INTERNATIONAL SCIENCE AND POLICY CONFERENCE

THE ECOSYSTEM APPROACH TO MANAGEMENT: STATUS OF IMPLEMENTATION IN THE ARCTIC

CONFERENCE SUMMARY

23-25 AUGUST 2016: FAIRBANKS - ALASKA

PAME

CAFF
Conservation of Arctic Flora and Fauna

AMAP
Arctic Monitoring and Assessment Programme

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Catherine Coon, Phil Mundy, Hein Rune Skjoldal ++ session chairs and panelists

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Introduction

The Ecosystem Approach to Management (EA) or Ecosystem-based Management (EBM), which are synonymous terms, is a globally accepted principle. The origins of the EA concept at the international level may be traced back to at least as early as 1972 (Bianchi 2008). In the ensuing years, the EA concept has been extensively discussed, elaborated and developed. The concept of managing natural resources and the environment on a geographic scale that is sufficient to insure sustainability is embedded in the core of the concept of Large Marine Ecosystems (LMEs), which are geographically identified ecosystems for applying the EA (Sherman et al. 2009, Sherman and Hamukuaya 2016). The United Nations Convention on Biological Diversity (CBD) uses EA as an overarching framework for the work of the Convention in implementing its objectives (CBD 2004), and the world leaders at the Johannesburg 2002 summit called for the application of EA to marine management by 2010 (see also Bianchi 2008).

The EA (or EBM) has been adopted as a key principle for the work of the Arctic Council. The Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among eight Arctic States, six organizations representing Arctic indigenous peoples (Permanent Participants), and many observer States and organizations, on issues of sustainable development and environmental protection in the Arctic. The Arctic Council has a rotating 2-years chairmanship among the Arctic States, with a ministerial meeting at the end of each chairmanship. The work of the council is overseen by a body of Senior Arctic Officials (SAOs) and is carried out by six permanent working groups as well as temporary Task Forces or Expert Groups to carry out specific work between ministerial meetings.

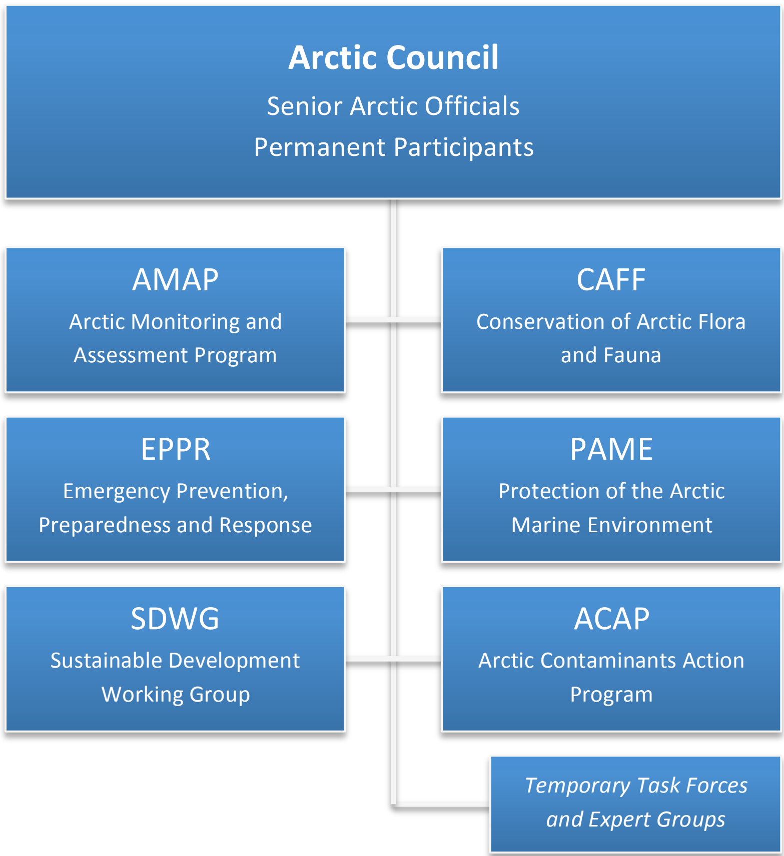


Figure 1: Organizational chart of the Arctic Council. Senior Arctic Officials from the eight Arctic states and representatives of six Indigenous Peoples organizations form a governance body, while work is carried out in six permanent working groups and temporary task forces and expert groups.

The working group Protection of the Arctic Marine Environment (PAME) has been leading work within the Arctic Council (AC) on developing and promoting the use of EA to the management of the Arctic coastal and marine environment. PAME established in 2007 an EA expert group (EA-EG) that was broadened in 2011 to include also other AC working groups (Arctic Monitoring and Assessment Program (AMAP), Conservation of Arctic Flora and Fauna (CAFF), and the Sustainable Development Working Group

(SDWG). The EA-EG has arranged five annual workshops on various EA related topics in 2011-2015 (Table 1). Following the workshop in 2015 it was decided that the next meeting should be elevated to an international conference to review the status of implementation of EA to management of Arctic ecosystems. This conference was held in Fairbanks, Alaska, 23-25 August 2016. We report here on the outcome of this meeting by providing a summary of the presentations at the various sessions, and conclusions and suggestions for direction and actions that could be taken for effective implementation of the EA by Arctic States, Permanent Participants, and other relevant partners and stakeholders.

The Fairbanks EA Conference

The EA Conference was planned and organized by representatives across the Arctic States, AC working groups, Indigenous Peoples organizations, and others. It was held at the facilities of the University of Alaska Fairbanks with local organization by Dr. Larry Hinzman and Cassie Pinkel from the university. The conference was attended by 68 participants (see List of participants).

While PAME and the EA-EG have a marine focus, the EA conference in Fairbanks was broadened to include terrestrial and freshwater environments in the Arctic. The participants came from Arctic communities, government agencies, private enterprise, academic institutions, and non-governmental and intergovernmental organizations to give talks about their experiences and to share case studies related to implementing the EA to management in the Arctic. Together they brought to the conference diverse terrestrial and marine perspectives from backgrounds in natural resource management, shipping, oil and gas, policy making and governance, scientific research, and indigenous knowledge and culture.

The program was structured with six sessions:

- ✓ Session I: The Vision and Role of the Arctic Council
- ✓ Session II: Status and Experiences from National Implementation
- ✓ Session III: Making EA operational - developing the knowledge base and enabling activities
- ✓ Session IV: Case studies - steps toward implementation
- ✓ Session V: Pan-Arctic Marine Science and Policy
- ✓ Session VI: Status of Implementing the Ecosystem Approach to Management in the Arctic

The conference was conducted entirely in plenary with each of the sessions (except the last) having individual presentations followed by questions and discussion. The sessions were introduced and summarized by a session chair. Altogether there were thirty-eight presentations in sessions 1-5. The conference program, abstracts, downloadable versions of graphic presentations, and audio-visual versions of the presentations are available online (PAME Secretariat 2016). In following sections of this report (paper), we provide summaries of the presentations and discussions for each of five sessions.

Session 1 set the stage by providing an overview of the work and achievements regarding development and use of the EA in the work of the Arctic Council. Session 2 included reports on national implementation with examples from Canada, Iceland, Norway and the USA. Session 3, which was the longest, provided updated information on concepts and activities to promote and facilitate effective use of the EA. Sessions 4 and 5 provided further examples of activities at both smaller and pan-Arctic scales that serve to illustrate and guide the implementation of the EA in the Arctic.

The final session (number 6) was organized as a panel discussion in two parts. The first focused on status of implementing the EA in the Arctic, while the second focused on the roles that the AC could play to facilitate the implementation. The panellists (Hermanni Kaartokallio, Erik Olsen, Darren Williams, Mark Dickey-Collas, Dennis Thurston, Lawson Brigham, Gunn-Britt Retter, Jacqueline Grebmeier) gave brief introductory statements followed by a plenary discussion chaired by Catherine Coon. The sixth session is summarised with a structure following the steps outlined in the Arctic EA implementation framework (PAME 2014). This includes a summary of possible roles which the Arctic Council could take in facilitating the implementation of EA in the Arctic.

Session I: The Vision and Role of the Arctic Council

Three presentations provided the introduction to the conference. *Alf Håkon Hoel* (et al., presented by Hein Rune Skjoldal) gave an overview of important international developments, e.g. in the United Nations, as well as an overview of the work on EA (or EBM) in the Arctic Council. Thus, the EA concept is implicit in the United Nations Convention on the Law of the Sea (UNCLOS) where it is stated in the Preamble that "the problems of ocean space are closely interrelated and needs to be considered as a whole." *Hein Rune Skjoldal* (et al.) then went on to describe some of the outcomes and achievements from the EA work in the Arctic Council. *Phillip Mundy* (et al.) provided a forward-looking perspective on the EA work, both during this conference and in subsequent work potentially guided by views and suggestions provided by the conference. Mundy emphasized that the EA Conference is the first realization of one of the recommendations from the Kiruna Ministerial meeting in 2013 (see below): "*Institute periodic Arctic Council reviews of EBM in the Arctic to exchange information on integrated ecosystem assessment and management experiences, including highlighting examples from Arctic States*."

Below we provide a summary of the EA work in the Arctic Council and highlight some of the achievements of this work. Table 1 gives a chronological listing of activities, projects and products to illustrate the timeline and milestones of development of EA within the Arctic Council.

Following from the Johannesburg 2002 Plan of Implementation to apply the EA to marine management (paragraph 30d), the PAME working group included the EA as a core principle in the Arctic Marine Strategic Plan (AMSP) 2004 that was adopted by the AC ministers. Among the strategic actions listed in AMSP 2004 were to:

- Identify the large marine ecosystems of the Arctic based on the best available ecological information (action 7.4.1), and
- Promote pilot projects that demonstrate the application of an ecosystem approach to management (action 7.4.3).

Year	Activity	Product
2004	Adopting the EA as an overarching principle	Arctic Marine Strategic Plan – AMSP 2004
2006	Delineating and adopting Arctic Large Marine Ecosystems (LMEs)	Working map of 17 Arctic LMEs
2007	PAME establishes an EA expert group (EA-EG)	
2007-2009	PAME and SDWG carry out the project '*Best Practices in Ecosystem-based Ocean Management in the Arctic*' (BePOMAr)	BePOMAr report (Hoel 2009)
2009-2011	PAME carries out the project 'Arctic Ocean Review' in two phases – I (2009-2011) and II (2011-2013)	The Arctic Ocean Review PHASE I Report (2009-2011)
2011	The EA-EG broadened to include AMAP, CAFF and SDWG	Report from PAME Workshop on EA
2011	First EA workshop, Tromsø, Norway (LME boundaries)	Workshop Report
2011-2013	'Arctic Ocean Review', phase II	The Arctic Ocean Review Project, Final Report, (Phase II 2011-2013)
2011-2013	Ministers at Nuuk (2011) established an EBM expert group (EG) who works over a two-years period with 3 meetings to deliver a report with EA recommendations (definition, principles, and activities)	Report 'Ecosystem-Based Management in the Arctic'
2012	2nd EA workshop, Stockholm, Sweden (EA framework)	Workshop Report
2012-2013	Revision and adoption of the map of Arctic Large Marine Ecosystems (LMEs)	Report 'Large Marine Ecosystems (LMEs) of the Arctic area. Revision of the Arctic LME map'
2013	3rd EA workshop, Reykjavik, Iceland (Data issues)	Workshop Report
2013	Ministers at Kiruna (2013) adopts the EA recommendations from the EBM EG	Kiruna Ministerial Declaration
2014	Joint EA-EG meeting in Whitehorse, Canada.	PAME progress report to SAO's
2014	Workshop on Implementing Recommendations for Ecosystem-Based Management in the Arctic (Trondheim, Norway)	Workshop report
2014	4th EA workshop, Vancouver, Canada (Beaufort Sea LME)	Workshop Report
2015	Request from Ministers at Iqaluit (2015) for the development of practical guidelines for an ecosystem-based approach to the work of the Arctic Council	Iqaluit Ministerial Declaration
2015	Joint EA-EG meeting in Tromsö, Norway.	Joint meeting summary report
2016	International conference on status of implementation of the Ecosystem Approach to Management of Arctic Ecosystems, Fairbanks, Alaska	Report 'Status of implementation of the Ecosystem Approach to management (EA) in the Arctic: a conference summary'.

