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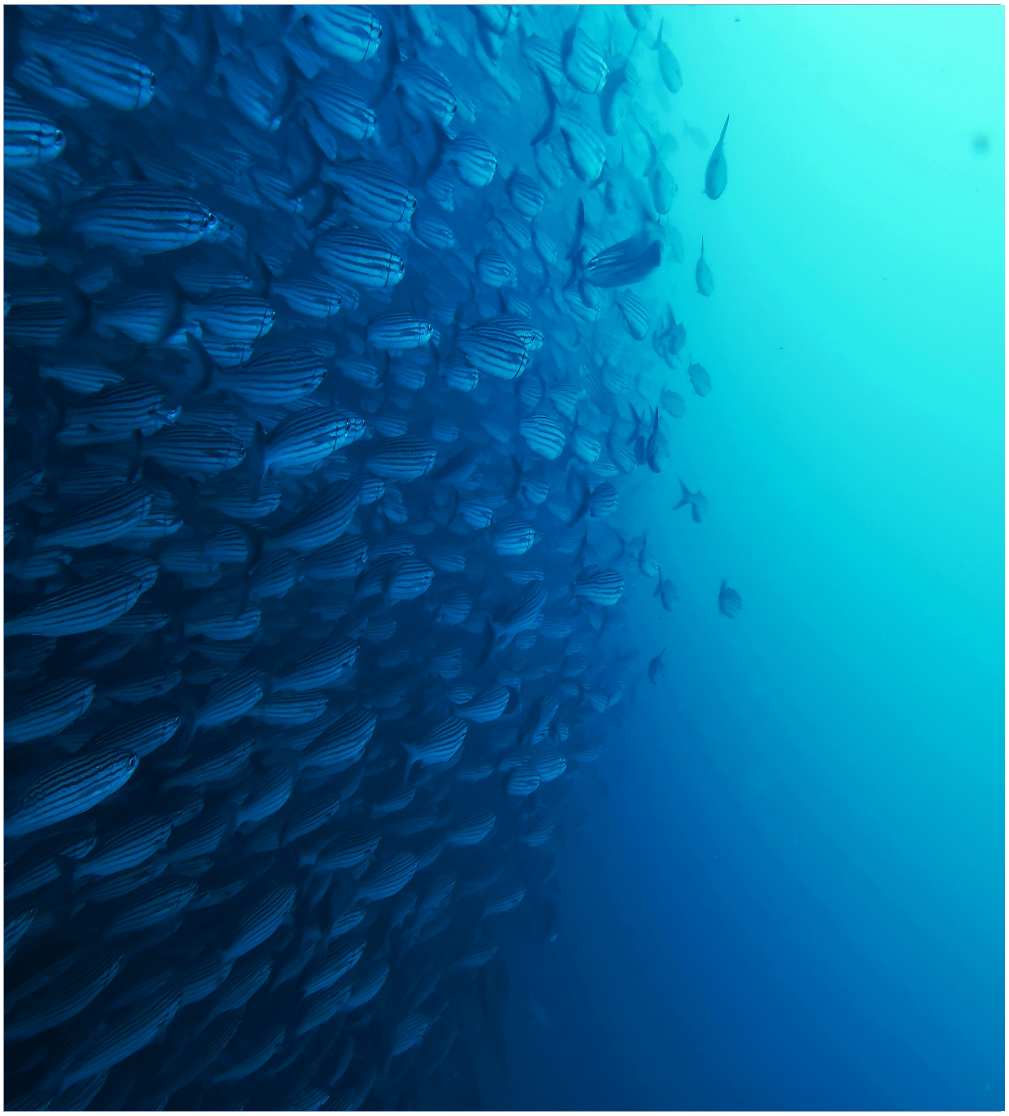

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
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Recommended citation:

ICES. 2024. ICES Sponsored Symposia Report 2023. 57 pp. https://doi.org/10.17895/ices.pub.25351930

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i Executive summary

Report on ICES sponsored symposia held in 2023:

From Echosounders to the Cloud: Transforming Acoustic Data to Information

Venue and date: 27–30 March 2023, Portland, Maine, USA

5th International Symposium on the Effects of Climate Change on the World's Ocean (ECCWO5)

Venue and date: 17–21 April 2023, Bergen, Norway

Human Impacts on Marine Functional Connectivity

Venue and date: 22–25 May 2023, Sesimbra, Portugal

Baltic Sea Science Congress

Venue and date: 21–25 August 2023, Helsinki, Finland

The Second International Symposium on Plastic Pollution in the Arctic and Sub-Arctic Regions

Venue and date: 22–23 November 2023, Reykjavik, Iceland

1 From Echosounders to the Cloud: Transforming Acoustic Data to Information

Venue and dates: Portland, Maine, USA, 27–30 March 2023

Conveners:

Michael Jech, NOAA/NEFSC, Woods Hole, USA

Anne Lebourges-Dhaussy, IRD, Brest, France

Gayle Zydlewski, Univ. Maine Sea Grant, Orono, USA

Justin Stevens, Univ. Maine Sea Grant, Orono, USA

Host: NOAA/NEFSC, Woods Hole, USA and UMaine Sea Grant, Orono, USA

1.1 Summary

The goal of the symposium was to facilitate exchange among the spectrum of scientists and engineers who develop acoustic instrumentation, collect data, and transform those bytes to information critical for conserving fisheries and ecosystems. The symposium programme consisted of 115 oral presentations and 38 posters distributed among the four theme sessions: Organism Detection: Models, Measures, and Classification; Advancements in Acoustic Devices, Platforms, and Combined Technologies; Data Integration: Analytics; and Data Integration: Application to Ecosystem, Conservation, and Society. We will publish the proceedings in the ICES Journal of Marine Science and will reflect the spectrum of science and engineering that are the foundation of observing ecosystems acoustically and the continued evolution of analytics.

We also featured three keynote speakers: Mr Andrew Lipsky, who is the NOAA Northeast Fisheries Science Center's (NEFSC) offshore wind development lead; Dr Michael Fogarty, who was the NEFSCs lead ecosystem scientist before he retired last year; and Dr Kathryn Mills, who is an ecosystem scientist at the Gulf of Maine Research Institute. The keynote speakers spoke about the boom of offshore wind development in the United States and its potential impact on fisheries and the ecosystem (Lipsky), the ecosystem approach to living marine resource management (Fogarty), and the effects of climate change and fishing on the ecosystem and the human dimension of managing fisheries (Mills). They provided guidance on what information is needed to manage ecosystems for resource utilization or other societal needs of aquatic environments where advanced technologies can provide information.

1.2 Sessions

Organism Detection: Models, Measures, and Classification

Chairs: Gavin Macaulaey, Aqualyd, Wakefield, New Zealand; Naig Le Bouffant, Ifremer, Brest, France; Sven Gastauer, Thünen Institute of Sea Fisheries, Bremerhaven, Germany.

Content: This session had 24 oral and 12 poster presentations with 14 coming from early career scientists. This session covered acoustic modelling, target-strength measurement, and target classification (from both active and passive acoustics).

Acoustic scattering models are becoming more widely available and are more commonly used with increasing sophistication. They have been important for many years for interpreting narrowband data, but are now especially crucial to supporting interpretation of broadband backscatter. In this session, presentations on the effects of model parameterization on the model outputs were investigated in detail, new species were modelled, and the acoustic method was extended to ecosystems and species where it has not previously been used, from zooplankton to mesopelagic communities to the largest fishes. Target strength (TS) of several new species at different length or life stages were presented from both in-situ and ex-situ environments. The impact of target orientation, depth, and changes in TS due to natural behaviour or physiology was also discussed. Comparisons between scatter model results and existing target strength relationships that bridge the traditional way of estimating animal length to new and innovative methods were presented. Machine learning and artificial intelligence methods addressing acoustic target classification are the future for analysing acoustic data as corroborated by inclusion in several presentations. The influence of different biological validation methods on classification was discussed, and sampling uncertainties for different surveys were presented. Broadband signals and data are now ubiquitous and several presentations highlighted progress in the processing techniques of broadband signals.

Advancements in Acoustic Devices, Platforms, and Combined Technologies

Chairs: Haley Viehmann, Echoview, Hobart, Australia; Tim Ryan, CSIRO, Hobart, Australia; Joe Warren, Stony Brook University, Stony Brook, USA; Alina Wieczorek, NIWA, Wellington, New Zealand.

Content: A total of 19 oral and 10 poster presentations, with six of these talks from early career scientists, were given within this session. Presentations highlighted how new and existing technologies can be utilized to address familiar and arising challenges in fisheries acoustic research.

One of these challenges is the differentiation of organisms within multispecies aggregations, as is often found in deep scattering layers. Environmental DNA sampling and acoustic observations from submersible broadband echosounders are promising tools for addressing this challenge. Presentations included examples of emerging benefits of these tools, as well as discussion of potential issues, such as: organism identification, interpretation of environmental DNA signals, and appropriate calibrations for submersible broadband echosounders.

Another widely addressed topic of this session was how unmanned submersibles and surface vehicles can be used to augment and, in part, replace traditional (hull-mounted) methods for hydroacoustic sampling. The use of these remote platforms was mainly driven by specific research questions, including increased survey coverage, targeting difficult-to-survey areas such as in and around offshore wind farms, and increasing the range, resolution, or quality of survey data.

Given the rise in remotely operated and monitored platforms, there was discussion about (real-time) data transfer and storage, and the associated cost and benefits, which are specific to project needs and data requirements.

Outside these overarching topics, presentations included insights on the use of seabed backscatter for single beam echosounder calibration, the use of multibeam data to elucidate fish positioning, light avoidance by fish and other organisms, and monitoring gas bubbles from CO2 injection sites.

Data Integration: Analytics

Chairs: Wu-Jung Lee, Univ. of Washington, Seattle, USA; Nils Olav Handegard, IMR, Bergen, Norway; Carrie Wall, NOAA/NCEI, Boulder, USA.

Content: The analytics session consisted of 12 oral presentations and four poster presentations, with three coming from early career scientists. The first authors represented institutions from eight countries (see figure below). Several sub-themes were highlighted from the presentations given. Open-source software, data preparation, and data accessibility are the critical first steps towards formatting and collating data so that they can be used in analytical models. Approaches to extract signal from noise are necessary for ensuring quality control of data. Application of artificial intelligence and machine learning models and methods are at the forefront of "big data" analytics. Understanding the impacts of uncertainty, errors, noise and sampling methods are important to understand from a methodology perspective as well as when implementing these analytical methods and results in population and ecosystem assessments.

This session contributes to an essential intermediary step transforming acoustic data to information. Scalable community tools and efficient ways to process data of small to large volumes that in turn allow scientists to extract signal or remove noise and place those details in the context of the environment are fundamental to informing fisheries acoustic science and its various applications.

Data Integration: Application to Ecosystem, Conservation, and Society

Chairs: Patrick Sullivan, Emeritus Cornell University, Ithaca, USA; Alejandro Ariza, Ifremer, Nantes, France.

Content: The ecosystem session comprised 22 oral and 12 poster presentations with 11 coming from early career scientists.

Large-scale distribution patterns of micronekton using acoustic surveys were important topics in this session. Interesting observations about the lack of of fish with resonance and gas-filled swimbladders in high-latitude systems and the contribution of siphonophore resonance to global acoustic backscatter was highlighted. Publicly available and discoverable acoustic databases were addressed as a vital need for the community to share data. Moored or drifting echosounders, and autonomous vehicles that can be used to monitor ecosystems and the impact of human intervention on marine fauna were excellent examples of the application of new technology to address scientific questions. Stock assessment of small pelagic fish and assessment of tuna species were examples of management and conservation of living marine resources. Observations of individual and group behavior using acoustics and observations of reef fish using dual optic-acoustic systems or imaging sonar demonstrated the utility of acoustical and optical methods for shallow-water and reef environments.

Presentations amply met the expectations for this session. They described ecosystems and answered ecological questions using a suite of acoustic observational approaches. They also identified future challenges to improve acoustic observation of marine systems

1.3 Participation

Number of participants: 150. We had participants from 26 countries representing all inhabited continents. The gender ratio was 105 males and 45 females for all participants. However, the 34 early career scientists (ECSs) were nearly gender uniform with 18 males and 16 females, which is a trend that we hope will continue. Of the 34 ECSs, we were able to waive the registration fee for 33 of them through the generosity of ICES

Number of contributions: We had four theme sessions: Organism Detection: Models, Measures, and Classification; Advancements in Acoustic Devices, Platforms, and Combined Technologies; Data Integration: Analytics; and Data Integration: Application to Ecosystem, Conservation, and Society. We had a total of 115 presentations, with 77 oral and 38 poster presentations. We had 24 oral and 12 poster presentations in the organism detection session, 19 oral and 10 poster presentations in the advancements in technologies session, 12 oral and 4 poster presentations in the data analytics session, and 22 oral and 12 poster presentations in the ecosystem session.

This symposium had the lowest turnout of all the ICES Fisheries and Plankton Acoustics symposia since the 1987 symposium, with only the 1973 and 1982 symposia having fewer participants. We received a number of reasons for participants not being able to attend. We did not have anyone report that the COVID pandemic was directly related, e.g. no one said that they were not coming because they did not want to meet in-person for fear of contracting COVID or that travel difficulties and airline/airport restrictions were a deterrent. However, we know there is a segment of the population that is still very cautious and will not meet at large in-person gatherings. The most prevalent reason given was budgetary. It seems that institutional budgets are tight and travel budgets are at levels less than before the pandemic. The war in Ukraine has restricted funds for some institutions and travel is low priority. Many institutions were reducing domestic and international travel overall so they only sent a fraction of those that could have attended. One institution cited reducing carbon footprint as a reason. Institutions used travel budgets to fund other activities during the pandemic and now are reluctant to restore travel funds. Other than budgetary reasons, other professional duties (e.g. surveys), visa issues, and emergency personal reasons kept people from attending.

Despite the less-than-anticipated turnout, we have heard only positive feedback from attendees. The level of enthusiasm was amazing. For some, this was the first in-person conference-style meeting they have attended since the pandemic. We had events scheduled for three of the evenings and these went late into the night because people stayed to talk to each other. The scientific program was excellent and we received many complements on how smoothly the symposium went. We heard praise for the venue and everyone seemed to like the city of Portland. Overall, the symposium was an overwhelming success.

1.4 Scientific steering committee

Babak Khodabandeloo, IMR, Bergen, Norway

Gavin Macaulaey, Aqualyd, Wakefield, New Zealand

Naig Le Bouffant, Ifremer, Brest, France

Sven Gastauer, Thünen Institute of Sea Fisheries, Bremerhaven, Germany

Haley Viehmann, Echoview, Hobart, Australia

Tim Ryan, CSIRO, Hobart, Australia

Joe Warren, Stony Brook University, Stony Brook, USA

Alina Wieczorek, NIWA, Wellington, New Zealand

Wu-Jung Lee, Univ. of Washington, Seattle, USA

Nils Olav Handegard, IMR, Bergen, Norway

Carrie Wall, NOAA/NCEI, Boulder, USA

Patrick Sullivan, Emeritus Cornell University, Ithaca, USA

Alejandro Ariza, Ifremer, Nantes, France

Aurore Receveur, Biodiversity Institute, Montpellier, France

Ndague Diogoul, Senegal Fisheries, Dakar, Senegal

Serdar Sakinan, WUR, Wageningen, Netherlands

1.5 Organizing committee

The conveners comprised the organizing committee:

Michael Jech, NOAA/NEFSC, Woods Hole, USA

Anne Lebourges-Dhaussy, IRD, Brest, France

Gayle Zydlewski, Univ. Maine Sea Grant, Orono, USA

Justin Stevens, Univ. Maine Sea Grant, Orono, USA

1.6 Sponsors

International Council for the Exploration of the Sea (ICES), Denmark; www.ices.dk; sponsoring participation of Early Career Scientists to attend the conference.

Kongsberg Ocean Science, Horton, Norway, https://www.kongsberg.com/maritime/products/ocean-science/ocean-science/; opening reception, poster session, and banquet

Echoview, Hobart, Australia, https://echoview.com/; opening reception, poster session, and banquet

Furuno, Nishinomiya, Japan, https://www.furunousa.com/en; opening reception, poster session, and banquet

ASL Environmental, Saanichton, Canada, https://www.aslenv.com/; opening reception, poster session, and banquet

Milne Technologies, Keene, Canada, http://www.milnetechnologies.ca/; opening reception, poster session, and banquet

Exail, Ile-de-France, France, https://www.exail.com; opening reception, poster session, and banquet

1.7 Outputs

The symposium proceedings will be published in the ICES Journal of Marine Science. The deadline for submission is 30 June 2023 with publication scheduled for early 2024.

