REPORTING FORM 2023

Please return completed form to imber@dal.ca **by 10th March** (in order to give everyone enough time to collate and read all the reports before the April SSC meeting)

REPORTING PERIOD: WHAT YOU HAVE DONE since the annual report submitted for the SSC meeting held virtually in August 2022 (Link to past annual reports)

and **PLANNED ACTIVITIES** over the next year (and beyond if details available)

N.B. The form focuses reporting on the research objectives (2022-2025) of the Grand Challenges (in order to align with how we are addressing IMBeR's commitments defined in the 5-year review process to SCOR and Future Earth)

Thank you.

Ecosystem Studies of the Subarctic and Arctic Seas (ESSAS)

Naomi Harada, Franz Mueter

1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges

(Among other uses, information will be used to update the Grand Challenge Factsheets)

1.a. Grand Challenge I

Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:

***Research Objective 1**. Evaluate and predict the cumulative effect of multiple stressors*
***Research Objective 2**. Integration of climate change and climate variability*
***Research Objective 3**. Impacts on society – preparation for a changed future*

The ESSAS program endorses national-level research programs that address ESSAS goals and contribute to Grand Challenge I. These endorsed projects often involve ESSAS members. Some examples are highlighted here:

In order to contribute to Research Objective 1 and 2, the Arctic Challenge for Sustainability II (ArCS II) project is going on in Japan. The theme is "Elucidation of Arctic Ocean environmental dynamics and constructions of a generic dataset" which is composed of three subprojects of 1 "Ocean heat and freshwater transport and material cycles from seasonal sea ice to perennial ice", subproject 2 "Assessing the vulnerability of marine ecosystems in response to rapid sea ice margin retreat", and subproject 3 "Atmosphere-ocean (including wave) interactions through sea ice". The purpose is to contribute the conservation and sustainable use of the drastically changing Arctic elucidating the environmental dynamics, such as ocean heat transport, ecosystems and material cycles in the Arctic Ocean basin and ice margins. The annual activities of FY2021 were reported and the overview is as follows:

Overall, the marine issues published 41 peer-reviewed papers in international journals and three press releases. Subproject 1 clarified, among other things, the transport processes of sediment particles resuspended from the shelf seabed. In Subproject 2, we identified a climate-insensitive evacuation zone for marine organisms in the Bering Sea, and elucidated the process by which large zooplankton decrease with earlier sea ice melting. In Subproject 3, the decadal variations of sea ice formation, sea temperature and salinity in the Barrow coastal polynya were elucidated. A special issue on oceanographic changes in the northern Bering Sea was organised by the members of the marine issue in Progress in Oceanography (ESSAS SSC member is one of the guest editors), and eight papers related to ArCS II were published. In addition to this, a special issue was also organised in the Journal of Geophysical Research Ocean, with four papers published in FY2021. Further results are expected to be published, as some papers are still under peer review. In addition, in the framework of international collaborative research, we contributed to the publication of several review papers, and wrote and published the polar part of the special issue on future plans organised by the Oceanographic Society of Japan.

In order to contribute to Research Objective 1, the research cruise was conducted in the Bering Sea and Chukchi Sea on September, 2022 by R/V Mirai. This cruise is also related to the ArCS II project of Japan. The details are described in section 2.a. **Selected scientific highlights since last report (1-5).**

Contributing to objectives 2 and 3, researchers based at Hokkaido University (I. Alabia, J. Garcia Molinos, T. Hirata), the US (F. Mueter) and Canada (C. David) collaborated on shifting biodiversity patterns along the interior shelves of the Arctic Ocean under climate change (Alabia et al. 2023, see 2b. Publications).

Contributing to all three objectives, the ESSAS-endorsed AMBON project (Arctic Marine Biodiversity Observing Network) participated in a multidisciplinary cruise in the northern Bering Sea and Chukchi Sea in fall 2022 to service moorings, including the Chukchi Ecosystem Observatory, and to sample stations along several DBO lines (part of the Distributed Biological Observatory). The overall goal was to assess biodiversity at multiple trophic levels from microbes to whales using net sampling, grab samples, passive acoustic sampling, flow cytometry, eDNA and other projects.

Addressing objectives 1 and 3, the ongoing Norwegian research project on "Arctic ecosystem impact assessment to oil in ice" (ACTION, Lead-PI: Frode Vikebø) supported by the Research Council of Norway includes a collaboration with US-based ESSAS members B. Laurel (Co-chair, Bioenergetics Working Group) and F. Mueter (ESSAS Co-Chair) to assess and model the potential impacts of oil spills on organisms in the Arctic. A project meeting has tentatively been scheduled in conjunction with the 2023 ESSAS Annual Science Meeting in Bergen, Norway.

