**Second International Science and Policy Conference on**

**Implementation of the Ecosystem Approach to Management in the Arctic**

**25-27 JUNE 2019 - BERGEN - NORWAY**

**Program with abstract, summaries and presentations**

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# Opening session

**Geir Huse** (Norway, Scientific Director, Institute of Marine Research)

Conference Opening and Welcome

**Talk:** [Conference Opening and Welcome](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Opening_session/S0_Huse_-_Arctic_IEA_meeting_-_welcom_address.pdf)

**Anne-Christine Brusendorff** (Denmark, ICES)

“Science for sustainable development in Areas Beyond National Jurisdiction – how can ICES support evidence needs in the Central Arctic Ocean?”

**Talk:** [“Science for sustainable development in Areas Beyond National Jurisdiction – how can ICES support evidence needs in the Central Arctic Ocean?”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Opening_session/S0_Brusendorf_Anne-Christine_Arctic_EA_Implementation-.pdf)

**Mayor Harry K. Brower, Jr.** (USA, Utqiagvik)

“Implementation as a Part of the Ecosystem and Through Sustaining an Inuit Way of Life”

**Pictures:** [“Implementation as a Part of the Ecosystem and Through Sustaining an Inuit Way of Life”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Opening_session/S0_Brower_H_North_Slope_Inuit_Way_of_Life.pdf)

**Hein Rune Skjoldal** (Norway, Institute of Marine Research)

“Scale Integration and EA Implementation: Goals of the 2nd EA Conference”

**Talk:** [“Scale Integration and EA Implementation: Goals of the 2nd EA Conference”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Opening_session/S0_Skjoldal_HR_Scale_Integration_EA.pdf)

# SESSION 1. INTEGRATED ECOSYSTEM ASSESSMENT

**Elena Eriksen** (Norway, Institute of Marine Research) - “IEA in practice – Experiences from the Working Group on the Integrated Assessments of the Barents Sea (WGIBAR)”

**Talk:** [“IEA in practice – Experiences from the Working Group on the Integrated Assessments of the Barents Sea (WGIBAR)”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Eriksen_E_WGIBAR.pdf)

**Per Arneberg** (Norway, Institute of Marine Research) - “IEA in practice – Experiences from the Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR)”

**Abstract:**

The ICES group WGINOR was established in 2013 to perform integrated ecosystem assessments (IEA) for the Norwegian Sea. During the first years, relevant time series of data on physical and biological components of the ecosystem were assembled and used to describe key aspects of the state and development of the system. Principal Component Analysis was initially used to perform integrated trend analyses (ITA). This approach was later shown to generate artefactual results for the time series collected by the group and was subsequently abandoned. Other analytical methods are now tried out for ITA, such the hypothesis-based method Structural Equation Modelling. In addition, in the coming years the group aims at developing new operational products that can be relevant for management. This includes a model-based food web assessment, a forecast product for the physical environment and routine assessments of signals of risk that are relevant for management. The group also aims at performing repeated scoping among managers and stakeholders to better serve the needs of these groups.

**Talk:** [IEA in practice – Experiences from the Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR)”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Arneberg_P_WGINOR.pdf)

**Andrea Niemi** (Canada, Fisheries and Oceans) - “Off-Shore Integrated Ecosystem Assessments in the Canadian Sector of the Beaufort Sea LME”

**Abstract:**

In support of an Ecosystem Approach to management, in the Canadian Beaufort Sea, the Beaufort Regional Environmental Assessment Marine Fishes Project (BREA-MFP) and follow-on Canadian Beaufort Sea Marine Ecosystem Assessment (CBS-MEA) have identified multiple scales of ecosystem interactions for investigation. These integrated, multi-year (2012-2014, 2017-present) programs are working to address appropriate temporal and spatial scales that support international, national, and co-management (Inuvialuit Settlement Region) priorities. Key themes assessed in these integrated programs include the scale of available baseline knowledge, scales of regional and inter-annual variability, and scales of connectivity linking oceanographic processes to key forage species and priority subsistence species in off-shore and coastal ecosystems. Challenges of scales identify the need for program integration to address management needs within the Beaufort Sea LME and in support of high-sea fishery commitments in the Central Arctic Ocean LME.

**Talk:** [“Off-Shore Integrated Ecosystem Assessments in the Canadian Sector of the Beaufort Sea LME”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Niemi_A_PAME_DFO.pdf)

**Summary: available in App 1**

***CANCELED: Kevin J. Hedges,*** *Marianne Marcoux, Chris Lewis (Canada, Fisheries and Oceans;) - “Integrated ecosystem assessments in the Eastern Canadian Arctic: a comparison between fiord and basin scale programs”*

***Abstract:***

*Several integrated ecosystem assessments are underway in the Eastern Canadian Arctic, including in Baffin Bay, Frobisher Bay, Scott Inlet and Tremblay Sound. The various programs were initially developed for different purposes (e.g. fisheries management, marine mammal management, biodiversity monitoring, environmental baseline quantification) but implement similar sampling methods, which facilitates comparisons among systems, or combined examinations. All of the programs include sampling of benthos, zooplankton, marine fishes and invertebrates, and marine mammals, and monitoring of oceanographic conditions. Data have been combined across programs to support the identification of ecologically and biologically significant areas, the development of fishery closures and the development of ecosystem status indicators. Here we provide an overview of the different integrated ecosystem assessment programs in the Eastern Canadian Arctic, including a discussion of the challenges faced by the various programs and factors that aided their successful development, with consideration of differences in spatial and temporal scales.*

**Tom Christensen** (Denmark, Aarhus University) Tom Barry, Kari Fannar Lárusson.

“The Circumpolar Biodiversity Monitoring Program – Monitoring and reporting changes in Arctic Biodiversity and ecosystems. Status and next steps”

**Abstract:**

Arctic marine biodiversity faces increasing threats from a variety of anthropogenic stressors including, chemical pollutants, climate change, and ocean acidification. The primary objective of CAFF´s Circumpolar Biodiversity Monitoring Programme, CBMP, is to provide early detection of changes in biodiversity and ecosystems and to coordinate ongoing monitoring and measure trends that can be used to inform the development of international policies to mitigate further degradation of Arctic biodiversity. CBMP, is an adaptive and question driven ecosystembased monitoring programme. This ecosystem-based approach integrates information across ecosystems, species, and their interactions, and lends itself to monitoring central biotic aspects of Arctic ecosystems called Focal Ecosystem Components (FECs). Changes in FECs status likely indicate changes in the overall marine and Coastal environment and which therefore CBMP monitors and tracks. The release of the State of Arctic Biodiversity reports as first outcomes from implementation of the CBMP ecosystem monitoring plans demonstrates how cooperative efforts to monitor and report on biodiversity can both help identify status and trends, as well as identify vital gaps in monitoring.

The State of the Arctic Marine Biodiversity Report (SAMBR) in 2017 is a synthesis of the state of knowledge about biodiversity in Arctic marine ecosystems, detectable changes, and important gaps in the ability to assess status and trends of biodiversity across six focal ecosystem components (FECs): marine mammals, seabirds, fishes, benthos, plankton, and sea ice biota. The *State of the Arctic Freshwater Biodiversity Report* (SAFBR) scheduled for release in May 2019 *State of the Arctic Terrestrial Biodiversity Report (START)* is under development and scheduled for release in 2020. The final CBMP ecosystem monitoring plan: the CBMP Coastal plan scheduled for release in May 2019 presents for the first time a platform to support co-production of knowledge and as such is an important step in ensuring a more comprehensive understanding of what is happing in Arctic ecosystems using different knowledge sources. The CBMP Marine group is currently undertaking a scoping process were national implementation of the recommendations presented in the SAMBR is being explored and next steps within the group being prioritized and would welcome input from meeting participants on how the CBMP could further contribute the IEA process.

The State of The Arctic Biodiversity Reports and also the newly published CBMP Coastal Plan and the CBMP strategic plan, each contain several activities related to increased cooperation between CBMP and other Arctic Council Working Groups. This talk will present latest developments in of the Circumpolar Biodiversity Monitoring Program’s (CBMP) progress and next steps.

**Talk:** [“The Circumpolar Biodiversity Monitoring Program – Monitoring and reporting changes in Arctic Biodiversity and ecosystems. Status and next steps”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Christensen_T_CBMP_EA.pdf)

**Sue Moore1,** Rebecca Shuford1, Jason Gedamke1 and Leila Hatch2

“Including underwater sound in Arctic and Subarctic IEAs: an ecosystem component to link ecological, social, and economic factors in support of holistic decision-making”

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**Abstract:**

Sound is a primary sensory modality for many aquatic organisms because it travels readily through water. With the dramatic reduction in sea ice and warming of Arctic and Subarctic

seas, concern is growing regarding the impact of sound from anthropogenic activities on

wildlife. This concern is especially focused on marine mammals, which are protected by US and international laws. Furthermore, Native communities rely upon marine mammals for

subsistence and cultural wellbeing; a point recognized in the 2009 Arctic Marine Shipping

Assessment. Although a key element of the marine environment, sound is not routinely

included as a component in ecosystem assessments, due primarily to a lack of standardization

in sampling protocols and soundscape metrics. However, increasing use of autonomous

recorders has provided rich datasets on seasonal variability of sounds from natural (e.g. wind,

sea ice, marine mammal calls) and anthropogenic (e.g. ships, sonars, seismic surveys) sources

within high-latitude LMEs offshore the USA-Alaska, Canada, Greenland and Norway-Svalbard. In 2014, a passive acoustic data archive was initiated at NOAA’s National Centers for Environmental Information and, in 2016, sound was included as a core variable for the US Integrated Ocean Observing System. Concurrently, NOAA developed an Ocean Noise Strategy that recommended including acoustics as a fundamental habitat quality, part of a coherent approach to reducing the impacts of anthropogenic sounds on marine life. Integrated Ecosystem Assessments (IEA) provide a framework for an ecosystem-based approach to management of marine ecosystems. Including underwater sound in Arctic and Subarctic IEAs would provide a component to link ecological (ambient sound, marine mammal detection), social (connection to local communities, subsistence food security) and economic (shipping, resource extraction, tourism) factors. The science of underwater sound is now mature enough to warrant inclusion in ecosystem assessments, to underscore its role in marine ecosystems and support holistic decision-making.