Table 1. Overview of work on the Ecosystem Approach to Management (EA) (or Ecosystem based Management – EBM) in the Arctic Council.

PAME addressed the first action by producing a working map of 17 geographically identified Large Marine Ecosystems (LMEs) for the marine Arctic in 2006. The second action was addressed in 2007-2009 by PAME and SDWG through the project, '***Best Practices in Ecosystem-based Ocean Management in the Arctic***' (BePOMAr) (Hoel 2009). BePOMAr summarized information on developments relevant to EA (or EBM) in Arctic States as seven case studies of how countries develop and implement ecosystems-based oceans management in the Arctic (Russia, Finland, Norway, Iceland, Greenland, Canada and the USA). An additional case study presented an indigenous perspective on the EA issues. Based on the case studies review, BePOMAr identified eight core elements that characterize the EA, and drew five conclusions regarding best practices for implementation:

- Flexible application of effective ecosystem-based oceans management
- Decision-making must be integrated and science based
- National commitment is required for effective management
- Area based approaches and transboundary perspectives are necessary
- Stakeholder and Arctic resident participation is a key element

The terms of reference for an Ecosystem Approach Expert Group (EA-EG), first established under PAME in 2007, were broadened in 2011 to include participation of AMAP, CAFF and SDWG. Proceeding according to two-year work plans, the EA-EG has provided annual written progress reports and a series of annual workshop reports leading up to this international conference (PAME Secretariat 2016c). The two most notable achievements of the group have been the Arctic LME map and a framework for EA implementation (see also Table 1).

Map of Arctic LMEs

The working map of 17 LMEs from 2006 was reviewed and revised by the EA-EG in consultations with national experts. A revised map, now of 18 Arctic LMEs, was produced in 2012 and adopted by the Arctic Council at the Kiruna 2013 ministerial meeting. The revised LME report includes the new LME map with explanatory text including justification of the LME boundaries (PAME 2013). The major changes in the revised map are that the Aleutian Islands is identified as a new LME, the boundary between the Chukchi Sea and Bering Sea LMEs has been moved south from the

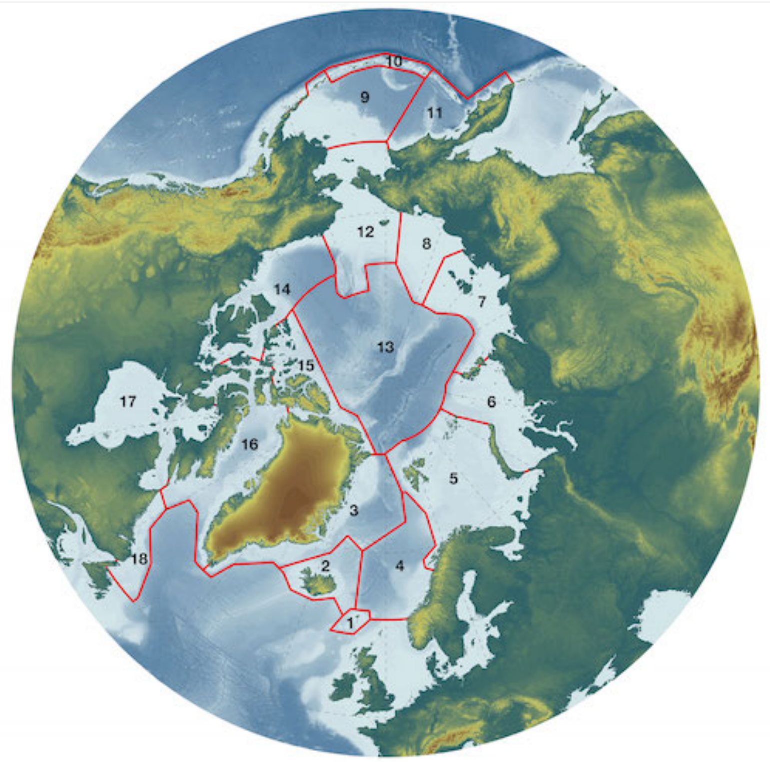


Figure 2: Map of the 18 LME's

Bering Strait to south of St. Lawrence Island, and the Canadian Arctic Archipelago LME has been split in three parts (a western part that adds to the Beaufort Sea LME, an eastern part that adds to Baffin Bay as the Canadian Eastern Arctic-West Greenland LME, and a northern part which along with North Greenland constitutes the new Canadian High Arctic-North Greenland LME).

The Arctic LMEs are identified and defined according to ecological criteria, and the boundaries do not therefore correspond to political boundaries. Most of them are between 0.4 and 1.4 million km^2 in extent; the Faroe Plateau LME is the smallest (0.11 km^2) while the Central Arctic Ocean is the largest (3.33 km^2). Six of the 18 LMEs lie fully within the Exclusive Economic Zone of one country (Hudson Bay LME and Labrador-Newfoundland LME in Canada; Kara Sea, Laptev Sea, East Siberian Sea, and West Bering Sea LMEs in the Russian Federation). The remaining 12 LMEs are transboundary and include EEZs of two or more countries. Examples of shared LMEs are the Northern Bering-Chukchi Sea LME between Russia and USA, Beaufort Sea LME between USA and Canada, the Canadian Eastern Arctic-West Greenland LME and the Canadian High Arctic-North Greenland LME between Canada and Kingdom of Denmark/Greenland, and the Barents Sea LME between Norway and Russia.

Nr.	Name of LME	Area (million km^2)	National areas	High Seas
1	Faroe Plateau LME	0.11	DK	
2	Iceland Shelf and Sea LME	0.51	IS, DK	
3	Greenland Sea LME	1.20	DK, NO	
4	Norwegian Sea LME	1.11	DK, NO, IS, UK	X
5	Barents Sea LME	2.01	NO, RU	X
6	Kara Sea LME	1.00	RU	
7	Laptev Sea LME	0.92	RU	
8	East Siberian Sea LME	0.64	RU	
9	East Bering Sea LME	1.38	US	X
10	Aleutian Islands LME	0.22	US	
11	West Bering Sea LME	0.76	RU	X
12	Northern Bering-Chukchi Seas LME	1.36	RU, US	
13	Central Arctic LME	3.33	CAN, DK, NO, RU	X
14	Beaufort Sea LME	1.11	CA, US	X
15	Canadian High Arctic-North Greenland LME	0.60	CAN, DK	
16	Canadian Eastern Arctic-West Greenland LME	1.40	CAN, DK	
17	Hudson Bay Complex LME	1.31	CAN	
18	Labrador-Newfoundland LME	0.41	CAN	

Table 2: List of the 18 Arctic Large Marine Ecosystems (LMEs) and their areas

High Seas areas of international waters (beyond areas of national jurisdiction) are found in nine of the LMEs; East Bering Sea and West Bering Sea LMEs (the 'Doughnut Hole'), Norwegian Sea LME (the 'Banana Hole'), Barents Sea LME (the 'Loophole'), Beaufort Sea LME, Northern Bering-Chukchi Seas LME, East Siberian Sea LME, Laptev Sea LME and the Central Arctic LME. Most of the Central Arctic

LME is comprised of High Seas. However, since the LME is defined by the basins outside the upper continental slope (about 1.000 m depth), the LME includes parts of the national EEZs of all Arctic costal states (Canada, Denmark/Greenland, Norway and Russia) except the United States. On the Pacific side, the 'Chukchi Borderlands' contain a complex and relatively deep geological structure (the Chukchi Plateau and the Northwind Ridge around 1.000 m deep) extending out from the Chukchi shelf), which is located in the High Seas portion of the Arctic Ocean.

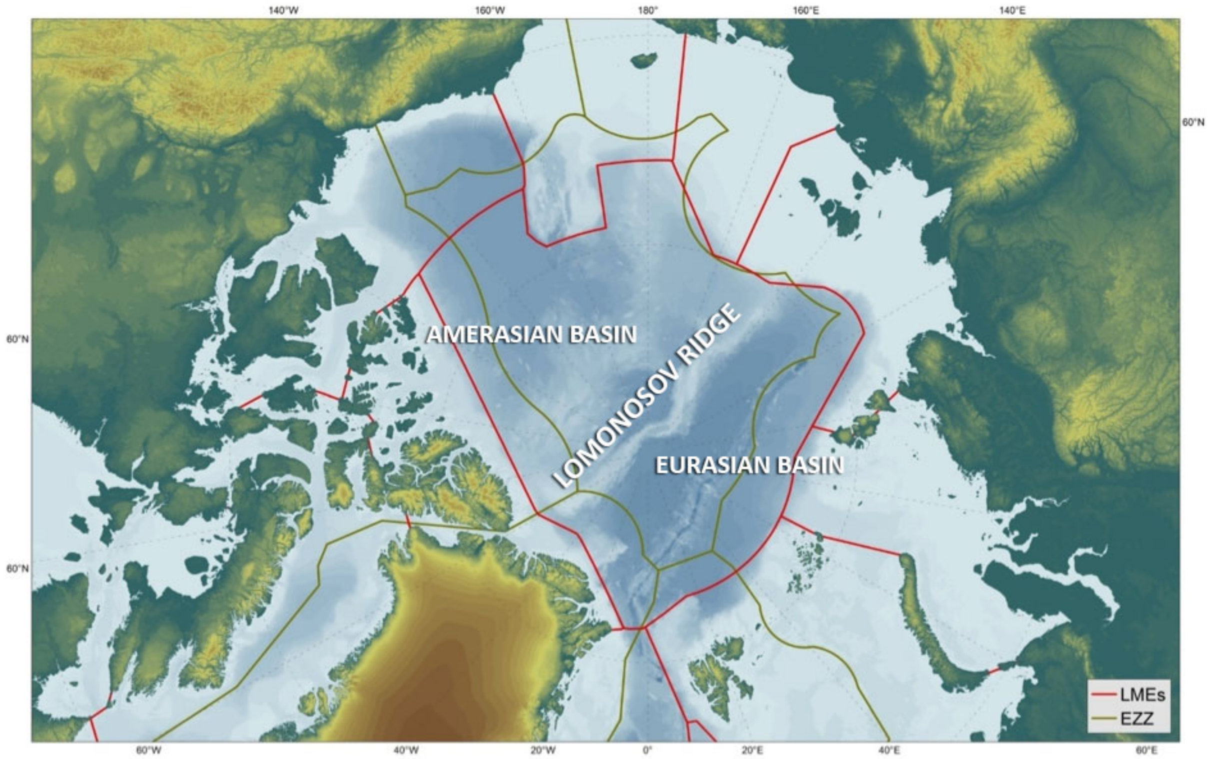


Figure 3: Map of the Central Arctic Ocean LME (red line) and Exclusive Economic Zones of Canada, Russia, Norway, Greenland (Kingdom of Denmark) and USA.