1.b. Grand Challenge II

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:

***Research Objective 4**. Development of integrated data systems and approaches for predictions and projections*
***Research Objective 5**. Development of predictive models and projections for use at regional scales*
***Research Objective 6**. Development of alternative scenarios to bridge the gap between physical climate sciences and humanities*

Members of ESSAS are involved in many relevant national-level and international projects related to GC II that have directly benefited from or have resulted from collaborations developed through ESSAS. This includes, among others, the following recent and ongoing activities:

A Norwegian-led research program "Winners and losers in the climate casino: Arctic marine resources under climate change" (CASINO, lead PI: S. Kvamsdal, SNF – Centre for Applied Research at NHH, Norway) involves researchers across multiple Institutions and Arctic countries, including include Alan Haynie (USA, previous chair of the ESSAS Human Dimensions Working Group) and F. Mueter (ESSAS Co-Chair). The group met twice online during the reporting period to discuss relevant cases studies on the impacts of climate change on cod and crab stocks and their fisheries in the Atlantic and Pacific Arctic gateways

The Norwegian Nansen Legacy project (2018-2023), aims to provide integrated scientific knowledge on the rapidly changing Barents Sea climate and ecosystem to support sustainable management through the 21st century. ESSAS co-chair B. Planque is involved in the research focus on "the future Barents Sea" which includes the development of forecasting and scenarios for climate and ecosystem.

1.c. Grand Challenge III

Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:

***Research Objective 7**. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation*
***Research Objective 8**. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture*
***Research Objective 9**. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas*

In order to contribute to Research Objectives 7 and 8, ESSAS has committed to an existing ICES/PAME (Protection of the Arctic Marine Environment) Working Group on an Integrated Ecosystem Assessment for the Central Arctic Ocean (WGICA) since 2016.

The WG meeting on August 24 was held virtually, Dr. Sei-Ichi Saitoh who serves on the ESSAS SSC, is leading the WG. Dr. Saitoh reported the overview of spring meeting of WGICA which was held in virtual on May 11–13, 2022. WGICA had a spring meeting to: 1) to discuss Report 2 part 1 (Human activities, pressures and management bodies) and 2) prepare for the next Meeting (Reports, new ToR, IA). The meeting was led by the co-leads: Drs. Lis Lindal Jørgensen, Martine van den Heuvel-Greve and Sei-Ichi Saitoh. In total over 30 scientists and ICES Secretariat members were participated on Day 1 and over 30 participates on Day 3.

The Report 2 part1: Human activities, pressures and management bodies is under preparation and will cover the Central Arctic Ocean Large Marine Ecosystem (CAO LME) as geographically defined by WGICA in the opening of this report. The focus is on present and future human activities, the pressures from these human activities, and the impact of these pressures on the living ecosystem. The report will also describe policy, management mechanisms, and existing measures. The report will include a final chapter on what type of analyses and models exist for compiling ecosystem, human activity, pressures, and policy metadata. Report 2, part 1 draws from published peer reviewed literature and information in Report 1 and the Ecosystem Overview Report. The six chapters are revised from 6 chapters to new 4 chapters.

Other activities related to GC III objectives 7 & 8 include:

- *The collaborative project "Winners and losers in the climate casino: Arctic marine resources under climate change" (noted above.) includes two work packages focusing on international governance of the Arctic.*
- *Several ESSAS SSC members have been involved in the development of Integrated Ecosystem Assessments for the Central Arctic Ocean (S.-I. Saitoh, N. Harada, see above), the Chukchi Sea (F. Mueter), and the Barents and Norwegian seas (B. Planque).*
- *A project in the Barents Sea led by Mette Skern-Mauritzen and Geir Ottersen from Norway seeks to assess the risks of cumulative impacts on the Barents Sea ecosystem and its services (BarentsRISK). The project is developed in direct collaboration with stakeholders and managers. In addition to researchers from Norway, the project involves Dr. Alan Haynie, former chair of the ESSAS Human Dimensions Working Group. This project was recently endorsed by ESSAS.*
- *Norwegian researchers (incl. ESSAS co-chair B. Planque) are developing tools to support integrated ecosystem assessment for the Norwegian Sea within the European project Mission Atlantic*

