PAME
Protection of the Arctic Marine Environment

The Ecosystem Approach to Management

CONCEPT PAPER

It means integrated management of human activities to achieve sustainability

The ecosystem approach to management has been described as a 'strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way' (UN Convention on Biological Diversity - CBD).

The ecosystem approach to management is defined as:

> 'The comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.'
>
> (Arctic Council, 2013)

Integrated management of natural systems, including humans, is a concept known by many different names such as **integrated ocean management, ecosystem-based management (EBM)**, or most simply, **the ecosystem approach to management (EA)**. EBM and EA are synonymous within the Arctic Council. Internationally the term EA is widely used, for example in global UN Biodiversity Convention (CBD).

It requires focus on the state of the ecosystem

The EA to management, as an inclusive framework for balancing competing development interests to enable the sustainability of ecosystems, differs from the conventional single–sector and single-species management commonly applied in the past by requiring specific knowledge of the overall state of the ecosystem. The focus on understanding the state of the ecosystem has two sides to it. One side is to define what good or acceptable states of the ecosystem enable sustainability, along with a corresponding set of **ecological objectives** that can guide management decisions toward achieving and maintaining good or acceptable status. The other side is to **assess or evaluate the state** in order to determine how much it is influenced by human uses and activities. The two sides of understanding the state of the ecosystem, while related, are not the same from a practical point of view. For example, we can set objectives for those ecosystem components amenable to directed management actions such as commercially exploited or threatened species. Other components, such as plankton communities or climate variability, while susceptible to the consequences of human activities, are not amenable to directed management actions, at least in the short term. Nonetheless understanding the state of the ecosystem in terms of as many physical and biological components as can be measured is essential to achieve the goal of sustainability for the Arctic ecosystems on which the sustainability of its economic and social systems depend.

An evolving concept that is ready for implementation

The EA concept has been around for at least 30 years and it has been extensively discussed, elaborated both inside and outside the Arctic Council. Thanks to this long history of engagement on EA, the Arctic Council community has achieved broad agreement on key features and elements of the EA. The Arctic Council EBM experts group articulated this agreement by identifying and elaborating a set of nine principles (Arctic Council 2013) that represent common elements in the application of the EA in the Arctic. The agreement is now sufficient to allow us to proceed to address how EA can be implemented in practice.

A framework for implementing EA in the Arctic

A framework for implementation of the EA is envisioned to have six main elements:

- Identify the ecosystem
- Describe the ecosystem
- Set ecological objectives
- Assess the ecosystem
- Value the ecosystem
- Manage human activities

The elements can be seen as steps in an iterative implementation cycle. Other than the first two, they are not necessarily sequential, so the practical arrangements of how and where the various elements occur in a particular management system can be adapted to its purposes during implementation.