Framework for EA implementation

The EA-EG has developed an EA concept paper (PAME 2014) that included a framework for implementation of the EA (or EBM) to management of Arctic marine and coastal environments. The framework consists of six related elements:

1) Identify the geographic extent of the ecosystem;
2) Describe the biological and physical components and processes of the ecosystem,
3) Set ecological objectives that define sustainability of the ecosystem,
4) Assess the current state of the ecosystem (Integrated Ecosystem Assessment),
5) Value the cultural, social and economic goods produced by the ecosystem,
6) Manage human activities to sustain the ecosystem.

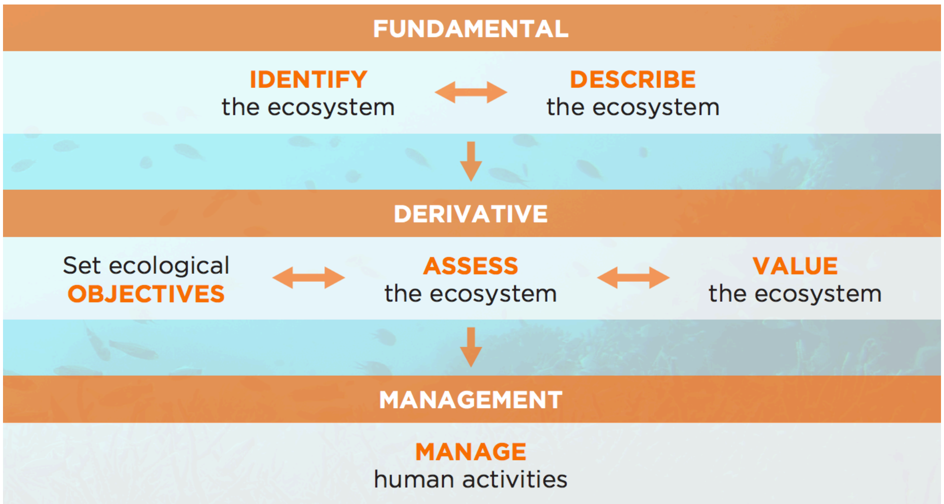


Figure 4: EA framework.

Identification of the 18 Arctic LMEs represents the first step. The LMEs are intended to be management units, with bilateral (or multi-lateral) cooperation among two or more Arctic states for transboundary LMEs. Description of the identified ecosystem should focus on key features and processes that will help to understand the basic functioning of the ecosystem (including processes and exchanges across the open boundaries of the LME). Defining sustainability in practical terms by setting ecological quality objectives (EcoQOs) is an essential but scientifically very demanding task. Taken as a comprehensive ensemble, the EcoQOs define the boundary (or envelope) between use and impacts from the combined human activities that are truly sustainable in the long-term, or not sustainable by depleting natural resources and degrading the environment (loss of biodiversity in sum). The fourth element of assessing the state of the ecosystem, including impacts from human activities, is an essential step that builds on updated information from monitoring and provides a basis for scientific advice for management measures in an adaptive management system (element 6). The assessment is through what is known as Integrated Ecosystem Assessment (IEA). The fifth element on valuation is intended to bring attention to benefits and costs involved in management of ecosystem goods and services, and to contribute to 'greening of the economy'.

Five EA workshops

The EA-EG completed five EA workshops between 2011 and 2015 (PAME Secretariat 2016c, see also Table 1). The first workshop (Tromsø, January 2011) focused on LME boundaries as part of the review and revision of the Arctic LME map. The second workshop (Stockhom, March 2012) considered the EA concept (based on a draft EA concept paper) and associated scale issues and role of IEA in the context of EA. The third workshop (Reykjavik, June 2013) dealt with the complex data issues related to IEA and EA. The fourth workshop (Vancouver, June 2014) focused on two cases of EA implementation in transboundary LMEs: the Beaufort Sea LME between Canada and the USA, and the Barents Sea LME between Norway and Russia. The fifth workshop (Bergen, June 2015) considered the issue of setting ecological quality objectives.

EBM Expert Group

A high-level EBM expert group (EBM-EG) was established after the ministerial meeting in Nuuk in 2011, and the group presented their report to the ministerial meeting in Kiruna in 2013. The group reviewed concepts, definitions and principles for EBM (or EA). They made a number of recommendations in their report (EBM-EG 2013) that were endorsed by the ministers in Kiruna. One of the recommendations was a definition of EBM (or EA):

> *Ecosystem-based management is the comprehensive, integrated management of human activities based on best available scientific and traditional knowledge about the ecosystem and its dynamics, in order to identify and take action on influences that are critical to the health of ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.*

The EBM-EG also recommended a set of nine principles for EBM, and they made several more recommendations for activities to be undertaken under headings of Policy and implementation, Institutional, and Science and information (see list of recommendations Annex I; see also EBM-EG 2013). One of the recommendations referred to above, was to institute periodic Arctic Council reviews of EBM in the Arctic, which was one of the purposes of this conference.

A follow-up workshop was held concurrent with the Arctic Biodiversity Congress (Trondheim, Norway) in December, 2014, to examine current Arctic Council efforts as they related to the EBM Expert Group findings. The workshop recommended a set of next steps for the Arctic Council Working Groups and their partners (include as annex/supplementary).

Arctic Ocean Review

PAME carried out the project 'Arctic Ocean Review' in two phases, 2009-2011 and 2011-2013 (PAME 2013 – ref to AOR). The AOR project constituted a review of potential opportunities and options to strengthen global and regional instruments, measures and arrangements in order to manage activities in the Arctic marine environment within respective sectors. The Phase I Report (AOR-I) identified international and regional instruments relevant to the management of activities in the Arctic marine environment. The Phase II report (AOR Final Report) focused on three cross-cutting themes: *Indigenous Peoples and Cultures* (Ch.2), *Ecosystem-based Management* (Ch. 7), and *Arctic Marine Science* (Ch.8). In addition, four sectors were examined: *Arctic Marine Operations and Shipping* (Ch.3), *Marine Living Resources* (Ch.4), *Arctic Offshore Oil and Gas* (Ch.5), and *Arctic Marine Pollution* (Ch.6).

The Arctic Ocean Review (Final Report) was endorsed by ministers at the Kiruna 2013 meeting. In the report it was emphasized that EA provides a coordinated and integrated approach that been recognized to achieve all four goals of the Arctic Marine Strategic Plan (AMSP 2004), namely: reduce and prevent pollution in the Arctic marine environment; conserve Arctic marine biodiversity and ecosystem functions; promote the health and prosperity of all Arctic inhabitants; and advance sustainable Arctic marine resource use. Related to EA the AOR made two recommendations; one on use of the six element EA framework in the AC, and the second on promoting a common understanding and sharing of lessons learned through periodic review across Arctic LMEs (PAME/AOR 2013, recommendations 20 and 21, page 5).

Iqaluit 2015

The ministerial meeting at the end of the Canadian chairmanship of the AC (2013-2015) was held in Iqaluit, Baffin Island, in April 2015. In the Iqaluit Declaration, the ministers stated: in paragraph 34:

> "***Recognize*** *the multiple stresses on the Arctic environment and the need for an ecosystem-based approach to management,* ***welcome*** *and continue to* ***encourage*** *progress toward implementation of the ecosystem-based management recommendations approved by Ministers in Kiruna, and* ***request*** *the development of practical guidelines for an ecosystem-based approach to the work of the Arctic Council be completed as soon as possible*"

In follow-up work on the request to develop practical guidelines for EBM (or EA), the six-element EA framework described in the foregoing, can be used as basis and point-of-departure. The EA framework offers general guidance to the overall structure of work and arrangements that need to be established for effective implementation of EA to management of Arctic ecosystems. For the various elements, such as setting of ecological objectives (no. 3) and IEA (no. 4), there is a potential to develop specific guidance or guidelines based on exchange of experiences and lessons learned among the Arctic States, as well as more broadly including in areas outside the Arctic.

Session II: Status and Experiences from National Implementation

In this session there were five presentations on national policies and experiences with implementation of the EA in four Arctic states: Canada, Iceland, Norway and the United States of America.

James Kendall (et al.) reported on EA developments in the USA, with a foundation for implementing EA in the Arctic being laid in 2011. This is commonly referred to as Integrated Arctic Management, or IAM, which is defined as "a science-based, whole-of-government approach to stewardship and planning in the U.S. Arctic that integrates and balances environmental, economic, and cultural needs and objectives." IAM is intended to facilitate a broad-based and consistent approach to addressing both development and conservation issues. The aim is to improve stewardship and planning actions through the Interagency Working Group on Coordination of Domestic Energy Development and Permitting and its Arctic regional component (Alaska Regional IWG). IAM represents a planning process with multiple feedback loops allowing for improvement and adaptation, using the best science and indigenous knowledge in partnerships across federal, state, tribal, and local governments, as well as commercial interests, Alaska Native corporations, and non-governmental organizations. Successful implementation will require innovative and coordinated approaches that build upon the vast knowledge and experience of the people who know this region well, and who are committed to finding sustainable solutions.

Gro van der Meeren (et al.) presented the experience in Norway of EA implementation through integrated management plans, as introduced in a government white paper in 2002 where EA as a management principle was adopted. Management plans were implemented for the Barents Sea in 2006, for the Norwegian Sea in 2010, and for the North Sea and Skagerrak in 2013. The overall aim of the plans is to provide a framework for balancing sustainable use of natural resources and ecosystem services on the one hand, with maintaining the structure, functions, productivity and diversity of the Norwegian LMEs, on the other. A wide range of government agencies are involved, with cooperation and coordination in two established mechanisms: a Forum for Integrated Marine Management, and an Advisory Group on Monitoring. These groups report regularly to an interministerial Steering Committee headed by the Ministry of Climate and Environment.

The Norwegian management plan for the Barents Sea was revised in 2012 and will be revised again in 2020. There is now 10 years of experience with the plan which provides many lessons-learned which can be used to improve EA management in the future, both in the Barents Sea as well as in LMEs elsewhere. On the positive side, there has been increased attention to particularly valued areas in a spatial management context, improved monitoring through coordinated ecosystem surveys, increased monitoring and mapping of seabirds and seafloor habitats, and a general increase in awareness and communication among agencies involved in various aspects of management in the Barents Sea. There are now ongoing efforts to improve the scientific basis for EA through Integrated Ecosystem Assessments of the Barents Sea and other Norwegian LMEs coordinated through ICES (see session 3 below).

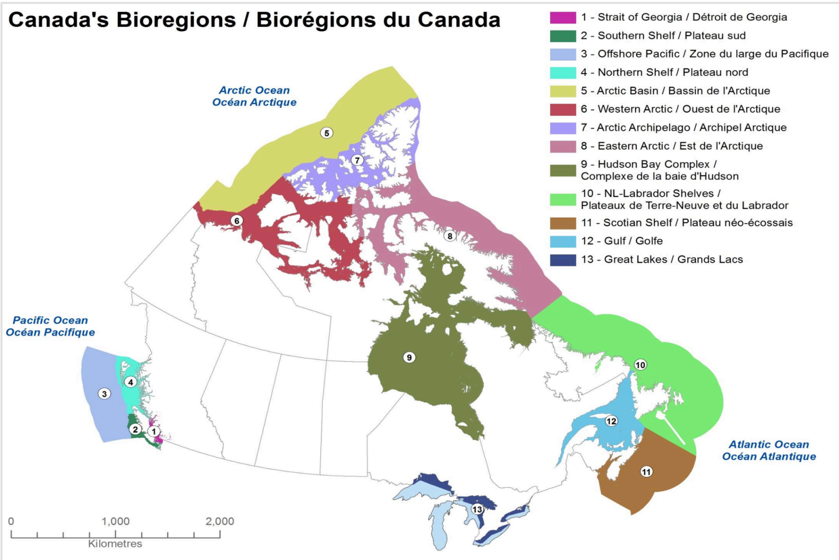


Figure 5: Bioregions in Canada's three oceans.