1.d. Innovation Challenge 3

To advance understanding of ecological feedbacks in the Earth System

No recent ESSAS activities address IC 3

1.e. Innovation Challenge 4

To advance and improve the use of social science data for ocean management, decision making and policy development

ESSAS has not recently sponsored activities directly related to this Innovation Challenge

1.f. Innovation Challenge 5

Interventions to change the course of climate impacts

ESSAS is starting activities to contribute to IC 5 and IC 6 at its upcoming ESSAS Annual Science Meeting in Bergen, Norway. In particular, Nina Bednarsek, one of the co-lead of IC 5 is also one of the co-convenors of a session focused on **Blue Carbon, mariculture and climate change mitigation and adaptation in the Subarctic and Arctic**, *contributing to a better alignment between ESSAS activities and IMBER goals.*

1.g. Innovation Challenge 6

Sustainable management of Blue Carbon ecosystems

See IC 5 above.

2. Selected highlights

2.a. Selected scientific highlights since last report (1-5)

Last report was submitted to SSC meeting, August 2022

- ***R/V Mirai Arctic Ocean Cruise in 2022***

To understand ongoing catastrophic environmental change in the Arctic Ocean and its impact on the marine ecosystems, the Arctic Ocean cruise of Research Vessel (R/V) Mirai has been conducted from 12 August to 29 September 2022 (Chief Scientist: Dr. Motoyo Itoh, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan) under the Arctic Challenge for Sustainability II (ArCS II) project. The Arctic Ocean is the area with the fastest rate of global oceanic warming in the world. The detailed research of the R/V Mirai along with other icebreaking vessels, satellite observation and numerical modeling have documented the impact of inflow of the Pacific origin water We have observed sea ice decrease and marine ecosystem changes associated with Pacific origin waters bringing heat, nutrients, fresh water into the Arctic. Its impact is getting greater and more widespread into the entire Arctic. The cruise track is shown in Figure 1.