1.8 History and future

This symposium was the eighth in the series of fisheries and plankton acoustic symposia sponsored by ICES. The first symposium was held in 1973 in Bergen, Norway, so the symposium we hosted in 2023 represented the 50th anniversary! These symposia are held every 5–8 years and characterize the state-of-the-art knowledge in technology and analytical methods, and the symposia proceedings mark the communities' advancements over time. We anticipate the next symposium will be held sometime during 2028–2030.

2 5th International Symposium on the Effects of Climate Change on the World's Ocean (ECCWO5)

Venue and dates: Bergen, Norway, 17–21 April 2023

Conveners:

Tarub Bahri, FAO, Rome, Italy

Sonia Batten, PICES, Sidney, Canada

Geir Huse, IMR, Bergen, Norway

Kirsten Isensee, IOC, Paris, France

Jörn Schmidt, ICES, Copenhagen, Denmark

Host: Institute of Marine Research, Bergen, Norway

2.1 Summary

The ECCWO5 symposium brought together over 700 experts from around the world, in person and online, to better understand climate impacts on ocean ecosystems, the ecosystem services they provide, and the people, businesses and communities that depend on them. The 2023 event highlighted the latest information on how oceans are changing, what is at risk, responses that are underway, and strategies for increasing climate resilience, mitigation and adaptation. It aimed to identify key knowledge gaps, promote collaborations, and stimulate the next generation of science and actions.

The Symposium was comprised of 19 topic sessions, four special sessions and a poster session. Informal workshops (4) took place on the Sunday preceding the opening ceremony. The main meeting days (Mon-Thur) began with a plenary session featuring a VIP welcome and key note speakers (Monday) and then plenary talks from that day's sessions (Tues-Thurs). After the plenary session there were 3 parallel sessions for the duration of each day. Friday started in parallel before ending with a closing plenary featuring a keynote speaker, review and awards for Early Career Ocean Professional outstanding presentations. The poster session on Tuesday evening, featured 149 posters contributed to the 19 sessions (listed below), as well as general posters relevant to the Symposium. Wednesday saw the afternoon finish with several Special Sessions (an ECOP networking event, a special session on Aquaculture, a session on the SUPREME initiative and a panel on the science-policy-action interface).

2.2 Sessions

S1: Marine spatial management supporting climate change adaptation and mitigation

Chairs: Ana Queiros (Corresponding), Plymouth Marine Laboratory, UK; Caitriona Nic Aonghusa (Marine Institute, Ireland).

Content: Climate change is redistributing ocean biodiversity, including species and habitats we want to protect as well as exploited marine resources. These changes challenge the effectiveness of Marine Spatial Planning processes. Climate-adaptive solutions for the spatial management of the ocean are therefore a global ambition for policy developers. We invite examples from around

the world, where climate change evidence is informing the design of spatial mechanisms supporting adaptive management practices. Case-studies focused on observational, modelling, social science and science-policy dialogue are welcome contributions, including those focused on adaptive climate change mitigation solutions, when showcasing approaches currently implemented or in development.

S2: Smart fishing for climate change mitigation and adaptation

Chairs: Jose A. Fernandes (Corresponding) AZTI, Spain; Pingguo He, University of Massachusetts, USA; Kayvan Pazouki, University of Newcastle, UK; Karl-Johan Reite, SINTEF, Norway.

Content: Recent high impact scientific publications show that global wild fish landings are now the same as twenty years ago, but requiring 20% more fuel while climate change is likely to reduce landings. Moreover, fuel use in capture fisheries emits greenhouse gases, which in turn affects the capture fisheries. Recent technological and scientific advances can help adapt to climate change and mitigate emissions from capture fisheries. The term 'smart' is starting to be used to highlight how the primary sector of the economy can benefit from these developments. This session aims to gather the latest research on evaluation of fuel use and emission, strategies to reduce fishing-related emission, and measure to adapt to climate change in capture fisheries, and will serve as the foundation of a 'smart fishing' transition decade aiming to reduce emissions from fishing by up to 50%.

The session will cover topics (but not limited) on fishing gear and fishing vessel design and operation, new and efficiency engines and fuel types for fishing vessels, measures to monitor fuel use and emission, use of artificial intelligence for selective fishing and route optimization for fuel consumption reduction, and means to adapt to and mitigate climate change in fisheries.

S3: Assessing climate change vulnerability of marine and coastal areas and associated communities

Chairs: Scott Heron (Corresponding) James Cook University, Australia; Jon Day, James Cook University, Australia.

Content: Marine and coastal protected areas are at the forefront of impacts from climate change. There is an urgent need to assess climate change vulnerability systematically and rapidly. This session will incorporate existing tools used to evaluate the vulnerability of the values recognized within protected areas but also include assessments of the vulnerability to economic, social and cultural aspects of the associated community. Applications of climate change vulnerability assessments to all types of marine and coastal protected areas are welcome, including for locations recognized internationally (World Heritage, RAMSAR), nationally (national heritage/trust, MPAs) and locally (First Nations land/sea country, community-based).

S4: Improving decision-making in response to change in marine-dependent coastal communities using transdisciplinary approaches

Chairs: Louise Gammage (Corresponding) University of Cape Town, South Africa; Kelly Ortega Cisneros, University of Cape Town, South Africa; Lynne Shannon University of Cape Town, South Africa.

Content: Marine-dependent communities, particularly fishery-reliant communities, are especially vulnerable to the impacts of environmental variability and climate change. The inherent complexity of the marine environment, together with the uncertainty brought on by anthropogenic change, hampers decision-making at all scales, undermining adaptive capacity

and resilience within communities. Inclusive transdisciplinary approaches are thus required to address existing vulnerabilities while building resilience to the effects of future changes on various system scales. In this session, we share case studies on how coastal communities can improve resilience to cli-mate change by using diverse co-design and participatory approaches. We also aim to identify barriers and opportunities to develop adaptive capacity and resilience of vulnerable coastal communities through improved multi-scalar decision-making.

S5: Measuring and predicting responses of marine social-ecological systems to climate extremes

Chairs: Stephanie Brodie (Corresponding) University of California Santa Cruz, USA; Lisa Colburn (Corresponding), NOAA Fisheries, USA; Kathy Mills (Corresponding) Gulf of Maine Research Institute, USA; Gabriel Reygondeau (Corresponding) University of British Columbia, Canada.

Content: Over the last few decades, extreme climate events are interacting with longer term climate change, leading to unprecedented environmental conditions for marine ecosystems and inter-connected social systems across the globe. These events include rapid or episodic physical events (marine heatwaves, hurricanes, storm surge) as well as disequilibrium triggered by biological responses to changing climate (ocean acidification, HABs, bleaching). These changes have caused widespread impacts on marine ecosystems, including increased physiological stresses, mass mortalities of marine life, community spatial shifts and destruction of coastal biogenic habitats. Ecosystem changes have affected coupled social systems, altering human activities such as commercial fishing and subsistence harvest, and impacting livelihoods, communities, and cultures. Simultaneous occurrences of multiple climate extremes, termed compound events, have the capacity to exacerbate societal and environmental impacts beyond any extreme event in isolation, challenging the resilience of ecosystems and coastal communities. Near-term forecasting at seasonal, annual, and decadal time-scales offers the potential to develop information that will enable ocean stakeholders and resource managers to better prepare for and respond to extreme events.

In this session, we encourage submissions related to climate extremes and associated compound events that: (1) improve understanding of the physical and biogeochemical processes of extreme events; (2) describe ecological and/or socio-economic consequences; (3) describe potential adaptation and management strategies that could mitigate these impacts, including those that advance forecasting of extreme and compound events.

S6: Deep-Sea responses to, and solutions for, Climate Change

Chairs: Lisa Levin (Corresponding) Scripps Institution of Oceanography, UC San Diego, USA; Nathalie Hilmi Centre Scientifique de Monaco, Monaco; Telmo Morato, University of Azores, Portugal; Moriaki Yasuhara, University of Hong Kong, China.

Content: This session will examine the intersection of deep-sea climate science, management, conservation, economics and governance. We invite contributions relevant to deep-ocean climate impacts, interface with human uses (e.g. energy, mining, fishing), climate adaptation, carbon services (storage and sequestration), and ocean-based climate interventions. Contributors from different disciplines (physical oceanography, chemistry, biology, social sciences) and approaches (modelling, observations, paleo studies, policy) are invited to think broadly about how their understanding of climate change in the deep ocean can inform actions going forward.

S7: Nature-based Solutions for Climate Adaptation and Mitigation - From Planning to Practice

Chairs: Myron Peck (Corresponding) Royal Netherlands Institute for Sea Research, the Netherlands; Silvana Birchenough, Cefas – Centre for Environment, Fisheries & Aquaculture Science, UK; Fabio Bulleri, Università di Pisa, Italy; Ana Queiros, Plymouth Marine Laboratory, UK.

Content: Nature-based Solutions (NBS) have been defined as "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptably, simultaneously providing human well-being and biodiversity benefits" by the IUCN. Implementing climate-ready NBS within marine habitats (i.e. restoration of habitat-forming species, establishment of marine protected areas, sustainably harvesting seafood) requires in-depth knowledge of the impacts of climate change on marine flora and fauna and the feedback pro-cesses whereby increasing ecosystem health and biodiversity reduce climate impacts. Contributions in this session will promote dialog on the relationships among NBS, climate change adaptation and mitigation, biodiversity and ecosystem services within marine social-ecological systems using real-world examples.

S8: Advances in coupling regional climate and social-ecological models to improve climate-ready ecosystem management

Chairs: Jonathan Reum (Corresponding) NOAA Fisheries, USA; Tyler Eddy, Memorial University of Newfoundland, Canada; Camilla Novaglio, University of Tasmania, Australia; Steven Bograd, NOAA Fisheries, USA; Phoebe Woodworth-Jefcoats, NOAA Fisheries, USA; Kirstin Holsman NOAA Fisheries, USA; Roger Griffis, NOAA Fisheries, USA.

Content: The effects of global climate change vary widely across ecosystems, and regional modelling frameworks are critical tools for evaluating impacts, risks, and the efficacy of management strategies. This session will highlight current approaches and identify critical gaps for coupling cli-mate models to regional social-ecological systems. In particular, presentations on modelling efforts that integrate climate impacts across spatial scales, disciplines, and aim to generate near- to long-term projections are encouraged. The session will emphasize approaches to incorporate statistically or dynamically downscaled climate projections into single species, foodweb, and social-ecological projections and identify strategies to support climate-ready ecosystem-based management advice.

S9: Transitioning from Vulnerable to Resilient and Viable Fisheries Social-Ecological Systems

Chairs: Katherine Maltby (Corresponding) Gulf of Maine Research Institute, USA; Catie Alves ECS Federal, Inc. In support of NOAA Fisheries, NFSC, Social Science Branch; Jacob Eurich, (Environmental Defense Fund; Prateep Nayak, Faculty of Environment, V2V Global Partnership, University of Waterloo, Canada.

Content: Fisheries provide income, jobs, food, and cultural connection to the oceans. Yet these systems are vulnerable to climate change, and are also influenced by broader ecological, socio-economic, and governance dimensions. Pathways to reduce vulnerability and operationalize climate resilience within fisheries are often context-, scale-, and resource-dependent. Identifying and understanding opportunities, as well as challenges or trade-offs, to meeting these aims is critical for achieving global Sustainable Development Goals. This is particularly important for small-scale fisheries, many of which remain economically and politically marginalised, are highly vulnerable to change, and remain invisible in policy debates. This session welcomes contributions that examine the diverse factors and conditions contributing to fisheries vulnerability and/or resilience, characterize ways fisheries are responding to climate change, and

reflect on pathways that facilitate transitions from vulnerability to resilient and viable fisheries systems. We encourage case studies reflecting a range of fisheries contexts.

S10: Beyond species on the move: emerging climate change impacts on the spatial dynamics of marine species, from detecting to forecasting and projecting

Chairs: Manuel Hidalgo (Corresponding) Spanish Institute of Oceanography, IEO, CSIC, Spain; Rebecca G. Asch, East Carolina University, USA, Lorenzo Ciannelli, Oregon State University, USA; Stazione Zoologica di Napoli Anton Dohrn, Italy; Shin-ichi Ito, University of Tokyo, Japan; Lauren Rogers, NOAA, USA.

Content: Many marine fish are shifting their horizontal and vertical distributions because of changing ocean conditions, with consequences for species interactions, assessments, management, and coastal economies. Mechanistic and statistical approaches developed to quantify distribution shifts still have unresolved challenges, which are both operational (model resolution, bias-correction, model parameterization and validation) and conceptual (ontogenetic constraints, non-stationarity, adaptive responses, depth gradients). In addition, further impacted spatial properties of marine species go beyond distribution shifts, including the population structure, early life dispersal, spatially dependent critical processes, collective behavior, and spatial co-occurrence and interactions of species. We invite contributions that present advances in forecasting and projecting spatio-temporal dynamics of marine species, as well as advances in under-standing climate change impacts on less investigated spatial properties.

S11: Ocean Deoxygenation: Physical, Biogeochemical and Ecological Research Advances and Future Needs

Chairs: Natalya Gallo (Corresponding), Department of Biological Sciences, University of Bergen and Bjerknes Center for Climate Research, Norway; Yassir Eddebbar, Scripps Institution of Oceanography, University of California San Diego, USA; Marilaure Gregoire, University of Liege, GO2NE Co-chair; Kirsten Isensee, IOC-UNESCO, Paris, France.

Content: The oceanic oxygen content continues to decline due to ocean warming and coastal eutrophication, with consequences for marine species, ecosystems, fisheries and biogeochemical cycles. Research investigating this has expanded rapidly in recent years, yielding major advances in identifying the drivers and consequences of ocean deoxygenation. This session will highlight recent progress in understanding the physical and biogeochemical mechanisms of ocean deoxygenation and its ecological and economic consequences in the coastal and open ocean. It aims at identifying knowledge gaps and stimulating cross-disciplinary discussions including with social sciences. This session provides a platform to highlight recent research and activities contributing to the Global Ocean Oxygen Decade, The United Nations Decade of Ocean Science for Sustainable Development Programme, a roadmap of future ocean oxygen research needs and possible solution-based actions for the coming decade.

S12: Improving pathways for delivery of multidisciplinary ocean observations into marine assessments across multiple scales

Chairs: Karen Evans (Corresponding), Commonwealth Scientific Industrial Research Organisation (CSIRO), Australia; Gabrielle Canonico, NOAA, USA; Indiah Hodgson-Johnston, Australia; Jörn Schmidt, ICES, Copenhagen, Denmark.

Content: Central to being able to provide comprehensive assessments of change in the marine environment are two components. First, is the utilization of multidisciplinary ocean observations for assessing marine environments comprehensively to establish their state and responses, including ongoing trends. Second, is the interpretation of multidisciplinary observations and

associated products to provide information that can be utilized and applied to address management and policy needs. This session will discuss current and developing pathways, priority needs and future work for improving linkages between observation systems and decision-making through the delivery of multidisciplinary ocean observations into marine assessments at multiple scales. Strategic topics addressed:

- Indicator-based frameworks for detecting and responding to climate impacts on ocean ecosystems
- Valuation and non-economic assessment of ecosystem services
- Data mobilization and accessibility challenges and solutions

S13: Detectability of non-linearities, abrupt shifts and tipping points in marine ecosystems

Chairs: Friederike Fröb (Corresponding), Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Norway; Thorsten Blenckner, Stockholm Resilience Centre, University of Stockholm, Sweden; Camilla Sguotti, Department of Biology, University of Padova, Italy.

Content: Regime shifts of marine ecosystems are increasingly observed in response to food production, coastal development and climate change, and abrupt changes are expected to occur even more frequently, if the anthropogenic perturbation remains unabated. Such abrupt shifts, associated with a substantial reorganization between different states of ecosystem structure and functioning, may even be irreversible. Gradual, but also non-linear changes, crossings of thresholds, and cascading effects associated with multiple stressors such as ocean warming, deoxygenation, or ocean acidification, but also other anthropogenic stressors such as overfishing, plastic contamination, pollution or eutrophication, can trigger abrupt changes and ecosystem-wide tipping points. The detectability of these abrupt shifts or tipping points is, however, limited due to non-linear dynamics of ecological systems, complex interactions between the physical-chemical environments and biota, and species-dependent physiological tolerances to change. Moreover, the large natural variability of the system may obscure gradual changes from abrupt shifts. Yet, particularly for ecosystem management and governance, a better understanding of the likelihood of abrupt change is crucial.