**Talk:** [“Including underwater sound in Arctic and Subarctic IEAs: an ecosystem component to link ecological, social, and economic factors in support of holistic decision-making”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Moore_S_DBO_PAME.IEA_Conference.June2019.pdf)

**Judith Rosellon-Druker** (USA, University of Alaska Fairbanks), Marysia Szymkowiak, Curry J. Cunningham, Stephen Kasperski, Gordon H. Kruse, Jamal H. Moss, and Ellen M. Yasumiishi

- “Development of socio-ecological conceptual models as the basis for an IEA framework in Southeast Alaska”

**Abstract:**

Integrated Ecosystem Assessment (IEA) is a framework that organizes and summarizes science to aid in the transition from a traditional single sector towards a holistic management approach known as Ecosystem Based Management (EBM). An essential step of the IEA framework is the development of conceptual models. These models allow the integration of intrinsically linked social, environmental and biological components of marine ecosystems which is pivotal to address unsolved questions in fisheries management. We constructed socio-ecological conceptual models of relevant commercial and subsistence fisheries for Sitka, a fisheries-based community in Southeast Alaska, by collecting and synthesizing available scientific information and local ecological knowledge (LEK). We conducted focus group workshops with key informants in Sitka who had in-depth knowledge of their community’s interactions with local fisheries and the structure and function of the surrounding ecosystem. The resulting models co-produced by scientists and Sitka stakeholders, illustrate the main biological and environmental factors driving the abundance of Pacific halibut (*Hippoglossus stenolepis*), Pacific herring (*Clupea pallasii*), Chinook salmon (*Oncorhynchus tshawytscha*), and sablefish (*Anoplopoma fimbria*) fisheries in Southeast Alaska. Furthermore, these co-produced models elucidate how the interaction between Sitka residents and these fisheries affect community well-being. Our models will serve as the basis to assess EBM objectives for Sitka as part of an IEA place-based framework. This study also highlights the importance of integrating LEK into science and potentially, into the broader Alaska fisheries management structure.

**Talk:** [“Development of socio-ecological conceptual models as the basis for an IEA framework in Southeast Alaska”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Druker_R_Socio-ecological_conceptual_models.pdf)

**Summary: available in App 1**

**Fern Wickson,** Genevieve Desportes, (Norway, North Atlantic Marine Mammal Commission)

“Integrating the Scales of Interest in Different Knowledge Systems for Ecosystem Management: An opportunity to share experiences and collectively build best practices”

**Abstract:**

NAMMCO (The North Atlantic Marine Mammal Commission) is a regional inter-governmental organization providing advice from both scientific and local and indigenous hunting communities for policy on the management of marine mammals. The organization considers impacts on marine mammal species from a wide range of sources (including hunting, fishing, pollution and climate change) and is committed to implementing an ecosystem approach to management (EA). One of the recurring questions that NAMMCO faces in its efforts to implement EA in practice is how to achieve effective integration of the diverse knowledge systems of scientists, local communities, and policy-makers. One of the key challenges associated with this is that these different stakeholders often operate not only with different worldviews, terminologies, cultures and positions, but also their knowledge systems can be focused on very different scales of interest (i.e. local, national, regional, global). For example, hunting communities may be specifically interested in local environments, policy makers may be particularly occupied with national level interests, and scientists may focus on regional or global perspectives in their work. Alternatively, it can also be the case that scientists may have a specialized focus on the local habitat of a single species, communities may be interested in the interconnected systems of their region, and policy makers may be particularly focused on international environmental laws and treaties. This means that working across different scales of interest in EA is not only present as a scientific challenge, but also as a challenge connected to integrating different knowledge systems. Given that human communities and activities cannot be separated from natural systems and there is a need to combine the best available science with local and traditional knowledge for robust environmental policy, recognizing and dealing with the potential for different scales of interest across various stakeholder groups is an essential component of effective EA implementation. With this in mind, NAMMCO proposes to open a space for dialogue with conference participants about matters of scale as they appear in the need to integrate diverse knowledge systems when implementing EA. The specific aims of the session would be to: a) enable the sharing of experiences related to integrating different knowledge systems and their diverse scales of interest in EA; b) build awareness of how the issue is being addressed across different organisations and communities implementing EA in practice; c) collect and collate examples of best practice that can be used to help advance the field as a whole.

**Talk:** [“Integrating the Scales of Interest in Different Knowledge Systems for Ecosystem Management: An opportunity to share experiences and collectively build best practices”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Wickson_F_NAMMCO_2019.pdf)

**Summary: available in App 1**

**Per Arneberg,** Anna Siwertsson(Norway, Institute of Marine Research)

“A system for assessing the state of ecosystems based on some principles from IPCC”

**Abstract:**

To follow up a governmental white paper on protection of biodiversity, a system for assessing the state of ecosystems is currently being developed in Norway. This is based on assessing ecological state for the seven following ecosystem traits: (1) primary productivity (2) distribution of biomass among trophic levels (3) diversity of functional groups (4) abundance of species that are central to the dynamics of the system (5) area of habitats (6) changes in species and genetic composition and (7) abiotic conditions. For each of these ecosystem traits, indicators are used to assess whether the trait is affected by anthropogenic activities. This is done through the following steps: (1) describe how we expect each indicator to change with the anthropogenic drivers present (2) perform analyses of time series to assess whether such change has occurred and estimate its magnitude, and (3) assess the overall evidence of human impact on a trait based on all its associated indicators. In this process, information on data quality is considered together with estimates of uncertainty in conclusions from the time series analyses as well as uncertainty in attribution (i.e. how sure we are about the links between drivers and indicators). Together, this produces an assessment framework with many similarities to key assessment processes in IPCC. The system is currently being tried out for the Arctic part of the Barents Sea and results will be presented from this.

**Talk:** [“A system for assessing the state of ecosystems based on some principles from IPCC”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Arneberg_P_Ecosystem_assessment_framework.pdf)

**Lisa Eisner** (USA, NOAA Fisheries), Seth Danielson (University of Alaska Fairbanks) and Carol Ladd (NOAA Pacific Marine Environmental Lab)
- “Arctic Integrated Ecosystem Research in the Chukchi and North Bering Seas”

**Abstract:**

Recent ecosystem level projects in the north Bering and Chukchi seas include Arctic Integrated Ecosystem Studies (IES) phase 1 (2012 and 2013) and 2 (2017, 2019), and Arctic Shelf Growth Advection Respiration and Deposition (ASGARD, 2017 and 2018). These projects are joint efforts among US government and academic scientists to understand the relationships among physics, lower and upper trophic levels including humans in the context of ongoing climate change. Arctic IES 1 and 2 were late summer (August-September) surveys. Data include vertical profiles of temperature, salinity, chlorophyll, light, oxygen, and nutrients, zooplankton and ichthyoplankton abundance from Bongo nets, pelagic fish from surface and midwater trawls and acoustics, and counts of seabirds and marine mammals. Arctic IES2, also included primary production experiments, microzooplankton and phytoplankton community analysis, lipid and fatty acid analyses of phytoplankton, zooplankton and fish, and beam trawls to quantify fish and epibenthic community abundance and distribution. The ASGARD spring (June) surveys collected many of the same measurements as Arctic IES2, with additional onboard measurements of rates (e.g., zooplankton incubation, egg production and respiration experiments), and multicore deployments to examine macro and meiofauna, chlorophyll and organic matter deposition, environmental DNA and sediment. Hydrographic, marine mammal and acoustic moorings were deployed throughout the study area to understand seasonal and interannual variations in physics and biology. Data from these projects, along with other sampling in this region (e.g., DBO), can be useful for ecosystem assessments of the western Arctic coastal regions.

**Talk:** [“Arctic Integrated Ecosystem Research in the Chukchi and North Bering Seas”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Eisner_L_Arctic_Integrated_Ecosystem_Research_Bergen_25Jun19_Eisner.pdf)

**Summary: available in App 1**

**Bérengère Husson,** Maria Fossheim, Mette Mauritzen (Norway, Institute of Marine Research) “What scale(s) to study an ecosystem? A case study in the Barents Sea”

**Abstract:**

The Arctic is experiencing the strongest warming on earth. The Barents Sea is under the conjugated influence of the Atlantic and the Arctic and is also strongly affected by the climate. Recent studies have shown that the increasing warming trend in temperatures is occurring at the same time as a northward shift of fish communities in the whole Barents Sea. BSECO project aims at understanding how those changes impact the functioning and the vulnerability of the ecosystem. As for all ecosystem studies, finding suitable spatial, temporal and taxonomic study scales are a challenge. Our work uses data collected during fifteen years of autumn ecosystem survey and assesses changes occurring through all functional groups of the ecosystem. Those data are analyzed through the lens of different temporal (trend and extreme years), spatial (over the whole Barents Sea and per subregion) and taxonomic (functional groups and individual species) scales. Community level analyses reveal large scale response patterns to climate that cannot be detected at species level. Results will later be combined with traits, food web analyses and end-to-end models to assess changes occurring in the state of the ecosystem.

**Talk:** [“What scale(s) to study an ecosystem? A case study in the Barents Sea”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Husson_B_EA_scales.pdf)

**Summary: available in App 1**

Jacqueline M Grebmeier1\*, Sue E Moore2, Lee W Cooper1, Karen E Frey3

“The Distributed Biological Observatory: A Change Detection Array in the Pacific Arctic”

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**Abstract:**

The Pacific Arctic region is experiencing major reductions in seasonal sea ice and increases in sea surface temperatures. A key uncertainty is how the marine ecosystem will respond to these shifts in the timing of spring sea ice retreat and/or delays in fall sea ice formation. Variations in upper-ocean water hydrography, stratification, light penetration, planktonic production, pelagic-benthic coupling and sediment carbon cycling are all influenced by sea ice and temperature changes. In order to evaluate these responses, the Distributed Biological Observatory (DBO) was initiated in 2010 as a change detection array for the identification and consistent monitoring of biophysical responses to environmental change in the Arctic. The DBO sampling approach to determine the status and developing trends for the ecosystem is facilitated by repeated sampling each year through multiple international occupations of agreed-to transect lines. Continuous data collections obtained through mooring and satellite observations, with an accompanying data sharing policy, help to integrate between shipboard sampling efforts. The Pacific DBO activities are focused on five regional biological transects (designated DBO1, 2, 3, 4, 5), which are located at biological hotspots along a latitudinal gradient in the Bering and Chukchi seas. Three additional locations have also been designated in the Beaufort Sea; expansion plans include development of DBO sites in the Baffin Bay/Davis Strait region, the Atlantic sector of the northern Barents Sea, and possibly into the Russian Arctic. Seasonal sampling along the five core DBO transects indicates freshening and warming as Pacific seawater transits northward during the open water season. Ongoing observations of reduced sea ice extent and duration, and seawater warming are being linked to shifts in species composition and abundance, and northward range expansions in higher trophic predators (e.g. gray and humpback whales, and commercially harvested fish). Spatial changes in carbon production and export to the sediments, shifts in macrofaunal community composition and biomass, changing sediment grain size, and range extensions for some benthic species are additional observations that have grown out of DBO sampling efforts. There is also direct evidence of negative impacts on ice dependent species, such as walruses. Notably in 2018, limited production of sea ice in the northern Bering Sea area south of St. Lawrence Island (DBO1), removed thermal barriers and allowed commercial fish species to travel north as far as Bering Strait. Both the changing seasonality of spring sea ice retreat and associated ice edge production have a dramatic potential to impact pelagic-benthic coupling processes that can have major impacts on the ecosystem structure in the Pacific Arctic region. The continued development of the DBO is proving to be a significant resource for the identification and consistent monitoring of biophysical responses in the changing Arctic.