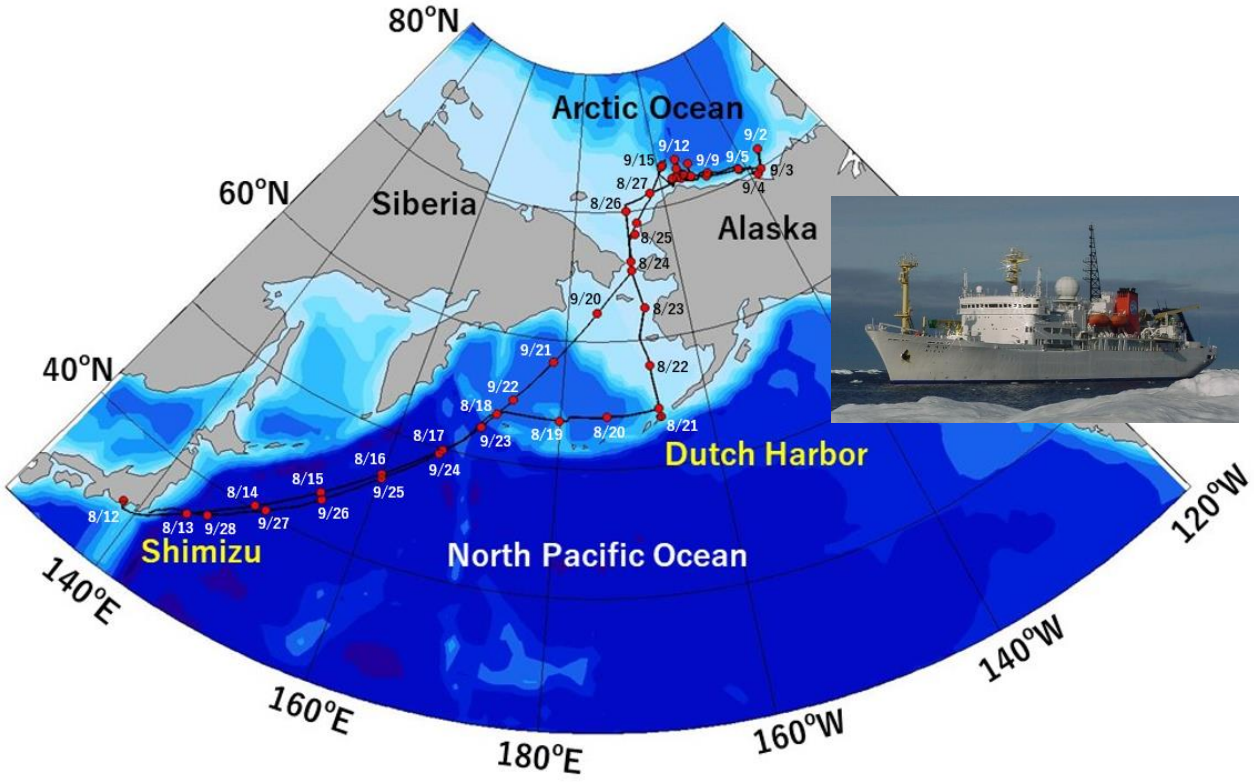

Figure 1 Map of the entire cruise track. The red dots indicate the noon positions (UTC).

In 2022, the hydrographic, paleoenvironmental and biogeochemical surveys, including plankton, trace-metals, microplastic, eDNA and aerosols were conducted in the Chukchi and Beaufort Seas. Three hydrographic moorings and a sediment trap mooring were also recovered and re-deployed on the pathway of the Pacific origin water to monitor transport and impact on marine ecosystem. In the marginal ice area (Figure 2), various drifting buoys were launched to measure the ocean waves and

sea ice interaction. Trials of an under-the-ice drone, designed for automated cruise and observations in the sea ice area, were carried out. In addition to observation of present Arctic environments, sediment records have been collected by piston, gravity, multicore and box corers to understand differences between the present environmental changes and past warming events in the Arctic Ocean. This cruise also contributed to Synoptic Arctic Survey (SAS) and Distributed Biological Observatory (DBO) that are muti-ship international research programs.

Figure 2: R/V Mirai in the ice edge zone of the Canada Basin. Photo by Tomotaka Katsuno, The Univ of Tokyo

- ***Biodiversity observations in the Northeast Chukchi Sea across multiple trophic levels***

New analyses conducted on data collected by the AMBON project in 2017 documented a consistent spatial gradient in the composition of multiple biological communities from macrobenthic infauna and zooplankton to demersal fish and seabirds in the Northeast Chukchi Sea (Fig. 3). The gradient reflects the inflow of Pacific water through Bering Strait that is associated with a pre-dominance of Pacific taxa on the southern portions of the shelf and the presence of Arctic water masses associated with an Arctic community on the northern portion of the shelf.

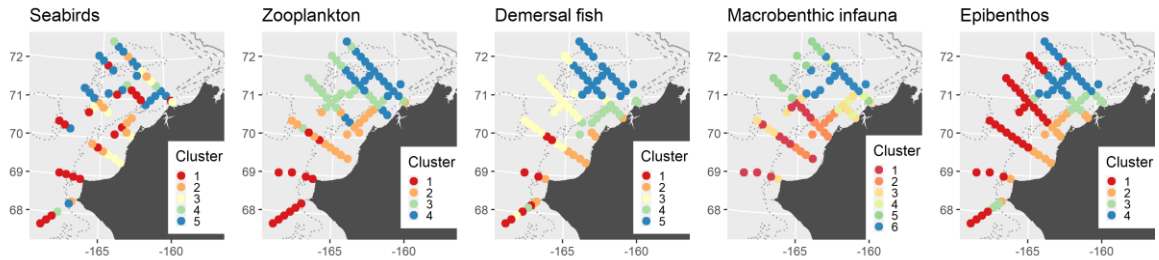

Figure 3: Assemblage composition of multiple biological communities in the Chukchi Sea as identified by a cluster analysis of species composition across stations. Each community was characterized by 4-6 clusters or assemblages that were color coded to show more southern assemblages in red and more northern assemblages in red.

- ***Recent trends in biodiversity across the Arctic***

A recent study by Alabia et al. (2023) explored marine biodiversity across eight Arctic marine regions over the last two decades (2000-2019). Species occurrences for 69 marine taxa (26 apex predators and 43 mesopredators) and potential environmental drivers of their spatial distribution were used to predict taxon-specific distributions using a multi-model ensemble approach. Results showed an Arctic-wide trend of increasing species richness over the last 20 years (Fig. 4), highlighted areas where new species are accruing due to climate-driven species redistributions.