In this session we invite contributions on all topics relating to interactions between multiple stressors that may lead to tipping points, abrupt shifts and cascading effects in marine ecosystems. We are particularly interested in various methodological approaches to detect non-linearities, identify early warning signals for abrupt change, and define safe operating spaces to avoid critical tipping points in marine ecosystems, using both observational data and Earth System Models.

S14: Cumulative anthropogenic impacts on key Arctic species

Chairs: Frode B. Vikebø (Corresponding), Institute of Marine Research, Norway; Ben Laurel, Hatfield Marine Science Center, USA; Mette Skern-Mauritzen, Institute of Marine Research, Norway; Franz Mueter, University of Alaska Fairbanks, USA.

Content: Warmer waters and retreating sea ice allows marine populations and human activities to extend northwards, introducing multiple pressures acting in synergy on Arctic coastal and oceanic eco-systems. This comes in addition to the long-range transport of contaminants bioaccumulated and biomagnified in the food chain. It is imperative to develop risk assessments that take into account not only changes in the structure and function of marine ecosystems induced by climate change, but also new initiatives to utilize Arctic marine ecosystem services, including living and non-living marine resource, shipping and tourism. A prerequisite for assessing risks is to under-stand processes linking drivers to effects and to combine experiments,

in situ and remote data collection and numerical ecosystem models to link effects at the individual level to impacts on populations and ecosystems. The session invites contributions focusing broadly on impacts of multiple pressures, including climate change, on key Arctic marine species, ecosystems and ecosystem services.

S15: Using Management Strategy Evaluation to establish robust fishery management in a changing ocean

Chairs: Desiree Tommasi (Corresponding) UCSC/NOAA SWFSC, USA; Caren Barceló, Oregon State University, USA; Beth Fulton, CSIRO, Australia; Isaac Kaplan, NOAA NWFSC, USA; Lisa Kerr, GMRI, USA, Sonia Sánchez-Maroño, AZTI, Spain, Robert Thorpe, CEFEAS, UK, Cassidy Peterson, NOAA SEFSC, USA; Alfonso Perez-Rodriguez, Spanish Institute of Oceanography, Spain.

Content: To maintain resilience of fish populations under climate change and limit sociological and eco-nomic impacts, future fishery management advice needs to be robust to uncertainty in climate-driven fisheries responses. The focus of this session will be on the use of management strategy evaluation (MSE) to assess robustness of current and novel, climate-ready fishery management strategies in a changing ocean. In addition to MSEs, we welcome contributions on methodological advances in stock assessment and operating models to simulate climate-driven changes in distribution, fleet dynamics, productivity, and foodweb interactions, including but not limited to, spatially explicit models, multispecies models, and environmentally enhanced stock assessments. We also encourage presentations highlighting the use of ecosystem indicators to directly inform harvest control rules and dynamic spatial management strategies.

S16: Emerging challenges in socio-ecological systems brought about by climate-related ecosystem changes and how to equitably manage them

Chairs: Rachel Seary (Corresponding), University of California, Santa Cruz and NOAA Southwest Fisheries Science Center, USA; Tim Frawley, University of California, Santa Cruz and NOAA Southwest Fisheries Science Center, USA; Felipe Quezada, University of California, Santa Cruz and NOAA Southwest Fisheries Science Center, USA.

Content: Climate change is restructuring ocean ecosystems and creating new challenges and opportunities for marine resource dependent individuals, communities, and industries. Novel environ-mental conditions increasingly necessitate management intervention in order to protect essential habitat, ensure resources sustainability, and reduce bycatch and other human wildlife conflicts. Critical in ensuring effective climate adaptation and the equitable distribution of associated costs and benefits will be measuring the response of individuals, communities, and industries to eco-system changes and the policies enacted to manage them. This session will discuss how socio-economic impacts can be measured and effectively communicated and how policies and interventions can be designed with equity across different resource user and stakeholder groups in mind. It will highlight the ever-expanding suite of tools available to fisheries managers and practitioners and discuss their relative suitability and success with addressing different objectives in diverse human and ecological contexts, and evaluate the implications of their use for different resource user and stakeholder groups.

S17: Coupling social science and economics in integrated marine climate modelling efforts

Chairs: Mitsutaku Makino (Corresponding), University of Tokyo, Japan; Alan Haynie, ICES, Copenhagen, Denmark; Katell Hamon, Wageningen Economic Research, Netherlands; Kanae Tokunaga, Gulf of Maine Research Institute, USA.

Content: The scientific community has recognized that the marine environment is a social-ecological system and that climate change alters human relationships with the biophysical environment. Social scientists have increasingly focused on understanding how climate change impacts human communities and their resource use so that local, national, and global adaptation and mitigation efforts can effectively address the needs of diverse stakeholders. We invite quantitative and qualitative presentations that couple social and economic modelling and research with integrated biophysical climate modelling efforts. We especially welcome work about when global approaches such as shared socio-economic pathways (SSPs) are appropriate vs. when local approaches are necessary or effective.

S18: Beyond blue carbon: Ocean-based carbon dioxide removal (CDR) approaches

Chairs: Darren Pilcher (Corresponding), Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington, USA; Brendan Carter, Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington, USA; Tiziana Luisetti, Centre for Environment, Fisheries & Aquaculture Science, UK; Prateep Nayak, Faculty of Environment, V2V Global Partnership, University of Waterloo, Canada.

Content: Recent reports suggest that carbon dioxide removal (CDR) is required to stabilize global temperatures following the Paris Climate Accords. The oceans, as one of the largest natural carbon sinks, are an ideal option for this removal, however, there are significant hurdles to overcome. This session will discuss the current natural science gaps in ocean CDR techniques (e.g. alkalinity enhancement, ocean fertilization), in addition to the economic, social science and governance knowledge required to ensure efficiency and effectiveness of CDR approaches (including blue carbon) and cooperation between diverse stakeholders and sectors in providing ocean-based solutions to tackle climate change.

S19: Ocean Acidification Research for Sustainability

Chairs: Katherina Schoo (Corresponding), IOC-UNESCO, Paris, France; Jan Newton, GOA-ON co-chair and University of Washington, USA; Steve Widdicombe, GOA-ON co-chair and Plymouth Marine Laboratory, UK.

Content: The United Nations Decade of Ocean Science for Sustainable Development Programme "Ocean Acidification Research for Sustainability (OARS)" will provide ocean acidification (OA) data and evidence, identify data and evidence needs for mitigation and adaptation, co-design and implement observation strategies, and increase understanding of OA impacts to protect marine life, by 2030. To ensure its success, OARS will require collaboration across the global OA community, spearheaded by OARS "co-champions" to coordinate these efforts. This session invites contributions that highlight activities addressing the 7 outcomes of OARS, such as OA biogeochemical and biological observations, data management, projections, capacity development and science-policy efforts.

2.3 Side events, workshops, and special sessions

2.3.1 Workshops

W1: A systematic and rapid assessment of climate vulnerability and adaptation in marine and coastal areas

Chairs: Jon Day (Corresponding), James Cook University, Australia; Scott Heron, James Cook University, Australia.

Content: Assessing vulnerability to climate change of cultural and natural heritage within marine and coastal areas (and beyond) begins with a clear definition of the objectives and the desired characteristics and implementation components of the assessment process. This workshop seeks to draw upon applications of climate vulnerability assessment tools and reflections by participants who have undertaken these. By sharing lessons learned, and benefits and limitations of different approaches, the workshop will seek to provide guidance for future applications and practitioners on how to effectively assess climate vulnerability – and how to work out what to do in response to help marine and coastal areas better cope with climate change. Implementing actions to reduce vulnerability can be affected by political and fiscal realities but can also benefit from broader perspectives across practitioner networks, which also require guidance and/or maintenance.

W2: The Climate-Fisheries Nexus Within the UN Decade of Ocean Science for Sustainable Development: Co-Designing Actions and Solutions for a Productive, Healthy and Resilient Ocean

Chairs: Steven Bograd (Corresponding), NOAA Fisheries, USA; Claudia Baron-Aguilar, University of South Florida, USA; Hannah Lachance, NOAA Fisheries, USA; Jörn Schmidt, ICES, Denmark

Content: The UN Decade of Ocean Science for Sustainable Development (2021–2030) addresses challenges associated with ecosystem health, food security, and climate change through synergistic programs, including SmartNet (network to advance and share scientific understanding of marine ecosystems); SUPREME (advance ocean forecasts and projections to guide climate-informed re-source management); FishSCORE (sustain fisheries, protect ocean ecosystems, and enhance equitable benefits); Marine Life 2030 (coordination to deliver actionable knowledge of ocean life and ecosystem restoration); and ECOP (empower early career ocean professionals and incorporate new thinking into ocean sustainability and stewardship). Workshop participants will learn about these and other Decade programmes, share knowledge and capacity, establish collaborative networks to advance Ocean Decade goals, and co-design transformative actions for the climate-fisheries nexus.

W3: Reconstructing past marine ecosystems and their interactions with climate

Cancelled

W4: A global ensemble of comparable marine ecosystem models to project climate risk to species and human communities

Chairs: Isaac Kaplan (Corresponding), NOAA NWFSC, Cameron Ainsworth, University of South Florida, USA; Gavin Fay, University of California Santa Cruz, USA; Elizabeth Fulton, CSIRO, Australia; Joseph Caracappa, NOAA, USA; Cecilie Hansen, Institute of Marine Research, USA; Pierre-Yves Hernvann, University of Massachusetts, Dartmouth, USA; Owen Liu, NOAA, USA; Hem Nalini Morzaria Luna, Long Live the Kings and NOAA, USA; Holly Perryman, University of South Florida, USA; Alberto Rovellini, University of Washington, USA; Rebecca Scott, University of South Florida, USA.

Content: Ensembles of coupled climate-marine ecosystem models have great potential to illustrate risks of global change and vulnerabilities of marine species and human communities and industries. These models are expected to inform the Seventh Assessment Report (AR7) of the IPCC and local efforts such as the (US) National Climate Assessment. A grand challenge of such ecological ensembles is grappling with uncertainty, in particular structural uncertainty

stemming from alternate ecological parameterization of responses to temperature, oxygen, and pH. In this workshop we will apply a global ensemble of 7+ Atlantis ecosystem models, built on a common modelling framework and code base. We aim to engage the broader ECCWO community to collectively in-form ecological parameterization of metabolic and spatial movement responses to climate change. Our goal is to identify future trends in regional ecosystem responses likely to stem from standardized, downscaled ocean projections.

W5: S-CCME/SICCME Workshop on integrated modelling to identify climate change tipping points in marine ecosystems

Chairs: Kirstin K. Holsman (Corresponding), NOAA Alaska Fisheries Science Center, USA; Elliott Hazen, Southwest Fisheries Science Center, USA; Kathy Mills, Gulf of Maine Research Institute, USA.

Content: Marine ecosystems are increasingly impacted by multiple climate change and non-climate stressors that are pushing some systems and species towards or past tipping points (critical points where a small change in a pressure or driver can induce a disproportionate change in system dynamics). The goal of this workshop is to draw upon recent PICES and ICES working group efforts to synthesize findings and outputs from recent integrated modelling projects across the globe. In particular, the workshop will review evidence and case studies for historical and future tipping points and thresholds in marine ecosystems to help support climate-informed management advice.

2.3.2 Other sessions

AQUACULTURE SPECIAL SESSION - Building Collaborations to Identify and Address Knowledge and Technology Gaps with the Goal of Promoting Resilient Aquaculture in the Face of Climate Change

Chairs: Michael Rust, Hubbs Seaworld Research Institute, San Diego CA, USA; Cliff Cosgrove, NOAA, Office of Aquaculture, Silver Spring MD, USA; Satoshi Watanabe, Fisheries Research and Education Agency, Kanagawa, Japan; Ann-Lisbeth Agnalt, Institute of Marine Research, Bergen, Norway; Albert Valdish Manuel, Fisheries Research and Education Agency, Nagasaki, Japan; Daniel Wieczorek, NOAA, Office of Aquaculture, Silver Spring MD, USA.

Content: Climate impacts to seafood supplies will be felt at different degrees based on geographic location. Nevertheless, there are common but currently unagreed upon strategies that need to be developed to ensure resilient seafood from aquaculture. In addition, there are gaps in knowledge which need to be addressed before aquaculture is fully realized with respect to promoting global food security. This session will aim to begin to identify those gaps and begin the process of an ordered transition to climate resiliency. This workshop is designed to: 1) make connections among researchers, 2) to begin to identify the most likely and impactful changes driven by cli-mate on aquaculture, and 3) to explore options for systematic analysis and reporting so that the scientific communities are focused and organized. Our working model would be to organize aquaculture experts to eventually develop a report(s) analogous to the annual risk survey put out by the World Economic Forum but with an aquaculture/climate focus. In addition to risks, we will include how aquaculture may present opportunities to adapt and potentially mitigate the effects of climate change.

The session will begin with a plenary presentation to set the context, outline the progress to date, and highlight the interactive workshops to follow. The workshop will use online tools to ask for attendee input over three 45-minute sessions and will add to similar data collected at other workshops (ICES Workshop on pathways to climate-aware advice, NOAA lead Climate

Conversations with the US aquaculture industry). Data collected from the first workshop session will be an articulation by the attendees of the most important risks and opportunities presented by cli-mate change to aquaculture produced seafood. The second workshop session will explore an organizational structure (working groups) and include commitments from members of the scientific community who wish to continue working on this issue. The final workshop will outline a suggested reporting format and include suggestions for moving forward.

SUPREME SPECIAL SESSION: SUstainability, Predictability, and REsilience of Marine Ecosystems (SUPREME) - A UN Decade of Ocean Science Programme to advance climate-informed marine ecosystem management

Chairs: Steven Bograd (Corresponding), NOAA, Northwest Fisheries Science Center, Monterey CA, USA; Edward Gorecki, NOAA, Office of Science and Technology, Silver Spring MD, USA; Roger Griffis, NOAA, Office of Science and Technology, Silver Spring MD, USA; Hannah Lachance, Leading Solutions in support of NOAA, Office of Science and Technology, Silver Spring MD, USA; Grace Roskar, ECS Federal in support of NOAA, Office of Science and Technology, Silver Spring MD, USA.

Content: The SUstainability, Predictability and REsilience of Marine Ecosystems Programme (SUPREME) is an interdisciplinary programme under the UN Decade of Ocean Science for Sustainable Development (UNDOS). SUPREME is convening a voluntary network of global partners to share in-formation and advance production of robust climate- and ocean-related forecasts, predictions, and projections to guide effective marine ecosystem management and adaptation strategies in a changing climate. The network is designed to bring together partners working on or interested in developing these tools to 1) provide easy access to information, examples, experts and peers and 2) to help advance this important field through sharing successes, challenges, and lessons learned.

This session will bring together current members and interested parties to learn about the SU-PREME Programme and start to build areas of action based on input from previous discussions of gaps and needs. The session will include a brief overview of the Programme, proposed activities for the first phase of the Programme, followed by a discussion of how to advance areas of interest to network participants. The session will conclude with a discussion of how partners can engage with, contribute to and benefit from the Programme to help advance climate-informed marine ecosystem management. The input from this session will be used by the SUPREME Steering Committee to continue mapping out next steps for the Programme.

SCIENCE-POLICY-ACTION PANEL: How is ocean science used in policy and action?

Chairs: Jörn Schmidt, ICES, Denmark.

Content: Marine science is critical to inform international policies, legislation, and action. Over the past 10 years policy and decision-makers increasingly recognized the role of the ocean and coastal zones in adapting to and mitigating climate change as well as for sustainable development. This session will provide an overview on the science-policy-action value chain, introducing global frameworks, which make use of the knowledge generated by marine scientists all over the world. The multidisciplinary panel will discuss different science-policy mechanisms, such as international topical working groups and assessments and how these are translated into regulatory frameworks and action, emphasizing existing challenges and opportunities.

ECOP EVENT: Conducting Science at the Intersection of Climate Change and Marine Ecosystems: A Networking Session and Discussion

Chairs: Erin Satterthwaite (Corresponding), California Sea Grant & CalCOFI, Scripps Institution of Oceanography, UCSD, USA; Natalya Gallo, Department of Biological Sciences, University of Bergen, Norway & Bjerknes Centre for Climate Research; Dawn Barlow, Oregon State University, USA; Yassir Eddebbar, Center for Climate Change Impacts and Adaptation, Scripps Institution of Oceanography, UCSD, CA, USA; Taraneh Westergerling, University of Bergen/Institute of Marine Research, Norway; Emilie Vereide, University of Oslo/Institute of Marine Research, Norway; Holly Perriman, College of Marine Science, University of South Florida, St Petersburg, FL USA; Julie Keister, NOAA AFSC, Seattle, WA USA; Sonia Batten, PICES Secretariat, Canada; Steven Bograd, NOAA SWFSC, Monterey, CA, USA; Hannah Lachance, International Fisheries Science Specialist, Leading Solutions in support of NOAA Fisheries, USA.