**Talk:** [“The Distributed Biological Observatory: A Change Detection Array in the Pacific Arctic”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Moore_S_Soundscape_Acoustics-IEAs_PAMEConference.pdf)

**Hein Rune Skjoldal** (Norway, Institute of Marine Research) “Description of Arctic species and Arctic LMEs – integrating information on species and habitats”

**Talk:** [“Description of Arctic species and Arctic LMEs – integrating information on species and habitats”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Skjoldal_HR_Arctic_species_and_LME.pdf)

**Phillip Wallhead,** Phil Wallhead1, Wenting Chen2, Laura Falkenberg2, Magnus Norling1, Richard Bellerby2,3, Sam Dupont4, Camilla with Fagerli1, Trine Dale2, Kasper Hancke1, Hartvig Christie1

“Urchin harvesting and culling in northern Norway under ocean acidification and warming”

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4 Department of Biological and Environmental Sciences - University of Gothenburg, The Sven Lovén Centre for Marine Infrastructure – Kristineberg, 45178 Fiskebäckskil, Sweden

**Abstract:**

The harvesting of green sea urchins in northern Norway is a potentially important fishery for the region because of the high value of urchin gonads on the global market.  We developed a computer model (integrated ecosystem assessment type of model) of urchin and kelp populations growing in a typical fjord in northern Norway and used it to simulate the impacts of different harvesting/culling strategies.  We did this both for present-day conditions and for a future scenario based on projected ocean acidification and warming for the next 30 years under a business-as-usual scenario (0.8°C warming, 100 micro atm pCO2 increase or ~0.1 pH unit decrease). Our simulations suggested that a minimum harvested urchin diameter of around 5 cm would give the highest sustainable harvest yield (in terms of gonad biomass) and that this optimal restriction would be little affected by climatic change.  However, the potential harvest yield was very strongly reduced (roughly sevenfold) in the future scenario.  This was partly due to acidification, but mainly due to warming. To provoke a regime shift from an urchin barren to a kelp forest state with high probability, simulations suggested that an annual cull of all urchins larger than 10 mm would be needed, and this requirement was also little affected by climatic change. This study highlights the pressing need for investigations of organismal sensitivities at moderate levels of warming and acidification, and of other ecological effects including disease and higher predation. The model is potentially a useful tool for ecosystem management and harvest optimization in the context of ocean acidification and warming. These results should however be treated with caution because they depend on urchin life stage sensitivities that are currently not well constrained by experimental data.  More experiments are needed at the required moderate levels of acidification and warming, and more field investigations are needed to understand the north-to-south variability in urchin abundance along the Norwegian coast.

**Talk**: [“Urchin harvesting and culling in northern Norway under ocean acidification and warming”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_1/S1_Wallhead_C_ABC2018.pdf)

# SESSION 2. MPAS AND OTHER SPECIAL AREAS

**Lauren Wenzel** (USA, NOAA Fisheries)

 “Marine Protected Areas and Networks as a Component of Ecosystem-Based Management”

**Talk**: [“Marine Protected Areas and Networks as a Component of Ecosystem-Based Management”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Wenzel_L_MPAs_as_part_of_an_EAM.pdf)

**Boris Solovyev** (Russia, Russian Academy of Sciences)

“From principles to practice: systematic conservation planning approach in the Arctic”

**Abstract:**

Systematic conservation planning, SCP (Margules & Pressey, 2000) is widely considered the most effective and most used approach for designing protected areas and other ecological networks (Smith et al., 2006). The approach was developed and applied mostly in the tropical or sub-tropical regions and before 2015 there were no attempts to apply the approach in the Arctic marine ecosystems. In most cases SCP was applied to the coastal regions and in the relatively small, regional scale.

The Arctic marine ecosystems are quite different as they are: 1) of a larger scale, 2) less diverse, 3) highly dynamic seasonally as well as interannualy.

As a group of experts under WWF Russia and Russian Academy of Sciences guidance started a study on identification of a network of conservation priority areas in the Russian Arctic Seas, these issues were encountered, and an interpretation of SCP approach led to the development of the practical solutions. This case study encompasses also other issues crucial for conservation planning such as lack of data, conservation feature selection criteria, target setting approach and post-analysis.

This set of practical solutions is now used for the expansion of the conservation priority area networks identification at the global (the Arctic Ocean) and regional (the Pechora Sea) scales contributing to the ecosystem approach to management in the Arctic.

**Talk**: [“From principles to practice: systematic conservation planning approach in the Arctic”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Solovev_Pechora.pdf)

**Martine Giangioppi** (Canada, World Wildlife Fund)

“Marine Ecological Conservation in the Canadian Eastern Arctic (MECCEA): A project to identify Priority Areas for Conservation (PACs).”

**Abstract:**

WWF- Canada initiated a project intended to inform the development by the Government of Canada of a network of Marine Protected Areas (MPAs); specifically, to address a current gap in MPA Network planning in the eastern Arctic. Priority Conservations Areas (PACs), based on ecological principals that rely on both scientific and indigenous knowledge, have been identified. The PACs are integrated into the wider landscape and seascape by patterns of connectivity, thus permitting the establishment of a true Network of arctic marine protected areas.The scope of the project includes the Arctic Basin, Arctic Archipelago, Eastern Arctic and Hudson Bay Complex marine bioregions. The outcomes of MECCEA can be used to inform future MPA Network planning in the Arctic, the establishment of individual marine conservation areas, and planning and management decisions outside of MPAs, including Ecosystem-Based Management, Marine Spatial Planning, Strategic Environmental Assessments, etc. This work will also contribute towards international efforts to support the development of a Pan Arctic Marine Protected Areas Network (PAMPAN).

**Talk**: [“Marine Ecological Conservation in the Canadian Eastern Arctic (MECCEA): A project to identify Priority Areas for Conservation (PACs).”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Giangioppi_M_Marine_Ecological_Conservation_Canadian_Eastern_Arctic.pdf)

**Martin Sommerkorn** (Norway, World Wildlife Fund)

“The Pan-Arctic Marine Protected Area Network initiative and its contribution to implementing the Ecosystem Approach to Management in the Arctic”

**Abstract:**

The Protection of the Arctic Marine Environment Working Group (PAME)-produced *Framework for a Pan-Arctic Network of Marine Protected Areas* (MPAs) approved by the Arctic Council sets forth an ambitious blueprint for area-based protection that is embedded in, and contributes to, the ecosystem approach to management. There is urgency to establish this network given increasing human pressures, industrial activities, climate change, and very few existing MPAs. There are also opportunities in that there can still be a pre-cautionary approach to designing and implementing protection measures given the relatively little human industrial impact in the Arctic to date. Having in mind the challenge to apply the Arctic Council’s vision in a systematic, transparent and participatory way that contributes to the ecosystem approach, WWF is carrying out the Pan-Arctic Marine Protected Area Network (PAMPAN) initiative. The goal of this WWF initiative are twofold. The first goal is to apply a systematic conservation approach to identify candidate sites for marine protection of biodiversity, ecological processes, and associated ecosystem services and cultural values in a representative, adequate and efficient way. The focus of the PAMPAN analysis is on conservation features that are representative or distinctive at the pan-Arctic scale and deserve a dedicated analysis – this may be a different set than e.g. national scale sets. The Pan-Arctic analysis is neither the same as the sum of lower scale analyses, nor does it not replace them. Secondly, PAMPAN initiates and engages a community of practice in an open and inclusive process that showcases and applies a transparent analysis to produce maps of candidate sites for marine protection as concrete proposals for planning and implementation processes. Post analyses will include oceanographic connectivity analysis, assessment of the identified network candidate sites against existing area-based conservation measures (gap analysis), and analysis of the persistence of candidate sites in a climate-changed Arctic Ocean. With this presentation, the authors seek to initiate discussions exploring the contribution of MPA networks to the ecosystem approach in the marine Arctic and potential implication for the design and implementation of area-based protection measures.

**Talk**: [“The Pan-Arctic Marine Protected Area Network initiative and its contribution to implementing the Ecosystem Approach to Management in the Arctic”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Martin_Sommerfeldt_PAMPAN_PAME.pdf)

**Boris Solovyev** (Russia, Russian Academy of Sciences)

“Systematic conservation planning for ecosystem based approach to management: case study from Pechora Sea”

**Abstract:**

Pechora Sea is the southeastern part of the Barents Sea, known for (still) an extensive and long-lasting sea ice cover, and a specific oceanographical regime. It was recognized as an Ecologically and Biologically Significant Area, according to the criteria adopted by the Convention on Biodiversity. On the other hand, this is the first region in the Eurasian Arctic where offshore oil production has recently been started (Prirazlomnaya field), and where a number of new areas have been leased for hydrocarbon exploration. It is characterized by intensive ship traffic. Although this sea now supports only limited coastal fishery, it may face an alien snow crab fishery in the future. We have used MARXAN as a decision support tool for conservation planning to develop a coherent network of conservation priority areas which can be further used for marine spatial planning in the region and as a model for other regions. 70 conservation features were considered, grouped into several categories: plankton and productivity, benthic communities, fishes, sea birds and marine mammals. Several MARXAN experiments and consultations with an expert community resulted in a rather conservative network of 13 areas, well representing the main subregions based on oceanography, and providing geographic and food web connectivity. A new methodology of threat and vulnerability assessment has been applied that made it possible to formulate ecosystem based recommendations for spatial management of the current and potential economic activities and monitoring of their impact in the Pechora Sea. The study was supported by WWF.

