Report from the PAME Workshop on Ecosystem Approach to Management

22-23 JANUARY 2011
TROMSØ, NORWAY

PAME
Protection of the Arctic Marine Environment

ARCTIC COUNCIL

PAME

Protection of the Arctic Marine Environment

Report from the PAME Workshop on Ecosystem Approach to Management

22-23 January 2011

Tromsø, Norway

Acknowledgements and support
We would like to gratefully acknowledge the financial support provided to this project from the Nordic Council of Ministers. Furthermore, both financial and in-kind support was provided by the lead countries, Norway and the United States. We would also like to thank all PAME countries, experts from other Arctic Council Working Groups and Permanent Participants to the Arctic Council for their support in this work.

norden

Nordic Council of Ministers

Table of Content

List of Figures:

Background

PAME has established an expert group (EG) on the ecosystem approach to management. As part of the work program for this EG, a workshop was held in Tromsø 22-23 January 2011 (just prior to the Arctic Frontiers Conference).

The aim of the workshop was to:

- ✓ *Review and update the working map on Arctic LMEs and provide justification for the chosen boundaries based on ecological criteria.*
- ✓ *Prepare a synthesis of existing or planned reports on ecosystem status, trends and pressures for regional ecosystems in the Arctic area.*

Workshop program and participants

The workshop program is included as the Agenda for the meeting in Annex 1. All items were dealt with in plenary sessions. There were presentations from workshop participants followed by discussions.

For item 1 (working map on Arctic LMEs; Fig. 1), the boundaries for the 17 LMEs on the working map were reviewed in a 'circumpolar tour' during the first day of the workshop. Justifications for the boundaries were discussed and options for changes were considered in some cases.

A total of 28 participants took part in the workshop. The List of participants is given in Annex 2. The participants included experts from Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the USA, as well as experts and representatives from 3 PP organizations (ICC Alaska, ICC Canada, Saami Council), the European Environment Agency, UNEP/GRID-Arendal, and WWF (International and Russia).

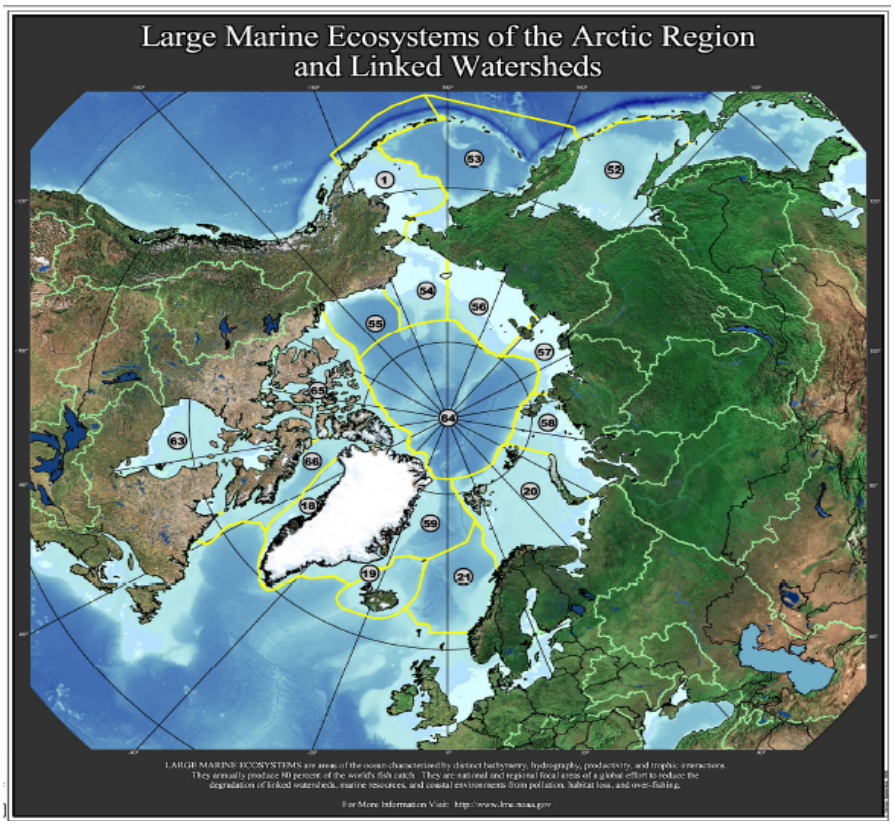

Figure 1 - PAME working map of Arctic LMEs.