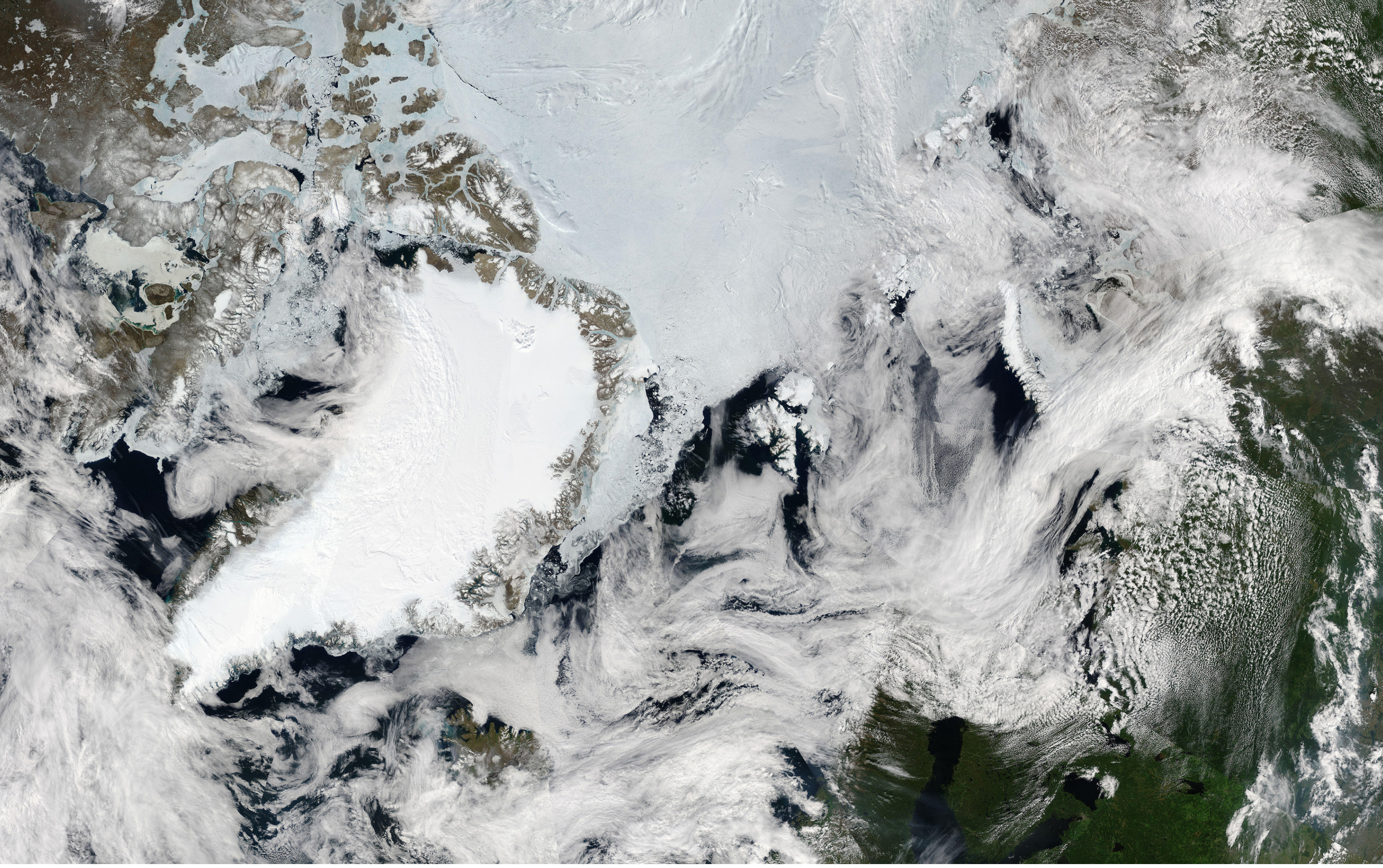
In accord with established principles, the EA is a science-based, place-based and adaptive approach to management of ecosystems. Within the iterative cycle described below it enables regulation of human activities with due attention to the state of the ecosystem, as translated into ecological objectives for what is a good or acceptable state of the ecosystem.

To **identify the ecosystem** requires defining the ecosystem as a geographical entity based on ecological criteria, which is a logical first step in an EA implementation process. Once identified, it becomes possible to **describe the ecosystem** in terms of its biological and physical characteristics (species and habitats), as well as the physical and biological processes and relationships that forge them into an ecosystem. The complexity of ecosystems invites a systems approach which may help us to understand the functional aspects (ecological processes) of the ecosystem, including fluxes and other processes at the open boundaries. Defining the ecosystem also identifies the management system including responsible agencies and jurisdictional aspects, as well as the legitimate stakeholders for that defined geographical area.

To **set ecological objectives** for ecosystem components (species and habitats) and for the overall state of the ecosystem is equivalent to defining the 'line of sustainability' through the ecosystem, or rather the envelope of conditions for ecosystem state that is compatible with sustainable use. The ecological objectives need to be translated into management objectives and management measures that will ensure ecosystem conservation and sustainable use.

To **assess the ecosystem** is to characterize the state of the ecosystem with due regard to its dynamic nature. Ecosystem assessment is necessarily integrated and comprehensive in providing synoptic observations on the status and trends of all relevant ecosystem components, which together comprise the overall state of the ecosystem. An integrated assessment includes measuring or estimating the impacts by various human activities such as fishing, pollution, coastal development, and others, as well as the overall or cumulative impacts of those activities. Integrated assessments also include socioeconomic factors and conditions, as driving forces for use and impacts, and as consequences for society arising from altered provision of ecosystem goods and services.

To **value the ecosystem** is to identify and value its goods and services in order that those economic, social and cultural values may be more fully incorporated into mainstream socioeconomics ('greening of the economy'). Socioeconomics in the broadest sense (including cultural, political and other aspects) come into play in all elements of the EA.



The view from the NASA Earth Observatory over the Greenland Sea, Barents Sea and the Central Arctic. Photo: Jeff Schmaltz

Setting ecological objectives is ultimately a societal choice where the balances between sustainable use and conservation and between diverse societal needs are considered.