**Talk:** [“Systematic conservation planning for ecosystem based approach to management: case study from Pechora Sea”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Solovev_EA_Systematic_conservation.pdf)

**Elizabeth Logerwell** (USA, NOAA Fisheries), Jørgensen LL (Norway), Blicher M & Hammeken N (Greenland), Roy V (Canada), Ólafsdóttir SH (Iceland), Strelkova N (Russia), Sørensen J (Faroe Island), Christiansen JS, Bodil Bluhm and Fredriksen R (Norway)

“Long-Term Benthos Monitoring network for identifying vulnerable areas in Arctic benthic ecosystems”

**Abstract:**

Arctic benthic ecosystems are vulnerable to climate change and human activities such as bottom trawling. One challenge to identifying vulnerable areas that could be candidates for spatial management is the lack of consistency and methodological standardization among monitoring efforts. One potential solution is to develop a time- and cost-effective, long-term and standardized monitoring of megabenthic communities in all Arctic regions that conduct regular groundfish assessment surveys. To investigate the viability of this approach, the “Long-Term Benthos Monitoring network” project was funded by the Nordic Council for 2017-2020. The goal of this project is to explore how national groundfish surveys including megabenthos bycatch can provide relevant data for evaluating the state of benthic communities. Two workshops have been held, in 2017 and 2018, involving representative from national groundfish monitoring programs from Russia, Norway, Greenland, Iceland, Faroe Islands, Canada and the USA. The 2017 workshop resulted in Pan-Arctic maps of survey effort; bottom depth, temperature and salinity; and megabenthos species richness and biomass. The 2018 workshop resulted in methods to use species traits analysis to identify vulnerable areas, which will be implemented in future workshops. Jorgensen et al (during this Conference) provide a detailed example of using this method to identify vulnerable areas in the Barents Sea and to communicate recommendations at the governmental level.

**Talk:** [“Long-Term Benthos Monitoring network for identifying vulnerable areas in Arctic benthic ecosystems”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Logerwell_L_LTM_Megabenthos.pdf)

**Ole Anders Turi** (Norway, Sámediggi/Sámi Parliament)

“What challenges could Ecosystem Approach solve at Saami resource use level”

**Talk:** [“What challenges could Ecosystem Approach solve at Saami resource use level”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Turi_OA_Saami_resource_use_level.pdf)

**Lis L. Jørgensen** (Norway, Institute of Marine Research), Gunnstein Bakke (Directorate of Fishery), Alf Håkon Hoel (UiT)

“Vulnerable areas and Ecosystem-based fishery management in the Barents Sea”

**Abstract:**

The Arctic Barents Sea is experiencing a record temperature increase and a poleward shift in the distributions of commercial fish stocks. An increase in Boreal species are observed, together with a reduced importance of Arctic species. Commercial fish stocks expand into the north western part of the Barents Sea which will increase exposure of large immobile species to trawling (Jørgensen et al 2019). How can these results be used in Ecosystem based Fishery management? We demonstrate the interaction between the scientist and the management, from the raw-data to the integrated maps and the final product presented to the governmental level. We also show how the Vessel-Monitoring-System (VMS) point out “good” fishing-grounds based on local knowledge. This can be used to direct an international fleet to areas where the fish catch, and hence the seabed, are not damaged doe to large aggregation of benthic fauna (complex habitats).

**Talk:** [“Vulnerable areas and Ecosystem-based fishery management in the Barents Sea”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_J%C3%B8rgensen_L_Benthos.pdf)

**Wenting Chen1**, David Barton3,  Kristof Van Assche2, Stephen Hynes4, Trine Bekkeby1, Hartvig Christie1, Hege Gundersen1

 “Marine ecosystem accounting to support coastal and marine governance”

1Norwegian Institute for Water Research(NIVA), 2 University of Alberta, 3 Norwegian Institute for Nature Research (NINA), 4 National University of Ireland

**Abstract:**

Natural capital accounting systems view nature and ecosystems as assets which provide a stream of ecosystem service benefits to society (UN 2014). Ecosystem accounting aims to identify periodic change in ecosystems’ contribution to the economy. The ability to identify change in the economic value of ecosystems is potentially important in evaluating aggregate effects of combinations of policy within an accounting area. Ecosystem accounts are potentially one of several tools in governance towards sustainable social- ecological systems. In 2014 the SEEA Experimental Ecosystem Accounting (EEA) was launched (UN 2014) and three years later SEEA EEA Technical Recommendations (UN 2017). Ecosystem accounting represents a fundamental methodological development in making national accounts sensitive to spatial variation in ecosystem services flows and their value as assets. Figure 1 illustrated how the ecosystem accounting areas can be divided spatially. For marine ecosystem accounting for example in the Arctic area, this means the division of ecosystem accounting areas in the coastal and marine area. Ecosystem accounting is still in experimental stages, while natural capital accounting has been applied mainly to terrestrial environments. Marine and coastal ecosystem accounting remains sparse. The paper carries out an experiment ecosystem accounting for Norwegian kelp forest along the whole Norwegian coast and highlights how the SEEA can be applied in the governance; for example, by assisting in the choosing of management hotspots for kelp forest. We discuss how SEEA can be applied in Norwegian Barents sea management plan and potentially the governance of the artic area when emerging industrial activities put increasing pressure on the ecosystems. For the artic area, we will focus on how SEEA can be applied in the planning and evaluate efficiency of marine protected areas (MPAs) and marine spatial planning (MSP).

**Talk:** [“Marine ecosystem accounting to support coastal and marine governance”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_ChenEA_Marine_ecosystem_accounting2.pdf)

**Summary: available in App 1**

**Gerold Janssen** and Marius Werner (Germany, Leibniz Institute of Ecological Urban and Regional Development)

“Implementing an Ecosystem-based approach in MSP”

**Abstract:**

Research findings have shown that MSP can be an effective instrument for preserving marine environments and present a way to translate the ecological requirements of an EBA into concrete marine spatial planning measures. In recent years the importance of considering marine environment in spatial planning has strongly increased by introducing an **ecosystem-based approach (EBA)** to MSP through different regulations and guidance documents. Research findings of two research and development projects carried out by Leibniz Institute of Ecological Urban and Regional Development and Leibniz Institute of Baltic Sea Research Warnemuende together with various research partners and supported by the Federal Agency for Nature ConservationThe mentioned projects have shown that the implementation of requirements of the EBA sets new challenges for competent authorities and stakeholders. Against this background it is important to make clear, **that an implementation of an EBA can effect two aspects of planning: the planning process itself and the content of plan.** Therefore an implementation of an EBA should result in changes of  both of these aspects. Still concrete implementation concepts remain vague. As a contribution to a further development of the implementation of an EBA in MSP both research projects aimed at presenting a proposal on how planners and stakeholders can handle new requirements for an ecosystem-based spatial planning. Therefore it has to be ensured that during the planning process the carrying capacity of ecosystems is considered and good environmental status according to the MSFD can be reached. Research findings have shown that MSP can be an effective instrument for preserving marine environments and **present a way to translate the ecological requirements of an EBA into concrete marine spatial planning measures.**

**Talk:** [“Implementing an Ecosystem-based approach in MSP”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_2/S2_Gerold_Janssen_Implementing_an_Ecosystem-based_approach_Bergen.pdf)

**Sheku Sei1** and Andrew Baio1, 2

“Resource user perception evaluation for the establishment of Marine Protected Areas in Sierra Leone”

1Natural Resource Management Consortium (NaReMaC), Fourah Bay College Campus, University of Sierra Leone, 2Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone

**Summary:**

Marine Protected Area (MPA) is an investment in stock rebuilding, the cost of which is the value of the catch that would have been harvested without the MPA. In order to evaluate this hypothesis, we have used a multi-criteria analysis to assess stakeholder perception on the establishment of marine protected areas in Sierra Leone. The ranking of stakeholder’s views on the problems and benefits associated with MPA establishment relied an Analytical Hierarchy Process (AHP) using the Intelligent Decision System (IDS) Multi Criteria Assessor (IDS). The set of resource user perception evaluation alternatives modelled include contextual variables, incentive to cooperate and coordinate patterns of interaction and outcomes, efficiency and equity. This provided the baseline socio-economic information for evaluation of the stakeholder needs and acceptability level for the establishment of viable MPAs along the coast of Sierra Leone. The result reveals a strong agreement among stakeholders that the MPAs will exclude them from their livelihood activities of fishing, woodcutting and sand extraction. The analysis produced an average score for stakeholder perception on the incentives to cooperate with management measures for MPAs. However, a good score was obtained for contextual variables on fish stock status but low on the other alternatives, showing that stakeholders are aware of a declining fish stock in their communities. The outcome of efficiency and equity ranks lowest among the alternative variables for the establishment of MPAs in the Sierra Leone River. Alternative livelihoods schemes including access to credit facilities was identified as major incentives that will encourage the fishermen to comply with MPA management measures. However, it is noted that any micro-credit scheme that will be conceived should draw on experiences and problems limiting loan recovery.

**Talk:** “Resource user perception evaluation for the establishment of Marine Protected Areas in Sierra Leone”

# SESSION 3. VOICES FROM THE NORTH – A CONVERSATION ABOUT PEOPLE, NATURE, AND SUSTAINABILITY

**Fred Phillips and Mellisa Heflin** (USA, Bering Sea Elders Group)

“The ocean is our garden”

**Talk:** [“The ocean is our garden”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_3/S3_Phillips_F_Heflin_M_Bering_sea_elders_group.pdf)

**Nicole Kanayurak** (USA, Utqiagvik, North Slope Borough Department of Wildlife Management)

“Inuit have an ‘Ecological Clock’”

**Talk:** [“Inuit have an ‘Ecological Clock’](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_3/S3_Kanayurak_N_Inuit_Have_an_Ecological_Clock.pdf)

**Gerry Inglangasuk** (Canada, Inuvialuit Member, Fisheries Joint Management Committee) and

**Alan Kennedy** (Canada, Chairman, Fisheries Joint Management Committee)

“Co-management as a Framework for Ecosystem Management of Arctic Resources: Experience from the Inuvialuit Region of Canada”

**Talk:** [“Co-management as a Framework for Ecosystem Management of Arctic Resources: Experience from the Inuvialuit Region of Canada”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_3/S3_Kennedy_A_Inuvialuit_Region_of_Canada_.pdf)

**Andrea Niemi/Lianne Postma and Elizabeth Hiltz** (Canada, Fisheries and Oceans)

“An Inclusive Approach to Public Outreach: A Case Study from Canada’s Arctic” with video “Guardians of Tariug”: **“Guardians of Tariuq” a music video celebrating Canada’s eastern arctic marine conservation areas starring school children**

Hiltz, Elizabeth (1) (beth.hiltz@dfo-mpo.gc.ca), B. Burke (2), S.D. Fuller (3), A. O’Rielly (4), T. Taylor (5), J. Qaumariaq (6), V. Karetak (7) and Z. Martin (8) [Introduced by Andrea Niemi, Fisheries and Oceans Canada]

1) Fisheries and Oceans Canada, Winnipeg MB, Canada, 2) Nunavut Fisheries Association, Iqaluit NU, Canada, 3) Oceans North, Halifax NS, Canada, 4) Northern Coalition, 5) Corporation, St. John’s NL, Canada, 6) Oceans North, Iqaluit NU, Canada, 7) The Trade Offs, Iqaluit NU, Canada, 8) Qanukiaq Studios, Iqaluit NU, Canada, 9) Fisheries and Oceans Canada, Iqaluit NU, Canada

In 2017, Fisheries and Oceans Canada, in collaboration with stakeholders, established three conservation areas in Canada’s Eastern Arctic to protect vulnerable species of corals and sponges. Inhabitants of Baffin Island, Nunavut are generally unaware that corals and sponges exist in the waters off their coast. To improve awareness of the Arctic marine ecosystem and protection efforts, a music video was created which involved youth and performance artists from Iqaluit, Nunavut. The music video incorporated two culturally important mediums - conversation and storytelling. The video demonstrates a special collaboration between government, industry, environmental, and community organizations to promote conservation initiatives.

