^{-1}$ ). Primary productivity has increased with the loss of summer sea ice.

The phytoplankton seasonal succession is characterized by first blooms of sympagic diatoms, followed by pelagic diatoms in the areas of the retreating ice edges, and thereafter other flagellates. The phytoplankton dynamics over the last decades can be characterized as more frequent autumn blooms, earlier spring blooms and enhanced under-ice blooms.

### Zooplankton

The zooplankton community of the ecoregion is diverse and contains epi- and mesopelagic communities from both Atlantic and Pacific waters. The greatest number of zooplankton species is found in the deep zones. Smaller copepods (such as *Oithona similis*, *Triconia borealis*, and *Microcalanus* spp.) dominate the epipelagic mesozooplankton in abundance, whereas larger Calanus species (*C. hyperboreus*, *C. glacialis*, and *C. finmarchicus*) account for most of the biomass.

Sympagic crustaceans (mainly ice amphipods) and meiofauna living inside sea ice brine channels largely depend on organic carbon synthesized by sea ice protists. Because of the reduction in sea ice thickness and extent, sea-ice algae (diatoms) have declined as well as the organisms that depend on them for energy.

The core distribution patterns of *C. glacialis* and *C. finmarchicus* are shifting northwards with retreating sea ice and changing climatic conditions. With less sea ice, zooplankton may ascend earlier to surface waters to match earlier algal blooms, with extended pelagic production anticipated to favour all *Calanus* species.

### **Benthic invertebrates**

The benthic invertebrate fauna of the ecoregion reflects the diversity of benthic habitats. It includes: sponges and the associated benthic biota of seamounts, ridge fauna (including chemoautotrophs), fauna associated with glacial drop stones, hyperbenthic and abysso-pelagic taxa associated with the thin benthic boundary layer, benthic invertebrate biota associated with the overlying marginal ice zone, and meio- and macro-benthos in soft sediments. A 2011 benthic species inventory from various data sources for the central Arctic (existing at depths of greater than 500 m) identified more than 1125 taxa. The inventory was dominated by arthropods (366 taxa), foraminiferans (197), annelids (194), and nematodes (140).

The benthic community structure differs among the upper and lower slope, the basin, and the adjacent shelf seas. Observations in the Chukchi Borderland indicate a decrease in taxon richness, biomass, and density of epifauna with increasing depth.

Status and trends of benthic communities are generally lacking within the ecoregion.

### **Fish**

Knowledge about the fish community and the existence of harvestable fish stocks in the ecoregion is very limited. Small gadoids (mainly sympagic polar cod [*Boreogadus saida*] and Arctic endemic ice cod [*Arctogadus glacialis*]) are found associated with ice habitats within the ecoregion, with fourteen other fish species living in and on muddy bottoms such as snailfishes (*Liparidae*) eelpouts (Zoarcidae)

An over 3100-kilometre-long uninterrupted acoustic layer at 100–500 m depth with Atlantic water hosted low abundances of Atlantic cod (*Gadus morhua*), along with lanternfish (Myctophidae), armhook squid (*Gonatus fabricii*), and Arctic endemic ice cod. In contrast to armhook squid, there is no evidence of a spawning population of Atlantic cod in the ecoregion. The Atlantic cod originated from Norwegian spawning grounds, with two potential migration pathways into the ecoregion, through: (i) the Barents Sea, and (ii) warmer waters west of Svalbard.

Some Atlantic predatory fish species, such as haddock (*Melanogrammus aeglefinus*), beaked redfish (*Sebastes mentella*), and Greenland halibut (*Reinhardtius hippoglossoides*) were found in close proximity of the border of the ecoregion, and they may enter the ecoregion. These species originate from spawning grounds outside the ecoregion and therefore the probability to establish themselves in the ecoregion depends on many factors (environmental conditions, food availability, and possibilities for successful reproduction) that at present are still unexplored.

Maximum possible fish abundance and biomass in the acoustic layer was very low with the calculated values of around 2000 individuals/km<sup>2</sup> and biomass around 50 kg/km<sup>2</sup>. The potential fish abundance is far below levels that can sustain a viable fishery and is expected to remain so in coming decades because of the low productivity of the ecoregion. The potential future increase in productivity is expected to remain low in the Central Arctic Ocean due to stratification-induced nutrient limitation.

### **Seabirds**

Seabird abundance is extremely low in the ecoregion and mainly consists of migratory species, although large numbers of seabirds occur in adjacent shelf regions. At least 30 species of seabirds have been recorded in the ecoregion, with two species being in their natural summer habitat (ivory gull and Ross' gull [*Rhodostethia rosea*]). Six other species commonly occur, though

in low numbers, along the ice edge (northern fulmar [*Fulmarus glacialis*], black-legged kittiwake [*Rissa tridactyla*], glaucous gull [*Larus hyperboreus*], Arctic skua [*Stercorarius parasiticus*], dovekie [*Alle alle*], and black guillemot [*Cephus grylle*]). These eight species include surface foragers and divers, which are primarily piscivores. Birds from breeding colonies in adjacent areas do not generally forage into the ecoregion, with the possible exception of ivory gulls.

There are strong signals that some Pacific seabirds are shifting their distribution northward, remaining longer along the ecoregion slope regions during summer and changing their migration patterns.

### Marine mammals

During periods of year-round ice coverage, observations of marine mammals in the Central Arctic Ocean ecoregion have been limited to very low numbers of ringed seals and polar bears. Recent retreats of the sea ice have been accompanied by increased observations of several ice-dependent species including polar bears, narwhals (*Monodon monoceros*), ringed seals, and hooded seals (*Cystophora cristata*). Very few dedicated abundance surveys of marine mammals have been conducted in this area and precise trend information therefore does not exist.

A 2015 marine mammal survey north of Svalbard showed that most polar bears in this area are now foraging on the southern border of the Eurasian Basin. Few seals were observed, but subsequent assessments of the bears' nutritional status suggest that a suitable prey base has been available over the last years. A rather large concentration of narwhals was also documented in this area for the first time.

Gateways and shelf areas adjacent to the ecoregion are documented feeding areas for all eleven ice-dependent Arctic marine mammal species (walrus (*Odobenus rosmarus*), bearded seals [*Erignathus barbatus*], ringed seals, harp seals [*Pagophilus groenlandicus*], hooded seals, ribbon seals [*Histiophoca fasciata*], spotted seals [*Phoca largha*], beluga whales [*Delphinapterus leucas*], narwhals, bowhead whales [*Balaena mysticetus*] and polar bears). In addition, other species like grey whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), minke whales (*Balaenoptera acutorostrata*), and killer whales (*Orcinus orca*) are increasingly observed in the border areas of the ecoregion during summer. Of these, grey whales have been considered endemic to the Pacific since the 18th century when the Atlantic grey whale population went extinct. Over the past decade, however, at least three grey whales are known to have entered the Atlantic Ocean, most likely via the shelf and slope areas bordering the ecoregion. This illustrates the increased potential for long distance species exchange, population mixing, and pathogen transfer between Arctic marine mammal communities due to reduced ice cover in the ecoregion.