There were two presentations with information from Canada. **Martine Giangioppi** presented a perspective from the Department of Fisheries and Oceans (DFO) where EA is being advanced and implemented at multiple scales in marine and coastal areas through policies and measures such as integrated ocean planning, marine conservation, and sustainable fisheries strategies. EA progress to date has included identification of national conservation objectives, Ecologically and Biologically Significant Areas (EBSAs), assessment and ranking of human-induced pressures, and development of standards for impacts to fish and fish habitats. Canada has adopted a marine bioregional approach to ocean planning and management where the identified bioregions are equivalents of LMEs, or Canada's portions of transboundary LMEs. The commitments related to EA implementation will require a fully committed approach, where engagement, consultation and collaboration are the foundation of Canada's approach to marine conservation. DFO is actively leading the coordination of Marine Protected Area (MPA) network development in Canada's three oceans with its co-management partners, Indigenous groups, industry, and non-governmental organizations and other stakeholders.

DFO Science provides ongoing research and collaborates with partners and community members to advance the state of knowledge of Canada's marine environment, including through use of community based monitoring and incorporation of traditional knowledge in assessments. To fully implement an EA to ocean management, it is essential that the Government of Canada continue to work with its Indigenous and international partners to advance policies and procedures to effectively incorporate ecosystem considerations and conservation objectives into modern ocean management practices.

The second presentation from Canada was by **Patrick Gruben** who shared his experience with Inuvialuit co-management in Canada's Western Arctic. The Inuvialuit Final Agreement (IFA) was signed in 1984 as the first comprehensive Land Claim Settlement in Canada. The IFA established a system of co-management with five co-management bodies that are responsible for management of wildlife and environment, and potential development activities in the Inuvialuit Settlement region (which is 1.1 million km^2 in area). Each co-management body is made up of 50% representation from the Inuvialuit and 50% representation from the Federal and/or Territorial governments. In order to promote the efficient and informed operation of the co-management bodies, the Inuvialuit approach to sustainable development and environmental management includes support for a full range of wildlife research programs, traditional knowledge studies, harvest monitoring, and establishment of protected areas. The Inuvialuit has established a Inuvialuit Game Council (IGC) which represents the collective Inuvialuit interest in wildlife management and includes members from local Hunters and Trappers Associations in 6 Inuvialuit communities (Aklavik, Inuvik, Olokhaktomiut, Paulatuk, Sachs Harbour, Tuktoyaktuk). The co-management system under the IFA has allowed the Inuvialuit to be equal partners in resource management with involvement at the individual and community levels, up to the international level.

Olafur Astthorsson presented the work in Iceland to implement the EA with a focus on fisheries which is the main marine industry and of great importance to the national economy. The fishery management is based on scientific advice often as part of Harvest Control Rules (HRCs) that aim at achieving Maximum Sustainable Yield (MSY). Development of HCRs is an important prerequisite for ecosystem based management in a marine ecosystem such as around Iceland where fisheries have large impacts on fish stock development. HCRs have been developed, evaluated and adopted for some of the main commercial fish stocks (cod, haddock, saithe, golden redfish, and capelin). HCRs are now being considered for other stock for which data and assessments are available (ling, tusk, plaice, wolfish, and (summer-spawning) herring). The Icelandic Marine and Freshwater Institute (IMFR) is now preparing a detailed overview of the Icelandic marine ecosystem (or ecoregion) including information on human-induced pressures and impacts. IMFR will carry out a major mapping of the seafloor of the Icelandic EEZ through multibeam acoustics to be completed by 2030. In Iceland the implementation of EA is seen as being stepwise and with continual development.

The session chair (James Kendall) in his introductory remarks and summary, stated that a Pan-Arctic tour of experiences and processes of implementation might reveal far more similarities than differences. As we took our tour, several terms, concepts, and practices resonated over and over again: Look holistically at the environment, incorporate both indigenous knowledge and science in your decision-making, strive for transparency, collaborate early and often with stakeholders, avoid working in a vacuum, take an adaptive approach to the management (e.g. revisit previous decisions when new information – both science and indigenous knowledge -- becomes available), acknowledge the “changes” that are occurring and that more are to come. As anticipated, the session clearly demonstrated that Arctic Nations have come a long way in their efforts to implement EA and that all can, and already have, benefited from the international collaboration that has already occurred.

Session III: Making EA operational – developing the knowledge base and enabling activities

This session was the longest with a total of 15 presentations followed by questions and discussion. The session was in two parts chaired by Jason Link and Jaqueline Grebmeier. In the summary below, the presentations have been grouped in three blocks: 1) presentations dealing with EA frameworks and perspectives, 2) presentations on data, monitoring and assessment, and 3) presentations from terrestrial environments. Several of the presentations in this session are supplementary to those in the previous session by providing additional information on aspects related to national implementation.

EA frameworks and perspectives

Jason Link (with Phil Mundy) addressed the issue of the status of national science that supports policies implementing EA in the Arctic. There are multiple policies and mandates that establish a broad array of management requirements, broadly known as ecological objectives, for marine resource management, including for example nearly 100 treaties, laws and orders in the US alone. The dizzying array of management requirements begs for an ecosystem approach, primarily to more systematically and cumulatively coordinate across these mandates. To do effective EA requires a solid science base, and, despite negative perceptions and objections that are based largely on myths, application of the EA was considered feasible. The presentation included terminology to describe the various stages going from single species fishery management to full-fledged ecosystem based management. NOAA has developed a framework for EA implementation through emphasis on Integrated Ecosystem Assessment (IEA) (Fig. – NOAA framework for EA-IEA). In the context of US marine fisheries, the recently released Ecosystem-based Fisheries Management Policy describes six guiding principles for implementation. While we need to continue to develop capacity in the midst of uncertainty, it was stressed that we also need to maintain and actually foster a ‘can-do’ attitude to find solutions. As the World Ocean continues to face rapid change, with the Arctic being ground zero for many of such changes, it was thought that we don’t really have a choice.

Mark Dickey-Collas (et al.) reported from a workshop held in January 2016 on the topic of EA implementation. The workshop was attended by 46 participants and was supported by the European Union, US NOAA, DFO in Canada, Norway, and the UN Food and Agriculture Organization (FAO). Thirteen examples of practical EA implementation were presented and reviewed as case studies at the workshop, including implementations that could be considered successful, and those that fell short of expectations. The workshop highlighted that despite the many gaps in knowledge on the functioning of the marine ecosystem and impacts of human activities, the main hindrance to EA application appears to be governance and legal frameworks. There was agreement at the workshop of the concept of EA (or EBM) and the associated processes and principles. Success criteria for EA implementation included mechanisms for setting objectives and priorities, getting buy-in from participants and partners while respecting their various roles and responsibilities, state a realistic ambition, and prepare a tangible knowledge base.

Charlotte B. Mogensen presented the OSPAR Convention, which works through a mix of legally binding Decisions and other Agreements, such as Recommendations and Guidelines. OSPAR is guided by the ecosystem approach to the integrated management of human activities in the North-East Atlantic. The work focuses on objectives and strategies to prevent loss of biodiversity and protect and conserve ecosystems, to combat eutrophication, to prevent and eliminate pollution, and to ensure integrated management of human activities. OSPAR recognizes that in order to achieve its commitment to an EA, cooperation with other international organizations is required. Cooperation has been established with organizations such as the UN International Maritime Organization, the Intergovernmental Oceanographic Commission under UNESCO, and the International Council for Exploration of the Sea. OSPAR seeks closer collaboration with the Arctic Council. It was suggested that OSPAR and the Arctic Council Working Groups can work across 'borders' to link up with non-Arctic convention areas from neighbouring seas and oceans to share best practice for implementing the ecosystem approach to management of the marine environment. One of the geographical regions of the OSPAR Convention area is Region I (Arctic Waters) which extends north from about 60oN in the NorthEast Atlantic and includes five Arctic LMEs (Faroe Plateau, Iceland Shelf and Sea, Greenland Sea, Norwegian Sea, and Barents Sea LMEs) as well as a sector of the Central Arctic Ocean LME.

Erik Olsen provided an overview of Marine Spatial Planning (MSP), which is seen as a practical way to implement marine ecosystem-based management. Development varies globally, with Europe and Australia in the lead. Supported by research projects, regional organizations like the European Union and global institutions like UNESCO have provided guidance both to develop the science base for MSP and to plan its implementation. The integrated management plans in Norway, first implemented for the Barents Sea in 2006 and subsequently for the Norwegian Sea and the North Sea, provide a practical example of MSP as a key element within a broader system for EA implementation.

Carolina Behe provided an Inuit perspective on the EA seen through what is called the Alaskan Inuit food security lens. The presentation provided an overview of an Inuit led project, *Alaskan Inuit Food Security Conceptual Framework: How to Assess the Arctic from an Inuit Perspective*. Inuit homelands in Alaska for the Iñupaiq, St. Lawrence Island Yupik, Central Yup'ik and Cup'ik peoples encompass the

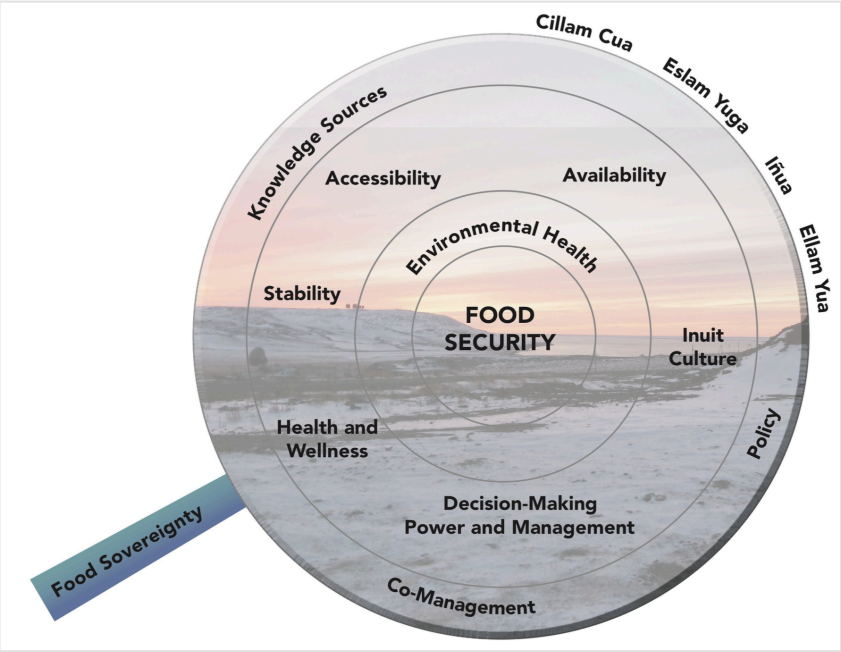


Figure 6: Illustration of the Alaskan Inuit 'food security lens'.