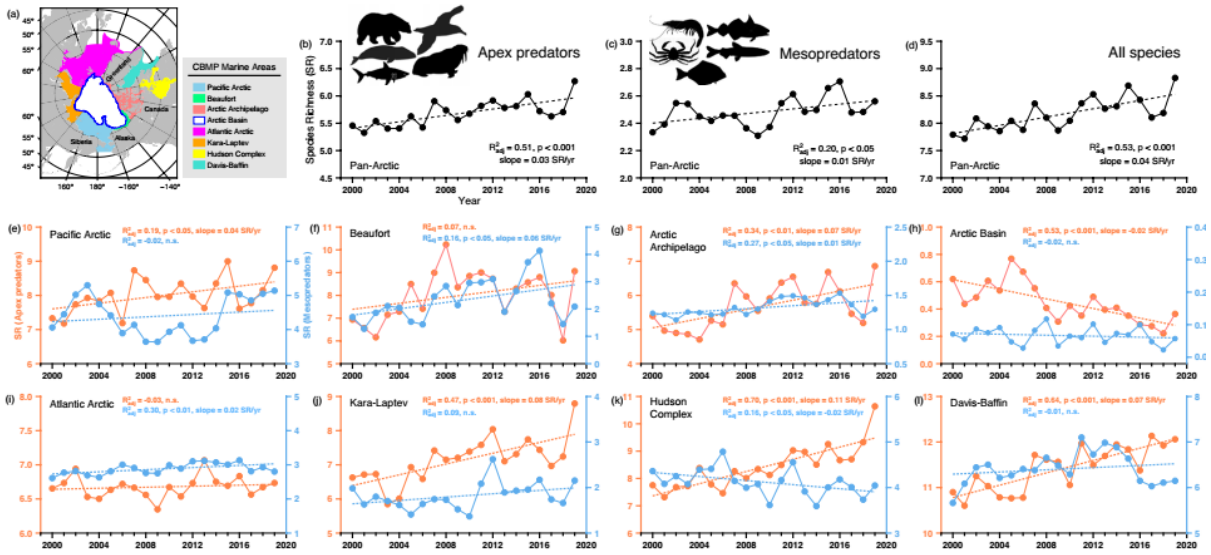

Figure 4: (a) Geographic map of the study area and annual time-series of predicted pan-Arctic species richness for (b) apex predators, (c) mesopredators, and (d) all species combined. Second and third row of panels show regional species richness by year with estimated linear trends over time for apex predators (orange) and mesopredators (blue) in the (e) Pacific Arctic, (f) Beaufort, (g) Arctic Archipelago, (h) Arctic Basin, (i) Atlantic Arctic, (j) Kara–Laptev, (k) Hudson complex, and (l) Davis-Baffin between 2000 and 2019. From Alabia et al. (2023).

2.b. Publications since last report

Publication *with DOI*	***Class 1, 2, 3***	***Activity****
Skjoldal, Hein Rune (2022): Ecosystem assessment of the Central Arctic Ocean: Description of the ecosystem. ICES Cooperative Research Reports (CRR). Report. https://doi.org/10.17895/ices.pub.20191787.v2	*2*	*Prof. Hirawake, SSC member contributes.*
*Futsuki, R., **T. Hirawake**, A. Fujiwara, H. Waga, T. Kikuchi, S. Nishino, T. Isada, K. Suzuki, Y. W. Watanabe (2022) Performance of primary production algorithm using absorption coefficient of phytoplankton in the Pacific Arctic. Journal of Oceanography, 78, 311-335. https://doi.org/10.1007/s10872-022-00646-5*	*2*	*Prof. Hirawake, SSC member contributes.*
*Ooki, A., K. Minamikawa, F. Meng, N. Miyashita, **T. Hirawake**, H. Ueno, Y. Nosaka, T. Takatsu (2022) Marine sediment as a likely source of methyl and ethyl iodides in*	*2*	*Prof. Hirawake, SSC member contributes.*