Content: An ECOP is someone who self-identifies as an early career professional at the beginning of their career, with ten years or less of professional experience.

Developing lasting relationships is an essential part of efforts to build a community to address sustainability and resilience in a changing climate. This session will bring together professionals across career stages, sectors, disciplines, and countries for networking and connection. Specifically, participants will engage in interactive roundtable discussions, to explore topics at the intersection of climate change and marine ecosystems. The session will contribute to ongoing discussions throughout the conference in thematic workshops, sessions, and other conference events. The synthesis of the roundtable discussions will inform a summary document which will be published as a short article in the PICES Press.

The session will conclude with an opportunity to join an informal net-walk, a networking session while walking.

2.4 Participation

Number of participants: There were 716 attendees (462 in-person, 254 online).

55% were female. 314 were Early Career Ocean Professionals

Participants came from 71 countries.

Number of contributions: There were 19 sessions comprising 9 plenary, 26 invited and 258 contributed oral presentations. There were 186 posters (37 online, 149 in-person during the poster session).

2.5 Scientific steering committee

Alan Baudron, Marine Scotland, UK

Laurent Bopp, CNRS, France

Lisa Colburn, NOAA, USA

Emanuel Di Lorenzo, Georgia Institute of Technology, USA

Carlos Duarte, King Abdullah University of Science and Technology, Saudi Arabia

Yimnang Golbuu, Palau International Coral Reef Center, Palau

Randi Ingvaldsen, IMR, Norway

Noel Keenlyside, University of Bergen, Norway

Sonya Legg, CLIVAR

Mitsutaku Makino, University of Tokyo, Japan

Caterina Martins, MOWI, Norway

Anna Metaxas, Dalhousie University, Canada

Ben Milligan, University of New South Wales, Australia

Kathy Mills, GMRI, USA

Christian Möllmann, University of Hamburg, Germany

Ivonne Montes, Instituto Geofisico de Peru, Peru

Daniel Murdiyarso, CIFOR

Elena Ojea, University of Vigo, Spain

Tsuneo Ono, Japan Fisheries Research and Education Agency, Japan

Edna Quansah, University of Ghana, Ghana

Ana M. Queirós, PML, UK

Erin Satterthwaite, UCSD/CalCOFI, USA

David Schoeman, University of the Sunshine Coast, Australia

Lynne Shannon, University of Cape Town, South Africa

Jaqueline Uku, Kenya Marine and Fisheries Research Institute (KMFRI), Kenya

Thomas Wernberg, IMR, Norway

2.6 Organizing committee

See Convener information above.

2.7 Sponsors

2.7.1 Primary International Sponsors

International Council for the Exploration of the Sea (ICES): http://www.ices.dk/

North Pacific Marine Science Organization (PICES): http://www.pices.int/

Intergovernmental Oceanographic Commission of UNESCO (IOC): http://ioc.unesco.org/

Food and Agriculture Organization of the United Nations (FAO): http://www.fao.org/

2.7.2 Local Host

Institute of Marine Research, Norway (IMR): https://www.hi.no/en

2.7.3 Co-Sponsoring Organizations

North Pacific Research Board, USA (NPRB): http://www.nprb.org/

2.7.4 ECOP presentation awards

Journal of Marine Science and Engineering (JMSE): https://www.mdpi.com/journal/jmse

Orienting Young ScienTists of Euromarine (OYSTER): https://euromarinenetwork.eu/oyster/

2.7.5 Travel support

National Science Foundation (NSF): https://www.nsf.gov/

Woods Hole Oceanographic Institution (WHOI, USA): https://www.whoi.edu/

Scientific Committee on Oceanic Research (SCOR): http://www.scor-int.org/

2.8 Outputs

Special issue of ICES Journal of Marine Science (deadline for submission of manuscripts 30 September 2023)

2.9 History and future

The history and content can be accessed on the symposia website: https://meetings.pices.int/meetings/international/2023/eccwo-5/scope (lower right hand side menu)

Planning and discussions for ECCWO6 will start soon.

3 Human Impacts on Marine Functional Connectivity

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Venue and dates: Sesimbra, Portugal, 22–25 May 2023

Conveners:

Lúcía López López, CN IEO, CSIC, Spain

Manuel Hidalgo, CN IEO, CSIC, Spain

Susanne Tanner, MARE/University of Lisbon, Portugal

Ant Türkmen, LifeWatch ERIC, Italy

Maria Beger, University of Leeds, UK

Host: MARE/University of Lisbon & CFE/University of Coimbra, Portugal

3.1 Summary

Driven by marine organismal movements, marine functional connectivity is a dynamic ecosystem property which sustains multiple ecological functions and marine ecosystem services through the spatio-temporal fluxes of nutrients, biomass, genes, and species. In the last decade, research has focused on understanding the drivers of marine connectivity and its role at the ecosystem level, but a critical lack of knowledge of how marine connectivity will respond to current

and future human impacts persists. Filling this research gap is paramount to design effective strategies for conservation, management and sustainable development. This has been acknowledged by the recent nomination of the COST Action SEA-UNICORN as an action of the UN Decade of Ocean Science for Sustainable Development 2021-2030, due to the essential role of marine connectivity for the future health of our oceans and coasts and the need to preserve this ecosystem property to the benefit of humanity.

The objective of this symposium was to gather the latest research on changes in marine connectivity under anthropogenic pressures, including the ubiquitous effects of global warming (e.g. increases in water temperature and extreme weather events, changes in oceanic circulation) but also regional human activities modifying marine habitats and ecosystems (e.g. fishing, offshore wind farms, shipping, aquaculture). Emphasis was placed on describing the effects on connectivity of a wide range of human activities at different scales, pinpointing cumulative impacts where possible, and showcasing adaptive management strategies.

These objectives aimed to contribute to:

- advancing ecosystem science, and particularly connectivity research
- exploring pressures on the marine environment that modify its structure and function
- advancing frameworks for ecosystem management and conservation and advising on options for adaptation and mitigation

This symposium brought together a diverse group of multi-skilled experts working in the emerging field of marine connectivity, to exchange knowledge and experience, and gather high-quality scientific articles for a special issue, which will help to shape marine connectivity research directions and to better fulfil management needs in the future.

3.2 Sessions

Pervasive human impacts on the environment and trends in marine connectivity

Chairs: Audrey Darnaude, CNRS, France; Konstantina Agiadi, University of Vienna, Austria.

Content: Humans have depended on and impacted marine ecosystems for thousands of years. From fishing and aquaculture to habitat destruction, pollution, climate change, and the expansion of offshore renewable energy and mining or fossil fuel extraction, impacts have diversified, often becoming chronic, modifying benthic and pelagic seascapes and ultimately impacting marine connectivity. Moreover, human activities have directly resulted in the forced, intentional and unintentional connection of marine populations, and the transport of non-indigenous species into new areas.

This session called for studies on temporal changes in marine connectivity patterns associated with human impacts, and their consequences on resource or ecosystem resilience.

Responses of marine connectivity to environmental extremes and incidental human impacts

Chairs: Lucía López López, IEO-CSIC, Spain; Susanne Tanner, MARE/University of Lisbon,

Portugal; Filip Volckaert, KU Leuven, Belgium.

Content: Incidental human impacts (e.g. oil spills, marine infrastructures) or increasingly frequent extreme events resulting from climate change (e.g. increasing frequency and severity of storms, marine heatwaves) are known to have profound and long-lasting impacts on the structure and functioning of marine ecosystems. Such impacts can also alter recurrent connectivity pathways of marine organisms and/or alter the functional implications of connectivity.

This session called for studies assessing the implications of incidental impacts and extreme events on connectivity processes. These may include studies that are field-, laboratory-, or model-based, or any combination of these. Research topics included, but were not limited to, movement ecology, behavioral ecology, biogeochemical cycles, foodweb studies, and the development of analytical methods and tools to investigate these processes.

Human impacts on species phenology and seasonality in marine connectivity

Chairs: Manuel Hidalgo, IEO- CSIC, Spain; Antonina do Santos, IPMA, Portugal; Filipe Martinho, CFE - University of Coimbra, Portugal.

Content: Marine ecosystems are characterized by strong seasonal variability of productivity and critical ecological processes across multiple trophic levels, shaping population and ecosystem dynamics. Climate change is known to substantially shift the timing of key seasonal processes, while supplementary human pressures can also impact functional connectivity.

This session called for studies assessing impacts on connectivity processes through direct or indirect human-induced alteration of the timing of environmental and/or ecological seasonal events.

Critical connectivity hubs and pathways at sea and the land-sea interface

Chairs: Anna Sturrock, University of Essex, UK; Maria Beger, University of Leeds, UK.

Content: Connectivity is defined by the flux of organisms across habitat patches and underpins ecological functions. Understanding the key hubs and pathways linking patches is critical to quantifying marine functional connectivity and implementing effective resource management. Importantly, humans have disrupted natural connectivity. Climate change, habitat fragmentation and spatially explicit stressors, such as shipping and fisheries, can reduce flows, but they can also modify pathways and create new ones, promoting the spread of invasive species.

This session called for studies assessing the role of critical habitats and pathways, physical structures, animal movement, individual behavior etc. on supporting and/or modifying connectivity, and how such knowledge can inform actions to preserve and manage it.

Using marine connectivity to inform management strategies and mitigate human impacts

Chairs: Ant Türkmen, LifeWatch ERIC, Italy; Burak Ali Çiçek, Eastern Mediterranean University, Cyprus.

Content: Marine ecosystems are connected – any management of marine habitats and species should be informed by marine connectivity to enhance recruitment, genetic exchange, and ontogenetic movement, as well as to avoid harmful connectivity of pathogens and pollutants. Marine resources are increasingly threatened, degraded or destroyed by human activities, reducing their ability to provide crucial ecosystem services. Important threats are, climate change, marine pollution, unsustainable extraction of marine resources and physical alterations and destruction of habitats and landscapes. Good governance, globally accepted targets, sustainable marine based human activities and adequate measures will be required to reduce the negative anthropogenic impacts on the marine environment. Projects and measures should ideally be designed and implemented in an integrated manner, in line with the ecological connectivity approach and involving all stakeholders.

This session aimed to showcase examples of connectivity-smart management and challenges, and the approaches required to achieve this. Presentations highlighted how the ecological, biophysical, and social dimensions of connectivity can or have informed marine management.

3.3 Side events and workshops

Science Communication Workshop: The Video Lab - Impactful science communication with your smartphone

Chair: Dávid Kulcsár, ICES, Denmark.

Content: This training workshop is aimed to early career scientists, with objective of providing a set of useful tools to improve their science communication skills through capturing compelling video footage using just their smartphone. The trainer discussed the most important factors to take into account, from lighting, angle, sound to content, providing practical tips and suggestions of userfriendly tools that will ECS. The session included practical exercises to produce a short video script based on a scientific text, identifying the main messages to capture the audience attention.

Workshop 1: Geohistorical perspectives on functional connectivity patterns

Chairs: Konstantina Agiadi, University of Vienna, Austria; Bryony Caswell, University of Hull, UK; PAGES-Q Mare.

Content: Geohistorical data are fundamental for understanding current species distributions, including their origin, movement, and vectors (whether they be natural or anthropogenic). Historical records can include documents and images, oral history, museum collections or archaeological records (e.g. shell middens) that can be used to recreate species distributions and track the rates, pathways and consequences of species movements. Geological records, from the recent and deeper past, can help us to understand the consequences of species redistribution due to natural environmental changes at geological time-scales including long-term patterns associated with climate change.

This workshop aimed to review the available resources, techniques and applications of geohistorical data in providing a baseline of pre-industrial changes in functional connectivity patterns, anticipating future species distributions, and the consequences for communities and ecosystem services.

Workshop 2: Marine connectivity, marine policy and stakeholder engagement

Chairs: Yael Teff-Seker, University of California Davis, USA; Anna Maria Addamo, Nord University, Norway; Peter Mackelworth, Blue World Institute, Croatia.

Content: The impacts on marine connectivity should be taken into consideration when developing marine policy for an ever-changing environment. Climate change and other old and new anthropogenic impacts (e.g. land-based pollution, offshore wind, overfishing, etc.), are having a compounded impact on marine functional connectivity. However, scientists studying marine connectivity often find it challenging to translate their work into policy and to reach the relevant stakeholders and decision-makers.

This workshop addressed these challenges and provided tools for scientists working at the science-policy interface. The first half of the workshop focused on how to engage government and NGO stakeholders to encourage the incorporation of marine connectivity and anthropogenic impacts in decision-making processes, planning, and policy. The second half of the workshop

addressed the challenges of cross-border cooperation, both within the EU and shared boundaries with non-EU countries. This type of cooperation requires collaboration of scientists and policymakers across multiple countries and organizations in order to ensure that marine connectivity is maintained or improved across wider marine areas.

3.4 Participation

Number of participants: 108 participants, of which 59 were early career researchers. Participants were from 26 different countries, 65% were female and 35% male.

Number of contributions: There were 5 different theme sessions with a total of 62 oral presentations and 25 poster presentations.

There was no specific evaluation of the conference shared among participants, but informal feedback received by the conveners was very positive.

3.5 Scientific steering committee

Audrey Darnaude, CNRS, France

Anna Sturrock, University of Essex, UK

Filip Volckaert, KU Leuven, Belgium

Federica Costantini, University of Bologna, Italy

Yael Yael Teff-Seker, University of California Davis, USA

Ewan Hunter, AFBI, UK

Antonina dos Santos, IPMA, Portugal

Debbi Pedreschi, Marine Institute, Ireland

Francisco Velasco, IEO-CSIC, Spain

Lidia Yebra, IEO-CSIC, Spain

Julie Kellner, WHOI, USA

3.6 Organizing committee

Susanne Tanner, MARE/University of Lisbon, Portugal

Vanessa Fonseca, MARE/University of Lisbon, Portugal

Filipe Martinho, CFE/University of Coimbra, Portugal

3.7 Sponsors

In addition to ICES, there were three sponsors that contributed to the development of the symposium:

- SEA-UNICORN COST Action (https://www.sea-unicorn.com): It covered the local organization costs, the travelling and accommodation of keynote speakers (when not ECR) and the participation of many researcher of the COST action through travel grants.
- PAGES-Q Mare (https://pastglobalchanges.org/science/wg/q-mare/intro): It covered the participation of some researchers members of PAGES.
- Camara Municipal de Sesimbra, Sesimbra, Portugal (https://www.sesimbra.pt): It covered the use of the venue and other facilities needed for the successful local organization as well as offered the reception during the poster session.

3.8 Outputs

The communications presented to the Symposium are all invited to the Symposium issue offered in ICES Journal of Marine Science (https://academic.oup.com/icesjms/pages/symposium_issues) with the preliminary deadline being September 30th. In addition, the discussions during workshop 1 will build the basis for a review paper led by the workshop conveners.

3.9 History and future

This Symposium emerged as an activity associated to the Sea Unicorn COST action, which still has two years more of funding and activities, including the next International Marine Connectivity Conference which will be held next spring in Montpellier. This conference and other activities associated to this COST action will contribute to strengthen the network and collaborations initiated in the recent Symposium on Human Impacts on Marine Functional Connectivity.

4 Baltic Sea Science Congress

Venue and dates: Helsinki, Finland, 21–25 August 2023

Conveners:

Kai Myrberg, SYKE, Helsinki, Finland

Jari Haapala FMI, Helsinki, Finland

Host: SYKE and FMI, Helsinki, Finland

4.1 Summary

The purpose of the Congress was to bring together scientists working on issues related to the Baltic Sea Region to present the most recent research and to discuss status, trends and the future of the Baltic Sea as well as future research needs. The specific focus was on the UN Decade of Ocean Science for Sustainable Development. The Baltic Sea Science Congress 2023 was a part of the Finnish National Implementation Plan for the UN Decade of Ocean Science. The Congress was also a part of Finnish Presidency program (2023–2024) of the Council of the Baltic Sea States (CBSS).

The target audience of the Congress was scientists working within the field of natural science in relation to the Baltic Sea Region. We also invite the sharing of research from other coastal seas that was of general relevance to the topic of the Congress.

4.2 Sessions

The 14th Baltic Sea Science Conference (BSSC) was organized in Helsinki on 21–25 August 2023. The event brought together hundreds of scientists working on issues to present their most recent research results. The special focus of the BSSC was towards the implementation of the United Nations Decade of Ocean Sciences (UNDOS) objectives related to the Baltic Sea research. Scientific sessions were guided by the overall theme of the UNDOS phrases as "the science we need for the ocean we want".