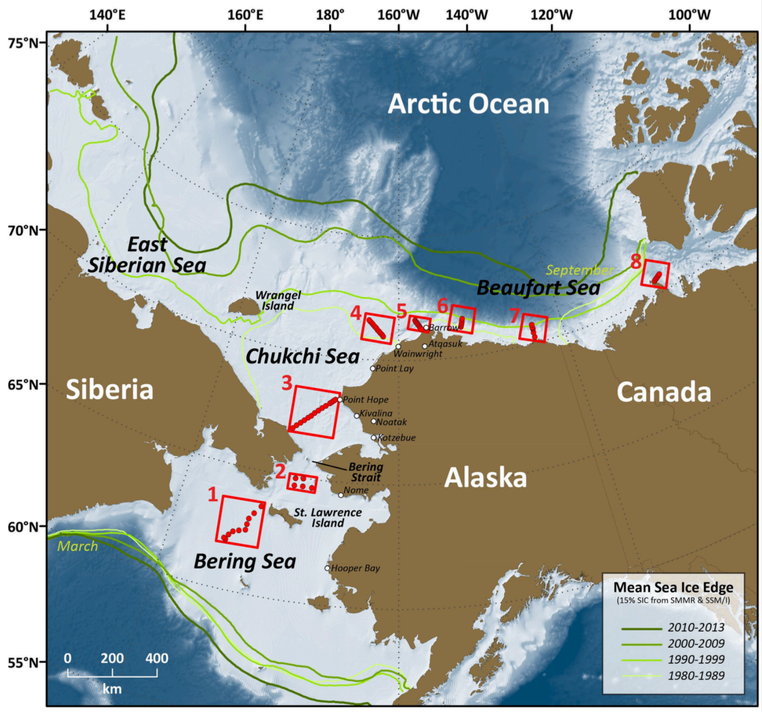
Arctic Ocean coastline from the Beaufort and Chukchi Seas southward to the Northern Bering Sea coastline at the Yukon and Kuskokwim River delta. The Alaskan Inuit understanding of food security encompasses complex and interlinked cultural and environmental systems. These systems are comprised of connections among the health of people, animals, and plants; the different states of land, sea, and air; and the cultural fabric held together by language, cultural expression, and social integrity. In the Inuit knowledge system it is impossible to disentangle some of these relationships; when we discuss an Inuit food security perspective, it is this interconnectivity and these relationships that we refer to. Alaska Inuit Food Security is the natural right of all Inuit to be **part of the ecosystem**, to access food, to care-take, protect, and respect all of life, land, water, and air. As such it represents an organizing principle for implementing the Ecosystem Approach to Management.

Becca Robbins Gisclair provided an environmental NGO perspective on EA implementation in the Arctic, representing Ocean Conservancy and the Circumpolar Conservation Union. She referred to the definition and framework for EA implementation that were presented in session 1. The focus was on the US Arctic with approaches related to fisheries as well as EA in a broader sense. Looking to the future, the presentation highlighted the need for more marine cooperation and to give more attention to the identified important marine areas (see AMSA IIC report) in an EA management context.

Scientific aspects – data, monitoring and assessment

Data issues related to Ecosystem-based Fisheries Management (EBFM) as well as the broader EA implementation in the Arctic was addressed by **Peter L. Pulsifier** (et al.). Pulsifier is with the National Snow and Ice Data Center (University of Colorado at Boulder) and is currently chair of IASC-SAON Arctic Data Committee. He provided an overview of what he termed the Arctic Data ‘Ecosystem’, meaning a connected system with components and hubs linked by data flow lines. The Arctic data ecosystem has multiple dimensions, going from local to international, from disciplinary to interdisciplinary, and from individual scientists to the larger scientific community. Pulsifer described many relevant initiatives and observing and data systems at the global, polar, national and local scales. Summarizing key opportunities, it was noted that improved data sharing would result in better science and decision making, and would give us a more complete view of the Arctic environment over time and space. It is also expected to lead to new kinds of integrative science and research and to provide economic opportunities. Parts of an Arctic data system are in place and we are making progress in establishing important new parts. However, we are still not having an integrated observing and supporting data system, one reason being that we lack a clear understanding of managing data as a system.

Three presentations dealt with the Pacific Arctic 'gateway', the inflow region of Pacific water through Bering Strait and the Chukchi Sea into the Canadian Basin. **Jacqueline M. Grebmeier** (et al.) presented the Distributed Biological Observatory (DBO), which is a system of eight geographical 'boxes' located as a latitudinal chain or array from the northern Bering Sea through the Chukchi to the eastern Beaufort Sea. This is along the advective transport route of nutrient-rich Pacific water into the Arctic, and the five boxes which are located in the northern Bering and Chukchi Sea LME include areas of very high production with strong pelagic-benthic coupling that connect lower trophic organisms to upper trophic level resource use. The DBO has been established with a view to document biological changes associated with the rapid sea ice loss and warming due to climate change. The DBO has been developed since 2010 by coordination through the Pacific Arctic Group (PAG), a consortium of 6 countries (Canada, China, Korea, Japan, Russia and the United States) operating as an independent cooperative associated with the International Arctic Science Committee (IASC). Standardized sampling protocols have been established for a range of physical and biological observations, and DBO data sharing protocols have been agreed. DBO operates on an annual cycle with two meetings by PAG in spring and fall to plan cruises and share scientific findings for coordinated DBO products such as scientific publications and presentations. There are plans to expand the Pacific DBO westwards into Russian waters, and to develop a larger pan-Arctic network including DBO-type lines in the northern Barents Sea in the Atlantic gateway region.



[updated by Karen Frey from Grebmeier et al. 2010, EOS 91]

Figure 7. Distributed Biological Observatory (DBO) in the Pacific Arctic.

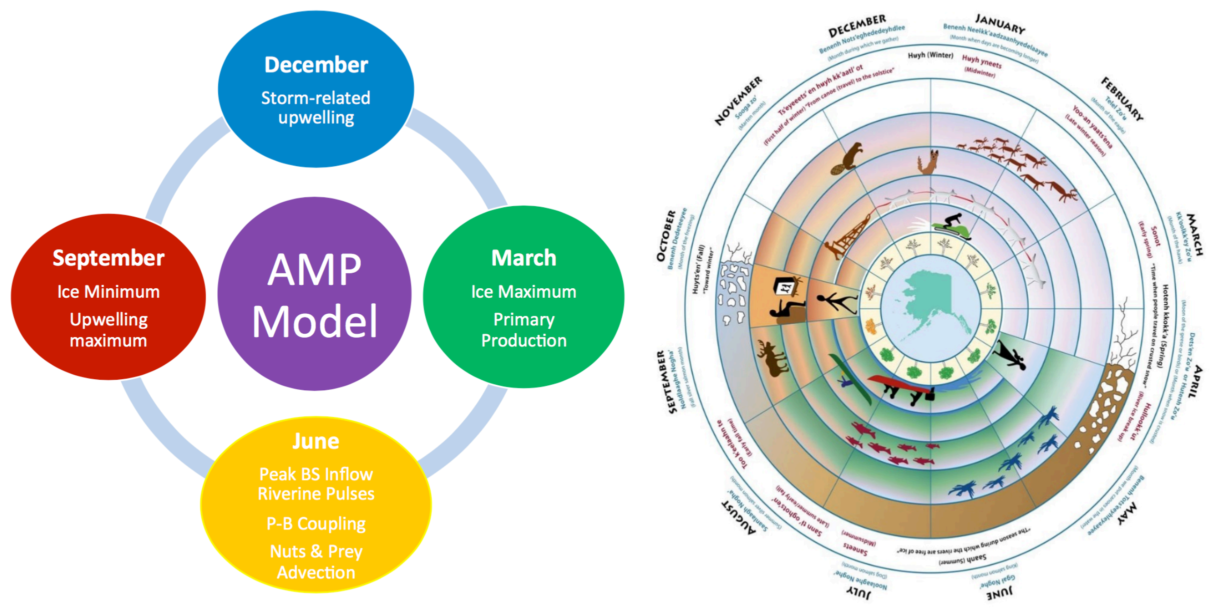


Figure 8. The Arctic Marine Pulses (AMP) Model relating scientific concepts of seasonal ecosystem phenology and the seasonal wheels of indigenous knowledge.

Sue Moore (et al., presented by **Jackie Grebmeier**) described the Arctic Marine Pulses (AMP) Model which is related to the DBO and aims to link contiguous ecological domains in the Pacific Arctic. The Pacific Arctic marine ecosystem extends from the northern Bering Sea, across the Chukchi and into the East Siberian and Beaufort seas. It is a system where advection, pelagic-benthic coupling, and strong seasonal changes are dominant features. The holistic AMP model was developed based on a concept of seasonal biophysical pulses' across a latitudinal gradient by linking processes in four previously described contiguous ecological domains: (1) Pacific Arctic, (2) seasonal ice zone, (3) continental margin, and (4) riverine coastal domain. The AMP model provides a spatiotemporal framework to guide research on dynamic ecosystem processes during the current period of rapid change, and it is expected to contribute substantially to holistic assessment of ecosystem processes and state (IEA). With its focus on phenology of events, the AMP model may facilitate communication between conventional science and seasonal-cycle based indigenous knowledge of Arctic marine ecosystems.

The third presentation from the Pacific gateway region was by ***Zhibo Lu*** (et al.) who described results on chlorophyll concentrations obtained during the 6th Chinese Arctic scientific expedition with the ice-breaker RV XUELONG in late summer 2014. Chlorophyll was recorded with a 'ferrybox' sampling system along the ship's track, which provided a high volume of data including hydrographic variables. Chlorophyll concentration decreased from south to north and was low in the Canada Basin where stratification was strongest. The study provides an example of 'en route' data collection of phytoplankton biomass which can supplement satellite remote sensed data with higher spatial and temporal resolution but with lower accuracy.

For the Atlantic side, there were also three presentations that dealt with various aspects of assessment. **Hein Rune Skjoldal** (et al.) described activities and results from work in two ICES

Working Groups for Integrated Ecosystem Assessments for the Barents Sea (WGIBAR) and the Norwegian Sea (WGINOR) LMEs. ICES, the International Council for Exploration of the Sea, has established a number of regional working groups for doing Integrated Ecosystem Assessment (IEA) (Fig. – map of ICES IEA groups). The most recent of the groups is WGICA for the Central Arctic Ocean which is a joint group with PAME and from 2017 also with PICES.

WGINOR and WGIBAR have taken similar approach and scope to doing IEA for the two Large Marine Ecosystems (LMEs). The scope has been to focus on the influence of climate variability and change on the (mostly) pelagic part of the ecosystems and on interactions with fisheries. The approach has been to assemble time series of oceanography, plankton and fish stocks and provide a multivariate description and analysis of the variability and changes in the two ecosystems. Information on seabirds, marine mammals, benthos, fishing activities and catches has also been included in some of the work. Much of the data comes from joint surveys in the Barents and Norwegian Seas and is presented both with spatial information (e.g. distribution maps from the surveys) as well as spatially aggregated (e.g. fish stocks, mean zooplankton biomass) as annual time series for the ecosystems. Integrated trend plots of all the time series variables (represented as anomalies) are used to visually show temporal patterns of change, which are further explored by multivariate analyses (MVA), notably Principle Component Analysis (PCA). The purpose is to understand the current situation in the ecosystem with focus on the most recent year. Use of time series and MVA help us see where we are coming from in interannual and decadal perspectives, which again may help us to better understand the current situation and likely short-term developments in the ecosystems.

Per Arneberg (et al.) described preliminary work to evaluate methods for assessing cumulative effects on marine ecosystems as part of an IEA. In a survey among 2179 scientists from 94 countries, assessing cumulative impacts of multiple stressors was considered the most important research issue for ocean governance and sustainability. Assessing the cumulative impact of anthropogenic factors is a developing field within applied ecology, and several methods and approaches have recently been developed and suggested for the marine realm. One line of development has been through spatially resolved approaches where impact of single pressures is first estimated independently of each other for defined spatial grid cells, and accumulated impact for each cell then assessed quantitatively from these single factor estimates. Examples of this approach include the methods developed within the HARMONY and ODEMM projects and the CUMELO method used by HELCOM for the Baltic Sea. Another type of approach is that used in development of the Norwegian governmental ecosystem-based management plans for the Barents Sea and the Norwegian Sea, and which has relied on qualitative expert assessments of how impact of single factors may combine into cumulative impacts.