subpolar and polar seas. Communications Earth and Environment, 3, 180. https://doi.org/10.1038/s43247-022-00513-7		
*Park, J.-W., Kim, Y., Kim, K.-W., Fujiwara, A., Waga, H., Kang, J. J., Lee, S.-H., Yang, E.-J., **Hirawake, T**., 2022. Contribution of small phytoplankton to primary production in the northern Bering and Chukchi Seas. Water, 14, 235. https://doi.org/10.3390/w14020235*	*2*	*Prof. Hirawake, SSC member contributes.*
*Waga, H., Fujiwara, A., **Hirawake, T**., Suzuki, K., Yoshida, K., Abe, H., Nomura D., 2022. Primary productivity and phytoplankton community structure in surface waters of the western subarctic Pacific and the Bering Sea during summer with reference to bloom stage. Progress in Oceanography, 201, 102595. https://doi.org/10.1016/j.pocean.2021.102595*	*2*	*Prof. Hirawake, SSC member contributes.*
*Shiozaki, T., Fujiwara, A., Sugie, K., Nishino, S., Makabe, A., **Harada, N.** (2022) Bottom-associated phytoplankton bloom and its expansion in the Arctic Ocean. Global Change Biology, https://doi.org/10.1111/gcb.16421*	*2*	*Prof. Harada, co-chair of ESSAS contributes.*
*Yoshikawa, C., Ogawa, N. O., Chikaraishi, Y., Makabe, A., Matsui, Y., Sasai, Y., Wakita, M., Honda, M. C., Mino, Y., Aita, M. N., Fujiki, T., Nunoura, T., **Harada, N**., Ohkouchi N. (2022) Nitrogen isotopes of sinking particles reveal the seasonal transition of the nitrogen source for phytoplankton Geophysical Research Letters, 49(17), https://doi.org/10.1029/2022GL098670*	*2*	*Prof. Harada, co-chair of ESSAS contributes.*
*Geoffroy, M., **C. Bouchard**, H. Flores, D. Robert, H. Gjøsæter, C. Hoover, H. Hop, N. E. Hussey, J. Nahrgang, N. Steiner, M. Bender, J. Berge, G. Castellani, N. Chernova, L. Copeman, C. L. David, A. Deary, G. Divoky, A. V. Dolgov, J. Duffy-Anderson, N. Dupont, J. M. Durant, K. Elliott, S. Gauthier, E. Goldstein, R. Gradinger, K. Hedges, J. Herbig, **B. Laurel**, L. Loseto, S. Maes, F. C. Mark, A. Mosbech, S. Pedro, H. Pettitt-Wade, I. Prokopchuk, P. E. Renaud, S. Schembri, C. Vestfals, and W. Walkusz. 2023. The circumpolar impacts of climate change and anthropogenic stressors on Arctic cod (Boreogadus saida) and its ecosystem. Elementa: Science of the Anthropocene.*	*2*	*This review paper was conceived and initiated by a number of the authors during a session on Arctic Gadids at the ESSAS 2018 Annual Science Meeting in Fairbanks, Alaska.*
***Geissinger EA**, Gregory R, **Laurel B**, Snelgrove PVR (2022) High site-fidelity and low mortality of juvenile Atlantic cod (Gadus morhua) in subarctic coastal habitat during their first winter. ICES J Mar Sci https://doi.org/10.1093/icesjms/fsac065*	*2*	*2022 ESSAS cod session. Highlights denote ESSAS affiliation*
***Copeman, L. A.**, M. A. Stowell, C. D. Salant, M. L. Ottmar, M. L. Spencer, P. J. Iseri, and **B. J. Laurel**. 2022. The role of temperature on overwinter survival, condition metrics and lipid loss in juvenile polar cod (Boreogadus saida): A laboratory experiment. Deep Sea Research Part II: Topical Studies in Oceanography, 205:105177, https://doi.org/10.1016/j.dsr2.2022.105177*	*2*	*2022 ESSAS cod session. Highlights denote ESSAS affiliation*
***Laurel BJ**, Abookire A, Barbeaux S, Almeida Z, **Copeman L**, Duffy-Anderson J, Hurst T, Litzow M, **Kristiansen T**, Miller J,*	*2*	*2022 ESSAS cod session. Highlights*