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The maps and figures in this document are produced as follows:

Figure 1: Produced by ICES Secretariat, Data used stems from:

- Exclusive Economic Zones. Marineregions.org (VLIZ).
- Depth contours. General Bathymetric Chart of the Oceans (GEBCO).
- Ecoregions. International Council for the Exploration of the Sea (ICES).

- Ports. Norwegian Institute of Marine Research (IMR).
- ICES areas. International Council for the Exploration of the Sea (ICES).

Figure 2: Reproduced, with permission, from Prowse *et al.*, [2009]; © The Royal Swedish Academy of Sciences.

Figure 3: Produced by ICES Secretariat.

Figure 4: Reproduced, with permission, from Chan *et al.*, [2019].

Figure 5: Based on data from Cavalieri *et al.*, [1996], updated yearly.

Figure 6: Based on data from <https://nsidc.org>.

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## **Appendix 7**

### **SG-ARC Final Report**

**Final Report of  
Study Group on the Arctic Ocean and the Pacific Gateways  
(SG-ARC)**

**April, 2024**

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## **1 Introduction**

### **1.1 Background**

The target Large Marine Ecosystems (LMEs) of WG39 and WG44 are the geographically and dynamically connected Central Arctic Ocean (CAO) and the Northern Bering Sea-Chukchi Sea (NBS-CS) (Figure 1). The CAO is in rapid transition, driven by North Pacific environmental changes in significant part, and has become accessible to a range of commercial activities. Rapid loss of sea ice cover has opened up the CAO for potential fishing opportunities. In this context, the agreement to Prevent Unregulated High Seas Fisheries in the CAO has been signed and entered into force, which will necessitate joint research and monitoring. The NBS-CS is also experiencing unprecedented warming and loss of sea ice as a result of climate change. Declines of seasonal sea ice and rising temperatures have been more prominent in the northern Bering and Chukchi seas as in most portions of the Arctic. Chronic and sudden changes in climate conditions in this Arctic gateway are clearly reshaping the system and its food-webs, and enlarging opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts. A coordinated integrated ecosystem assessment (IEA) of the CAO and NBS-CS thus is a useful and pertinent approach in this circumstance, especially given the substantial science and policy challenges emerging in the Arctic.

### **1.2 Past and current Status**

#### **1.2.1 WGICA**

The Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean (WGICA) was established jointly by ICES and PAME in 2016. The goal of this working group is to conduct an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO), a needed step to provide scientific advice on issues such as the prospect for future fisheries in the Arctic Ocean and sensitivity and vulnerability of marine ecosystems in relation to human activities (including shipping, fisheries, tourism). WGICA links human activities, pressures and ecosystem vulnerability into a semi-quantitative risk analysis by assessing the spatial and temporal overlap using best available data. The first WGICA meeting was held in May 24-26, 2016, at the ICES headquarters in Copenhagen, Denmark. PICES joined WGICA in 2017 and WGICA became the Joint ICES/PICES/PAME working group for the CAO IEA. WGICA published comprehensive IEA Report No. 1 (Skjoldal, 2022) with IEA Report No. 2 underway.



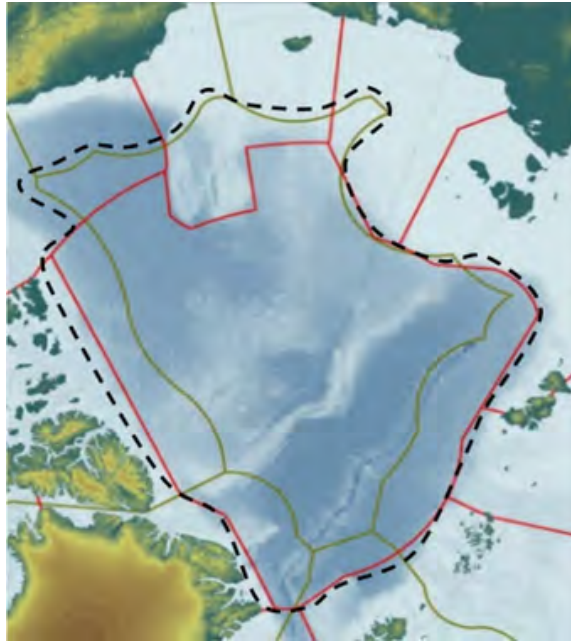


Figure 1. The Central Arctic Ocean study area (black broken line; CAO) with the Large Marine Ecosystems (red lines) as defined by PAME (Protection of the Arctic Marine Environment), one of the working groups in the Arctic Council, the borders of the five National Economic Zones (green), and the High Seas being the center area outside the 200 nautical miles of the five bordering nations.

### 1.2.2 PICES WG39

At PICES-2016, the ICES President requested that PICES join the existing Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean (WGICA), established jointly by ICES and PAME in 2016. This request was approved by Governing Council (Decision 2016/6/5). PICES joined as a co-sponsor of the group in 2017, making WGICA an ICES/PICES/PAME Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean.

WG39 will consider approaches and methodologies for the IEA in the Central Arctic Ocean. In PICES, WG39 was established for supporting WGICA in 2017.

Parent Committee: SB

Term: PICES-2016 – PICES-2022

Extended

at PICES-2018 until PICES-2021 (GC decisions S/4 (vii))

at PICES-2021 until PICES-2022 (GC decisions S/10 (x))

The following are Terms of Reference of WG39 approved in July 2020.

1. Review and consider approaches and methodologies for conducting an IEA of the CAO ecosystem;
2. Review and report on ongoing and recent changes and events in the CAO ecosystem associated with changes such as in sea ice, oceanographic circulation, and hydrographic properties;
3. Continue to examine the effects of climate change on the CAO ecosystem by compiling and reviewing information on changes in response to the ongoing 'Great melt', and assess likely consequences to the CAO ecosystem of projected future changes associated with further loss of sea ice and other climate-related changes (i.e., a climate impact assessment);
4. Assess the consequences of recent and ongoing climatic and oceanographic changes on transport pathways (physical and biological) and potential effects of contaminants in the CAO ecosystem;
5. Review and report on new studies on fish as well as other biological components of the CAO ecosystem;
6. Continue to identify priority research needs and monitor how identified knowledge gaps (needed to improve IEA and management effectiveness) are being addressed and filled;
7. Prepare an Ecosystem Overview for the CAO ecosystem.