In addition to discussion on recent scientific results, the conference facilitated discussion on status, trends, and the future of the Baltic Sea and its catchment area. This forms a part of the global ocean studies, planning of joint research activities and interaction among science and society.

The conference sessions thus covered a wide range of topics according to the objectives of Decade of Ocean Science in the Baltic Sea:

1. A clean Baltic Sea
2. A healthy and resilient Baltic Sea
3. A productive Baltic Sea
4. A predictive Baltic Sea
5. A safe Baltic Sea
6. An accessible Baltic Sea
7. An inspiring and engaging Baltic Sea

The conference was multidisciplinary and it had common panels for policy and decision-makers. We aimed at a common conference memo "the science we need for the Baltic Sea we want". This means knowledge exchange between marine scientists in order to contribute to informed society and policy decisions for sustainable management of the Baltic Sea today and future.

We also invited the sharing of research from other coastal seas that are of general relevance to the topic of the Congress. In particular, we encourage presentations focusing on coastal and marginal seas that contribute to the UN Decade of Ocean Science for Sustainable Development.

BSSC2023 focused on seven sessions:

A clean Baltic

Chairs: Kai Myrberg; Aarno Kotilainen; Kari Hyytiäinen; Inna Sokolova; Taavi Liblik.

Content: A clean Baltic Sea where sources of pollution are identified and reduced or removed.

This session focused on the Baltic Sea pollution with natural and man-made harmful substances, heat, and noise. We welcomed studies related to monitoring, managing, and predicting existing pollution sources on land and sea as well as identifying potential future sources of pollution due to e.g. offshore wind energy production, dredging, shipping, aquaculture, or from other growing sectors. Observational and modelling studies on the circulation and transport of pollutants were highly encouraged. This is important for evaluating the patterns and movement of various substances in the sea. Studies on the environmental impacts of natural and anthropogenic pollutants on the Baltic Sea biota and the hazard and risk assessment of the emerging pollutants on the Baltic Sea ecosystems from organisms to populations and communities were of interest. Theoretical and numerical economic research including cost-effectiveness and cost–benefit analyses on alternative environmental projects, mitigation measures or policy instruments were welcomed. Studies on modelling the land-coast-sea continuum were encouraged.

A healthy and resilient Baltic

Chairs: Alf Norkko; Astra Labuce; Karol Kulinski; Maren Voss; David N. Thomas; Jacob Carstensen.

Content: A healthy and resilient Baltic where marine ecosystems are understood, protected, restored and managed.

The Baltic Sea is at the forefront of global change where its sensitive ecosystems are struggling with a legacy of multiple anthropogenic pressures: Including marine biodiversity, the provision of ecosystem services, but also its resilience to additional change. Accelerating climate change highlights the urgent need to understand future ecosystem trajectories in order to better protect and restore the Baltic Sea. To address the societal concerns on the state of the Baltic Sea (including underlying physics and biogeochemistry), we welcomed submissions emphasizing biogeochemical cycles, biodiversity and foodweb dynamics. We encouraged both experimental and modelling studies that address environmental drivers and their relationship with the structure and function of the ecosystem: From short- to long-term variability and spanning timescales from the paleo perspective through the recent past and into the future, which combined helped us understand the trajectories of change. Moreover, the evaluation of marine protected areas as well as the impact of climate change and other anthropogenic pressures on marine biodiversity and ecosystem services were discussed. The implications for improved ecosystem-based management in a rapidly changing ecosystem were highlighted.

A productive Baltic

Chairs: Arttu Polojärvi; Gregor Rehder; Meri Kallasvuo; Nina Tynkkynen.

Content: A productive Baltic supporting sustainable food supply and a sustainable ocean economy.

Increasing demand on using marine space for energy and food production, material sourcing and other marine activities cause additional pressures on the Baltic Sea ecosystem and cause conflicting interests. This session invited interdisciplinary studies related to natural resource management, coordination of conflicting interests as well as impacts of large-scale energy and food production and marine livelihoods on the marine ecosystem and coastal society. Also, papers on technological and circular economy solutions to minimize footprint of offshore activities on the ecosystem were encouraged.

A predictive Baltic

Chairs: Markus Meier; Inga Dailidiene; Inna Sokolova.

Content: A predictive Baltic where society understands and can respond to changing ocean conditions.

Impact of the climate change for the Baltic Sea conditions is already now manifested in shrinking ice cover, amplified marine heat waves and increasing eustatic sea level rise. Regional climate model projections indicate continuation of these changes but also emphasizes strong decadal scale natural variability. In this session, we invited contributions on assessing uncertainty of climate projections to Baltic Sea scale, in particular for salinity, estimations changes in marine extreme events and their impact on infrastructure, societies and human health.

A safe Baltic

Chairs: Laura Tuomi; Arttu Polojärvi; Inga Koszalka; Vibeke Huess.

Content: A safe Baltic where life and livelihoods are protected from ocean-related hazards.

Marine hazards in the Baltic Sea are related but not limited to storms, storm surges and coastal flooding, extreme waves, icing, coastal erosion, harmful algal blooms and marine heat waves. This session called for papers focusing on development of deterministic, probabilistic and statistical modelling and prediction systems. We also encouraged studies related to improving coastal protection, safety of marine traffic, and recreational use of the Baltic Sea.

An accessible Baltic

Chairs: Jari Haapala; Laura Uusitalo; Joanna Staneva.

Content: An accessible Baltic with open and equitable access to data, information, technology and innovation.

During the last decade, remarkable progress has occurred in utilization of automatic real time instruments in the Baltic Sea monitoring, development in numerical modelling systems as well as digitalization in shipping and other marine industry sectors. Increasing number of the operators follow the FAIR principles (Findable, Accessible, Interoperable, Re-usable data) but still much of the data are difficult to access.

A goal of this decade should be the development of the Digital Twin of the Baltic. This system should be a next generation decision-making system for the Baltic Sea community. It should integrate all available data describing the state of the Baltic Sea as well as on human activities. It should be built on the basis of open source data and code as the other EU initiatives of

Destination Earth. This session invited studies on developments of new sensors and automatic ocean monitoring systems, utilization of satellite data, integration and interoperability of data sources, numerical models, and machine learning techniques on determining the state of the Baltic Sea as well as the development of ocean models for exascale computing.

An inspiring and engaging Baltic

Chairs: Paula Kankaanpää; Anda Ikauniece; Kai Myrberg.

Content: An inspiring and engaging Baltic where society understands and values the ocean in relation to human well-being and sustainable development.

The objective was to discuss how to engage wide public, interest groups and educators on topics of ocean sustainability. It presented science based decision support tools, described inclusive and holistic policy processes and discussed how to include market and non-market valuation of marine ecosystems and cultural perspectives into decision-making. It presented novel research about the interface of marine science and policy and exchanges best practices. It aimed at inspiring new innovations on ways, methods and resources of engagement and coproduction of knowledge, as well as formal and informal education on sea and marine sustainable development. The session contributed to the ocean literacy topic of the Decade of Ocean science: "the ocean influence of you, and your influence on the ocean".

4.3 Side events, workshops, and special sessions

Press conference

Content: Monday, 21 August, 16:30–17:30

Panel Discussion: Finance for Baltic Sea biodiversity

Chairs: WWF Finland

Content: Monday, 21 August, 16:45–18:00.

The newly adopted Global Biodiversity Framework acknowledges the need to increase finance to protect and restore nature. Similarly, to bring back a healthy Baltic Sea, financing harmful activities must stop, and funds and resources for biodiversity need to be mobilized. Today funding for biodiversity largely comes from governments and public funds, but to halt and reverse the loss of biodiversity both financial actors and business must help close the finance gap for biodiversity.

This session started off by looking at current financial flows into the Baltic Sea maritime economy and then discussed what is needed to incentivize investments in sustainable practices and a shift away from business as usual. We also explored what role financial actors and businesses can play in helping protect and restore the Baltic Sea, and how science can help enable mobilizing finance for biodiversity.

Panelists:

Johanna Källén Fox, WWF

Jukka Ahonen, Nordic Investment Bank

Dennis Hamro-Drotz, NEFCO

Patrick Lees TAI Malin Sjöblom, OX2

Nina Tynkkynen, Åbo Akademi

Enclosed Lagoons: What Don't We Know But Should

Chairs: Mindaugas Zilius, KU MRI; Maren Voss, IOW.

Content: Wednesday, 23 August, 12:30–14:00

BSSC Technology Workshop

Chairs: Regine Labrenz, IOW; Jari Haapala, FMI.

Content: Friday, 25 August, 8:30–10:30.

As part of the Baltic Sea Science Conference, we organized again a half-day technology workshop. The workshop aimed to provide a platform for communication on technological innovation or new applications in marine research.

This year the focus was supposed to lie on automatic ocean and sea ice measurement systems and sensors in major infrastructure projects. The aim of the workshop was to bring together marine research infrastructure developers, ocean instruments manufactures and marine database developers to share and discuss needs, possibilities and prospects of real-time monitoring of the Baltic Sea.

Experts of the Baltic Sea Science community gave an overview of the latest upcoming trends and applications concerning data acquisition, analysis and processing. Suppliers or manufacturers took the chance to present their latest developments/innovative instruments for marine applications, research or monitoring to an audience of experts of marine science and the associated technologies.

The workshop offered the unique opportunity for discussions between scientists as well as users and developers and can establish new international cooperation all over the Baltic Sea Region and widen the marketplace for highly innovative and professional technologies.

4.4 Participation

Number of participants: 250

Number of contributions: 150 oral presentations, 50 posters.

4.5 Scientific steering committee

Jari Haapala Finland (Chair)

Elinor Andrén, Sweden

Jacob Carstensen, Denmark

Inga Dailidiene, Lithuania

Vibeke Huess, Denmark.

Kari Hyytiäinen, Finland

Anda Ikauniece, Latvia

Meri Kallasvuo, Finland

Arno Kotilainen, Finland

Karol Kulinski, Poland

Astra Labuce, Latvia

Taavi Liblik, Estonia

Markus Meier, Germany

Kai Myrberg, Finland

Alf Norkko, Finland

Arttu Polojärvi, Finland

Gregor Rehder, Germany

Inna Sokolova, Germany

David Thomas, Finland/UK

Laura Tuomi, Finland

Laura Uusitalo, Finland

Maren Voss, Germany

4.6 Organizing committee

Local Organizing Committee:

Kai Myrberg, Syke (Chair)

Ljudmila Vesikko, Syke

Eija Rantajärvi, Syke

Jari Haapala, FMI

Laura Tuomi, FMI

4.7 Sponsors

Finnish Environment Institute

Finnish Meteorological Institute

Ministry for Foreign Affairs of Finland

Prime Minister's Office of Finland

City of Helsinki

International Council for the Exploration of the Sea (ICES)

United Nations Decade of Ocean Science for Sustainable Development

Council of the Baltic Sea States

EU Missions: Restore our ocean waters (HorizonEU)

4.8 Outputs

Full programme:

https://www.syke.fi/en-US/Research__development/Research_and_development_projects/Projects/Baltic_Sea_Science_Congress_2023/Scientific_programme/Full_programme

BSSC2023: List of posters (pdf):

https://www.syke.fi/download/noname/%7BC13016FB-BE65-40B3-9EF1-7A99F9B57CE6%7D/181058

BSSC2023: Book of Abstracts (pdf):

https://www.syke.fi/download/noname/%7BE0FA248C-6A9C-43B5-B2F9-9D43116D4C33%7D/181059

4.9 History and future

Previous BSSC:

1996 October 22–26, Rønne, Denmark

1998 November 23–28, Warnemünde, Germany

2001 November 25–29, Stockholm, Sweden

2003 August 24–28, Helsinki, Finland

2005 June 20–24, Sopot, Poland

2007 March 19–23, Rostock, Germany

2009 August 17–21, Tallinn, Estonia

2011 August 22–26, St Petersburg, Russia

2013 August 26–30, Klaipeda, Lithuania

2015 June 15–19, Riga, Latvia

2017 June 12–16, Rostock, Germany

2019 August 19–23, Stockholm, Sweden

2021 October 18–22, Aarhus, Denmark

2023 August 21–25, Helsinki, Finland

Next BSSC:

2025 in Sopot, Poland

5 The Second International Symposium on Plastic Pollution in the Arctic and Sub-Arctic Regions

Venue and dates: Reykjavík, Iceland, 22–23 November

Conveners:

The Centre for the Ocean and the Arctic

UiT Arctic University of Norway

The Greenland Institute of Natural Resources

ICES

The United Nations Environment Programme (UNEP)

GRID Arendal

OSPAR

UNESCO IOC

PAME

The International Arctic Science Committee (IASC)

The UArctic, and the Polar Institute

Wilson Centre

Host: The Government of Iceland (Ministry for Foreign Affairs, Ministry of Food, Agriculture and Fisheries, Ministry of Environment, Energy and Climate)

5.1 Summary

Plastic pollution is of ever-growing concern. It is a well-known fact that plastic litter is omnipresent in our environment and the eventual sink for plastic waste is the world oceans. Even in the Arctic region plastic pollution is widespread. There is now a great urgency for actions to stem the plastic tide. Recently, the United Nations Environment Assembly adopted a broad negotiating mandate for a new legally binding international agreement to end plastic pollution. The new agreement is expected to include provisions to promote national and international cooperative measures to reduce plastic pollution in the marine environment.

Scientific research and studies into plastic pollution have been growing quite fast over the last couple of decades. It is essential that we take full advantage of the best available knowledge when we look for solutions to tackle this global problem. In March 2021, Iceland and the Nordic Council of Ministers hosted a successful First symposium on Plastics in the Arctic and Sub-Arctic Region with participants calling for a follow up in the near future.

For these reasons, the Government of Iceland, with the support of the Nordic Council of Ministers, will host a Second International Symposium on Plastics in the Arctic and Sub-Arctic Region at Harpa, Reykjavík Concert Hall and Conference Center, on 22-23 November 2023. The aim was to:

- gather scientific, Indigenous and local knowledge of plastic pollution and discuss ways and means to reduce the impact of plastics on Arctic ecosystems.
- build on the foundation of science of the first symposium and produce information and advice for decision-makers.
- foster exchange of views and updates of knowledge from various sources.
- evaluate the present extent and nature of plastic pollution in the Arctic and Sub-Arctic regions and discuss its impact on ecosystems and communities.
- address the origin of plastic litter, how it is transported to or in the Arctic and Sub-Arctic region and how breakdown processes are affecting the status of pollution will also be addressed.
- focus on possible mitigation methods and how they can be implemented and provide useful input to the ongoing negotiations on an international agreement on plastic polltion, and to other ongoing relevant international work to support protection of the marine environment.

5.2 Sessions

For information on session and summaries of content please see Annex 1, Annex 2 and Annex 3 for the conference program and summaries of day 1 and day 2, provided by GRID-Arendal.

5.3 Side events

Poster session

Approximately 40 posters were included and on displayed throughout both Symposium days.

5.4 Participation

Number of participants: 250 participants from 25 countries, including European, Scandinavian, North American, and Asian countries (Austria, Canada, China, Denmark, Finland, Germany, Greece, Greenland, Iceland, India, Ireland, Israel, Italy, Japan, Kenya, Netherlands, Nigeria, Norway, Poland, Portugal, South Korea, Sweden, Switzerland, Turkey, United Kingdom, United States). Gender balance appr. 50/50.

Number of contributions: In addition to opening and closing plenaries and three thematic plenaries there were 6 parallel thematic session with 64 oral presentations and approximately 40 posters.

The Symposium was very well received, and all received feedback has been positive.

5.5 Scientific steering committee

Scientific committee members were as follows:

Chair: Magnús Jóhannesson, Former Director of the Arctic Council Secretariat.

Hrönn Jörundsdóttir, Director General, Icelandic Food and Veterinary Authority, Iceland

Thomas Maes, Senior Scientist, GRID-Arendal

Anne Katrine Normann, Project Manager, Center for the Ocean and the Arctic, UiT Norway

Henrik Enevoldsen, Head of Ocean Science Section, IOC UNESCO

Jennifer Provencher, Wildlife Health Unit Head, Environment and Climate Change Canada

Helene Svendsen, Project Manager, Arctic Marine Litter, GRID-Arendal

Eirini Glyki, Science Professional Officer, ICES

Soffía Guðmundsdóttir, Executive Director, PAME

Katrin Vorkamp, Professor, Department of Environmental Science, Aarhus University

Josephine Nymand, Head of Department, Greenland Institute of Natural Resources

Josie Russell, Senior Marine Litter Scientific Advisory, Cefas

Adil Bakir, Principal Scientist, Microplastics, Cefas

Katrín Sóley Bjarnadóttir, Specialist in Team for Ocean and Water, Environment Agency of Iceland;

Hrönn Egilsdóttir, Head of Environmental Division, Marine & Freshwater Institute, Iceland

Hildur Hauksdóttir, Sustainability Officer, Fisheries Iceland

Gunn-Britt Retter, Head of Arctic – and Environmental Unit, Saami Council

Emily Jaimes Richey-Stavrand, Circular Economy Representative, the Icelandic Youth Environmentalist Association.