Palsson W, Rooney S, Thalmann H, Rogers L. (in revision) Towards a recruitment paradigm for Pacific cod in the Anthropocene: an early life history perspective under changing thermal habitats. Fish and Fisheries		*denote ESSAS affiliation*
***Almeida Z, Laurel B, Thalmann H**, Miller J (in review) Warmer, earlier, faster: Cumulative effects of Gulf of Alaska heatwaves on the early life history of Pacific Cod. Elementa: Science of the Anthropocene*	*2*	*2022 ESSAS cod session. Highlights denote ESSAS affiliation*
***Alabia, I. D.,** García Molinos, J., Hirata, T., **Mueter, F. J.**, and **David, C. L.** 2023. Pan-Arctic marine biodiversity and species co-occurrence patterns under recent climate. Scientific Reports, 13: 4076. https://doi.org/10.1038/s41598-023-30943-y*	*2*	*Highlights denote ESSAS affiliation. ESSAS collaboration*
*Chapman, Z. M., **Mueter, F. J.**, Norcross, B. L., Oxman, D. S. (2023). Arctic cod (Boreogadus saida) hatching season and growth rates in the Bering, Chukchi and Beaufort seas. Deep Sea Research II, 207: 105226. https://doi.org/10.1016/j.dsr2.2022.105226*	*2*	*Presented at 2022 ESSAS meeting*
Oke, K. B., **Mueter, F. J.**, Litzow, M. A. (2022). Warming leads to opposite patterns in weight-at-age for young versus old age classes of Bering Sea walleye pollock. Canadian Journal of Fisheries and Aquatic Sciences 79:1655-1666, https://doi.org/10.1139/cjfas-2021-0315	*2*	*Benefitted from previous ESSAS collaborations*
Mousing, E. A., **Planque, B.**, Arneberg, P., Bjørdal, V. R., Keulder-Stenevik, F., Liebig, P. L., Mørk, H. L., et al. 2023. Quantifying diets for small pelagic fish: effects of weight versus occurrence methods and sampling effort. ICES Journal of Marine Science: fsac240. https://doi.org/10.1093/icesjms/fsac240/6990985	*3*	*Result from ESSAS endorsed project. B. Planque is ESSAS co-chair.*
Planque, B., Favreau, A., Husson, B., Mousing, E. A., Hansen, C., Broms, C., Lindstrøm, U., et al. 2022. Quantification of trophic interactions in the Norwegian Sea pelagic food-web over multiple decades. ICES Journal of Marine Science: https://doi.org/10.1093/icesjms/fsac111/6644750	*3*	*Result from ESSAS endorsed project. B. Planque is ESSAS co-chair*
Sivel, E., **Planque, B.**, Lindstrøm, U., and Yoccoz, N. G. 2023. Combined effects of temperature and fishing mortality on the Barents Sea ecosystem stability. Fisheries Oceanography, 32: 106–120. 10.1111/fog.12604	*3*	*Result from ESSAS endorsed project. B. Planque is ESSAS co-chair.*
Oke, K. B., **Mueter, F. J.**, Litzow, M. A. (2022). Warming leads to opposite patterns in weight-at-age for young versus old age classes of Bering Sea walleye pollock. Canadian Journal of Fisheries and Aquatic Sciences 79:1655-1666, https://doi.org/10.1139/cjfas-2021-0315	*3*	*Informed by ESSAS session. F. Mueter is ESSAS co-chair*
Chapman, Z. M., **Mueter, F. J.**, Norcross, B. L., Oxman, D. S. (2023). Arctic cod (*Boreogadus saida*) hatching season and growth rates in the Bering, Chukchi and Beaufort seas. Deep Sea Research II, 207: 105226. https://doi.org/10.1016/j.dsr2.2022.105226	*3*	*Presented at ESSAS ASM. F. Mueter is ESSAS co-chair*

**If appropriate, please list the IMBeR activity through / by / from / during which the publication arose*

2.c. Events, Meetings, and Workshops

List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Regional Programme / Working Group committee meetings and workshops.

No events since August 2022.

3. International collaboration and links

ESSAS works across the circumpolar north and has members from all Arctic countries, as well as Japan and Korea. ESSAS fosters collaboration among scientists from these countries.

One example of a recent international effort that involves partcipants from all ESSAS countries is the Synoptic Arctic Survey (SAS), an international collaborative project for simultaneous area-wide observations of the Arctic Ocean. The Japanese ArCS II program coordinated observation lines and data acquisition methods with other involved countries, and conducted an observation cruise of the Pacific Ocean side by the oceanographic research vessel Mirai. Although the observation and work activities were reduced due to the impact of COVID-19, such as the change of departure port from Seattle to Shimizu, Japan and the cancellation of workboat observations in the ice edge area due to the absence of bear watchers, the planned observation items from the Chukchi Sea land shelf area to the land shelf slope area were generally carried out, and a wide range of marine environmental data (water temperature, salinity, nutrients, etc.) was obtained. It should also be noted that the sampling of environmental DNA and microplastics in seawater was continued. With regard to marine plastics, many marine task force members participated in the study group organised by the International Legal System Task Force to deepen inter-task cooperation.

4. Input to management, policy and SOCIETY* over the last year

Add anything that is not covered under "1.c. Grand Challenge III"

**As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

ESSAS members serve on national and international scientific advisory bodies and in other roles to provide input on management and policy issues that are directly or indirectly informed by ESSAS activities. These general roles were described in last year's report.