Review and update of the working map on Arctic LMEs

CAFF Focal Marine Areas

To facilitate the development of the Circumpolar Biodiversity Monitoring Program (CBMP), the CAFF-led work has provided a delineation of the Arctic into 8 Focal Marine Areas (FMAs; Fig. 2). In deriving at these areas, CBMP has taken a 'pathway approach' with emphasis on regions with fluxes into and out of the Arctic. The FMAs differ somewhat in size and nature between different parts of the Arctic. In the Pacific sector, the Pacific-Arctic FMA does not include the central and southern portions of the Bering Sea with open water and the southern extent of winter ice. For the Atlantic-Arctic FMA, open water areas are included with the southern extent following the CAFF boundary across the Norwegian Sea and south around the Faroe Isles and Iceland. The Beaufort FMA is restricted to the shelves along the southern and eastern Beaufort Sea. The Pacific-Arctic and Atlantic-Arctic FMAs each include 4 of the LMEs on the working map (in full or parts), while the Beaufort FMA includes only a part (the shelf portion) of the Beaufort Sea LME. In other areas there is closer correspondence between MFAs and LMEs, e.g. the Hudson Bay Complex and Canadian Arctic Archipelago.

The FMAs and LMEs are different in nature and purpose. The FMAs are meant to be used in planning and compiling information from monitoring of biodiversity. LMEs are intended as management units that will facilitate the application of the ecosystem approach (to management) and the integrated ecosystem assessments that are required for this purpose. The CBMP plan recognized a need to adjust boundaries to conform to the LME boundaries following revision. The aim should be to have similar outer boundaries so that there will be better alignment even if some of the FMAs may span two or more LMEs.

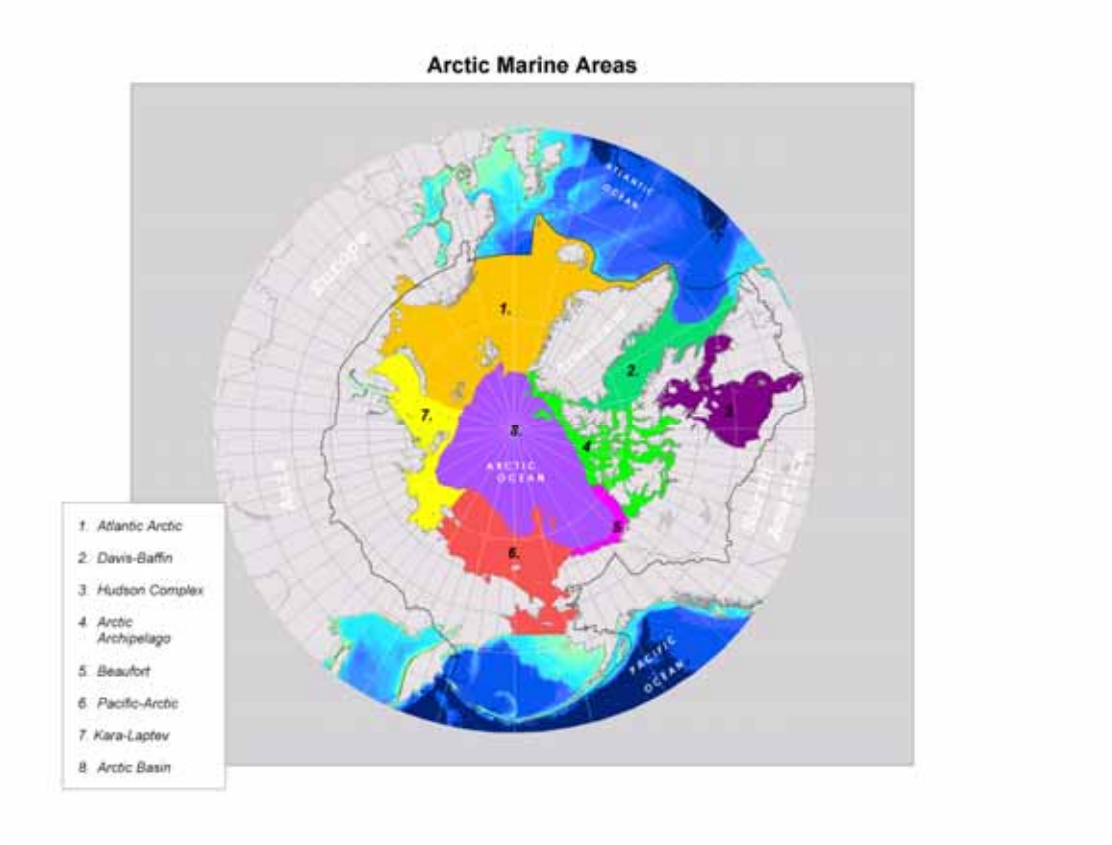

Figure 2 - Map of Marine Focal Areas used in the preparation of the Circumpolar Biodiversity Monitoring Program.