5.6 Organizing committee

Pétur Ásgeirsson, Ambassador & SAO Iceland, Ministry for Foreign Affairs

Hugi Ólafsson, Director General, Ministry of the Environment, Energy, and Climate

Björn Helgi Barkarson, Director General, Ministry of Food, Agriculture and Fisheries

5.7 Organizing team

Embla Eir Oddsdóttir, Director, Icelandic Arctic Cooperation Network

Friðrik Þórsson, Communications Manager, Icelandic Arctic Cooperation Network

Ariana Telzerow, Communications Officer, Icelandic Arctic Cooperation Network

Federica Scarpa, Project Manager, Icelandic Arctic Cooperation Network

Hjalti Hreinsson, Project Manager, PAME

Olga Pálsdóttir, Executive Assistant, PAME

5.8 Sponsors

The Government of Iceland

The Nordic Council of Ministers

5.9 Outputs

Outputs will include the following:

All material recorded and shared on www.arcticplastics.is

Presentations shared on www.arcticplastics.is

Summaries of days 1 and 2 available on www.arcticplastics.is

Conference report will be compiled by GRID-Arendal and edited by Pétur Ásgeirsson, Magnús Jóhannesson and Embla Eir Oddsdóttir

An ICES Journal of Marine Science Special Issue

5.10 History and future

In March 2021, Iceland and the Nordic Council of Ministers hosted a successful First symposium on Plastics in the Arctic and Sub-Arctic Region with participants calling for a follow up in the near future.

In 2023 the Government of Iceland, with the support of the Nordic Council of Ministers, hosted a Second International Symposium on Plastics in the Arctic and Sub-Arctic Region at Harpa, Reykjavík Concert Hall and Conference Center, on 22–23 November.

The Prime Minister of Iceland, Katrín Jakobsdóttir, announced in her closing remarks that the Government of Iceland will be hosting the 3rd International Symposium on Plastics in the Arctic and Sub-Arctic Region, in 2025.

Annex 1: The Second International Symposium on Plastic Pollution in the Arctic and Sub-Arctic Regions: Conference Program

Conference Presenter: Helen Inga von Ernst, Ministry for Foreign Affairs

22 November 2023

08:00-09:00
REGISTRATION, HARPA 2ND FLOOR

09:00-10:30
PLENARY: Welcoming and Opening Addresses

Location: Norðurljós

Moderator: Ambassador **Pétur Ásgeirsson**, SAO Iceland

Opening Address by *Bjarni Benediktsson,* Minister for Foreign Affairs of Iceland

Address by Ambassador *Morten Höglund,* SAO Chair, Norway

Address on the INC by *Jyoti Mathur-Filipp*, Executive Secretary of the INC Secretariat of UNEP

Keynote address by *David Hik*, Chief Scientist and Executive Director – Programs, Polar Knowledge Canada

Address by *John Aldag*, Member of Parliament, Canada on the OSCE Parliamentary Resolution on Macroplastic and Nanoplastic Pollution

Short welcome by Symposium Partner, *Eirini Glyki*, Science Professional Officer, ICES

"Are you feeding the plastic monster?" *Olav Lekve*, Senior Communication Adviser, Norwegian Directorate of Fisheries and *Lise M. Strömqvist*, Communication Adviser, Norwegian Centre against Marine Litter

10:30-11:00
Coffee break

Location: Hörpuhorn

11:00-15:30

Three parallel sessions on thematic discussions:

11:00 – 12:35
THEME 1: Monitoring and assessment of plastic pollution in the Arctic

Location: Norðurljós

Moderator: **Anne Katrine Normann**, Centre for the Ocean and the Arctic, UiT Arctic University of Norway
Rapporteur: **Ólafur Ástþórsson,** former Deputy Director of the Marine Research Institute

11:00- 11:20 Keynote speaker: *Jennifer Provencher*, Environment and Climate Change Canada
11:20- 11:35 Beach Litter Monitoring in the Arctic using drone and satellite imagery. *Marc Schnuwara*, BioConsult SH GmbH & Co. KG
11:35- 11:50 Floating microplastics in the Eurasian Arctic: spatial and temporal trends. *Svetlana Pakhomova*, Norwegian Institute for Water Research
11:50- 12:05 Reproducible pipelines and readiness levels in plastic monitoring. *Amy Lusher*, Norwegian Institute for Water Research (NIVA)
12:05- 12:20 First analysis of micro- and meso-plastic particles in sea-surface samples collected in Icelandic coastal waters. *Belen Ovide*, Ocean Missions
12:20- 12:35 Sentinels of plastic: Monitoring plastic pollution in the Sub-Arctic ecosystem using Icelandic fin whales as indicators. *Valerie Chosson*, Marine and Freshwater Research Institute (MFRI)

11:00 – 12:35
THEME 2: Methodological developments to determine macro, micro and nano plastics

Location: Silfurberg A

Moderator: **Jóhann Sigurjónsson,** former Director, Marine Research Institute
Rapporteur: **Hrönn Egilsdóttir**, Head of Environmental Division, Marine & Freshwater Research Institute

11:00- 11:20 Keynote speaker: *Amy Lusher*, Norwegian Institute for Water Research (NIVA)
11:20- 11:35 Nanoplastics in Arctic' ecosystems: Myth or Reality? *Julien Gigault*, Takuvik (CNRS/Université Laval)
11:35- 11:50 Microplastic pollution in Ny-Alesund, Svalbard. *Yubo Li,* Shanghai Municipal Engineering Design Institute (Group) Co., Ltd.
11:50- 12:05 A pan-Arctic Monitoring program for litter and microplastics. *Jennifer Provencher*, Environment and Climate Change Canada
12:05- 12:20 Marine litter pollution in Southern Spitsbergen – lessons learnt from 6 tonnes of litter picked up from 30 km of the coast. *Adam Nawrot*, for Science Foundation
12:20- 12:35 Differentiating between microplastics, algae and dissolved organic matter using single particle ICPTOFMS. *Lyndsey Hendriks*, TOFWERK

11:00 – 12:35
THEME 3: Sources and transport of plastic in the Arctic and sub-Arctic

Location: Silfurberg B

Moderator: **Eirini Glyki**, Science Professional Officer, ICES
Rapporteur: **Gunn-Britt Retter**, Head of Arctic – and Environmental Unit, Saami Council.

11:00- 11:20 Keynote speaker: *Peter Murphy*, NOAA Marine Debris Program (US)
11:20- 11:35 Atmospheric microplastic in the Arctic and the Norwegian mainland. *Dorte Herzke*, NILU & NIPH
11:35- 11:50 A plastic archive in Greenland: micro and nano particles in marine sediment. *Karla Parga Martinez*, University of Copenhagen
11:50- 12:05 Fishing nets on the coastline of the North Atlantic region - What is causing the issue and how can it be solved? *Wouter-Jan Strietman*, Wageningen Economic Research
12:05- 12:20 Vertical fluxes of microplastics and other anthropogenic particles measured using moored sediment traps in two Arctic glacial fjords (Svalbard archipelago). *Andrea Paluselli*, CNR-ISMAR
12:20- 12:35 Modelling influence of biogeochemical processes on the transport of microplastics in the Arctic Ocean. *Anfisa Berezina*, Norwegian Institute for Water Research NIVA

12:35 – 13:30

Lunch

Location: Hörpuhorn

13:30 – 15:30

THEME 1: Monitoring and assessment of plastic pollution in the Arctic (continued)

Location: Norðurljós

13:30- 13:45 Implementing national monitoring of plastic pollution in Norway. *Eivind Farmen*, Miljødirektoratet
13:45- 14:00 Microplastic monitoring in the ice cover of a Finnish freshwater lake. *Tuomo Soininen*, University of Eastern Finland
14:00- 14:15 Monitoring the Presence, Abundance, and Identity of Micro- and Nano-plastics of Arctic and Beringian foodwebs. *Soren George-Nichol*, University of Alaska Anchorage
14:15- 14:30 Microplastics and plastic additives in salmonids from the central Canadian Arctic. *Bonnie Hamilton*, Environment and Climate Change Canada / University of Alberta
14:30- 14:45 Indicators for plastic monitoring – linking the plastic value chain with environmental occurrence. *Katrin Vorkamp*, Aarhus University

14:45- 15:30 Panel discussions – outcomes from the presentations
***Moderator**: Anne Katrine Normann*, Centre for the Ocean and the Arctic, UiT Arctic University of Norway

Jennifer Provencher, Environment and Climate Change Canada; *Ólafur Ástþórsson***,** former Deputy Director of the Marine Research Institute; *Matthew, Johnson*, Volatus Aerospace; *Emily Cowan*, SINTEF Ocean

13:30 – 15:30

THEME 2: Methodological developments to determine macro, micro and nano plastics (continued)

Location: Silfurberg A

13:30- 13:45 Characterization of microplastics in surface waters from Great Slave Lake and the Mackenzie River, Northwest Territories. *Madelaine Bourdages*, Carleton University
13:45- 14:00 Marine beach litter in the Baltic Sea. Outcome from the HELCOM BLUES project. *Eva Blidberg*, Keep Sweden Tidy Foundation

14:00- 14:15 Uptake and accumulation of car tire rubber-related organic chemicals in blue mussels (Mytilus edulis). *Kristin Galtung*, Norwegian Institute for Water Research (NIVA)
14:15- 14:30 Production and analysis methods for pristine and degraded microplastic and nanoplastic reference materials. *Andy Booth*, SINTEF Ocean
14:30- 14:45 Challenges and opportunities regarding beach litter monitoring in Norway: Lessons learned from three different datasets. *Marthe Larsen-Haarr*, Salt Lofoten AS

14:45- 15:30 Panel discussions - outcomes from the presentations
***Moderator**: Jóhann Sigurjónsson*, former Director, Marine Research Institute
Amy Lusher, Norwegian Institute for Water Research (NIVA); *Hrönn Egilsdóttir*, Head of Environmental Division, Marine & Freshwater Research Institute; *Charlotte Carrier-Belleau*, Laval university and University College Dublin; *Ryan d'Arcy Metcalfe*, KIMO International

13:30 – 15:30
THEME 3: Sources and transport of plastic in the Arctic and sub-Arctic (continued)

Location: Silfurberg B

13:30- 13:45 Atmospheric deposition-flux rates of microplastics particles recorded in Icelandic surface-lake sediments. *Mathis Blache*, University of Iceland
13:45- 14:00 Microplastic pollution in sediments around Svalbard, from sea-ice covered areas on the continental shelf to deep slope gullies. *France Collard*, Norwegian Institute for Water Research
14:00- 14:15 Microplastic concentrations and modelling of microplastic transport in the Baltic Sea and Arctic Sea ice. *Hermanni Kaartokallio*, Finnish Environment Institute
14:15- 14:30 Evidence of highly local marine litter sources in an Arctic Archipelago (Lofoten, Norway). *Vilde Sørnes Solbakken*, SALT Lofoten AS
14:30- 14:45 Marine litter on the seafloor around Iceland: Analysing seafloor images from benthic habitat mapping in 2004-2019. *Petrún Sigurðardóttir*, Marine and Freshwater Research Institute

14:45- 15:30 Panel discussions - outcomes from the presentations
***Moderator**: Eirini Glyki*, Science Professional Officer, ICES

Peter Murphy, NOAA Marine Debris Program (US); *Gunn-Britt Retter*, Head of Arctic – and Environmental Unit, Saami Council; *Jake Thompson*, University Centre of the Westfjords; *Sydney Fox*, Reykjavík University

15:30 – 16:00
Coffee break

Location: Hörpuhorn

16:00 – 17:00

PLENARY: Main messages from THEMES 1, 2 AND 3

Location: Norðurljós

Messages from science to governments, industry, public and the global INC process

Theme 1: Presented by *Anne Katrine Normann*, Centre for the Ocean and the Arctic, UiT Arctic University of Norway

Theme 2: Presented by *Jóhann Sigurjónsson***,** former Director, Marine Research Institute
Theme 3: Presented by *Eirini Glyki*, Science Professional Officer, ICES

17:00 – 19:00

Reception hosted by the Icelandic Government, Minister of Food, Agriculture and Fisheries

Location: Hörpuhorn

23rd November 2023

08:30 – 12:30

Three parallel sessions on thematic discussions

08:30 – 10:05

THEME 4: Impacts of marine litter in the Arctic (environmental, economic, and social)

Location: Norðurljós

Moderator: **Kristian Jensen**, Communications and Program Consultant, Lofotrådet
Rapporteur: **Sigurrós Friðriksdóttir**, Advisor, Environment Agency

08:30- 08:50	Keynote speaker: *Lisa Qiluqqi Koperqualuk*, ICC Canada President
08:50- 09:05	Development of a decision matrix for coastal litter clean-ups in Norway. *Jannike Falk-Andersson*, Norsk Institutt for Vannforskning
09:05- 09:20	Social perspectives on plastic pollution. Example from northern Norway. *Christina Koch*, Vårt Hav. Troms og Finnmark/ Naturvernforbundet i Finnmark
09:20- 09:35	Benthic organisms in Arctic ecosystems: presence and effects of nanoparticles in the context of single and multiple stressors. *Charlotte Carrier-Belleau*, Laval University and University College Dublin
09:35- 09:50	Plastic pollution in Norwegian coastal soils affect microbial diversity and soil gas composition. *Gunhild Bødtker*, NORCE
09:50-10:05	Characteristics of microplastic particles that influence atmospheric deposition in remote regions. *Sydney Fox*, Reykjavik University

08:30 – 10:05

THEME 5: Arctic challenges and solutions for improved waste management

Location: Silfurberg A

Moderator: **Sigurgeir Bárðarson**, Attorney at Law, Fisheries Iceland
Rapporteur: **Katrin Vorkamp**, Department of Environmental Science, Aarhus University

08:30- 08:50 Keynote speaker*:* Thomais Vlachogianni, Senior Policy & Programme Officer, MIO-ECSDE
08:50- 09:05 Microplastic in gravity-driven membrane filtration for cold climate decentralized wastewater treatment: fouling analysis and water quality investigation. *Selina Hube*, University of Iceland - Faculty of Civil and Environmental Engineering
09:05- 09:20 Net cuttings waste from fishing: developing best practices in the fishing industry. *Ryan d´Arcy Metcalfe*, KIMO International
09:20- 09:35 Occurrence of microplastics in the subarctic waters near a wastewater treatment plant in Reykjavík, Iceland. *Ásta Margrét Ásmundsdóttir*, University of Akureyri
09:35- 09:50 Novel bio-inspired alternatives to plastic packaging in Arctic fisheries. *Philippe Amstislavski*, University of Alaska Anchorage
09:50-10:05 Plastics: From wishcycling to recycling. *Audrey Matthews*, University of Akureyri

08:30 – 10:05

THEME 6: Tackling plastic pollution: international collaboration, policies, best practices and novel developments from around the world

Location: Silfurberg B

Moderator: **Josephine Nymand**, Head of Department, Greenland Institute of Natural Resources
Rapporteur: **K. Sóley Bjarnadóttir**, Advisor, Environment Agency of Iceland

08:30- 08:50 Keynote speaker: *Sæunn Júlía Sigurjónsdóttir*, the Nature Conservation representative for the Young Environmentalists
08:50- 09:05 FAO global efforts to prevent and reduce ALDFG. *Haraldur Einarsson*, Fishing Technology and operations team (NFIFO)/ Food and Agriculture Organization of the United Nations (FAO)
09:05- 09:20 A marine plastic cloud - Global oceanic plastic pollution mass balance in relation to the Arctic. *Thomas Maes*, GRID-Arendal/SEAMOHT
09:20- 09:35 Plastics in dental care clinics and growing concerns about the environmental impact. *Ásbjörn Jokstad*, UiT the Arctic University of Norway
09:35- 09:50 The Arctic on a global scale: influence of Arctic States within the ongoing global plastic treaty negotiations. *Emily Cowan*, SINTEF Ocean
09:50-10:05 Fighting marine litter in the Arctic: How to engage tourists. *Julia Hager*, mountain2ocean & PolarJournal

10:05 – 10:30

Coffee break

Location: Hörpuhorn

10:30 – 12:30

THEME 4: Impacts of marine litter in the Arctic (environmental, economic, and social) (continued)