The first WG39 business meeting was held on September 24, 2017, at PICES-2017 in Vladivostok, Russia (<http://meetings.pices.int/publications/Annual-Reports/2017/2017-WG-39.pdf>).

The first workshop of WG39 "PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment" was held on March 22-23, 2018 at Hokkaido University, Sapporo, Japan. Since then, WG39 has been promoting workshops in subsequent PICES annual meetings:

- PICES-2018: W2, PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment (Second)
- PICES-2019: W7, PICES contribution to Central Arctic Ocean (CAO) ecosystem assessment (Third)
- PICES-2020: VW4, How does the Pacific Arctic gateway affect the marine system in the Central Arctic Ocean (WG39 and WG44 joint workshop)
- PICES-2022: W2, Integrated Ecosystem Assessment (IEA) to understand the present and future of the Central Arctic Ocean (CAO) and Northern Bering and

## Chukchi Seas (NBS-CS) (WG39 and WG44 joint workshop)

### 1.2.3 PICES WG44

#### Background and Purpose

The Northern Bering Sea-Chukchi Sea (NBS-CS) region is experiencing unprecedented ocean warming and loss of sea ice as a result of climate change. Seasonal sea ice declines and warming temperatures have been more prominent in the northern Bering and Chukchi seas as almost all other portions of the Arctic. Chronic and sudden changes in climate conditions in this Arctic gateway are increasingly impacting marine species and food-webs and expanding opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts. There are strong concerns about the impacts of climate change and industrial activities, and these impacts may be particularly pronounced in Arctic indigenous communities dependent on the health and stability of the ecosystem. The combination of unprecedented, rapid change and increased interest in the Arctic in general and the NBS-CS specifically make this an opportune time for a synthesis of issues and knowledge. An Integrated Ecosystem Assessment (IEA) can accomplish this synthesis.

Reporting to: FIS, HD

Term: Nov. 2019- Nov. 2023

#### Year 1 Deliverables:

- Inventory of metadata, knowledge, institutions and programs relevant to the Northern Bering Sea-Chukchi Sea LME. (accomplished)

#### Final Deliverables:

- Ecosystem description from both Indigenous world views and science (shared conceptual models), indicators and hypotheses. PICES Report and/or Journal article. Knowledge Gap and Next Steps Report. PICES Report and/or Journal article.

#### Current status (as of PICES 2022)

Approach and methodology: We developed three conceptual models with a team of interdisciplinary and multi-national scientists and Indigenous representatives from the Northern Bering and Arctic region. The models themselves were created using Mental Modeler

software. Initial models were reviewed and refined over the course of several months. One important finding was the diverse ways of experiencing, thinking and talking about the marine ecosystem as informed by disciplinary training, worldview, and engagement over time. It was a challenge to include these multiple perspectives in a western science model that tends toward linearity and categorization. Indigenous worldviews may take more holistic and relational approaches to ecosystem elements, making it a challenge to “box” entire concepts or domains as separate from others. In an attempt to bridge (and include) multiple perspectives, working group members offered qualitative descriptions to enhance the conceptual models and provide greater context.

The model results will be released in a PICES Report. Our next steps are to finish our IEA scoping document and finalize IEA goals by spring 2023. We are also planning on identifying indigenous partners this coming fall and winter.

Indigenous Knowledge provides valuable information that reflects deeply meaningful Indigenous worldviews to accommodate and respond to environmental changes. Resource policies, however, often develop outside of this realm of knowledge, instead, primarily relying on Western science. In an effort to better understand the complexities (cultural, linguistic, and institution) of Bering Sea coastal communities, the team developed an institutional model that identified linkages across spatial and governance levels. This model depicted the unweighted local, national, and global connections of individual communities in the area of study, indicating the complex connectivity of highly rural coastal communities. Indigenous knowledge sharing. “Multiple Ways of Knowing the Bering Sea-Chukchi Sea Ecosystem” workshop. Workshop organizers have transcribed the 2022 workshop notes and summarizing the ideas for bridging multiple knowledge systems into our IEA process. Including multiple knowledge systems in IEAs offers a longitudinal perspective across generations of ecological observations, and supports community resilience through information sharing, relationship building, and informed decision-making. The workshop included discussions about the vital importance of relationship building and co-production of knowledge methods in IEAs. Several points were emphasized including: the need to develop a shared language through co-production approaches. By first defining terms and confirming mutual understanding of concepts, it is then possible to build on those ideas that is inclusive of Indigenous worldviews in meaningful ways. A final report was distributed to the team.

Milestones: Shared report from first workshop. Distributed information in digital and hardcopy format. A manuscript is in development to submit for peer review.

We are in the process of organizing a larger workshop in 2023 in Seattle, WA at the PICES Annual meeting (October 20-21, 2023). Working in partnership with the Ocean Decade Collaborative Centre, we have invited 29 Indigenous Knowledge holders, issue experts, and practitioners to share information about bridging multiple knowledge systems in marine ecosystem assessments. The workshop is designed to provide an invited space for Indigenous knowledge holders to share information and experiences with the North Pacific marine environment. The second day will open to all PICES members for presentations to identify lessons learned across multiple regions. Deliverables include a final report and a North Pacific and Arctic marine ecosystem knowledge network.

#### **1.2.4 WGIEANBS-CS**

WGIEANBS-CS is ICES/PICES joint working group and the members and activities are fully same as WG44.

#### **1.2.5 PICES SG-ARC**

PICES took upon responsibilities concerning the CAO issues when it joined the WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)) by establishing WG39 in 2017. In 2019, PICES also established WG44 (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) in efforts to understand the Arctic system and its impacts to the sub-Arctic and mid-latitude North Pacific. An integrated ecosystem assessment (IEA) is a useful approach that is shared by these two Working Groups, particularly relevant with substantial science and policy needs emerging for the sustainable Arctic. This renders a coordinated IEA of the CAO and NBS-CS as a priority task. In addition, it is of particular significance to developing future approaches for The United Nations Decade of Ocean Science for Sustainable Development in the Arctic Ocean (UNDOS-Arctic), where science for resilience and sustainability is more important than anywhere else in the world oceans. Despite this continuing significance and unfinished commitment to WGICA and also WGIEANBS-CS, WG 39 ended the term with the closure of PICES 2022 Annual Meeting and WG 44 will end the term with the closure of PICES 2023 Annual Meeting. In this context, PICES established Study Group on the Arctic Ocean and the Pacific Gateways (SG-ARC) to coordinate and integrate PICES scientific activities on the Arctic issues and to further advance the understanding of the

Arctic system and linkages and impacts to the North Pacific.