Lis Lindahl Jørgensen (et al.) described an approach to assess the effects of mutiple stressors on benthos in the Barents Sea based on life history traits for epibenthic megafauna that are collected with bottom trawls. Data collected since 2007 from a joint Norwegian-Russian ecosystem survey in the autumn comprise now (2016) a total of 3073 stations with 590 identified species with recorded abundance and biomass. Using a coding system for sensitivity of species to impacts of bottom trawling, warming and predatory impacts from introduced and spreading snow crabs, a geographical pattern of vulnerability is suggested for the combined effects of these three stressors.

Terrestrial cases

Amy Breen (et al.) described the Integrated Ecosystem Model (IEM) for Alaska and Northwest Canada, which is developed as an interdisciplinary decision support tool to inform adaptation to Arctic environmental change. The physical and biotic components of Arctic and boreal terrestrial ecosystems in Alaska and Northwest Canada (permafrost, hydrology, vegetation, biochemistry, and disturbance) are tightly linked and sensitive to climate change. The IEM is under development by dynamically coupling three models: a model of disturbance and species establishment, a model of soil dynamics, hydrology, vegetation succession, and ecosystem biochemistry, and a model of permafrost dynamics. The IEM is a decision support tool designed to aid in understanding the nature and rate of landscape change, and to illustrate how landscapes are expected to respond to climate driven changes

E. Jamie Trammell described work to develop an Integrated Landscape Assessment in Alaska. The U.S. Bureau of Land Management has instituted a 'Landscape Approach' to managing their lands. The crucial first step in such an approach in the Rapid Ecoregional Assessment (REA) that transcends management boundaries by synthesizing existing data at an ecoregional level for current, near-term (2025) and long-term (2060) landscape trends. Results were presented for a REA for the Alaska North Slope ecoregion, with a focus on cumulative effects of climate change, wildfire, invasive species, and human land use and development on overall ecosystem function. The assessment was based in a Geographic Information System, with the goal of providing a spatially-explicit tool for more informed arctic planning in Alaska.

Session IV: Case studies - steps toward implementation

There were eleven presentations in this session which was chaired by Martin Robards. As for the previous session, several of the presentations are supplementary to the reports on national implementation in Session 2. They all deal with issues at a more local or sub-LME scales for the marine cases. Six (or seven) of the presentations dealt with aspects of co-management and/or marine mammals. Two more marine cases concerned EA implementation for selected parts of LMEs (Bristol Bay and the waters around Svalbard), while two cases dealt with terrestrial cases.

Co-management

John Noksana Jr described the arrangements for adaptive co-management of beluga in the Inuvialuit Settlement Region (ISR). This presentation was supplementary to the one given by Patrick Gruben in Session 2 and described specifically how beluga monitoring and harvest was co-managed under the Inuvialuit Final Agreement (IFA). The Fisheries Joint Management Committee (FJMC) is one of the five co-management boards set up under the IFA for the co-management of fish and marine mammals, and their habitats, in the ISR. The FJMC is made of representatives of the Inuvialuit (Inuvialuit Hunters and Trappers Committees, via the Inuvialuit Game Council) and the federal Fisheries and Oceans Canada (DFO), and it serves as a bridge to ensure that the resources are effectively co-managed. The co-management of beluga (as well as other marine mammals and fish) has been successful for several reasons, including: legislative authority and funding provided for the FJMC under the IFA, transparency and open communication, mutual trust and respect developed by working together over many years, and a focus on adaptive co-management with a continuous cycle of reviewing and revising management measures. Co-management of beluga under FJMC have built from an expanding harvest monitoring program into a robust and adaptive ecosystem-broad management system that involves a wide range of stakeholders. Milestones and achievements in this work have included: a Beaufort Sea Beluga Management Plan (1990), the Inuvialuit-Inupiat Beaufort Sea Beluga Whale Agreement (2000), creation of the Beaufort Sea Partnership (BSP) and a Regional Coordination Committee (RCC) as planning body for the Beaufort Sea LOMA (as part of the National Oceans Strategy in 2002), establishment of the Tarium Niryutait Marine Protected Area (TNMPA) (as the first Arctic MPA in Canada in 2010), and a Beluga Summit that was held in Inuvik in 2016.

MacPhee (et al.) described in more detail the beluga monitoring program in the ISR, which provides one of the most long-term marine mammal data sets in the Arctic, and supports co-management under the Fisheries Joint Management Committee (FJMC). The Eastern Beaufort Sea beluga stock form one of the world's largest summer aggregations in the Mackenzie estuary, representing a critical food resource for Inuvialuit. The program has evolved toward refining monitoring approaches that narrow on key ecological indicators, including local knowledge and perspectives, while expanding spatially and temporally to characterize ecosystem connectivity and regional-scale variability needed to understand ecological responses to stressors. The long-term monitoring of beluga, combined with recent process studies, have revealed within-population shifts and dynamic temporal trends in contaminants that are partially related to diet and loss of sea ice habitat. This has provided insight into the consequences of climate change to the beluga habitat use and diet, and will support the provision of advice needed for the consideration of cumulative impacts of multiple ecosystem stressors in a co-management framework.

Martin Robards (et al.) described two arrangements, the Open Water Season Conflict Avoidance Agreement and the Arctic Waterways Safety Plan, as examples of bottom-up approaches to manage conflict in Arctic marine ecosystems, in this case the northern Bering-Chukchi seas LME and the Beaufort Sea LME. This agreement and plan aim to reduce the potential conflict between marine shipping activities and the subsistence use of marine areas by Indigenous Peoples through measures such as time-area closures and vessel movement restrictions. One of the take-home messages from these successfully negotiated agreements was the importance to involve the affected local communities from the very beginning, to ensure the integration of local knowledge and the economic and traditional needs of local communities in all outcomes. They provide examples of highly successful processes that started informally, at the local level, and are succeeding at addressing local, national, and international maritime conflicts between development, traditional practices, and wildlife.

The presentation by **Nicole Kanayurak** addressed the issue of co-management of marine mammals in the light of climate change and increased uncertainty. She provided an example case study of polar bear co-management in Alaska. The polar bear case shows the importance of working across scales and boundaries to address impediments to conservation and to develop best practices for co-management. There is a complex institutional polar bear map with international agreements (e.g. 1973 Polar Bear Agreement among range states) and institutions, the Arctic states and a wide range of national agencies, committees and other groups, and Indigenous Peoples and their management organization including co-management arrangements (e.g. Alaska Native Corporations, North Slope Inupiat, and Inuvialuit Game Council in Canada). Co-management is an opportunity to co-identify and manage human activities, including supporting research, creation of scenarios, evaluate human influences, and co-monitor efficiencies. The use of EA (or EBM) emphasizes a holistic approach that better communicates with Indigenous Knowledge and Indigenous approaches to management.

Kelsey Aho in her presentation used the *Polar Bear Agreement* from 1993 and the *International Convention for Regulation of Whaling* as case studies to examine the effectiveness of bi-lateral co-management between Russia and the United States and Indigenous Peoples of both sides of the Bering Strait region. Noting the present cold political climate between Russia and the US, there has been much contact between the indigenous communities in the region over very long time, resulting in cultures and management practices that still are in use on both sides of the political border. Early research indicates that the Polar Bear Agreement has decreased in effectiveness due to the reduction of local representation, while the Whaling conventions' effectiveness is increasing. The research conducted on the two cases is intended to be used to provide guidance on a possible new bi-lateral agreement for Pacific walrus between Russia and the US for the large migratory population in the northern Bering-Chukchi seas LME.

Lesley Laukea described a study on the cultural aspect of forced migration secondary to Sea Level Rise. Native people are connected to land through genealogy and cosmology, and live in a cyclical relationship built-on an understanding of connections between man and environment. Laukea has developed tools for navigating different pathways in assessing the ecosystem approach to solutions based on traditional knowledge for large scale migration as well as ecosystem disruptions. These tools are used on the U.S. Indigenous Climate Change Task Force and were presented at COP21 in Paris, France in 2015. Collaboration across countries, organizations and agencies is necessary to apply the 'Native lens' as a viable option to recognize better solutions and practices to deal with the many challenges of global climate change, both in the Arctic and wider.

Geneviève Desportes described work in the North Atlantic Marine Mammal Commission (NAMMCO) which advice its parties (Faroes, Greenland, Iceland and Norway) on the sustainable and responsible use of marine mammal resources. While not directly on co-management, the presentation is relevant in that context through the advisory role of NAMMCO. The advice was first focused on the direct impact of sealing and whaling activities, as direct removals versus stock size and trends, then moved towards the integration of other human impacts such as fisheries by-catch and human disturbances (incl. marine pollution, shipping, anthropogenic noise, overfishing), and that of climate change corollaries, such as changes in sea ice cover and increased human activities in the Arctic. Applying an Ecosystem Service (ES) assessment and an Ecosystem Approach to the management of marine mammals help providing clarity of both the role of marine mammals in the ecosystem and the impact of changes in the ecosystem on marine mammals. This may help shaping the future research agenda for informing pro-active and strategic management and thus support the resilience of arctic communities.

Regional marine case studies

Lis L. Jørgensen (et al.) provided a case study for the Fram Strait region and the waters north of Svalbard which is part of the Atlantic gateway for the flow of relatively warm Atlantic water into the Arctic Ocean. The area constitutes the northwestern corner of the Barents Sea LME and straddles into the adjacent Greenland Sea and Central Arctic Ocean LMEs. The Institute of Marine Research (IMR) in Norway is conducting a research project (SI-Arctic) which aims to increase the scientific knowledge base, explore options for providing ecosystem-based advice, and establish long-term monitoring programs for these high Arctic waters under Norwegian jurisdiction.

Todd Radenbaugh presented another marine case study for Bristol Bay, which is a large sub-Arctic water body (over 110.000 km2) on the wide shelf in southwest Alaska (part of the East Bering Sea LME). Along its shoreline there are six large estuaries that receive the inflow from watersheds including the Cinder, Egegik, Igushik, Kvichak, Meshik, Nushagak, Naknek, Togiak, and Ugashik rivers. Each summer millions of migrating Pacific salmon (5 different species) use these estuaries as a staging and physiological transition area. The associated salmon fishery, among the world's largest, is prized both for its subsistence and commercial values. To maintain a sustainable fishery, salmon escapement goals are stringently managed so adult salmon enter pristine watersheds to breed. However, the ecological function and the full range of ecological services of Bristol Bay's estuaries have not yet been extensively studied or monitored (e.g. nutrient cycling, wildlife habitats, effects of fish waste). The limited data on the ecological dynamics is further compounded by the underlying influences of rapid climate change and human altered nutrient cycling. We need a more robust understanding of how Bristol Bay estuaries function as part of a changing sub-Arctic LME (East Bering Sea) so that scientists and policy makers can better manage to maintain the ecological health.

Terrestrial case studies

Gino Graziano described work on response to invasive species in Alaska and the role of education and awareness rising for effective implementation of measures as part of an ecosystem approach. The Arctic was once thought to be resistant to the impact of invasive species, but recently increased rates of introductions combined with climate change have altered the situation. Management of invasive species in Alaska takes multiple steps including adoption of prevention practices, monitoring for early detection, use of integrated pest management, and education. If an invasive species becomes established, management is done under the principles of pest management. It is recognized that management of invasive species is a disturbance to the ecosystem, and attempts are made to manage the pest with minimal impact to the surrounding environment. Educating agencies, businesses, and the public about prevention and management of invasive species is of great importance, and educational efforts include development of mobile applications, online training courses for professionals to detect and report invasive species, social media such as Facebook to continuously engage trainees, and traditional face to face workshops and courses.