5. Education, Outreach and Capacity Development

Faculty of Fisheries Sciences, Hokkaido University plans to conduct 'ArCS II Outreach Cruise in the Arctic Ocean' by training ship (T/S) Oshoro-maru in July 2023. The cruise involves 10 students who belong to universities in relation to social science, art, medical, education, agriculture, veterinary medicine etc. The students will carry out marine surveys and studies of oceanography, marine ecosystem, social issues, mass media, etc., in the Arctic during the cruise. As a trial cruise, they participated in a domestic cruise of T/S Oshoro-maru in February 2023.

6. Planned activities

6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

Our main activity in 2023 is the Annual Science Meeting, which includes 4 sessions and a workshop:

***Session 1**: Cooperative studies of coastal ecosystems engaging local communities in the sub-Arctic and Arctic.*

> *This session related to Grand Challenge I, in particular research objective 3, as it examines how collaborative approaches can be used to address the needs of coastal communities to adapt to a changing environment.*

***Session 2**: Natural disasters, multiple stressors and cumulative impacts along sub-arctic and arctic coasts.*

> *This session relates to Grand Challenge I, in particular research objectives 1 and 3 as it directly addresses the cumulative effects of multiple stressors (Obj. 1) and aims to better understand and prepare for impacts on coastal community from both anthropogenic and natural stressors.*

***Session 3**: Blue Carbon, mariculture and climate change mitigation and adaptation in the Subarctic and Arctic*

> *This session directly relates to Innovation Challenges 5 and 6 as it considers sustainable mariculture and blue carbon initiatives (IC 6), as well as how these initiatives can be used to mitigate climate change impacts (IC 5).*

***Session 4**: Cod and climate change at the coastal interface*

> *This session relates to Grand Challenge I, in particular research objectives 1 and 2, and GC II, in particular objective 5, as the session explores the impacts of climate change on commercially important cod species that use coastal areas as nursery grounds and provide important sources of food and income to many coastal communities..*

***Workshop**: AnalogueART - Using natural analogues to investigate the effects of climate change on northern ecosystems; moving from gradient to mosaic approaches*

> *The workshop addresses objectives under both GC I and GC II as it aims to better understand the drivers of change that impact the chemistry and ecology of marine ecosystem and how natural analogues can provide insights into these drivers.*

6.b. Upcoming papers (Community-Position-Review-etc)

No specific papers are planned but worksops and sessions typically result in one or more research papers and occasional synthesis or review papers. For example, the first AnalogueART workshop results in a review paper (Rastrick et al. 2018) and the planned 2023 workshop is anticipated to follow up with a paper on best practices for future research using natural analogues.

7. Funding

7.a. Funding from external sources

We currently have no external funding sources except some anticipated support from the Norwegian Institute of Marine Research to support attendance of Early Career Scientists at the Annual Science Meeting in Bergen. For the meeting and other activities, we rely on in-kind contributions from member's home institutions.

7.b. Funding proposals in progress or planned

None specific to ESSAS

7.c. Funding requested from IMBeR for 2023-2024

Include a brief budget and justify requests

We request the same level of funding ($7,500) as last year to support 3-4 scientists to participate in the 2024 Annual Science Meeting in Canada. Preference will be given to unfunded SSC members and Early Career Scientists. We find that this level of funding, along with a moderate registration fee and local in-kind support from host countries, has typically been sufficient to successfully conduct our Annual Science Meeting.

8. Changes to Organisational Structure (e.g. SSC) of RP / WG / IMECaN

None

9. Images / Figures

Participants in the 2022 ESSAS Annual Science Meeting held at the School of Aquatic and Fisheries Sciences, University of Washington, in Seattle, USA.

10. Update on Action Items from 2022 SSC meeting

Please update the table of Action Items

N/A

11. Anything not covered above

In terms of open data, a dataset for satellite sea-surface dynamic height with improved spatio-temporal resolution by combining multiple sensors is expected to be constructed by the time of the interim evaluation. For the results of the inter-annual variability experiment using the Arctic Ocean domain model, a dataset of the atmosphere-ocean CO2 exchange compared in RECCAP2 is expected to be available by the mid-term assessment. For phytoplankton, a dataset of chlorophyll-a concentrations was constructed in addition to basic production. Among the in-situ observation data, sea ice and oceanographic data obtained from time-series observations of mooring systems installed in the Barrow coastal polynya area were also made available on the Arctic Data archive System (ADS), Japan.

12. How to improve this form

Please give suggestions on how to improve this form and make it better next time.

Add text…

13. Appendices

Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)

Add text…