### **1.3 Impacts of Arctic changes on its marine ecosystem and biodiversity and the linkage to mid-latitude oceans**

Ecological monitoring of the Pacific Arctic conducted over the past ten years has shed light on the impacts of recent warming and reduced sea-ice conditions to Arctic marine ecosystems. In the period of 1974-2014, the date of sea ice retreat has occurred earlier in the year at a rate approximately -0.7 d/yr (Serreze et al., 2016). The years 2017-2019 were anomalously warm in the Northern Bering and Chukchi seas and further characterized by substantial winter sea ice loss (Huntington et al., 2020). Additional physical changes in the Pacific Arctic include increased transport of Pacific water through the Bering Strait increased storm activity in the High Arctic (prefaced by Moore and Stabeno 2015). These physical conditions underlie many ecological impacts that span the entire range of the Arctic ecosystem from phytoplankton and marine bacteria to marine mammals and ultimately impact Arctic native communities that rely on the marine ecosystem for sustenance and cultural value (Moore et al. 2018).

Warming ocean temperatures, reduced ice extent, and increased poleward advection of warmer Pacific water to the Chukchi Sea had modified the marine environment and food resources to resemble those of subarctic marine ecosystems. Goldstein et al. (2023) concluded that the combination of those aspects led to poleward shifts in the distributions of large-bodied (i.e., energy-rich) copepods in the *Calanus* genus and Arctic cod (*Boreogadus saida*) on the Chukchi Shelf with the dominance of subarctic water associated with reduced isotropic niche for forage fishes. The anomalously warm 2017-2019 period also affected the distribution of seabirds in the area (Kuletz et al., 2020), namely a decrease in piscivorous seabirds like murre (i.e., *Uria* spp.; Romano et al., 2020), an increase in planktivorous *Aethia* auklets, and a northern shift for short-tailed shearwaters (*Ardenna tenuirostris*). Benthic macroinvertebrates are a major component of the Chukchi marine ecosystem and while benthic thermal habitats are projected to increase for some benthic taxa (e.g., basketstars), the loss of cold thermal habitats affects the majority of the epibenthic biodiversity present in the Chukchi Sea (Logerwell et al., 2022). However, the expansion or contraction of the spatial distributions of these benthic taxa will depend on how well they can acclimatize to continued long-term warming in the Arctic region.

These changes in the environmental conditions also favor the expansion of boreal marine taxa into a warmer Arctic Ocean. The more striking of these distributional

expansions has been for gadids, e.g., walleye pollock, saffron cod, and Pacific cod (Wildes et al., 2022; Cooper et al., 2023; Maznikova et al., 2023). The expansion of large populations of adult pollock into the Western Chukchi Sea (Datsky et al., 2022; Emelin et al., 2022) led to recommendations to the development of a Chukchi Sea Russian pollock fishery in the early 2020s. The success of these subarctic fish populations expanding their ranges into the Arctic Ocean and posing potential competitive pressure to Arctic fish populations, i.e., Arctic cod, will depend on future thermal and advective conditions, successful adaptation, and continued poleward immigration.

Sea ice is an important physical component of many of the life histories of marine mammals. Pacific walrus (*Odobenus rosmarus divergens*) use ice floes to rest in between foraging trips as well as rear their young and molt. During a period of low ice cover in the Chukchi Sea (2008-2011), walruses were observed using more coastal and nearshore areas to forage for benthic invertebrates in lieu of more offshore areas occupied in past periods of higher ice cover (Jay et al., 2012). Polar bears (*Ursus maritimus*) which use both sea ice and land in their life history, utilized land for summering and denning for longer periods when substantial sea ice loss occurred (Rode, 2015). The end of the breeding season for bearded seals (*Erignathus barbatus*) is tied with the sea ice retreat, thus earlier sea ice retreat could alter breeding phenology (Crance et al., 2022). The increase in the number of open water days in the Chukchi and Beaufort seas may also potentially expand the usually Bering Sea-constrained wintering grounds and affect the distribution of summer foraging of bowhead whales (*Balaena mysticetus*). The concurrent expansion in the potential range of killer whales (*Orchinus orca*) into the Arctic Ocean introduces potential changes in the predation of fish and marine mammals (Clarke et al. 2013; Filatova et al. 2019).

#### **1.4 Human activities and Pressures in the Arctic Ocean**

Considerable progress has been made to document the levels of human activities and the human induced pressures on the central Arctic Ocean ecoregion. It is important to note at the outset that the focus is limited to the Central Arctic Ocean (CAO) and not the bordering Exclusive Economic Zones in the Arctic. This geographic distinction can create some difficulties accounting for activities and pressures that overlap given that human activities within coastal communities in the region tend to stay within the EEZ. It is important to note however, that the effects of human activities within the CAO may extend well beyond. Work, so far, has generally taken a more inclusive approach rather than an exclusive approach in terms of characterizing activities

and pressures. Still, it is useful to point out that historically, the Central Arctic Ocean has had less direct activity and thereby pressures than continental shelf areas which tend to become ice free and thus are more accessible to ship borne activity, have more fish and wildlife, coastal ports and other economic activity, etc.

The human activities on which there has been significant focus are nearly all vessel-based and surface oriented, i.e., transport, tourism, research, and military although research and military activities may have subsurface extensions. Indigenous communities across the region have observed increasing direct human activities offshore, as well as the resulting effects of those activities.

Fisheries are not a current activity. In 2021, Arctic nations agreed to a 16 year moratorium on fishing in the CAO until research demonstrates that sufficient resources to support a commercial fishery exist and can be sustained. That moratorium is set to end in 2037. Most human activities have increased in the CAO in recent years enabled by climate change and decreasing ice cover, but also motivated by a desire to study the rapidly changing Arctic and to take advantage of economic development. Most human activity in the CAO is seasonal with summer accessibility (limited to ice free summer months) Winter months with substantial sea ice cover have not been accessible historically; however technological advances in vessel design, shifts in political will, and warmer winters with less ice coverage continue to drive increases in marine traffic in the CAO. Since 1996, marine traffic in the Arctic has increased by 300% and continues to increase. Research vessels is the one activity on the rise during the winter season to better understand year-round ecosystem changes.

The scale and intensity of human activities is comparatively low given the large area of the CAO and the cost of operations in the high Arctic. Shipping mostly follows the Northern Sea Route with less following the Northwest Passage Route outside of the CAO. A modest amount of curiosity-driven tourism attracts tourists to the North Pole and ice camping. The extreme depths and other operational difficulties so far preclude mineral and oil and gas exploration and development. Such activities are carried out in a few areas on the Continental shelves.