Location: Norðurljós

10:30- 10:45 Educating our future Arctic plastics researchers. *Matthew Johnson*, Volatus Aerospace
10:45- 11:00 A spatiotemporal analysis of plastic ingestion in Canadian Arctic-breeding northern fulmars (Fulmarus glacialis). *Kristine Hanifen*, Acadia University
11:00- 11:15 Clean-up Norway Svalbard. *Snorre Sklet*, SALT
11:15- 11:30 Including local voices in the marine debris conversation to advance environmental justice for island and coastal communities: Perspectives from St Paul Island, Alaska. *Douglas Causey*, University of Alaska Anchorage

11:30- 11:45 Marine litter in the Arctic: Results from three years of citizen science, *Malin Dahl*, Keep Norway Beautiful

11:45- 12:30 Panel discussions – outcomes from the presentations
Moderator: Kristian Jensen, Communications and Program Consultant, Lofotrådet

Lisa Qiluqqi Koperqualuk, ICC Canada President*; Sigurrós Friðriksdóttir*, Advisor, Environment Agency; *Bonnie Hamilton*, University of Alberta; *Andy Booth*, SINTEF Ocean

10:30 – 12:30

THEME 5: Arctic challenges and solutions for improved waste management (continued)

Location: Silfurberg A

10:30- 10:45 Marine debris from wastewater outfalls. *Jake Thompson*, University Centre of the Westfjords
10:45- 11:00 Blurred interface: How lack of coordination between governance levels obstructs waste management in fishing harbors. The case of Tromsø. *Anne Katrine Normann*, Center for the Ocean and the Arctic, UiT
11:00- 11:15 Creative Solutions for Marine Debris Prevention in the Arctic. *Veronica Padula*, Aleut Community of St Paul Island Tribal Government and Seattle Aquarium
11:15- 11:30 Bringing value to marine waste. *Øistein Aleksandersen*, Nofir
11:30- 11:45 Climate Change and Plastic Pollution – Similar Needs for Systemic Changes. *Jakob Bonnevie Cyvin*, Norwegian University of Technology and Science (NTNU)

11:45- 12:30 Panel discussions – outcomes from the presentations
Moderator: Sigurgeir Bárðarson, Attorney at Law, Fisheries Iceland

Thomais Vlachogianni, Senior Policy & Programme Officer, MIO-ECSDE; *Katrin Vorkamp*, Department of Environmental Science, Aarhus University; *Lyndsey Hendriks*, TOFWERK; *Wouter-Jan Strietman*, Wageningen Economic Research

10:30 – 12:30

THEME 6: Tackling plastic pollution: international collaboration, policies, best practices and novel developments from around the world (continued)

Location: Silfurberg B

10:30- 10:45 Raising awareness of marine litter and engaging international partners through the Arctic cleanup. *Kristina Tirman*, Ocean Conservancy
10:45- 11:00 Clean Up Iceland: The expedition cruise industry's efforts to clean Icelandic shorelines. *Gyða Guðmundsdóttir*, Association of Arctic Expedition Cruise Operators (AECO)
11:00- 11:15 Developing a solid policy framework for plastic pollution and waste management in the Arctic through multistakeholder co-creation - Implications for national and international policymakers and Indigenous groups. *Dimitris Symeonidis*, Afforest4Future
11:15- 11:30 Experience and challenges through development of Rent Hav – a digital tool for mapping marine litter. *Eirik Okkenhaug*, The Norwegian center against marine litter
11:30- 11:45 "Valuation of nature" as a tool to reduce (the impact of) plastic pollution. *Gunn-Britt Retter*, Saami Council

11:45- 12:30 Panel discussions – outcomes from the presentations
Moderator: *Josephine Nymand*, Head of Department, Greenland Institute of Natural Resources

Sæunn Júlía Sigurjónsdóttir, the Nature Conservation representative for the Young Environmentalists; *K. Sóley Bjarnadóttir*, Advisor, Environment Agency of Iceland; *Vilde Sørnes Solbakken*, SALT Lofoten AS; *Madelaine Bourdage*, Carleton University

12:30 – 13:30

Lunch

Location: Hörpuhorn

13:30 – 18:00

Plenary

13:30 – 14:30

PLENARY: Main messages from THEMES 4, 5 AND 6

Location: Norðurljós

Messages from science to governments, industry, public and the global INC process

Theme 4: Presented by *Kristian Jensen*, Communications and Program Consultant, Lofotrådet

Theme 5: Presented by *Sigurgeir Bárðarson,* Attorney at Law, Fisheries Iceland

Theme 6: Presented by *Josephine Nymand*, Head of Department, Greenland Institute of Natural Resources

14:30 – 15:15

PLENARY PANEL I: Conserving the Arctic

Location: Norðurljós

Moderator**: Thomas Maes**, GRID-Arendal

Georg Hanke, European Commission, Joint Research Centre
Eva Kruemmel, ICC Canada
Susana Hancock, APECS
Árni Finnsson, Icelandic Environment Association

15:15 – 15:45

Coffee break

Location: Hörpuhorn

15:45 – 16:30

PLENARY PANEL II: From Local to Global Actions

Location: Norðurljós

Moderator**: Hrönn Jörundsdóttir**, Icelandic Food and Veterinary Authority

Todd Gouvin, TG Environmental
Peter Murphy, NOAA Marine Debris Program (US)
Georg Haney, Environmental Manager, Hampiðjan Group
Veronica Padula, Aleut Community of St Paul Island Tribal Government and Seattle Aquarium.

16:30 – 17:15

PLENARY PANEL III: Innovative Plastic Pollution Reduction

Location: Norðurljós

Moderator: **Magnús Jóhannesson**, Former Director Arctic Council Secretariat, Chair, Scientific Steering Committee

Hlöðver Stefán Þorgeirsson, Waste Water R&D Lead, Water Supply and Wastewater
Elin Bergman, Chair of Cradlenet
Heiðrún Lind Marteinsdóttir, Manager, Fisheries Iceland
Robert B. Larsen, UiT Norway

17:15 – 17:45

Ministerial Discussion

Location: Norðurljós

Moderator: **Jóhanna Vilhjálmsdóttir**, writer, radio host and former TV reporter

Guðlaugur Þór Þórðarson, Minister of the Environment, Energy and Climate
Malcolm Noonan, Minister of State, Housing and Local Government, Ireland

17:45 – 18:00

Symposium Closing Remarks

Prime Minister of Iceland, Ms *Katrín Jakobsdóttir*

Annex 2: The Second International Symposium on Plastic Pollution in the Arctic and Sub-Arctic Regions: Summary of day 1

Welcoming and Opening Addresses

In the opening remarks, Bjarni Benediktsson (Minister for Foreign Affairs of Iceland) reminded us about the importance of solidarity to address the problem of plastic pollution, worldwide. In 2021, the First Symposium on Plastics in the Arctic and Sub-Arctic Region was held, and it became clear that further discussions were necessary. By hosting the Second Symposium, the Government of Iceland hopes to raise awareness, facilitate collaboration, and foster more robust efforts.

Morten Høglund (SAO Chair, Norway), reminded us about the importance and history of the Arctic Council. It is challenging times for circumpolar collaborations. In the six months since Norway took over chairship of the Arctic Council, the overall objective has been to to promote stability and constructive collaboration. The Norwegian chairship prioritizes four topics: the oceans; climate and environment, sustainable economic development; and people in the North.

Lise M. Strømqvist (Norwegian Centre against Marine Litter) and Olav Lekve (Norwegian Directorate of Fisheries) presented the promotional video: Are you feeding the plastic monster? Small pieces of ropes and net cuttings make a large portion of marine litter found in Norway. To understand the complexity and parts of like nature and human behaviour, we create myths and creatures like monsters. Stories can show how problems can be solved by creating awareness and changing people's attitudes towards the types of litter that are abundant in the Arctic. People need to stop throwing rope cuttings and other pieces of plastic overboard, and manageable routines for litter handling must be introduced.

Jyoti Mathur-Filipp (INC Secretariat of United Nations Environmental Program), gave us an update on the Intergovernmental Negotiating Committee (INC) process, only three days after the last negotiation meeting in Nairobi. In the face of a plastic pollution crisis, the United Nations Environment Assembly adopted the historic resolution 5/14 in March 2022, initiating the development of an international legally binding instrument on plastic pollution. The third session of the INC in Nairobi marked a critical milestone, progressing discussions on the Chair's zero draft text. Over 1,900 delegates from 161 UN member states participated, electing a new committee chair and two vice-chairs. The session concluded with an agreement on a starting point for negotiation at the fourth session. The revised zero draft text will be released on December 31, and the momentum of collaboration, compromise, and commitment from Nairobi must continue into future sessions in Ottawa and Busan. The ambitious timeline aims to combat plastic pollution by the end of 2024, reflecting the strong engagement of governments and civil society in addressing the crisis.

David Hik (Polar Knowledge Canada), based in the Canadian High Arctic in the community of Cambridge Bay, emphasizes the significance of local research facilities, particularly the new Canadian High Arctic Research Station (CHARS), in understanding and addressing global issues like plastic pollution. He highlighted the challenges faced by remote communities in waste management due to the limitations of supply chains and emphasize the need for sustainable local solutions. The talk underscores the impact of plastics on the environment, particularly in the Arctic, and the importance of research in raising awareness and finding viable solutions. Hik

also mentions ongoing efforts in waste diversion and the engagement of young people and national leaders in addressing plastic pollution.

John Aldag (Canadian Member of Parliament, on the OSCE Parliamentary Resolution on Macroplastic and Nanoplastic Pollution) provides an overview of the work of the OSCE Parliamentary Assembly (PA) work on environmental issues, particularly pollution. Aldag highlights the significance of parliamentarians in addressing environmental challenges, leveraging their power to develop legislation and hold governments accountable. The OSCE PA has a history of addressing pollution in its declarations, and Aldag discusses their resolution on microplastic and nanoplastic pollution, which was adopted in July in Vancouver. This resolution is the first to express concern about the presence of micro- and nanoplastics in the Arctic. Aldag emphasizes the importance of international cooperation, urging OSCE participating states to work towards a binding treaty to control and reduce plastic pollution. The declaration also stresses the need for funding research to advance knowledge and address gaps in understanding micro- and nanoplastic pollution.

The last address came from Eirini Glyki (Science Professional Officer, ICES) discussing the involvement of the International Council for the Exploration of the Sea (ICES) in various Arctic research initiatives and collaborations. ICES is participating in conferences, projects, and organizations related to Arctic research planning, high seas fisheries, and ecosystem management. Specifically in the Arctic, we are faced with applying ecosystem based management in situations where marine ecosystems are changing fundamentally and as we heard before, we face a range of cumulative impacts from human activities. The organization emphasizes a multidisciplinary and ecosystem-based approach, seeking solutions to challenges posed by changing marine ecosystems in the Arctic. ICES expresses a commitment to inclusivity by incorporating knowledge from diverse sources, including local and Indigenous communities. The message also extends a welcome to early career scientists, highlighting their importance in contributing ideas and insights to ICES initiatives.

Glyki adds: “By bridging the gap between diverse fields of study, we can then tap into a wealth of knowledge, insights, and perspectives that will enable us to develop comprehensive solutions.”

Parallel sessions on thematic discussions

Please note: An overview of the presentations from the thematic sessions will be presented in the upcoming Symposium Summary Report. The following is a summary from each of the first day’s themes.

THEME 1: Monitoring and assessment of plastic pollution in the Arctic

Key findings presented by Anne Katrine Normann (Centre for the Ocean and the Arctic, UiT—The Arctic University of Norway).

The presentations during the session were enlightening, underscoring a key realization: we possess a wealth of data, but the need for data harmonization is imperative. Standardizing the collection and management of data are crucial, emphasizing collaboration between scientists and industry stakeholders. The focus should shift from creating more databases to determining what data are essential and how it should be utilized.

Efforts toward harmonization should involve transdisciplinary and cross-sectoral collaboration, prompting questions about the purpose of data creation—is it for researchers or broader stakeholders? The idea of putting a price on research efforts was raised, highlighting the need to

quantify and understand the economic basis of these endeavors. Drawing parallels, Normann recalled working with Norwegian fishers who lacked routines for quantifying the downtime of their boats, a valuable metric that could be monetized.

The issue of knowledge and data sharing remains challenging, both within countries and internationally. The complexity of accessing such information was emphasized, raising concerns about permissions, collaboration, and research ethics. Temporal trends and seasonal changes were also discussed, questioning the duration required to address these trends effectively. The conversation extended to the incorporation of machine learning technologies in monitoring and the necessity for critical evaluation of data generation and dissemination methods. Overall, the discussions underscored the importance of strategic collaboration, ethical considerations, and thoughtful approaches in navigating the landscape of data in research and monitoring efforts.

THEME 2: Methodological developments to determine macro, micro and nano plastics

Key findings presented by Jóhann Sigurjónsson (former Director, Marine Research Institute).

Reporting on the session on methodological developments in nano-, micro-, and macroplastics has been a challenging yet enlightening task. The discussions during the session provided valuable insights into the disciplined nature of plastics scientists, who adhered to time constraints, reflecting the critical importance of methodological advancements in the theme of the conference.

While the field has witnessed significant progress, the pervasive issue of plastics is relatively recent for many researchers, and long-term monitoring poses challenges. Achieving a comprehensive understanding of the current situation and identifying effective pathways forward necessitates harmonized methods across different geographical contexts. Several speakers highlighted the need for standardization and harmonization in addressing this challenge.

The complexity of plastics research was emphasized, given the diverse nature of plastic materials. The inclusion of artificial intelligence (AI) as a new method and the exploration of appropriate research methods were key points of discussion. The critical question emerged: how can we best support the development and identification of appropriate research methods?

The final point underscored the importance of making information relevant to society, policy, and other stakeholders. This aspect was deemed equally crucial as the research itself, emphasizing the need for widespread collaboration and careful dissemination of accurate information. Acknowledging the role of international bodies, the session participants highlighted the significance of coordinated efforts, with organizations like AMAP serving as exemplary leaders in leveraging expertise from diverse countries. The collective agreement emphasized the need for a united front in addressing the global challenge of plastic pollution.

THEME 3: Sources and transport of plastic in the Arctic and sub-Arctic

Key findings presented by Eirini Glyki (Science Professional Officer, ICES)

To effectively address plastic pollution in the Arctic and meet policy and management objectives, a comprehensive understanding of sources and pathways is imperative. Despite its remoteness, the Arctic has not escaped the impacts of the Anthropocene and the "plastic boom" since the 1950s, evident in beach pollution, terrestrial contamination, and seabed debris.

Microplastics reach the Arctic predominantly from the EU mainland and through the North Atlantic via currents, challenging the perception of the Arctic's pristine state. The session delved

into the various pathways, including atmospheric, ice, sea currents, and rivers, emphasizing the need for international collaboration in monitoring, research, and policy implementation.

Local sources significantly contribute to microplastic pollution, necessitating a focus on household waste management and the fishing industry in Arctic communities. The importance of local and Indigenous Knowledge was highlighted in addressing this aspect. Ensuring that research data resonates with policy-makers, media, and the public is crucial. Utilizing various media such as articles, films, infographics, and maps can aid in effectively conveying complex information. Establishing relationships and fostering two-way discussions are integral parts of the communication process. Presenting data in ways that cater to different communities and scaling the level of research to suit the audience's understanding ensures inclusivity and active participation in discussions.

Abandoned, lost, or otherwise discarded fishing gear (ALDFG)—particularly fishing nets—poses a significant threat to marine life and to navigation. Mitigation efforts should concentrate on improving the collection and storage of net cuttings on bottom-trawl vessels and implementing proper disposal procedures in ports. Research around Iceland revealed that longlines and trawlnets, made from durable plastic, constitute the majority of marine litter on the seafloor. These materials, entangled with corals and rocks, pose a threat to vulnerable marine ecosystems (VME). This research led to the creation of a Marine Protected Area (MPA), underscoring the importance of funding and continuing investigations to leverage MPAs and marine spatial planning tools for the protection of essential ecosystems.

Addressing this issue requires consideration of cultural and social drivers, as emphasized in the Norwegian Centre against Marine Litter video shown during the opening session. A compelling message connecting waste management to people's daily lives is essential, necessitating an understanding of the underlying human-induced practices. Investigating cultural and social drivers is crucial to implementing effective waste prevention and improvement strategies.

Annex 3: The Second International Symposium on Plastic Pollution in the Arctic and Sub-Arctic Regions: Summary of day 2

Parallel sessions on thematic discussions

Please note: An overview of the presentations from the thematic discussions will be presented in the upcoming Symposium Summary Report. The following is a summary of the second day of the symposium.