Miho Morimoto described management of boreal forests in Interior Alaska and challenges imposed by rapid climate change. Alaska's boreal forest is mostly ecologically intact, with wildfire and insect damage and mortality as the dominant disturbances, while forest harvest affects an area equal to only 3.9% of area burned in forest fires. However, the boreal forest is now going through profound changes due primarily to climate change, which calls for adaptive management practices. This study offered adaptive management approaches based on 40 years of forest harvest and regeneration management experiences by synthesizing the expert knowledge and practices of the past, and applying scientific knowledge to meet the needs and challenges of today.

Session V: Pan-Arctic marine science and policy

This session had four presentations, one on governance and three on monitoring and assessment work by working groups under the Arctic Council.

Kaja Brix addressed governance from a theoretical perspective. The need for more integration in the EA is well recognized (see the Introduction, Page 1). The challenge of integration across scientific, policy, or science-policy sectors is in how we view and define integration and how it is executed. Integration is traditionally thought of as one end of a fragmentation-integration spectrum, with a concept of a normative movement *towards* integration. Such a model has certain characteristics, i.e. it is static, unidirectional and end-point driven. The model serves the purpose of integration of knowledge, but it loses the value derived from fragmentation. Brix presented a new theoretical model of regime integration that considers the dual benefit of fragmentation derived from independent scientific or policy sectors and the benefit derived from integration of those sectors. Most significantly the model accommodates adaptation to change among sectors and across time. She argued that a dynamic model is more likely to serve the needs for sustainable management of a dynamic ecosystem. The basic characteristics of the theoretical model consist of concepts such as divergence, convergence, and flow. From a practical standpoint, the model envisions full utilization of existing institutional arrangements while adding a novel functional arrangement. This means that no new governance structures are required, rather simply that a new orientation to governance is considered. Kaja Brix illustrated the new governance model with a long-standing empirical case in Alaska involving the interaction between commercial groundfish fisheries and the endangered Steller sea lion.

Lawson W. Brigham described experience related to EA in the work on the Arctic Council's Arctic Marine Shipping Assessment (AMSA), conducted under PAME during 2004-2009. AMSA can be viewed in three, key perspectives: a baseline or snapshot of marine traffic/use; a strategic guide for a host of 'owners,' actors and stakeholders; and, a policy framework for the Arctic states to address Arctic marine safety and environmental protection. Critical to AMSA's success has been its 17 recommendations that were approved by consensus of the Arctic Ministers, a consensus that will likely be necessary to implement EA across the Arctic. The holding of AMSA Town Hall meetings in Arctic coastal communities provided critical information that influenced the development of AMSA's recommendations. Traditional knowledge and indigenous user perspectives were important to AMSA, but the integration of this information was complex and challenging as it would be in EA implementation. The use of scenarios, or plausible futures, of Arctic marine navigation was one of the successful tools used during AMSA. In many respects, AMSA is an Arctic Council model for conducting an integrated assessment that resulted in realistic and achievable recommendations, a goal to be pursued in applying EA to the complexities of the Arctic.

John Payne (et al., presented by **Becci Anderson**) described the Circumpolar Biodiversity Monitoring Program (CBMP) which is the cornerstone program of the Conservation of Arctic Flora and Fauna (CAFF) working group. The CBMP is an international network of scientists, governments, indigenous organizations and conservation groups working to harmonize and integrate efforts to monitor the Arctic's living resources. The CBMP organizes its efforts around the major ecosystems of the Arctic: marine, freshwater, terrestrial, and coastal. The goal of CBMP is to facilitate more rapid detection, communication, and response to the significant biodiversity-related trends and pressures affecting the circumpolar world. Coordinated monitoring is a critical building block in achieving ecosystem-based management.

Jon L. Fuglestad described work in the Arctic Monitoring and Assessment Programme (AMAP) working group on contaminants and pollution in the Arctic. Arctic states have implemented AMAP's Trends and Effects Monitoring Program which recommends the different contaminants and matrices (water, sediments, biota) to be monitored in the Arctic. The results from the monitoring are used in AMAP assessments of Arctic contaminants and pollution, and can be used for assessment of the status of Arctic marine ecosystems. Due to ocean currents and prevailing wind directions, contaminants are long-range transported from sources at lower latitudes to the Arctic. Despite few local Arctic sources, contaminant levels in Arctic marine biota can be as high as levels closer to the main sources of pollution in Asia, Europe and North America. Highest levels of lipid-soluble contaminants are found at the highest trophic levels which includes species of marine mammals harvested for human consumption. This is a human health issue, and an important aspect is to set limits to human consumption taking into account the most vulnerable individuals like children and pregnant women. The Arctic environment is changing faster than other parts of the globe due to climate change, which can give cascades of other changes associated with warming. The ongoing AMAP assessment 'Adaptation Actions for a Changing Arctic' (AACA) assesses future Arctic change and how to adapt to the changes. Arctic change requires management to closely follow the environmental changes which is a key feature of EA. Ice melting could release contaminants and make them bioavailable. Emerging Arctic contaminants like brominated flame retardants (BFRs) and perfluorinated alkylated substances (PFAS) are examples of substances that can have effects on Arctic biota, either as single substances or as components of the cocktail mixture that all living organisms are exposed to.

Session VI: Status of Implementing the Ecosystem Approach to Management in the Arctic

This session was chaired by Catherine Coon and consisted of a panel discussion in two parts, addressing respectively the status of EA implementation in the Arctic and the roles of the Arctic Council in implementation. It should be noted that the responsibility for EA implementation lies with the Arctic states within the areas of national jurisdiction, with the Arctic Council as a forum playing supporting and coordinating roles. This is particularly the case for ecosystems that transgress national boundaries (e.g. Exclusive Economic Zones) and/or include areas of High Seas in transboundary LMEs.

The short interventions by panelists and the panel discussions are reflected in the following, organized by first considering implementation at the EA framework level before considering each of the EA framework elements separately (except element no. 6 – management actions - which is considered as part of the overall framework).

EA Implementation

Management of human activities on the scale of the ecosystem to sustain the flow of ecosystem goods and services is not presently occurring widely across the Arctic. At the level of individual Large Marine Ecosystems (LMEs), the situation varies, with encouraging development of integrated management across human activity sectors in some cases (e.g. Barents Sea LME).

Practical EA guidelines will benefit Arctic states and the work of the Arctic Council focused on Arctic regulatory and other management actions to sustain the provision of ecosystem goods and services. Such guidelines are particularly important in locations where management actions are targeting activities that transcend national boundaries and activity sectors. Education of the public on the rationale for management measures is important to build the political support essential to sustaining the flow of Arctic ecosystem goods and services. Management actions should be adaptable and in principle respond to information on the changing state of the ecosystem (from Integrated Ecosystem Assessment, element 4), and the degree to which defined ecological objectives (element 3) are met.

It is important to consider and develop the means to translate assessment information to managers for decision-making through a scientific advisory process. It is equally important to consider how to assess the confidence in information regarding EA. How you increase knowledge is as important as what you discover, data discovery needs to occur in ways that help society evaluate this information. Societal evaluation would be comprised not only of policy makers but would include permanent participants, local communities, and resource managers – the practitioners of applying both Indigenous Knowledge (IK) and science into policy. During guideline development, it is important to take a collaborative approach that utilizes both IK and various disciplines of science. Mechanisms of EA implementation across industry sectors should not replace existing strategies that have proven effective, such as conventional sector based management approaches that bring the sector managers together, but perhaps additional processes to deal with cross-sectoral implications of specific issues should be considered. Management measures need to be translated into policy instruments, laws, and economic stimulus.

Identify the Geographic Extent of the Ecosystem (Element 1)

The geographic extents of the major Arctic marine ecosystems have been defined.

Formal identification of Arctic Large Marine Ecosystems (LME) meets one of the needs for common definitions and similar approaches among Arctic states in implementing EA. The adoption by the AC of the definitions of the Arctic LMEs (Kiruna 2013), provided a good starting point for implementation. The extent to which the Arctic states have adopted the LME as management units remains unclear; however, the application of LMEs within the AC is apparent. While the LME defines the largest physically and biologically coherent geographic units, smaller spatial scales are important, such as those appropriate to Ecologically and Biologically Significant Areas (EBSAs), Areas of heightened ecological and cultural significance (AMSA IIC areas), Marine bioregions, Marine Protected Areas (MPA), and other biophysically defined geographic areas that form the elements of frameworks for advancing marine spatial planning (MSP).

Describe Ecosystem: Biological and Physical components and Processes (Element 2)

The foundational knowledge necessary to move forward with the integrated ecosystem assessment and monitoring is in hand.

Although the extent to which it is complete varies by Large Marine Ecosystem, the overall knowledge of the community structures of plants and animals, the extent and integrity of essential habitats, climatology, basic physiography, hydrography and environmental chemistry, and the relationships of Arctic people to all of the foregoing, is extensive and growing. Much of the data collected in the Arctic is collected by AC observer countries, for example Germany and Japan. The challenge for the AC and others is how to make all the relevant data collected by the different countries accessible. Arctic states and observer nations need to work together to solving scientific information needs.

Set Ecological Objectives that Define Sustainability of the Ecosystem (Element 3)

Common definitions of ecological objectives that define status of attainment of sustainability within an ecosystem approach remain to be established among the Arctic states.

Perhaps the most important measure to insure success of EA is to set up objectives early on in the management and/or regulatory process, so that all sectors and stakeholders have the same expectations, and be based on the area, the objectives and processes. It is also essential for successful EA implementation for sectors and departments of governments to be working from common ecosystem objectives. Even in difficult management and/or regulatory environments, having at least a few objectives in common among the parties would allow communications to be established. Focus IEA on objectives so that we have the information to answer the questions. Systems of ecological objectives that could guide development of ecological objectives for the Arctic are available from the European Union, the Baltic Sea (HELCOM) and the North Atlantic (OSPAR). Such systems of ecological objectives serve as examples of approaches endorsed by some of the Arctic states. Ecological objectives have a direct link to integrated ecosystem assessment, as the objectives define the elements of assessment that serve as measurable sets of variables or indicators of ecosystem status. Monitoring programs based on variables or indicators resulting from, or defined by, the ecological objectives advise and support management actions (6).

Assess the Current State of the Ecosystem (Element 4)

A common understanding of integrated ecosystem assessment (IEA) in relation to implementing the ecosystem approach remains to be established among the Arctic states.

In implementing the EA to Arctic ecosystems, it is important to strive toward similar approaches. There is on-going work to develop and carry out Integrated Ecosystem Assessment (IEA) for Arctic marine ecosystems, e.g. by ICES for the Barents and Norwegian Sea LMEs and by ICES and PAME for the Central Arctic Ocean. Through such assessment processes, we are learning-by-doing how to carry out an IEA. It is important to continue to review developments and share experiences from doing IEAs, both within and outside the Arctic. This can allow development of (IEA) guidelines providing

Arctic states with the tools and method needed to conduct IEAs. One important aspect here is the temporal and spatial scales of observations, which will allow to determine status across scales (i.e. Panarchy principles) and serve the function as 'change detection arrays' across space and time by each LME. Common approaches to observation and analysis allow scientists and Arctic communities to present a comprehensive picture of the status of the LME to managers and arctic states. Better coordination of monitoring systems is required, even those within the AC working groups; one reason to develop a SAON was to achieve this coordination of monitoring that would be essential to EA implementation. All the diverse data that is collected for integrated assessments (such as the traffic data for AMSA) should be drawn from the 'official data' of the Arctic states; each Arctic state can collect data as they wish using government exerts and/or contract personnel, but the data submission should be executed the Arctic state.