Human generated pressures on the CAO result from both external, and to a limited extent, internal processes. Ship noise is recognized as a new element in the CAO ecosystem, albeit minor at present. Marine debris and plastics, and the settling of air and water borne contaminants in ocean and atmospheric circulation is mostly from external sources. Of recent note is the CAO as an area where water borne plastics collect and there is growing concern about invasive species entering the CAO ecosystem.



Further, because some of the seabird and marine mammal species migrate through the CAO, it is recognized that such species may be affected by human activities and pressures to an unknown degree. Indigenous communities in the Arctic are highly dependent on living marine resources in the CAO. As such, these communities will bear the brunt of any human activity driven impacts, leading to concerns over inequitable distribution of impacts on vulnerable communities.

A major focus of work in the WGICA is gaining an understanding of the structure and functioning of the CAO, an area that is little understood, with enormous gaps in observational data and with very difficult conditions for performing scientific research. Work of WGICA that is underway has sought preliminary ways to characterize the level of risk and our collective confidence in knowledge about by human activities and pressures as a way to better understand the vulnerability of the CAO to them. There is currently a joint author paper under construction for peer review that documents progress being made.

## **2. SG and the need for a new EG**

The Study Group on the Arctic Ocean and the Pacific Gateways (SG-ARC) was formed to help PICES better prepare for the new emerging issues in the Central Arctic Ocean and Pacific gateways. Until recently, two relevant working groups have been in operation and in cooperation within PICES, namely WG 39 and WG 44. These two groups share a range of research themes in areas closely connected geographically as well as in an ecosystem context. As mentioned above, joint WG 39/WG 44 workshops were held at the PICES Annual Meeting in 2020 and 2022. This SG-ARC is expected to continue until the WG 44 completes its mission, after which we have proposed to transition the SG into an Expert Group (EG) subject to the decision of PICES.

As mentioned in section 1.2.5, despite this continuing significance and unfinished commitment to WGICA and also WGIEANBS-CS, WG 39 ended the term with the closure of PICES 2022 Annual Meeting and WG 44 will end the term with the closure of PICES 2023 Annual Meeting. PICES need a new EG to serve as the liaison between WGICA and WGIEANBS-CS ICES/PICES joint activities after the conclusion of both WG 39 and WG 44. Time line of each WG/EG are summarized in Figure 2. PICES needs to understand the impacts of Arctic changes on its marine ecosystem and biodiversity and the linkage to sub-Arctic and mid-latitude oceans (PICES target waters) and the new EG could compile and digest more comprehensive scientific information on this subject including monitoring activities in the Arctic Ocean and the Pacific gateways in collaboration with

other international initiatives, e.g., MOSAiC, SAS, UNDOS-Arctic, CAOFS, ESSAS etc. (Figure 3).

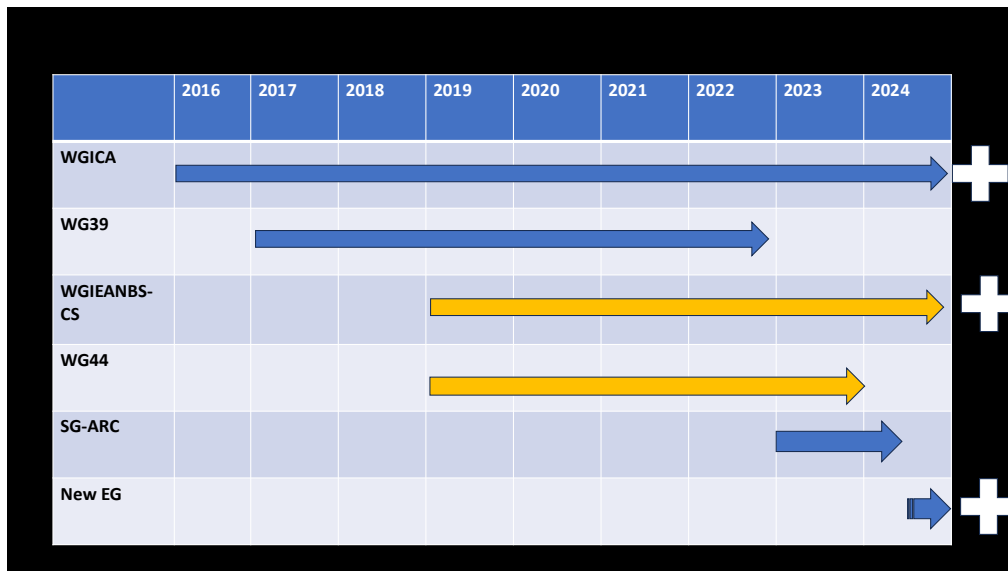


Figure 2. Time line of WG/EG

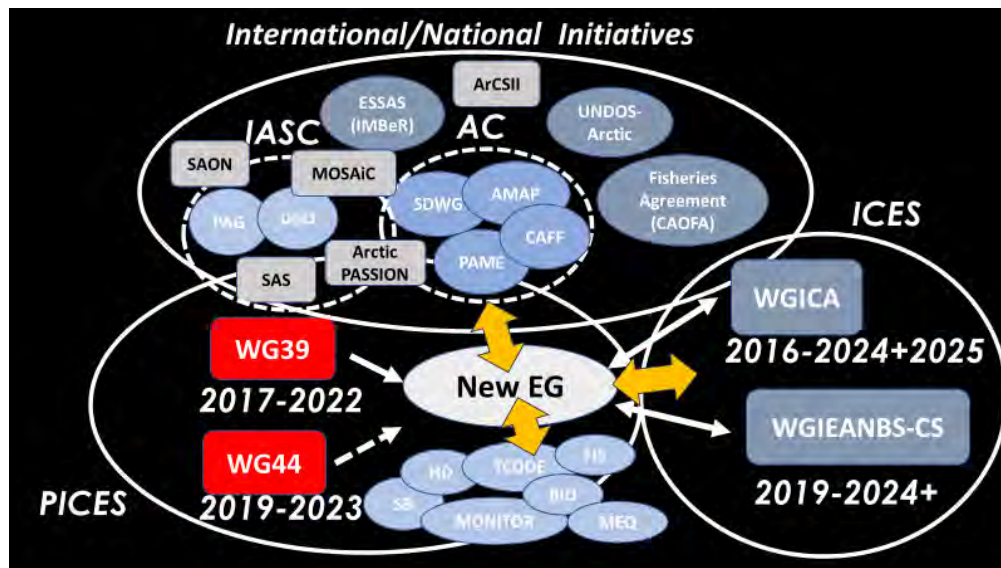


Figure 3. Relationship map between New EG and groups

### **3. Plan and contributions of new EG and the follow-up**

The proposed EG, when officially launched, is expected to begin middle 2024. The responsibilities of the group should include, although these will need to be refined and clearly laid down in the Terms of Reference:

1. Provide information and scientific expertise to the Science Board, and other scientific and technical committees (as needed), on the key physical, ecological and societal effects of climate change in the Pacific Arctic including its Gateways, with focus on how these changes are relevant for both the Arctic and mid-latitude marine environments and ecosystems in the PICES region;
2. Convene workshops/sessions to discuss and exchange information on the strong influence of the Pacific Arctic including its Gateways on the Arctic and mid-latitude Oceans, and its linkages to broader PICES activities;
3. Represent and coordinate responses of PICES concerning the Arctic Ocean and the connected waters in cooperation with partners and other international organizations, including WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)), WGIEANBS-CS (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) ;
4. Develop trans-disciplinary and collaborative approaches that include human dimension with focus on Indigenous knowledge systems and coproduction methods in the Pacific Arctic including its Gateways in support of PICES activities;
5. Develop recommendations for PICES to better collaborate within PICES, and with larger international initiatives relevant to the Arctic Ocean including IASC, Arctic Council, CAOFA, PAG, ESSAS, ICES and UNDOS-Arctic;

In order to fulfill these responsibilities, the EG will need to review and digest the research findings, continue collaborations with colleagues from the other side of the Arctic and deliver the policy-ready or at least policy-friendly product to the wider PICES community. The EG will also exert efforts to understand the indigenous perspectives on the issues and have those reflected in the deliberations of the group.

The EG will initially develop an agreed-upon three-year timeline. The work of the

EG will focus mostly on the available data from published literature, rather than being field survey oriented, or assisting the designing process. Identification of key areas such as biological hotspots both in the sub-Arctic and the Central Arctic and delineating the mutually interacting mechanisms and the pathways will remain at the heart of the task of the EG for the first three years, at least. To undertake its work, the EG will hold online consultations prior to the annual meeting in order to discuss the findings and distill tentative conclusions and to have them ready for report at the annual meeting. In the third year, at its end of the first term, the EG will organize a workshop to encapsulate the outcomes and determine future recommendations. The following are potential theme of Report/Workshop/Symposium.

- Review and prospect of national flag research on the Arctic Ocean and Pacific gateways
- Understanding the climate change related connections among the Arctic Ocean, the Pacific Arctic including its Gateways, and mid-latitude marine environments and ecosystem in PICES
- Monitoring of Arctic Ocean and Pacific gateways using research ice breakers and other means
- Development of research plans for International Polar Year 2032/2033
- Coordination across scale and discipline in transboundary Arctic science

At last, we look for an appropriate Expert Group for new EG, Advisory Panel (AP) or Sections not Working Group. Sections is sub-committee of some Scientific and Technical Committees and more specific. AP is more overall EG in compared with Sections focusing specific issue. Arctic issue is more broad, not specific, so that we decide to organize AP for new EG.

#### **4. Conclusion**

The variabilities of the Arctic Ocean strongly influence the global climate via atmosphere-ocean interactions and Arctic-subarctic freshwater and heat fluxes. The changing ocean has had both local and far-reaching effects on atmospheric circulation, including intensified storms and more frequent extreme weather conditions. Recent study shows that Arctic warming plays an important role in the increase in Northeast

Pacific marine heatwave days during boreal summers (Song et al., 2023). PICES should understand the impacts of Arctic changes on its marine ecosystem and biodiversity and the linkage to sub-Arctic and mid-latitude oceans and contribute the development of IEA in CAO and NBS-CS through the joint PICES/ICES cooperation.

Accessing and utilizing the best available information in understanding ecosystem processes requires the inclusion of multiple knowledge systems from an early stage. Drawing from successful methods used in other working groups, this group will work to bridge Indigenous Knowledges across the region with modern science to achieve more robust understanding. In conclusion, we propose the new EG as an Advisory Panel on the Arctic Ocean and the Pacific Gateways (AP-ARC) for this initiative.

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## **6. Appendix**

### **A. Proposal of AP-ARC (separate file)**

**Proposal for**  
**PICES Advisory Panel on the Arctic Ocean and the Pacific Gateways**  
**(AP-ARC)**

**Acronym:** AP-ARC

**Potential Parent Committee:** Science Board (SB)

**Term:** May 2024 - TBD

**Background**

The Central Arctic Ocean (CAO), that is in between the North Pacific and North Atlantic, is in rapid transition, in interaction with and impacting these waters. It has become more accessible to a range of activities. For example, rapid loss of sea ice cover has opened up the CAO for potential fishing opportunities. In this context, the agreement to Prevent Unregulated High Seas Fisheries in the CAO has been signed and entered into force which will necessitate joint research and monitoring. The Pacific gateway to the CAO, i.e., the Northern Bering Sea-Chukchi Sea (NBS-CS) is also experiencing unprecedented warming and loss of sea ice as a result of climate change. Declines of seasonal sea ice and warming temperatures have been more prominent in the northern Bering and Chukchi seas than in the European Arctic. Chronic and sudden changes in climate conditions in this Arctic gateway are clearly reshaping the system and its food-webs, and enlarging opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts.

PICES took upon responsibilities in the CAO issues when it joined the WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)) by establishing WG39 in 2017. In 2019, PICES also established WG44 (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) in efforts to understand the Arctic system and its impacts to the sub-Arctic and mid-latitude North Pacific. An integrated ecosystem assessment (IEA) is a useful approach that is shared by these two Working Groups, particularly relevant with substantial science and policy needs emerging for the sustainable Arctic. This renders a coordinated IEA of the CAO and NBS-CS as a priority task. In addition, it is of particular significance to developing future approaches for The



United Nations Decade of Ocean Science for Sustainable Development in the Arctic Ocean (UNDOS-Arctic), where science for resilience and sustainability is more important than anywhere else in the world oceans. Despite this continuing significance and unfinished commitment to WGICA and also WGIEANBS-CS, WG 39 ended the term with the closure of PICES 2022 and WG 44 will end the term with the closure of PICES 2023 Annual Meeting. In this context, we propose PICES establish AP-ARC to coordinate and integrate PICES scientific activities on the Arctic issues and to further advance the understanding of the Arctic system and linkages and impacts to the North Pacific.