LMEs and subdivision into sub-areas or eco-regions

LMEs are in general relatively large, 200.000 km^2 or larger. The 17 Arctic LMEs are of the order 0.5-1 million km^2 for most of them (Fig. 3). The Arctic Ocean LME is larger, about 3.5 million km^2 and the Barents Sea LME is also large, about 2 million km^2. The smallest is the Faroe LME which is less than 0.1 million km^2.

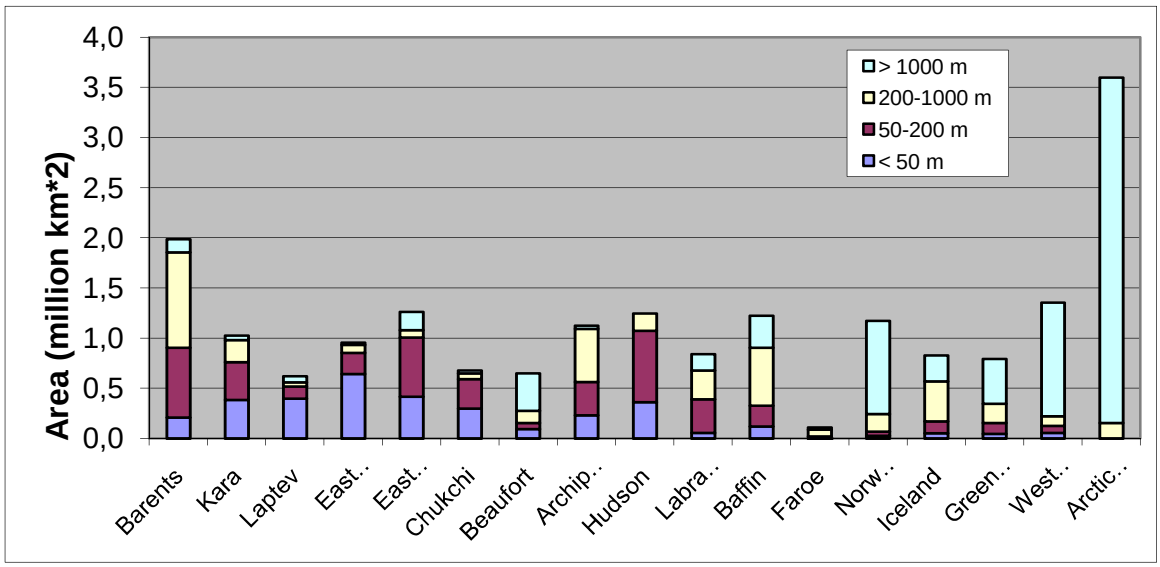

Figure 3 - Areal extent of the 17 Arctic LMEs in 4 different depth strata (shallow waters <50 m, shelf 50-200 m, slope 200-1000 m, and lower slope and basin >1000 m).

LMEs can often be subdivided into several smaller and more homogenous subareas based on hydrography or other ecological features. Thus the Barents Sea LME can be subdivided into a northern part with cold Arctic water and a southern part with relatively warm Atlantic water. The cold and warm parts are separated by an oceanographic polar front which is a pronounced biogeographical boundary. However, migratory species such as the large capelin stock in the Barents Sea link the two parts together in strong ecological relationships. Through trophic couplings in food webs, capelin and other migratory fish such as Atlantic cod and polar cod, and marine mammals such as harp seal, give system characteristics to the Barents Sea LME.

During workshop discussions (particularly on the Baffin Bay area) it became clear that it sometimes was possible to identify or recognize subareas but that grouping the areas into LMEs may not always be so obvious and straightforward. While fish stocks are relatively well known in the subarctic seas with major commercial fisheries, such as in the Barents, Bering, Iceland and Norwegian seas, there is generally limited information on fish stocks in the ice-covered arctic seas. Thus polar cod, which is known to be a key species in the food webs of most arctic LMEs, is poorly characterized when it comes to stock structure, spatial distribution and migratory dynamics. Fish stocks therefore is less applicable in helping us define Arctic LMEs due to the lack of detailed information.

In contrast, marine mammals are better known in terms of populations and migrations. This is not the least due to satelitte-tracked tagging of individual animals, which has helped reveal migratory patterns, and modern genetic techniques, applied during the last decade or two. Populations (or subpopulations) of resident Arctic mammals such as polar bear and walrus may help us in the delineation of the Arctic LMEs and in providing justification for chosen boundaries. Other mammals and seabirds tend to have longer migrations that typically span two or more LMEs. This is exemplified by bowhead and beluga stocks that migrate between the northern Bering Sea through the Chukchi Sea to the Beaufort Sea in the Pacific sector, and between Davis Strait through Baffin Bay into the Canadian Arctic Archipelago in the Atlantic

sector. For such highly migratory species or stocks, they must be considered mainly from the perspective of the relationships between habitats within specific LMEs and their use by the migratory animals, for instance as seasonal feeding grounds (the 'lunch box' concept).