**Talk/video:** [“An Inclusive Approach to Public Outreach: A Case Study from Canada’s Arctic” with video “Guardians of Tariug”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_3/S3_Hiltz_E_Guardians_of_tariuq.pdf)

**Summary: available in App 1 (see Hiltz, Elizabeth)**

# SESSION 4. NATIONAL EA IMPLEMENTATION

**Cecilie von Quillfeldt** (Norway, Norwegian Polar Institute)

“Integrated Management Plans for Norwegian Sea Areas”

**Abstract:**

The Johannesburg declaration of 2002 calls for Ecosystem Approach (EA) to management of all marine ecosystems by 2010. As a result, the management plan for the Barents Sea-Lofoten area was first announced in the white paper Protecting the Riches of the Sea (St.meld. nr. 12 (2001-2002)). The white paper states that an ecosystem approach to management of marine sea areas should provide a framework for sustainable use of natural resources and goods derived from the area that at the same time maintain the structure, functioning and productivity of the ecosystems of the area. Since then, Norway has established management plans as the basis for integrated ecosystem approach to management of all Norwegian Sea areas (Barents Sea 2006, Norwegian Sea 2009, North Sea/Skagerrak 2013). Furthermore, Norway has signed several international conventions and agreements and participates in international processes that also provide guidance on the design of the Norwegian marine management plans. These plans represent a strictly knowledge-based management regime. Knowledge about ecosystem functions and about the extent of human activities and influences is critical to good management, and scientific data about changes in the different components of the ecosystem is essential for any functional management of an area. The management plans have contributed to a shift of Norwegian management, now taking into account individual species to ecosystems (e.g. Barents Sea as an ecosystem), dealing with short time frame to longer time frame (e.g. future scenarios), sector management to integrated management (e.g. combined assessment of impact of oil and gas activities, shipping and fisheries) and better cooperation between management and research (e.g. research and monitoring priorities set based on management needs).

**Talk:** [“Integrated Management Plans for Norwegian Sea Areas”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Quillfeldt_EA_Norway.pdf)

**Daniel Van Vliet** (Crown Indigenous Relations and Northern Affairs Canada)

“Strategic Environmental Assessment Processes in Canada’s Arctic”

**Abstract:**

Crown Indigenous Relations and Northern Affairs Canada is undertaking 2 Strategic Environmental Assessment Processes in Canada’s Arctic. These processes were developed in order to inform decision making around Offshore Oil and Gas activities in Canada’s Arctic waters. These strategic environmental assessment processes were co-developed with Land Claim organizations in Nunavut and Northwest Territories. Daniel will be presenting on the co-management approach to this work and the practice of inclusion of both science and indigenous traditional knowledge to inform decision makers. He will also discuss the approaches to local indigenous community engagement used throughout this work.

**Talk:** [“Strategic Environmental Assessment Processes in Canada’s Arctic”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_van_Vliet_D_Assessment_in_Canadas_Arctic.pdf)

**Elizabeth Logerwell** (USA, NOAA Fisheries)

“NOAA’s Integrated Ecosystem Assessment (IEA) Program”

**Talk:** [“NOAA’s Integrated Ecosystem Assessment (IEA) Program”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Logerwell_NOAA_IEA.pdf)

**Boris Solovyev** (Russia, WWF Russia/Russian Academy of Sciences)

“EA Implementation in Russian Arctic”

**Abstract:**

In 2016 WWF and Russian experts developed a new methodology for the identification of networks of marine areas based on an ecosystem approach. During the last 3 years this methodology was applied in the Russian Arctic at both the national and regional scales.

At the national level, an analysis was carried out for the entire marine area of the Russian Arctic. As a result, 47 marine areas which require the application of environmental measures at the Russian federal level were identified. Six of these areas have been included in the Russian federal plans for new MPAs and should be formally gazetted by 2023. To date one of the six areas “New Siberian Islands” has been established as a new MPA covering an area of more than 6 million ha. The remaining five areas in the plan cover more than 10 million ha. Additionally, some from these 47 areas will have conservation regime as buffer zones of the federal PAs and zones of marine mammal conservation. At the regional level, an analysis of the Pechora Sea (part of the Barents Sea) has been completed. While the Pechora Sea has been recognized as an Ecologically and Biologically Significant Area, it is also one of the most intensive areas in the Russian Arctic for hydrocarbon exploration and shipping.

The purpose of the analysis was not only to identify a system of important marine areas, but also to prepare recommendations for developing economic activity across the entire sea.

The analysis assessed the environmental value and vulnerability for each part of the sea. A network of important marine areas were identified and for each of these a set of management recommendations were developed covering the intensity of use of different zones, seasonal restrictions, and conservation areas etc.. . Now the results of this work we use as a basis for the Integrated Sea Use Management (ISUM) of the Pechora Sea and for communication with different nature use companies including oil& gas.

**Talk:** [“EA Implementation in Russian Arctic”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Solovev_EA_Russian_Arctic_Seas.pdf)

**Anders Mosbech** (Denmark, Aarhus University), Tom Christensen, Kasper Lambert Johansen, David Boertmann, Daniel Spelling Clausen.

“On the road to EA in Greenland: The use of spatial biodiversity data to identify important areas”

**Abstract:**

In recent years a number of studies, mainly from Aarhus University and Greenland Institute of Natural Resources, have provided an overview of important areas for ecosystems and species in Greenland. Abundance, occurrence, migration routes etc. for more than 100 species and/ or ecosystem components has been mapped focusing on the spatial distribution of important biological areas. The map has further been combined to identify the most biologically important areas according to a set of criteria informed by national priorities and international processes such as the Convention on Biological Diversity to identify Ecologically and Biological Sensitive Areas (EBSAs) and the International Maritime Organization (IMO) to identify Particular Sensitive Sea Areas (PSSA). In relation to mineral exploitation in Greenland, a number of areas has been identified as sensitive, and the spatial analysis has further been used to identify biologically important areas in finer scales in the North Water and Disco Bay/ Store Hellefiskebanke areas. In relation to Disko Bay / Store Hellefiskebanke, each of the biological layers where further assessed and ranked according to their specific sensitivity to potential environmental effects caused by shipping, to identify where there may be a need for heightened awareness in relation to impacts from the shipping sector. In relation to an Arctic Council initiative about Adaptation Actions to a Changing Arctic (AACA), the spatial data will be further discussed in Greenland at a workshop in May 2019 with the purpose to explore the possibilities for a more ecosystem based management approach to spatial planning in Greenland.

**Talk:** [“On the road to EA in Greenland: The use of spatial biodiversity data to identify important areas”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Mosbech_A_EA_in_Greenland.pdf)

**Summary: available in App 1**

**Bjarne Lyberth** (Greenland, The Association of Fishers & Hunters in Greenland)

“International and national wildlife management from a local perspective (fishers and hunters in Greenland)”

**Abstract:**

Hunting is an important part of the formal and informal economy for many Greenlanders, particularly in communities with no facilities for storing and processing fish. Sustainable management of living resources is reliant on up-to-date knowledge of the status and abundance of the resources. One of the aims of the Fishers’ and Hunters’ Association of Greenland (KNAPK) is to stimulate the inclusion of user knowledge in the Government’s management of the living resources. The Hunting Act of Greenland also stresses the importance of inclusion of user knowledge in the management of the country’s wildlife. The Pikialasorsuaq Commission documented Inuit knowledge about the environment. The Commission concluded its work with a number of management recommendations, including a recommendation to develop an Inuit management authority for the Pikialasorsuaq area. KNAPK hosted a workshop in 2018 about national and international wildlife management in Greenland with participation from hunters’ representatives as well as scientist and other experts on wildlife and ecosystem management from Greenland, Alaska and Denmark. Following the workshop, a set of recommendations were delivered to the Government of Greenland. The recommendations suggest the use of the existing community-based documentation and management program PISUNA (Piniakkanik Sumiiffinni Nalunaarsuineq) to advise the decision-making on living resources by the management authority. This monitoring program is based on observations gathered by local natural resource councils during every day activities in the nature. The natural resource councils provide management advice every quarter of a year. The observations and management advices cover a wide range of natural resources and parameters. Presently the natural resources councils are operating in three Greenlandic communities. With partners from central government and municipalities, KNAPK is currently working towards enabling the establishment of more local natural resource councils across Greenland.