### **Proposed Terms of Reference (ToRs)**

1. Provide information and scientific expertise to the Science Board, and other scientific and technical committees (as needed), on the key physical, ecological and societal effects of climate change in the Pacific Arctic including its Gateways, with focus on how these changes are relevant for both the Arctic and mid-latitude marine environments and ecosystems in the PICES region;
2. Convene workshops/sessions to discuss and exchange information on the strong influence of the Pacific Arctic including its Gateways on the Arctic and mid-latitude Oceans, and its linkages to broader PICES activities;
3. Represent and coordinate responses of PICES concerning the Arctic Ocean and the connected waters in cooperation with partners and other international organizations, including WGICA (Joint PICES/ICES/PAME Working Group on an Integrated Ecosystem Assessment (IEA) for the Central Arctic Ocean (CAO)), WGIEANBS-CS (Joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea - Chukchi Sea) ;
4. Develop trans-disciplinary and collaborative approaches that include human dimension with focus on Indigenous knowledge systems and coproduction methods in the Pacific Arctic including its Gateways in support of PICES activities;
5. Develop recommendations for PICES to better collaborate within PICES, and with larger international initiatives relevant to the Arctic Ocean including IASC, Arctic Council, CAOFA, PAG, ESSAS, ICES and UNDOS-Arctic;

### **Potential Theme of Report/Workshop/Symposium**

- Review and prospect of national flag research on the Arctic Ocean and Pacific gateways
- Understanding the climate change related connections among the Arctic Ocean, the Pacific Arctic including its Gateways, and mid-latitude marine environments and ecosystem in PICES
- Monitoring of Arctic Ocean and Pacific gateways using research ice breakers and other means
- Development of research plans for International Polar Year 2032/2033
- Coordination across scale and discipline in transboundary Arctic science

### **Proposed Co-chairs** (Two from west and two from east)

Sei-Ichi Saitoh (SG-ARC, WG39) (Japan) - [ssaitoh@arc.hokudai.ac.jp](mailto:ssaitoh@arc.hokudai.ac.jp)

Hyoung Chul Shin (SG-ARC, WG39) (Korea) - [hcshin@kopri.re.kr](mailto:hcshin@kopri.re.kr)

Nadja Stefanie Steiner (WG44) (Canada) - [nadja.steiner@dfo-mpo.gc.ca](mailto:nadja.steiner@dfo-mpo.gc.ca)

Sarah Wise (WG44) (USA) - [Sarah.Wise@noaa.gov](mailto:Sarah.Wise@noaa.gov)

### **Proposed Membership**

Andrea Niemi (WG44) (Canada)

Nadja Stefanie Steiner (WG44) (Canada)

Zhongyong Gao (CC-S, SG-ARC, WG39, WG44) (China)

Guangshui Na (FUTURE-SSC, MEQ, SB, SG-ARC, WG35, WG39) (China)

Fang Zhang (SG-ARC, WG39) (China)

Hyoung Chul Shin (SG-ARC, WG39) (Korea)

Hyoung Sul La (SG-ARC, WG44) (Korea)

Sei-Ichi Saitoh (SG-ARC, WG39) (Japan)

Fujio Ohnishi (SG-ARC, WG39) (Japan)

Takafumi Hirata (SG-ARC, WG44) (Japan)

Shigeto Nishino (WG44) (Japan)

Yury I. Zuenko (CREAMS-AP, POC, S-CCME, SG-UNDOS, WG35, WG40, WG44) (Russia)  
Kirill Kivva (WG44) (Russia)

Zack Oyafuso (SG-ARC)(USA)

Sarah Wise (WG44) (USA)

Elizabeth A. Logerwell (FIS, WG44) (USA)

Lisa B. Eisner (MONITOR, WG44) (USA)

David L. Fluharty (SG-ARC, WG39) (USA)

\*This membership is tentative and subject to changes.

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<https://doi.org/10.17895/ices.pub.20191787>

## **Appendix 8**

### **WG43 Journal Special Issues Information**

2022 Symposium on “Small Pelagic Fish: New Frontiers in Science and Sustainable Management”  
(November 2022, Lisbon, Portugal)

**Special Peer-reviewed Publications**

The 2017 PICES/ICES international symposium on “Drivers of Dynamics of Small Pelagic Fish Resources” (Victoria, Canada) produced two publications in primary journals. The special issue on “Drivers of Dynamics of Small Pelagic Fish Resources: Environmental Control of Long-term Changes” was published in January 2019 in *Deep-Sea Research II* ([Vol. 159, pp. 1-182](#)) and includes the Editorial and 15 original research papers. The theme section on “Drivers of Dynamics of Small Pelagic Fish Resources: Biology, Management and Human Factors” was published in May 2019 in *Marine Ecology Progress Series* ([Vol. 617-618, pp. 1-376](#)) and includes the Introduction and 22 original research papers.

The 2022 PICES/ICES/FAO international symposium on “Small Pelagic Fish: New Frontiers in Science and Sustainable Management” (Lisbon, Portugal) similarly generated two peer-reviewed publications – a Theme Section in *Marine Ecology Progress Series* (MEPS) and a Special Issue in *Canadian Journal of Fisheries and Aquatic Sciences* (CJFAS). These volumes are a product of the joint ICES-PICES Working Group on Small Pelagic Fish (ICES WGSPF, PICES WG43). Taken together, the papers stemming from the 2022 symposium and published in these collections will advance fundamental knowledge not only on the ecology and environmental drivers of small pelagic fish (SPF) populations, but also on the management tools and impacts of changes in SPF on vulnerable human communities.

The MEPS Theme Section “Small Pelagic Fish: New Research Frontiers” (edited by Myron Peck, Ignacio Catalán, Susana Garrido, Ryan Rykaczewski, Rebecca Asch, Jan McDowell, Elliott Hazen, and Isaak Kaplan) includes the Introduction and 18 original research contributions examining the biology and ecology of SPF from 6 regions as well as 3 global analyses. These studies cover a wide range of topics – from parasitology, behaviour and trophodynamics to growth and spawning. A total of 13 papers listed below are currently published with [Advance View at the MEPS website](#) (4 in Open Access). Other 5 papers (all with minor revisions) and the Introduction (Small Pelagic Fish: New Frontiers in Ecological Research) are due in early May. The complete Theme Section will be published in May or early June 2024.