Value the Cultural, Social and Economic Goods Produced by the Ecosystem (Element 5)

Valuations of the cultural, social, and economic goods and services produced by Arctic ecosystems is far from complete. Ecosystem valuation is an emerging field and not much resource is available for conducting such studies. It is an important part of an EA process but there has been very limited progress on that front across Arctic States.

The public needs more complete and timely information about the values of ecosystem goods and services provided by Arctic ecosystems, and that are at risk of being diminished or lost during the course of human activities and climate change. Understanding the extent and magnitude of the ecosystem goods and services that are at risk of being diminished or lost provides managers and the public with context for regulating human activities. Nonetheless the issue needs to be approached with care and humility by all concerned in view of the role of culture and national interests in determining value. Any cost-benefit analysis or trade-off mechanism is likely to be defined differently under different cultures. The valuation process in indigenous cultures is clearly very different from those of the Arctic states and industry sectors. Work on this EA element should start with a discussion leading to a solid foundation of principles for approaching the role of culture in determining valuations.

Roles of the Arctic Council in EA implementation in the Arctic

Possible roles of the Arctic Council (AC) in facilitating the implementation of EA to management of Arctic ecosystems were suggested during the panel discussion as well as during a round of commenting of the draft panel session report in the months following the conference.

Perhaps the most important role was for the AC to ***develop codes of practices and guidelines*** implementable by Arctic states for achieving and measuring the attainment of sustainable management of human activities within and across sectors and forums (including environmental organizations, academic institutions, and government agencies). This would be a response to the request in the Iqaluit Declaration (2015) for the development of practical guidelines for an ecosystem-based approach to the work of the Arctic Council. The codes of practices and guidelines for implementing EA would be applied across multiple working groups of the AC and should be communicated to industry and public forums. It is important for us to remember that EA would be a process that begins with how information is gathered to inform decision making.

The 6-element EA framework developed under the Arctic Council is guidance at a conceptual level for implementing the EA to management of Arctic ecosystems, specifically the Arctic LMEs. The framework should therefore be used as the starting point for development of codes of practices and guidelines. The AC should continue to review application of EA in the Arctic to facilitate exchange of information on management experiences, including integrated ecosystem assessment and highlighting examples from Arctic States. Specifically, this could include comparison of the transboundary regulatory experiences of Canada and the US in the Beaufort Sea, and those of Norway and the Russian Federation in the Barents Sea.

The AC should ***promote adoption of LME as management units*** for the marine Arctic. Many of the LMEs are transboundary and/or include portions of High Seas and this requires management cooperation between two or more Arctic states for LMEs that straddle their boundaries of national jurisdiction. The LMEs have open boundaries, and adjacent LMEs 'communicate' through fluxes of water via ocean currents, transport of plankton and contaminants, and migrations of fish, birds and mammals. The AC could serve a coordinating function for harmonization and collaboration across LMEs as well as with the adjacent land and freshwater systems. Related to this, there is need to continue collaborative work on EBSAs, existing MPA's and other special areas which would provide a possible framework for advancing marine spatial planning and management in the context of the LMEs.

Related to the guidelines of EA implementation mentioned in the foregoing, there is a need for guidelines for specific elements of the EA framework. This includes development of ***guidelines for how to set ecological objectives*** for Arctic ecosystems including the associated information needs to allow assessment of whether objectives are achieved or not. Such guidelines could include information on how to map management actions to the state of ecosystem components as reflected by variables or indicators (e.g. as is done in Ecosystem overviews produced by ICES).

Based on continued review of work on Integrated Ecosystem Assessments (in ICES and elsewhere), the Arctic Council should facilitate the ***development of guidelines for conducting IEAs***. This could be done in collaboration with ICES, which develops and conducts IEA in an EA context to advise on the status, pressures, and management options for marine ecosystems. The Arctic Council may also ***foster and sustain working groups on IEA for transboundary and extraterritorial Arctic LMEs*** using a common IEA approach (e.g. the model under development by the ICES/PICES/PAME Working Group on IEA for the Central Arctic Ocean (WGICA). Foster communication among Arctic states regarding standards of comparison for ecosystem status among LMEs, especially those transboundary and extraterritorial LMEs.

The basis for IEA is updated information on the changing states of ecosystems provided through monitoring. The Arctic Council should ***promote the work of international Arctic monitoring programs***, such as the Distributed Biological Observatory (DBO) sponsored by the Pacific Arctic Group and the Sustained Arctic Observing Network (SAON) hosted by AMAP. There is a recognized need for ***better integration, cooperation and communication among the different monitoring programs now operating within the AC community***. The coordination needed within the AC working groups may be less about ensuring and agreeing to similar monitoring methodologies and more about a need for guidelines that will get us to a holistic approach to monitoring, i.e. one where abiotic, biotic and social elements are looked at together based on coordinated monitoring of the various interrelated elements.

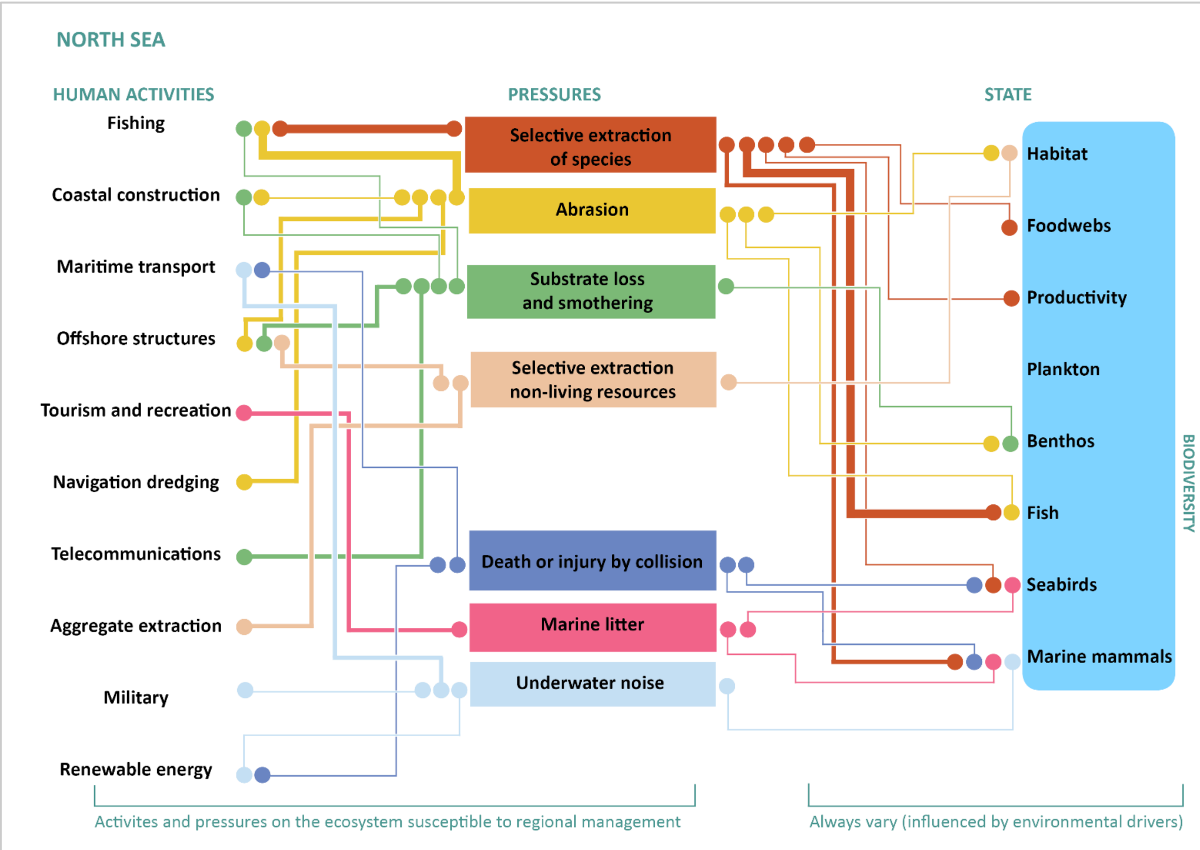


Figure 9. Schematic ecosystem overview for the North Sea showing linkages between human activities, pressures, and effects on ecosystem components. From ICES Advice 2016, Book 6. ICES Ecosystem Overviews Greater North Sea Ecoregion.

The Arctic Council should continue to ***contribute to the development of global Arctic information sharing systems*** so that the status of foundational knowledge may be compared across Arctic LMEs. The information system would support the assessments and contribute to design and adaptive adjustments of monitoring programs to meet the continued need for information in assessments, including IEAs. Collaborative work between experts from Arctic states and observer nations in AC working groups (e.g. PAME, AMAP, CAFF) provides an important mechanism for making national Arctic observations available to all working in the Arctic.

The Arctic council should ***facilitate a stepwise process to progress the issue of values and valuations of ecosystem goods and services*** produced by Arctic ecosystems, taking into account economic and social values as well as non-monetary values related to spiritual and cultural aspects of life. The AC is a good place for fostering the thinking around this complex issue where a balance of cultural, ethical and national perspectives is represented.

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Annex I. Kiruna EBM recommendations.

Recommendations from the EBM expert group (2013) on activities that could promote the application of EA (or EBM) in the Arctic.

No.	Recommendation
1.	***Policy and implementation***
1.1	Develop an overarching Arctic EBM goal, derived from established Arctic Council goals and visions, and provide guidance on how to develop and operationalize objectives supporting this goal.
1.2	Explore ways in which Arctic States can cooperate to advance conservation and management of biologically, ecologically, and culturally significant areas.
1.3	Develop and adopt a policy and best practices for incorporating traditional knowledge into EBM activities as appropriate.
1.4	Encourage initiatives between two or more Arctic States to advance implementation of EBM in the Arctic and demonstrate how knowledge is collected, shared, processed and used to contribute to EBM in the Arctic.
1.5	Review, update and adjust the Observed Best Practices in Ecosystem-based Ocean Management in the Arctic, endorsed by the 2009 Arctic Council Ministerial, to be applicable to all environments, including marine, coastal and terrestrial.
2.	***Institutional***
2.1	Identify a lead to assure coordination of a common approach to the work of the Arctic Council on EBM in the Arctic and ensure appropriate reporting of progress to the Senior Arctic Officials.
2.2	Institute periodic Arctic Council reviews of EBM in the Arctic to exchange information on integrated assessment and management experiences, including highlighting examples from Arctic States.
3.	***Science and Information***
3.1	Encourage the use of the revised map of 17 Large Marine Ecosystems to inform EBM implementation; and explore the development of terrestrial assessment units (landscape equivalents to LMEs) based upon ecological criteria or existing ecoregions.
3.2	Identify biologically, ecologically, and culturally significant areas in the coastal, marine and terrestrial environments, and consider EBM-related needs for these areas. Identify the coastal, marine and terrestrial areas most vulnerable to human impacts.
3.3	Assess the value of significant Arctic ecosystem services relevant to the well-being of local communities and regional economies, and those of particular global significance.
3.4	Enhance access to, and use of, the multidisciplinary data required for the implementation of EBM by building upon ongoing work in the Arctic Council to contribute to an Arctic Council data portal.
3.5	Exchange information and experiences with integrated assessments of ecosystem status, trends and pressures for coastal, marine, and terrestrial areas and provide guidance on approaches for integrating existing assessments.

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