**Talk:** [“International and national wildlife management from a local perspective (fishers and hunters in Greenland)”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Lyberth_B_Greenland_Fishers_and_Hunters.pdf)

**Mandy Karnauskas** (USA, NOAA Fisheries)

“Identifying relevant spatial scales and priorities for ecosystem-based management of the Gulf of Mexico snapper-grouper fishery complex”

Matt McPherson, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Adyan Rios, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Skyler Sagarese, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

John Walter, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Daniel Goethel, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Suzana Blake, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Amanda Stoltz, NOAA Fisheries Southeast Fisheries Science Center, Miami, USA

Chris Kelble, NOAA Atlantic Oceanographic and Meteorological Laboratory, Miami, USA

Michael Jepson, NOAA Fisheries Southeast Regional Office, Miami, USA

**Abstract:**

As NOAA Fisheries endeavors to develop more holistic approaches to fisheries management there is an increasing need to engage resource managers and users in identifying relevant ecosystem drivers, risks, and trade-offs. Engaging resource users and capturing their local and traditional knowledge (LTK) lends valuable insights into the relevant scales of management, and informs priority areas for research that feeds into decision-making. During a series of participatory fisheries system modeling workshops with resource managers and users in the West Florida Shelf region, many concerns were highlighted regarding the multifaceted impacts of severe harmful algal bloom events known as “red tides.” Typically, the impacts of red tides are incorporated in the stock assessment process, whereby red-tide induced fish mortality is estimated and accounted for in recommendations on sustainable levels of fishing mortality. However, the participatory workshops unveiled a number of additional concerns beyond the impacts on fish mortality; red tide events also affect habitat condition, commercial and for-hire fishing businesses, aquaculture, tourism, protected species, and human health. These additive or potentially synergistic red tide impacts have implications for: the stock assessment, the ecosystem, and fishing communities, the sum of which define a discrete problem that can be addressed via the ecosystem approach. Comparison of participatory models across fishing communities also elucidated the scales at which common drivers and processes occur. We will discuss the strength of the participatory modeling approach for building partnerships and identifying information gaps, defining relevant ecosystem management scales, and conducting research to inform decision-making.

**Talk:** [“Identifying relevant spatial scales and priorities for ecosystem-based management of the Gulf of Mexico snapper-grouper fishery complex”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Karnauskas_M_management_in_the_Gulf_of_Mexico.pdf)

**Summary: available in App 1**

**Daniel Taukie** (Canada, Nunavut Tunngavik Inc.)

“Inuit-led Marine Monitoring in Nunavut, Canada”

**Talk:** [“Inuit-led Marine Monitoring in Nunavut, Canada”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Taukie_D_Inuit_Marine_Monitoring_Program.pdf)

**Gunn-Britt Retter** (Norway, Saami Council)

“The Arctic Environmental Impact Assessment – a Model for Meaningful Engagement of Indigenous Peoples”

**Talk:** [“The Arctic Environmental Impact Assessment – a Model for Meaningful Engagement of Indigenous Peoples”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_4/S4_Retter_GB_EIA_Report_Slides_June2019_GBR.pdf)

**Summary: available in App 1**

# SESSION 5. CENTRAL ARCTIC OCEAN

**Alf Håkon Hoel** (Norway, University of Tromsø; presented by Hein Rune Skjoldal)

“Organizing science for the central Arctic Ocean”

**Abstract:**

The Agreement on Preventing Unregulated Fishing in the High Seas Portion of the Central Arctic Ocean is the result of almost a decade of negotiations, first among the five coastal states, then including also potential distant water fishing nations. Through the entire process the interactions between science and policy actors have been critically important, and will continue to remain so when the agreement enters into force. This presentation examines lessons to be learnt from this process, and discuss implications for future research cooperation in the CAO.

**Talk:** [“Organizing science for the central Arctic Ocean”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_5/S5_Hoel_AH_Organizing_Science_for_the_CAO.pdf)

**Hein Rune Skjoldal** (Norway, Institute of Marine Research) - “WGICA Integrated Ecosystem Assessment report for the CAO”

**Talk:** [“WGICA Integrated Ecosystem Assessment report for the CAO”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_5/S5_Skjoldal_HR_WGICA.pdf)

**Vasily Spiridonov** (Russia, Russian Academy of Sciences)

“Indicators of vulnerable benthic biotopes in the Arctic Ocean”

**Abstract:**

Vulnerable benthic biotopes are those that fit at least some criteria of vulnerable marine ecosystems as defined by FAO (2009). They mainly include bottom biotopes and communities forming by habitat-making organisms (aedificators), such as deep-water corals, sponges, mollusks and some other taxa building biogenic structures as well as biotopes built around underwater volcanism and hydrothermalism. Except of some boundary areas, i.e. the Barents, Norwegian, and the Bering Seas they have been never identified in the Arctic Ocean. Within a WWF project for marine systematic conservation planning (PAMPAN – Pan Arctic Marine Protected Areas Network) we attempted to include vulnerable marine biotopes as distinct conservation features in the process of constructing a network of conservation priority areas, using MARXAN as a decision support tool. Actual data on deep sea (cold-water) coral spots were obtained from the World Conservation Monitoring Center database. Cold seeps and mud volcanoes with a characteristic biota have been recently identified on the Arctic shelf, i.e. in the Laptev and Beaufort Seas. Other possible vulnerable biotopes can be inferred from indicative geological and geomorphological structures. In particular, hydrothermal phenomena have been documented for the slow-spreading Gakkel (Mid-Ocean) Ridge. Although no actual observations of biota in these spots are available. Gakkel Ridge is also known for a number of distinct seamounts. The data recently obtained by the expedition on R/V “Polarstern” to the Karasik Seamount indicate that these seamounts may host communities that are not necessarily based on hemosynthetic production but are nevertherless rich and diverse, with sponges as the main habitat forming organisms. The proposed Pan-Arctic network of conservation priority areas included thus possible deep sea vulnerable biotopes which need further research and developing of conservation strategy at the national and international level.

**Talk:** [“Indicators of vulnerable benthic biotopes in the Arctic Ocean”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_5/S5_Spiridonov_V_Indicators_of_VMEs_in_the_AO.pdf)

**Øyvind Paasche** (Bjerknes Centre for Climate Research/Geophysical Institute, University of Bergen, presented by Are Olsen)

“The Synoptic Arctic Survey (SAS) –towards 2020”

**Talk:** [“An Outline of the Synoptic Arctic Survey”](https://pame.is/images/03_Projects/EA/EA_Conference/Bergen/Presentations/Session_5/S5_Paashe_O_The_Synoptic_Arctic_Survey.pdf)

# APPENDIX 1 – Summaries

**in alphabetic order (family name)**

**Eisner, Lisa**1and Seth Danielson2, Ed Farley1, Carol Ladd3

1Alaska Fisheries Science Center, NOAA, 2University of Alaska, 3Pacific Marine Environmental Lab, NOAA

**Arctic Integrated Ecosystem Research in the Chukchi and North Bering Seas**

**Background:**

Recent ecosystem level projects in the north Bering and Chukchi seas include Arctic Integrated Ecosystem Studies (IES) phase1 (2012 and 2013) and 2 (2017, 2019), and Arctic Shelf Growth Advection Respiration and Deposition (ASGARD, 2017 and 2018). This is a joint effort among US government and academic scientists to understand the relationships among physics, lower and upper trophic levels, including humans, in the context of ongoing climate change. Arctic IES 1 and 2 were late summer (August-September) surveys. Data include profiles of temperature, salinity, chlorophyll, light, oxygen, and nutrients, zooplankton and ichthyoplankton abundance from Bongo nets, pelagic fish from surface and midwater trawls and acoustics, and counts of seabirds and marine mammals. Arctic IES2, also includes primary production experiments, microzooplankton and phytoplankton community analysis, lipid and fatty acid analyses of plankton and fish, and beam trawls to quantify fish and epibenthic community abundances. ASGARD spring (June) surveys collected similar data, along with onboard rate measurements (e.g., zooplankton egg production, benthic respiration), and multicore deployments to examine macro and meiofauna, organic matter deposition, environmental DNA and sediment. Hydrographic, marine mammal and acoustic moorings deployed over the study area provide information on daily, seasonal and interannual variations in physics and biology. Our data, along with other sampling programs (e.g., DBO), can aid ecosystem assessments of the western Arctic.

**Goals:**

Three questions addressed are: How will reductions in sea ice and associated environmental changes influence the flow of energy through the northern Bering & Chukchi sea ecosystems? How will warming likely affect abundance of fishes and invertebrates? How is food security influenced by environmental vs. socio-economic factors? We show examples of year-round, seasonal, interannual and spatial comparisons that begin to address these questions.

**Results:**

Preliminary findings indicate that over recent years near-bottom temperatures over the NE Chukchi shelf have increased in magnitude and duration, with almost no time with temperatures above 0 °C in fall 2014 (mean T of -1 °C) up to 4 months in fall 2017 (T up to 3°C). The melt period in spring and freeze-up period in fall has decreased by 30 and 40 days since 1979, so there is less time for ice edge processes to manifest. Seasonal comparisons indicate there is higher primary production in spring than summer and production scales with carbon biomass. Pelagic export appears to be highly efficient, even in a warm year, with ~ 50% of primary production exported to benthos. There were large interannual differences in spring zooplankton communities with much higher abundances in 2017 than 2018 of *Neocalanus* spp., an important lipid-rich copepod prey for fish, seabirds and marine mammals. Acoustic backscatter transect data indicate that age-0 Arctic cod had much higher abundances in 2017 than in 2012, 2013 and 2018. Acoustic mooring data indicate that Arctic cod disappear in mid-winter and return in spring after ice breakup. Consequences for humans include altered seasonality for subsistence hunting, altered access to winter hunting grounds, new subsistence food sources, new management decisions for commercial fishery oversight, increased vessel traffic in ice-free waters, earlier open water, and changes in timing of arrival of toxin-producing phytoplankton.

**Discussion:**

Our research is still in the collection and analysis phase. However, potential applications of the data to IEA include filling gaps at under-sampled times of year, providing abundance, biomass and rate measurements for lower and higher trophic levels to understand carbon turnover and partitioning within the ecosystem. This will improve our ability to model the ecosystem and to evaluate mechanisms to better understand and predict effects of climate change as baselines shift.

**Hiltz, Elizabeth**1 and B. Burke2, S.D. Fuller3, A. O’Rielly4, T. Taylor5, J. Qaumariaq6, V. Karetak7 and Z. Martin8

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 **“Guardians of Tariuq” a music video celebrating Canada’s eastern arctic marine conservation areas starring school children** (Introduced by Andrea Niemi1)

In 2017, Fisheries and Oceans Canada, in collaboration with stakeholders, established three conservation areas in Canada’s Eastern Arctic to protect vulnerable species of corals and sponges. Inhabitants of Baffin Island, Nunavut are generally unaware that corals and sponges exist in the waters off their coast. To improve awareness of the Arctic marine ecosystem and protection efforts, a music video was created which involved youth and performance artists from Iqaluit, Nunavut. The music video incorporated two culturally important mediums - conversation and storytelling. The video demonstrates a special collaboration between government, industry, environmental, and community organizations to promote conservation initiatives.