*Rooper CN, Boldt JL, Cleary J, Peña M, Thompson M, Grinnell M*

Evaluating factors affecting the distribution and timing of Pacific Herring *Clupea pallasii* spawn in British Columbia (<https://doi.org/10.3354/meps14274>; Open Access)

*Wells BK, Santora JA, Bizzarro JJ, Billings A, Brodeur RD, Daly EA, Field JC, Richerson KE, Thorson JT*

Trophoscapes of predatory fish reveal biogeographic structuring of spatial dietary overlap and inform fisheries bycatch patterns (<https://doi.org/10.3354/meps14319>)

*Gunther KM, Baker MR, Aydin KY*

Using predator diets to infer forage fish distribution and assess responses to climate variability in the eastern Bering Sea (<https://doi.org/10.3354/meps14389>)

*Maathuis MAM, Couperus B, van der Molen J, Poos JJ, Tulp I, Sakinan*

Resolving the variability in habitat use by juvenile small pelagic fish in a major tidal system by continuous echosounder measurements (<https://doi.org/10.3354/meps14368>; Open Access)

*Thorvaldsen KG, Neuenfeldt S, Mariani P, Nielsen JR*

Hiding in plain sight: predator avoidance behaviour of mesopelagic *Maurolicus muelleri* during foraging (<https://doi.org/10.3354/meps14424>)

*Fonseca P, Barata M, Castanho S, Pousão-Ferreira P, Garrido S*

Effect of diet composition and temperature on the gastric evacuation rate of European sardine: implication for egg predation estimates (<https://doi.org/10.3354/meps14445>; Open Access)

*Luján C, Oliveros-Ramos R, Barrier N, Leadley P, Shin YJ*

Key species and indicators revealed by an uncertainty analysis of the marine ecosystem model OSMOSE (<https://doi.org/10.3354/meps14465>)

*Veríssimo A, Fonseca P, Garrido S*

Molecular barcoding reveals patterns of egg predation in small pelagic fish (<https://doi.org/10.3354/meps14498>)

*Ruzicka J, Chiaverano L, Coll M, Garrido S, Tam J, Murase H, Robinson K, Romagnoni G, Shannon L, Silva A, Szalaj D, Watari S*

The role of small pelagic fish in diverse ecosystems: knowledge gleaned from food-web models (<https://doi.org/10.3354/meps14513>)

*Jacobson KC, Marcogliese DJ, MacKenzie K*

Parasites of small pelagics reflect their role in marine ecosystems (<https://doi.org/10.3354/meps14529>)

*Berg F, Seljestad G, Folkvord A*

Growth of spring- and autumn-spawned larvae of Atlantic herring *Clupea harengus*: a long-term experiment mimicking seasonal light conditions (<https://doi.org/10.3354/meps14521>; Open Access)

*Garrido S, Albo-Puigserver M, Moyano M*

REVIEW: Larval trophic ecology of small pelagic fishes: a review of recent advances and pathways to fill remaining knowledge gaps (<https://doi.org/10.3354/meps14543>)

*Teles-Machado A, Plecha SM, Peliz A, Garrido S*

Anomalous ocean currents and European anchovy dispersal in the Iberian ecosystem (<https://doi.org/10.3354/meps14526>)

The CJFAS special issue “Small Pelagic Fish: New Frontiers in Science for Sustainable Management” (edited by Christopher Rooper, Jennifer Boldt, Andres Uriarte, Cecilie Hansen, Tim Ward, and Sarah Gaichas) includes the Introduction and 10 original research papers (3 in Open Access) that explore approaches currently being developed and used to assess and manage SPF. In particular, this issue covers topics on novel approaches to surveying SPF, incorporating environmental covariates into management, management strategy evaluation, and aspects of the economics of SPF. The first 9 papers from the list below have been already posted in [the “E-first” section](#) or in [the “Just-In” section](#) on the CJFAS website, and the last paper and the Introduction are expected to appear on this site by the end of April. The complete special issue will be published in May 2024.

*Katja Mäkinen, Marjut Rajasilta, Suvi Ruuskanen, Tiia Karpela, Aarne O. Lauerma, and Johannes Sahlstén*

Effects of incubation temperature and maternal phenotype on Baltic herring (*Clupea harengus membras*) eggs and larvae: An experimental study (<https://doi.org/10.1139/cjfas-2023-0032>)

*Sarah K. Gaichas, James Gartland, Brian E Smith, Anthony Wood, Elizabeth Ng, Michael Celestino, Katie Drew, Abigail S. Tyrell, and James T Thorson*

Assessing small pelagic fish trends in space and time using piscivore stomach contents (<https://doi.org/10.1139/cjfas-2023-0093>)

*Carryn Lee de Moor*

Explicitly Incorporating Ecosystem-Based Fisheries Management into Management Strategy Evaluation, with a focus on Small Pelagics (<https://doi.org/10.1139/cjfas-2023-0092>)

*Felipe Javier Quezada, Desiree Tommasi, Timothy Frawley, Barbara Muhling, Isaac Kaplan, and Stephen Stohs*

Catch as catch can: Markets, availability, and fishery closures drive distinct responses among the U.S. West Coast Coastal Pelagic Species fleet segments (<https://doi.org/10.1139/cjfas-2023-0094>; Open Access)

*Samantha Schiano, Geneviève Nesslage, Katie Drew, Amy Schueller, Ryan J. Woodland, and Michael Wilberg*

Evaluation of Alternative Harvest Policies for Striped Bass and Their Prey, Atlantic Menhaden (<https://doi.org/10.1139/cjfas-2023-0089>)

*Robert P. Wildermuth, Desiree Tommasi, Peter Kuriyama, James Smith, and Isaac Kaplan*

Evaluating robustness of harvest control rules to climate-driven variability in Pacific sardine recruitment (<https://doi.org/10.1139/cjfas-2023-0169>; Open Access)

*Leire Citores, Leire Ibaibarriaga, Maria Santos, and Andres Uriarte*

A Bayesian spatially explicit estimation of daily egg production: application to anchovy in the Bay of Biscay (<https://doi.org/10.1139/cjfas-2023-0126>; Open Access)

*Jennifer Beckensteiner, Sebastian Villasante, Anthony Charles, Pierre Petitgas, Christelle Le Grand, and Olivier Thebaud*

A systemic approach to analyzing post-collapse adaptations in the Bay of Biscay anchovy fishery (<https://doi.org/10.1139/cjfas-2023-008>)

*Naseera Moosa and Doug S Butterworth*

Investigating the influence of minor krill-predators on the krill-predator dynamics of the Antarctic ecosystem in the International Whaling Commission's Management Area II (<https://doi.org/10.1139/cjfas-2023-0086>)

*Kell, L., Bentley, J., Egan, A., Feary, D., and Nolan, C.*

Developing management procedures for sprat (*Sprattus sprattus*) in the Celtic Sea consistent with an ecosystem approach to fisheries.

*Christopher Rooper, Jennifer Boldt, Andres Uriarte, Cecilie Hansen, Tim Ward, and Sarah Gaichas*

Small Pelagic Fish: New Frontiers in Science for Sustainable Management (Introduction)