To **manage human activities** requires applying methods for shaping human behavior that are adaptive, meaning that actions are regularly tailored to the shifting ecological and social conditions to achieve and maintain the agreed ecological objectives. Making the best use of available scientific and other knowledge, the outcomes of integrated assessments need to be translated through a scientific advisory process into clear and transparent advice to inform adaptive management. Management decisions should be taken at the lowest appropriate level, but within the overall framework where ecological objectives have been set for the larger system.

Defining the elements of the EA implementation cycle

The six main elements have been approached from a number of different perspectives within the Arctic Council and elsewhere. The following is a summary of our efforts to define some of the most prominent elements.

Identify and describe the ecosystem: Large marine ecosystems

Large marine ecosystems (LMEs) are geographical areas that have been identified and described as ecosystems based on a set of four ecological criteria; bathymetry, hydrography, productivity, and trophic linkages. One of the strategic actions of the 2004 Arctic Marine Strategic Plan of the Arctic Council was to identify the large marine ecosystems of the Arctic based on the best available ecological information. A working map of 17 Arctic LMEs was adopted in 2006 and has subsequently been revised with a new version in 2013. (Include map). Canada has identified similar areas (termed 'bio-regions') based on biogeographical criteria for their marine waters. These bio-regions are sufficiently similar to be considered equivalents of LMEs on the revised map.

The LMEs represent the appropriate and primary units for applying the ecosystem approach to management of the marine environment recognizing that it accommodates management at other spatial scales. The issue of scale is important since there is a need to deal with ecological features and processes and human activities that operate on many different scales in a nested approach. The LMEs offer a

Atlantic cod (gadus morhua). Photo: Erlendur Bogason, www.strytan.is

framework for doing this in a structured manner from both scientific and management perspectives. The scale of LMEs is appropriate for in-depth analysis of interactions between species in food webs and between species and their habitats within an LME. At smaller scales, an LME can be represented as a mosaic of habitats with different physical and biological attributes (rocky bottoms, muddy sediments, kelp forests, ocean fronts, etc). The overall state and integrity of the ecosystem is a reflection of the status of species and habitats and their interactions at all appropriate scales within the LME.

The Arctic LMEs do not sit in isolation. On the contrary, they are open ecosystems where exchanges between them are important system characteristics. Water flows across the boundaries transporting plankton, organic matter and pollutants. Mammals, birds and fish swim or fly across the boundaries, and neighboring LMEs are functionally connected through such transports and migrations. Many stocks of migratory birds and mammals (e.g. whales) use two or more Arctic LMEs during their annual cycle (and many move south to winter in ecosystems at lower latitudes and even the southern hemisphere for many birds). These larger scale migrations need clearly to be taken into account in the management of the migratory species. One way this can be done is to focus on the relationship between the migratory animals and specific habitats and food web interactions in each of the Arctic LMEs they are frequenting during their seasonal visits.

Identify and describe the ecosystem: Ecologically important areas

Ecologically and biologically significant areas (EBSAs) (or areas of heightened ecological significance) are habitats that play particularly important functions in the ecosystem, e.g. for migratory species at some stages during their life history or annual migratory cycles, or for the wider productivity in the system. Identification and information on EBSAs represent therefore important information which can be used in descriptions and management of Arctic LMEs. Through their ecological significance the EBSAs convey information on functional aspects of these areas in the context of the wider ecosystem, including dependencies of species on specific habitats for many of them.

Areas of heightened ecological significance have been identified in all of the Arctic LMEs based on a thorough ecological review in the follow-on project to AMSA Recommendation IIC. Most of these areas have been identified as important habitats for fish, birds or mammals. Oceanographic features such as polynyas and ice edges and productive areas are included indirectly through their ecological functions, e.g. for migratory mammals and birds.

Atlantic wolffish (Anarhichas lupus). Photo: Erlendur Bogason, www.strytan.is

Set ecological objectives: Further definition of ecological objectives

Current management is guided by management objectives. We have general policy objectives like the goals formulated in the 2004 AMSP, including:

- Reduce and prevent pollution in the Arctic marine environment
- Conserve Arctic marine biodiversity and ecosystem functions
- Advance sustainable Arctic marine resource use

More specific objectives often exist related to fisheries and hunting (keeping populations at safe and healthy levels), threatened species (restoring them to non-threatened status), pollution (keeping contaminant levels below set standards), and industrial activities (keeping impacts at or below acceptable levels).