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**Husson, Berengere** and Maria Fossheim, Mette Mauritzen (IMR, Norway)

**What scale(s) to study an ecosystem? A case study in the Barents Sea**

The Arctic is experiencing the strongest warming on earth. The Barents Sea is under the conjugated influence of the Atlantic and the Arctic and is also strongly affected by the climate. Recent studies have shown that the increasing warming trend in temperatures is occurring at the same time as a northward shift of fish communities in the whole Barents Sea. BSECO project aims at understanding how those changes impact the functioning and the vulnerability of the ecosystem. As for all ecosystem studies, finding suitable spatial, temporal and taxonomic study scales are a challenge. Spatial scales influence the type of question you can answer (e.g. Chapin et al., 2011). Temporal scales are traditionally studied on the long term, but recent research focusing on extreme events linked to climate change draw the attention on short temporal scales (e.g. Ummenhofer and Meehl 2017; Jentsch et al., 2007; Harris et al., 2018; Bailey and Pol 2016). Thirdly and finally, changing taxonomic scales greatly affects the observed patterns (e.g. Smith et al. 2019; Queenborough et al., 2009; Sale and Guy, 1992). Our work uses data collected during fourteen years of autumn ecosystem survey (2004-2017) and assesses changes occurring through all functional groups of the ecosystem. Those data are analyzed through the lens of different temporal (trend and extreme years), spatial (over the whole Barents Sea and per subregion) and taxonomic (functional groups and individual species) scales. Simple standardized time series of each species are hard to analyze. However, when pooling all the species together, we can see that the whole demersal community is pulsing in 2006, 2012, 2016. Those pulses occur on years with low sea ice import and high heat content in the water (Lind et al., 2018). Through cross correlation analysis, we found which species are causing those pulses. They are several small demersal fish from the arctic area. Our hypothesis is that we observe larger abundances because their habitat is shrinking, and they regroup. The response was different according to the spatial scale at which the temporal trends were studied. Community level analyses reveal large scale response patterns to climate that cannot be detected at species level. Results will later be combined with traits, food web analyses and end-to-end models to assess changes occurring in the state of the ecosystem.

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**Karnauskas, Mandy** and Matt McPherson, Adyan Rios, Skyler Sagarese, John Walter, Daniel Goethel, Suzana Blake, Amanda Stoltz1, Chris Kelble2, Michael Jepson3, Casey Streeter4

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**Identifying relevant spatial scales and priorities for ecosystem-based management in the Gulf of Mexico**

***Background***

In 2016, NOAA Fisheries released its National Ecosystem-Based Fishery Management (EBFM) Policy, affirming a commitment to support an ecosystem approach to management applied at regional scales. The Gulf of Mexico Fisheries Management Council is the primary governing body for federal fisheries of the U.S. Gulf of Mexico. Although the Gulf Council has existing Fishery Management Plans containing many elements of EBFM, it has yet to adopt a Fishery Ecosystem Plan or other policy statement outlining priorities or objectives for the region. To engage stakeholders in planning for the region and development of a Fishery Ecosystem Plan, and to determine the appropriate scale and scope of EBFM in the region, the NOAA Fisheries Southeast Fisheries Science Center initiated a participatory fisheries system modeling approach.

***Goals***

The goal of this effort was to increase information flow between scientists, managers, and stakeholders, in support of improved stock assessment and ecosystem assessment in the Gulf of Mexico. A series of workshops were held in 2018 with both fishing communities and groups of fishery scientists and managers, with an initial focus on snapper-grouper fisheries of the West Florida Shelf. Fishery system conceptual models resulting from each workshop were then merged into a single network model, after first standardizing like terms used across workshops and then simplifying by grouping similar concepts into umbrella terms.

***Results***

Network analysis showed that the most influential nodes in the system were fishing pressure, followed by water quality – which was dominated by factors related to the harmful algal blooms known as “red tides.” The impacts of red tides had already been incorporated in the stock assessment process, whereby red-tide induced fish mortality is estimated and advice can be given on the appropriate and sustainable levels of fishing mortality in light of these events. However the participatory workshops brought to light a number of additional concerns beyond the immediate impacts of red tide on fish mortality; red tide events are also observed to affect habitat condition, commercial and for-hire fishing businesses, aquaculture, tourism, protected species, and human health. These additive or potentially synergistic red tide impacts have further implications for the stock assessment, the ecosystem, and fishing communities as a whole. By leveraging resources and collaborating with state, federal, academic and private agencies, a red tide response plan was developed to better understand the severe red tide events and its impacts on the biological and human communities of the West Florida Shelf.

***Discussion***

The participatory modeling approach was useful for defining discrete priority EBFM issues, with specific scales, knowledge gaps and linkages to management. At the same time, it is an effective method for engaging both researchers and stakeholders, and building synergies and partnerships to work toward common objectives. Future work will focus on continuing collaborative work to improve our understanding of harmful algal blooms in the region, with the goal of ultimately mitigating blooms where possible and providing advice to managers on how they can improve the resiliency of coastal communities in light of events that are increasing in severity and frequency. The main challenge is to maintain a long-term, coordinated response, in the face of varying resource levels for budgets and staff time. Also, during this process it is essential to not only report back results to coastal community members regularly, but also to meaningfully engage stakeholders in the scientific process and find ways to transfer insights and capacity back to the communities.

**Mosbech, Anders** and Tom Christensen, Kasper Lambert Johansen, David Boertmann, Daniel Spelling Clausen (Denmark, Aarhus University).

**On the road to EA in Greenland: The use of spatial biodiversity data to identify important areas**

In recent years a number of studies have provided an overview of important areas for ecosystems and species in Greenland (e.g. Boertmann and Mosbech 2017). Abundance, occurrence, migration routes etc. for more than 100 species or ecosystem components has been mapped focusing on the spatial distribution of important biological areas. The maps have further been combined to identify the most biologically important areas according to a set of criteria informed by national priorities and international processes such as the Convention on Biological Diversity to identify Ecologically and Biological Sensitive Areas (EBSAs) and the International Maritime Organization (IMO) to identify Particular Sensitive Sea Areas (PSSA) (Christensen et al. 2016). In relation to mineral exploitation in Greenland, a number of areas has been identified as sensitive (Important areas for wildlife, Mosbech et al. 2019), and the spatial analysis has further been used to identify biologically important areas in finer scales in the North Water polynya and Disko Bay and Store Hellefiskebanke areas. In relation to Disko Bay an Store Hellefiskebanke, each of the biological layers where further assessed and ranked according to their specific sensitivity to potential environmental effects caused by shipping, to identify where there may be a need for heightened awareness in relation to impacts from the shipping sector. Local knowledge has also been used in the process of gathering spatial information, mainly through interviews, but recently also in collaborative studies where hunters have used GPS devices to map their activities (Flora et al. 2018).

In relation to the Arctic Council initiative about Adaptation Actions to a Changing Arctic (AACA) (Mosbech et al. 2018), the use of spatial data was discussed in Greenland at a workshop in May 2019 with the purpose to explore the possibilities for a more ecosystem based approach to manage spatial planning in Greenland. Different departments from the administration, and representatives from industry as well as from representatives form subsistence hunting and fishing and NGOs took part in the workshop. Across all contributions there was a positive view on the EA approach, among other things underlining the advantages in relation to eco certification of fisheries (MSC) and hunting (CITES NDF), and the potential for a common ground in mediation of potential conflicting interests in area usage. Some EA work in relation to the North Water Polynya has been initiated by the administration.

However, it was evident at the workshop that lack of administrative resources to work across administrative sectors was a bottle-necks for the development of the EA approach. Greenland has a small population (approx. 56.000) and it was discussed how a resource efficient greenlandic ”model” for EA can be developed. As part of the way forward it was discussed to plan a case study to eplore new ways of cooperation. The need for strong local involvement and outreach was underlined, as well as monitoring of important animal populations to secure sustainable use.

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**Niemi Andrea** and Andy Majewski, Jim Reist, Rob Young (Fisheries and Oceans Canada, Winnipeg MB, Canada).

**Off-shore Integrated Ecosystem Assessment in the Canadian Sector of the Beaufort Sea LME**

The Canadian Beaufort Sea Marine Ecosystem Assessment (CBS-MEA) is an off-shore, ship-based research program. Fisheries and Oceans Canada developed the program, in consultation with co-management partners in the Inuvialuit Settlement Region (ISR), to provide integrated ecosystem-based information in support of climate change science and co-management priorities including subsistence resource security. Integration of information across ecosystem components, including marine fishes, provides needed baseline information for species and processes, measures of inter-annual variability and assessments of ecosystem connectivity at different scales. The CBS-MEA is integrated with other programs, including community-based beluga programs in the ISR, in order to provide a more holistic understanding of the Beaufort Sea ecosystem.

**Andrea Niemi (****Andrea.Niemi@dfo-mpo.gc.ca****),**

**Retter, Gunn-Britt** (Saami Council)

 **“The Arctic Environmental Impact Assessment – a model for Meaningful Engagement of indigneous Peoples”**

Background

Finland lead the project “Good Practices for Environmental impact Assessment and Meaningful Engagement in the Arctic – including Good Practice Recommendations” under the auspices of the Sustainable Development Working groups during the Finnish chairmanship of the Arctic Council 2017-2019. More on the project: <https://www.sdwg.org/activities/sdwg-projects-2017-2019/arctic-eia/> The first attempt to do so was the Arctic EIA Guideline from 1997. Each Arctic State already have national legislation on EIA

Goals

The aim of the project was to improve the application of EIA in the Arctic region and identify a common framework across the Arctic. The project focused on issues that were found to be Arctic specific, or what deserved additional emphasis compared to the earlier guidelines and in the general EIA framework in the states. They are gathered in the report for wider application.

Results

The project developed five recommendations for good practice:

1. Seek true dialogue to meaningfully engage
2. Utilize Indigenous knowledge and local knowledge
3. Build internal capacity and provide resources to meaningfully engage in EIA
4. Allow EIA to influence project design and decision-making process
5. Strengthen circumpolar cooperation on transboundary EIA

My emphasis was on models of meaningful engagement, as that is important for the Saami Council and an issue that was also stressed by the indigenous peoples during the EA discussions. Early engagement in the various processes is essential. The Arctic EIA project identifies several models of meaningful engagement of indigenous Peoples: Indigenous-led Impact Assessment, Indigenous Knowledge-based Impact Assessment, Specific Impact Assessments (Health-, Ethnological- and Cumulative Impact Assessment) and Collaborative Mitigation. The PAME project Meaningful Engagement of Indigenous Peoples and local communities in Marine Activities (MEMA) also underscores the similar points on what make engagement meaningful.