THEME 4: Impacts of marine litter in the Arctic (environmental, economic, and social)

Key findings presented by Kristian Jensen (Communications and Program Consultant, Lofotrådet)

Jensen highlighted the global nature of plastic pollution, emphasizing its disproportionate impact on the Arctic. Plastic pollution infringes on human rights. It affects our traditional way of life, our food security and our health. Plastic pollution is linked to climate change, amplifying its adverse effects in the Arctic. Jensen called for comprehensive research, data harmonization, and international collaboration for effective policies based on sound science. The unfair burden of cleaning up this generations' plastic litter falls on our children. Jensen stressed the need for proactive communication by researchers to influence policymakers. The omnipresence of plastics challenges the notion of Arctic pristine environments, and the cost and impacts of clean-up projects necessitate careful consideration.

"Plastics are now considered omnipresent, making even the word pristine sound hollow."

The importance of consumers' right to refuse certain plastics and the need for limitations on plastic production were highlighted. Local Indigenous communities should not bear the sole responsibility for cleaning up plastic waste, and discussions touched on the possibility of using plastic for circular economy practices. Communicating scientific insights creatively to policymakers and acknowledging the gaps in understanding the full impacts of plastic on the environment, people, and the economy were also emphasized.

THEME 5: Arctic challenges and solutions for improved waste management

Key findings presented by Sigurgeir Bárðarson (Attorney at Law, Fisheries Iceland)

Bárðarson highlighted three main issues that came up during the discussions:

First, the pervasive issue of microplastic pollution in Arctic environments, particularly from wastewater and fishing activities, was emphasized. Innovative solutions such as gravity-driven membrane filtration and bioinspired alternatives are discussed. The importance of monitoring and addressing microplastic contamination, especially from municipal wastewater treatment plants, was underscored.

Secondly, the fishing industry's contribution to marine debris, particularly from discarded nets and cuttings, is a focal point. Approximately 30% of beach litter in the Northeast Atlantic comes from fishing-industry waste. The need for best practices and policy solutions involving

stakeholders across the fishing and agriculture industries is stressed. Successful projects, like the collaboration between Asian fisheries and Icelandic net manufacturers, were cited as examples.

Finally, Bárðarson highlighted the lack of coordination between government levels and challenges in accurate plastic sorting. The need for better systems, processes, and public education in waste management was emphasized. Art and design projects are suggested as effective tools to raise awareness, and increasing awareness among fishers about available resources can enhance recycling efforts.

THEME 6: Tackling plastic pollution: international collaboration, policies, best practices and novel developments from around the world

Key findings presented by Josephine Nymand (Head of Department, Greenland Institute of Natural Resources)

Nymand shared insights from discussions on plastic-pollution initiatives from local to global scales; from plastics in dental work to the efforts of the upcoming legally binding instrument on plastic pollution. Numerous efforts, from individuals to entire countries, address the issue in the Circumpolar region, resulting in highly diverse data collection. Challenges arise from these varying approaches, making analytical work complicated. Monitoring coverage varies across Arctic areas, and despite extensive data, there are "white areas" where knowledge is limited.

Estimating ocean waste presents difficulties, as plastic's fate remains partially unknown, with invisible fragments posing challenges for detection through satellite imagery or navigation. Nymand emphasized the need to involve the younger generation in finding solutions, acknowledging the limitations of the current generation. The gap between scientists, decision-makers, and young people was highlighted, urging closer collaboration and discussion. Despite having abundant data and guidelines, Nymand stressed the importance of creating a legal framework that aligns with the lives of the younger generation. The takeaway messages emphasized the need for collaboration, shared understanding, and engaging discussions across different levels to effectively address plastic pollution. The importance of scientists adapting behaviour to connect with the next generation and allocate time for discussions with them was underlined, emphasizing the urgency of these actions for finding sustainable solutions.

PLENARY PANEL I: Conserving the Arctic

Moderator: Thomas Maes (GRID-Arendal)

The panel discussion on Conservation in the Arctic encompassed elements such as policy frameworks, research initiatives, Indigenous perspectives and the imperative for international collaboration.

Georg Hanke (European Commission, Joint Research Centre) provided an overview of the EU's approach to marine litter, starting with its origins back in 2008. He highlighted the challenge of policy outpacing science, noting that the EU marine-strategy framework commits its member states to monitor marine litter. He emphasized the need for effective measures to mitigate plastic production, citing initiatives such as the EU's single-use plastics directive and regulations on extended producer responsibility. While acknowledging the challenges, he expressed optimism about the possibilities that we can implement to clean up. With the next step to implement measures, the role of continued research and funding were also addressed, as it can solve a lot of our still open questions.

Eva Kruemmel (Inuit Circumpolar Council Canada) shed light on the efforts of the Inuit Circumpolar Council (ICC) to integrate human and indigenous rights into the plastic treaty. She called for a precautionary approach to treaties, emphasizing the reduction of plastic at its source and addressing human-rights impacts throughout the life cycle of plastics. Additionally, she underscored the impact of contaminants on the Inuit community, emphasizing the transboundary nature of pollutants. Kruemmel stressed the pivotal role of incorporating Indigenous Knowledge and voices in addressing plastic pollution, while also drawing attention to the use of information from programs like the Northern Contaminants Program (NCP) and the Arctic Monitoring and Assessment Programme (AMAP).

Susana Hancock (APECS) shared her first-hand experience encountering plastic pollution during an Arctic expedition, revealing the contrast and the shock value of seeing the problem for herself in a place with little human presence. Her discovery of nylon lines in the water and ice underscored the pervasive nature of plastic pollution in even the remotest Arctic regions. She also highlighted the importance of turning off the "plastic tap" in order to end the creation of new plastic litter, as well as of moving away from an oil-based economy. While recognizing the necessity for just transitions, enhanced management practices, technology implementation, and the establishment of consistent, enforceable policies in the Arctic, she argued that we cannot legislate our way out of this issue.

The dialogue explored the geopolitical dimension to the issue, with Árni Finnsson (Icelandic Environmental Association) noting what had been the diminishing importance of boarders due to international regimes. However, he lamented that this trend was in danger of reversing, particularly with Russia's war against Ukraine affecting Arctic cooperation. Finnsson emphasized the need to return to the process of vanishing borders and to strengthen global cooperation in addressing environmental threats, echoing a sentiment of urgency and collaboration.

Practical considerations for addressing plastic pollution were also explored. Hanke responded to inquiries about the harmonization of methods by elucidating the evolution from early data searches to the current emphasis on specific data types that inform policy measures. He stressed the importance of understanding baselines, continuous monitoring, and identifying sources of plastic pollution both on land and in the Arctic environment.

On the topic of tourism, Hancock addressed the surge in this sector, advocating for more sustainable practices. She introduced the concept of "extinction tourism"—visiting places, such as the Arctic, that are seeing themselves fundamentally altered by global warming. She finds it imperative that the industry become less damaging.

Finnsson suggested that the Nordic Council should brand itself on environmentalism, taking a proactive stance in addressing global environmental issues. He pointed to the urgency of addressing issues such as heavy fuel oils (HFOs) on an international scale and stressed the importance of low-hanging fruits for immediate action.

PLENARY PANEL II: From Local to Global Actions

Moderator: Eirini Glyki (Science Professional Officer, ICES)

The discussion began with consensus that addressing plastic pollution will require action at the international and local levels. Crucial in this respect is finding responses that are appropriate and—in the case of communities—feasible for those charged with carrying them out.

Veronica Padula (Aleut community of St Paul Island Tribal Government and Seattle Aquarium) suggested that these ought to include initiatives that could formulate the concerns and experiences of communities and then communicate them to a broader audience in order to spread awareness of the impact of plastic pollution on people who bear no responsibility for it.

Many of these communities, she said, rely on marine resources, such as seals, and, as such, any disruption to the marine environment has an acute local impact. Messages of this sort make it clear that, while impacts may be unique from community to community, their impact is undeniable and their source must be addressed.

Peter Murphy (NOAA Marine Debris Program) found that the discussions about the issue were strikingly similar, regardless of which part of the Arctic was being talked about. Although concerning that the problem was so widespread, he found it reassuring that measures to address it in one location might be applicable in another.

In Alaska, his experience is that tailoring responses to local conditions is crucial. Equally important is not waiting too long to act. He described Alaskan communities as prepared to "give something a try" based on local observations. Although such observations would likely be considered inadequate for action at the national level or for academics, at the local level—"where people just want to see their coasts clean"— there are lower barriers to action. For scientists and decision-makers, this is an opportunity to obtain valuable data and information.

This highlights a paradox: maritime litter in the Arctic is a painful nuisance, but it is also powerful tool. Beyond catalysing local action, it shows visitors how communities, often with a close connection to the land, suffer under pollution that has never passed through their hands.

The panel was aware that overdoing messages like this can be counterproductive. "Plastic fatigue", as Todd Gouvin (TG Environmental) called it, needs to be prevented by mixing in messages about the gains that are being made.

He agreed the presence of plastic in the environment is a sign of failure, but, drawing on the example of the airline industry, he suggested that assessing how things had gone wrong could provide us with suggestions for how to sort it out. It is also helpful that—unlike when it comes to an issue like climate change—stakeholders are all in agreement about some of the basics of the issue. No-one, for example, believes that plastic belongs in the environment. Turning agreement into action, though, will require stakeholders speak with each other.

Ultimately, Gouvin suggested, moving the discussion forward will require changing the value we place on plastic. Everyone sees plastic as useful, but no-one sees it as valuable; the popular conception is that it is something cheap and easy to discard.

Eliminating plastic waste is often synonymous with recycling, and according to Georg Haney (Hampiðjan Group), we increasingly have no other option, as landfills reuse to accept it and incinerators to burn it.

Plastic is a product that, he said, has great opportunities for recycling, but only if done properly and with the cooperation of industry and producers of not just plastics, but also of products that contain reused plastic.

There has to be a recognition, however, that whatever works in one place might not work someplace else. Though the lessons learned in once place can serve as a point of departure for others.

He also noted that plastics is a problem that requires more than recycling to solve. As he put it "even if we change our minds completely and start recycling everything, we'll still have a problem well into the future."

PLENARY PANEL III: Innovative Plastic Pollution Reduction

Moderator: Magnús Jóhannesson (Former Director Arctic Council Secretariat, Chair, Scientific Steering Committee)

The final plenary panel discussed various perspectives the topic. These included the experiences of Iceland's fisheries industry, circular-economy goals, the positive impacts of wastewater recycling, and sustainable fishing practices for marine-pollution reduction.

Heiðrún Lind Marteinsdóttir (Fisheries Iceland) explained that, in recent years, Iceland's fisheries industry has undergone a transformative revolution that has seen it go from a big source of plastic pollution to a part of the solution, thanks, in part to its collaboration with technology firms. One added benefit of this progress has been a substantial increase in productivity. The cooperation and positive intentions of fishing companies have driven the progress. Marteinsdóttir cautioned, though, that innovations hold little value for pioneers unless the companies actively embrace and test them. She believes a change of mindset is required. Many good products are already available and waiting to be used, but without adequate economic incentives, they are unlikely to become widely used.

Elin Bergmann (Cradlenet) argued that countries must establish ambitious and well-defined national goals to transition to a circular economy, along with roadmaps outlining the steps to achieve them. Otherwise, many companies may delay taking the initiative, waiting for others to lead. Numerous initiatives are emerging across various sectors, although these endeavors remain somewhat disjointed. She disagreed with Marteinsdóttir and instead emphasized the importance of governments taking prompt action. There are plenty of examples of bad products, and regulation is the best way provide the necessary impetus for improving them. No individual business can achieve circularity on its own. Collaboration is essential to progress toward a circular future, leveraging the diverse resources and strengths each brings.

Hlöðver Stefán Þorgeirsson (Water Supply and Wastewater) suggested that, when looking for solutions to problems of the sort plastics pose, the most efficient methods were likely to be found in our past, or in nature itself. In his line of business, the approach had created new business opportunities and generated additional "green" jobs, contributing to positive outcomes in multiple sectors. As an example, he noted that enhancing wastewater-recycling and safe reuse will improve water quality and availability, fostering advancements in public health, environmental sustainability, and economic development.

For Robert B. Larsen (UiT, Norway), promoting "sustainable fishing practices" stands to bring global advantages to fishers. Full-scale trials in commercial fisheries are essential to testing and validating these practices. Using biodegradable materials as a method to reduce marine plastic pollution in fisheries promises to reduce some of the most harmful impacts, but moving forward will require involving industry, both in terms of testing, but also in order to spread acceptance.

In the end, transitioning to a circular economy will require well-defined goals, roadmaps, and government intervention, with collaboration being key to success. The collective efforts of businesses, governments, and innovators are essential to a sustainable and circular future.

Ministerial discussion

Guðlaugur Þór Þórðarson (Minister of the Environment, Energy and Climate, Iceland)

Malcolm Noonan (Minister of State, Housing and Local Government, Ireland)

As the penultimate element of the symposium, Malcolm Noonan, the Irish Minister of State, Housing and Local Government, and Guðlaugur Þór Þórðarson, the Icelandic Minister of the

Environment, Energy and Climate, held a discussion that focused on responsibility for issues like nature restoration and biodiversity and the challenges associated with these goals.

Minister Noonan admitted that there were significant challenges associated with meeting these goals and that they were deeply intertwined with the broader nature crisis. “It extends beyond simply planting trees or meadows; it involves evaluating our consumption patterns,” he underscored.

The Irish government adopts an approach of “designing out” plastic waste. Success in this ares is partly a matter of exercising the political leadership necessary to put forward what, for many, will be unpopular decisions intended to induce the sort of radical behavioral change the situation demands of us – and that voters may ultimately even accept is necessary. However, even the most ambitious lawmakers need to accept the reality that, in order to see what are often long-term initiatives through to completion, they need to get re-elected, and that limits how much disruption to people’s lives they can cause.

Minister Þórðarson described plastic pollution and other environmental issues as global challenges that we all share some responsibility for addressing. Yet, despite a general awareness of the problem, there are still many things we don’t know about it, including the vast amount of plastics in the oceans. We do know that much originates from Southeast Asia, and that this must be dealt with, we do will do little to address the problem.

A collective effort is crucial, with oceans being a shared concern requiring everyone in government to add climate to their portfolio, and the public to serve as climate ambassadors.

The discussion turned to successful policies, with Minister Martin highlighting the effectiveness of bottom–up approaches from communities, as well as top–down measures, such as bag bans or taxes, to modify people’s behavior. Lawmakers need to be vigilant, however, since actions may have unintended consequences in the form of other resources being used, or industry finding loopholes that undermine their effectiveness.

Minister Þórðarson pointed to industry initiatives, like fishing-net disposal programs, as an indication that firms are aware of the importance of sustainability. Implementing a comprehensive recycling system, where producers bear the cost of pollution, encourages cleaner products. The complexity of the system necessitates more efficient mechanisms, however, including the ability to adjust the costs imposed, according to Minister Þórðarson.

Ultimately, behavioral change requires a carrot-and-stick approach. For decision-makers, the focus needs to be on designing ways to eliminate wasteful elements from manufacturing processes. In reality, recycling should be the option of last resort when it comes to waste management; the focus, instead, ought to be on the right to repair, promoting durability in products that should last more than a few years (i.e. making durable goods that are actually durable). Recycling will always be necessary, but it takes an adequate infrastructure for it to be effective.

Symposium Closing Remarks

Prime Minister of Iceland, Ms Katrín Jakobsdóttir

The symposium ended with an address by Icelandic Prime Minister Katrín Jakobsdóttir. She noted that the recent global negotiations on plastic pollution are a cause for optimism, comparing them with the significance of the 2015 Paris Agreement on climate change. Further, she acknowledged the positive steps taken by Iceland, including the national action plan covering the entire life cycle of plastics.

Despite recognizing plastic's valuable properties, such as durability, Jakobsdóttir highlighted the environmental consequences of single-use plastics, particularly their persistence in the environment—which is measured in centuries. A thought experiment is presented, comparing the transient inconvenience of using a paper drinking straw with the lasting and diverse impacts of a single plastic straw. Noting the longevity of plastic waste found during beach clean-ups, Jakobsdóttir reflected on the personal experience of finding a plastic bottle that was produced in the same year she was born; it yet to begin degrading.

She highlighted the environmental cost of mismanaged plastics, entering water bodies daily, and made economic arguments for addressing plastic pollution now, stating that the cost is much less than the alternative of doing nothing.

Jakobsdóttir expressed her gratitude for the work that went into the symposium and announced that a third symposium would be held, highlighting the limited time available for such critical initiatives. She concluded with an invitation to reconvene in two years, hoping for significant progress had been made in addressing this pressing global challenge before it convenes.