An important task of the EA is to develop existing and supplementary new objectives into a holistic and consistent set of ecological objectives that together represent the general policy goals of sustainable use and conservation of species and habitats (or biodiversity for short). This task has two main steps. The first is to formulate ecological objectives for species and habitats; e.g. how large should animal populations be to be safe, viable and productive, and how much of habitats should be protected and in what condition should they be maintained? The second step is to translate these objectives into clear management objectives and/or management options and actions. This translation would often be best done in a **scientific advisory** process institutionalized as part of the EA to management and with stakeholder participation.

A comprehensive and consistent set of ecological objectives represents a practical definition of sustainability for a given ecosystem. In principle it draws up the balance between use and conservation, defining the level of use that is sustainable, does not represent a threat to any species or populations, and leaves sufficient natural habitats to fulfill ecological functions necessary for the functional integrity of the ecosystem. We should not fool ourselves to believe that this is easy in practice. However, it is not impossible and we need to go along this avenue of work in order to deliver on the political goal of sustainability.

Ecological objectives developed as part of the EA to management of Arctic LMEs would collectively represent a basis for sustainable development of the Arctic region. With climate change and other pressures developing, there will be a continuous and perhaps increasing need to adjust the ecological objectives as part of an adaptive EA management system.

Auk in foreground and guillemots in the background. Photo: Erlendur Bogason, www.strytan.is

Assess the ecosystem: Ecosystem status reports

A wide range of ecosystem components and features are regularly monitored and assessed in many of the Arctic LMEs (e.g. commercial fish stocks, threatened species, marine mammals, breeding birds, benthic communities, hydrography, and more). This monitoring is done as part of existing (mostly sector-wise) management systems to fill their need for updated information to guide management decisions. Along with results from on-going and past research this forms a basis for preparation of ecosystem status reports where a broader picture of the ecosystem with its various components are drawn up, including considerations of human activities and impacts on the ecosystem.

Examples of such ecosystem status reports are the 'Beaufort Sea Large Ocean Management Area: Ecosystem Overview and Assessment Report' prepared by Canada in 2008, and the 'Joint PINRO/IMR Report on the State of the Barents Sea Ecosystem in 2007, with Expected Situation and Considerations for Management' prepared by Norway and Russia. Another example is the report 'Ecosystem considerations 2011 for the Eastern Bering Sea' produced by the Alaska Fisheries Science Center of NOAA in the USA. Such reports represent important steps and foundations for the production of integrated assessment reports for various Arctic LMEs.

In broad terms the Arctic LMEs can be subdivided in two main groups. LMEs located in the northern boreal and sub-arctic bioclimatic zones represent some of the major fisheries areas on the global scale. These areas include the East Bering Sea LME, the Iceland Shelf and Sea LME, the Norwegian Sea LME, and the Barents Sea LME. The second group includes LMEs located in ice-covered waters in the low and high arctic zones, such as the Beaufort Sea LME, the Chukchi Sea LME, and the Kara Sea LME. Fisheries also take place in these LMEs but at a much lower rate and at local scales. Subsistence hunting of birds and mammals on the other hand plays a particularly large role in the northern group of LMEs.

Production of ecosystem status reports and integrated ecosystem assessments must draw upon information collected by a wide range of management agencies and others (e.g. academia and industries). This include agencies responsible for weather forecast and operational oceanography, fisheries, hunting, wildlife management and conservation, environmental protection, human health, shipping, oil and gas activities, mining, and other industrial activities. As part of the EA, these various agencies and others need to collaborate, and one of the tasks

Capelin (Mallotus villosus) returning from the Arctic waters to spawn in warmer waters Photo: Erlendur Bogason

is to contribute to the production of integrated assessments that inform management decisions in a better integrated system.

Ecosystem status reports for each of the Arctic LMEs, once they are developed, would serve an important source of information for aggregated reporting on the status of the wider Arctic region. At the same time there are clearly issues that are pan-Arctic (or wider) in scale. Climate change and pollution by POPs (persistent organic pollutants) are prominent examples of the highest significance and concern for the Arctic environment and peoples. These issues need to be addressed and assessed at the pan-Arctic scale. There is however an important synergy with the LME scale, where climate variability and change and long-range pollutants are drivers for change in the LMEs and where the more detailed and in-depth analysis of biological and ecological effects can be done as part of the integrated assessments of each of the LMEs. The more detailed analyses of effects in the LMEs can then feed information back to the pan-Arctic assessments that can present an aggregated and overall picture of the situation for the Arctic region.

For more information:

PAME International Secretariat
Borgir, Nordurslod
Akureyri, Iceland
Tel: +354 461-1355
Email: pame@pame.is
Homepage: www.pame.is

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