Discussion including “what is the main challenge” and “recommendation for further work”

The EIA and ecosystem approach to management serve different purposes, but when it comes to meaningful engagement with Indigenous Peoples, the recommendations and challenges are similar. A common Arctic Council guidebook for engagement with indigenous peoples could be useful to set a standard and state some principles. But most importantly is how indigenous peoples as a rightholders are involved in the ecosystem management regimes and how indigenous knowledge is recognized and valued as part of the knowledge foundation for decision-making as well as ecosystem approach systems. Capacity building is important to facilitate indigenous contribution and meaningful engagement. The involved communities need capacity building and resources to engage and authorities and proponents (Related to EIA) should receive training to work with Arctic communities.

**Rosellon-Druker, Judith** and Marysia Szymkowiak, Curry J. Cunningham, Stephen Kasperski, Gordon H. Kruse, Jamal H. Moss, and Ellen M. Yasumiishi (NOAA and University of Alaska Fairbanks, USA)

**Development of socio-ecological conceptual models as the basis for an IEA framework in Southeast Alaska**

**Introduction**

Integrated Ecosystem Assessment (IEA) is a framework that organizes science to aid in the transition from a traditional single species management towards a holistic management approach known as Ecosystem Based Management (EBM). An essential step of the IEA framework is the development of conceptual models. These models allow the integration of intrinsically linked social, environmental and biological components of marine ecosystems which is pivotal to address unsolved questions in fisheries management.

The U.S NOAA Integrated Ecosystem Assessment (IEA) Program currently has five active regional programs:

* California Current
* Pacific Islands
* Alaska Complex
* Northeast Shelf
* Gulf of Mexico

Within the Gulf of Alaska LME place-based IEA efforts have started. Sitka is a relatively small fishing community located in Southeast Alaska. Commercial, subsistence and recreational fisheries are the most important economic, social and cultural activities in this coastal community.

**Methods**

We constructed socio-ecological conceptual models of relevant commercial and subsistence focal fisheries for Sitka by collecting and synthesizing available scientific information and local ecological knowledge (LEK). We operationalized these models by using a modeling approach called Qualitative Network Models (QNMs). QNMs are mathematical representation of a conceptual model in where perturbations can be assessed for their qualitative impact on the system of interest.

**Results**

The resulting models co-produced by scientists and Sitka stakeholders, illustrate the main biological and environmental factors driving the abundance of Pacific halibut (*Hippoglossus stenolepis*), Pacific herring (*Clupea pallasii*), Chinook salmon (*Oncorhynchus tshawytscha*), and sablefish (*Anoplopoma fimbria*) fisheries in Southeast Alaska. These co-produced models also elucidate how the interaction between Sitka residents and these fisheries affect community well-being. Operationalizing these models via QNMs allowed to highlight pivotal current research questions about these stocks. For example, in the case of sablefish, abundant smaller size classes that are favored by certain environmental conditions and are unwanted by fishermen may result in avoidance behaviors. These avoidance behaviors may have an effect on different components of the system and on the well-being that is being derived from this fishery.

**Conclusions**

* Conceptual models serve as the basis to assess EBM objectives for Sitka as part of an IEA place-based framework
* Sitka is a unique fishing community in terms of its people and in terms of the relationship that people have with their local fisheries.
* Sitka stakeholders have a deep understanding of their local ecosystem
* Conceptual models are a pivotal exercise to capture and integrate LEK into science and to highlight important knowledge gaps in the ecosystem structure.
* Incorporation of LEK into science is needed to achieve sustainable, effective, and equitable management of fisheries
* Stakeholder participation in the scientific process leads to a more informed and empowered community in relation to their local ecosystem and resources
* IEA inherently leads to a more holistic view of fisheries management
* Operationalizing conceptual models allow an understanding of how different components of the model respond to a particular perturbation

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**Marine ecosystem accounting to support coastal and marine governance in the Arctic**

**Summary**

Marine ecosystems cover large parts of the Arctic. The 18 large marine ecosystems of the Arctic Ocean covers 10 million km2. The arctic ecosystems provide various ecosystem services to human society (CAFF 2015). The Arctic marine areas provide many important biochemical and medicinal resources and raw materials (provisioning services). The arctic marine and coastal ecosystems also allow for carbon storage and sequestration (regulating services), and provide habitats that are important for food web maintenance (supporting services). The coastal areas of the Arctic provide aesthetic views and recreation for both the locals and the tourists from other regions (cultural services). Much of the cultural identity and sense of place are closely connected to the marine ecosystems and the coastal areas (CAFF 2015).

The arctic has faced a series of challenges in recent decades. Increases in ocean economic activity such as new oil and gas fields, potential new shipping routes and increasing tourism brought both economic growth and at the same time increasing threats to the local environment and ecosystems as well as conflicts among various resource users. Other factors such as climate change, persistent organic pollutants and radiative waste pose additional challenge to the arctic environment (PRETEAR, 2010).

Natural capital accounting view nature and ecosystems as assets which provide a stream of ecosystem service benefits to society. Ecosystem accounting aims to identify periodic change in ecosystems’ contribution to the economy. It is a holistic approach for measuring ecosystem, ecosystem services and their benefits to economic and human activities spatially and over time. Ecosystem accounting represents a fundamental methodological development in making national accounts sensitive to spatial variation in ecosystem services flows and their value as assets. The ability to identify change in the economic value of ecosystems is potentially important in evaluating aggregate effects of combinations of policy within an accounting area. Ecosystem accounts are potentially one of several tools in governance towards sustainable social-ecological systems. For example, ecosystem accounting will provide information on the quantity and location of the supply of a wide range of ecosystem services. It is vital for monitoring and achieving sustainable use of ecosystem assets and preventing further loss of biodiversity. Ecosystem accounting provides a tool to monitor status of ecosystem assets not only about physical indicators but also about ecosystem assets values. Via ecosystem accounting, we can easily identify the ecosystem assets and ecosystem types and services that are changing most significantly and hence help to determine the priorities for policy interventions. By addressing causes of change or degradation, relevant measures can be identified for effective policy responses (UN 2017).

Ecosystem accounting is still in experimental stages. Natural capital accounting has been applied mainly to terrestrial environments. Marine and coastal ecosystem accounting remains sparse. We carried out an experiment ecosystem accounting for Norwegian kelp forest along the whole Norwegian coast. Our study shows that Barents Sea should be the prioritized area for kelp recovery (Saccharina Latissma) if we only consider the extent of kelp forest. Measures aiming to reduce sea urchin predation should be adopted. When we consider the change in extent of kelp coverage or change in values of ecosystem services provided by kelp forest such as change in the social cost of carbon, change in the value of supporting services and provisioning services, the Norwegian Sea would be prioritized.

Ecosystem accounting will be a useful tool to study both ecological impacts and social impacts of ecosystem change over time and space in the Arctic area. It can assist in the choosing of management hotspots and in facilitating the policy responses by identifying potential management measures. Beside the kelp recovery, ecosystem accounting can be applied in the Arctic area to study for example the effectiveness of marine protected areas (MPAs) and to support integrated coastal zone planning (ICZP) and marine spatial planning (MSP). It is important to make use of existing monitoring and socio-economic data from coastal communities in the coastal areas of the Arctic when carrying out accounting while it is also important to establish new data collection systems for ecosystem assets, ecosystem services and their change where there is no or limited data. We also need to be aware that there are various groups of indigenous people living along the Arctic coast. Most of them still live in a subsistence economy or a hybrid subsistence and market economy. Applications of ecosystem accounting need to be adjusted to fit the subsistence economy where food for example are produced and consumed within the family or the community. This means a family production model and relevant data should be applied to evaluate the value of ecosystem service change provided by ecosystem assets rather than the evaluation methods mentioned in the UN SEEA EEA Technical Recommendation (2017).

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**Integrating Scales of Interest Across Different Knowledge Systems for Ecosystem Management**

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NAMMCO (The North Atlantic Marine Mammal Commission) is a regional inter-governmental organization providing advice from both scientific and local communities for policy on the management of marine mammals. The organization considers impacts on marine mammal species from a wide range of sources (e.g. hunting, fishing, pollution, climate change) and is committed to implementing an ecosystem approach to management (EA). In trying to implement EA in practice, NAMMCO regularly deals with the difficulties of achieving effective integration of diverse knowledge systems and diverging interests from scientists, local communities, and policy-makers. Not only do these different stakeholders have varying worldviews, terminologies, and cultures, their knowledge systems can also operate at different scales of interest. This can be the case for biophysical, geographical, temporal and jurisdictional scales.

Knowledge systems are often characterized into two broad categories. One is compartmentalized, quantitative, based on abstraction and generalisation, striving for a value free ideal and relying on written documentation. The contrasting approach is then characterized as holistic, qualitative, based on experiential knowledge, integrated with morals and beliefs, and relying on oral documentation. Typically, the first knowledge system is seen as embodied by western science, while the latter more representative of local, traditional or indigenous knowledge systems. Although this is not a strict or complete match – because there is variance across different disciplines of science and local and indigenous cultures - the distinction between two general types of knowledge systems is widely recognised.

In a body of academic work on ´politics of scale´, emphasis has been placed on the way choices regarding scale are not neutral and favour some actors and knowledges while disadvantaging others (Swyngedouw 2000). This is because the different actors and knowledge systems often have preferences for operating at certain biophysical, geographical, temporal and jurisdictional scales. For example, hunting communities are typically specifically interested in local environments, long multi-generational timeframes and community based approaches to management; policy makers typically operate on short timeframes connected to political cycles and are particularly occupied with national level interests; while scientists may have regional or global interests and work across timeframes spanning several decades. Making choices on “meaningful scales” for EA therefore presents not only scientific challenges, but also difficulties for integrating different knowledge systems.

Given that human communities and activities cannot be separated from natural systems, robust environmental policy requires combining the best available science with local and traditional knowledge. Reflecting on the politics of scale is important for our ability to integrate these knowledge systems. In this presentation, I highlight how some of NAMMCO’s foundational choices regarding scale (i.e. the choice of a regional geographic scale, an inter-governmental jurisdictional scale and short temporal scales for policy advice) tend to favour scientific knowledge. Recognising NAMMCO´s ongoing commitment to integrate science and user knowledge in management advice, I emphasise the importance of reflecting on the politics of scale in our future work and present an upcoming working group on narwhal in east Greenland as an illustrative opportunity. I briefly explore different models available to NAMMCO for responding to such cross-scale challenges, including institutional interplay, co-management and boundary/bridging organizations (Cash et al. 2006). In closing I invite conference participants to share their experiences and best practices for integrating diverse scales of interest across different knowledge systems to help advance our collective learning and ability to adapt in future work.

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