The concept of 'ecoregions' are used at different scales. In Canada, ecoregions have been identified for areas within the wide Canadian Arctic. These ecoregions are relatively distinct and uniform based on biogeographical and bioclimatic conditions and are typically at the scale of subareas within LMEs. The ecoregion boundaries are helpful information in defining the outer boundaries for LMEs.

WWF is also using ecoregions at a somewhat larger geographical scale (marine ecoregions of the world). In an adaptation for the Racer project, the marine study units for the Arctic (Fig. 4) are partly at the scale of LMEs (in some cases being similar to the Arctic LMEs, e.g. for Hudson Bay Complex, and the Siberian LMEs (Kara, Laptev, E Siberian Sea)), while in other cases they are more finely divided, e.g. for Baffin Bay-Davis Strait and the Canadian Arctic Archipelago.

It would be worthwhile to aim to align the 'ecoregion' boundaries of WWF with the LME boundaries and to further consider the subdivison of LMEs into subareas corresponding to 'ecoregions' at the finer scale.

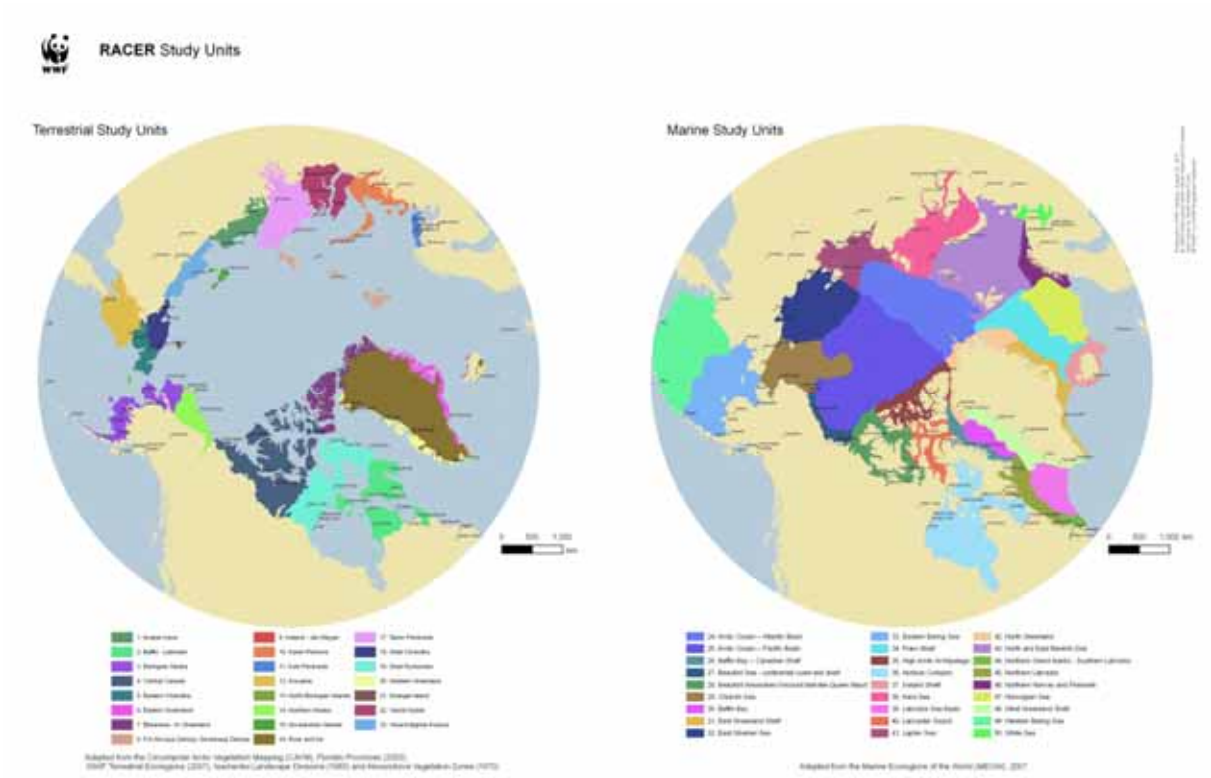

Figure 4 - Map of marine ecoregions of the Arctic area used by WWF in the RACER project.

Straight lines or bathymetric isolines?

The boundaries of LMEs in some cases follow topographic features such as a shelf edge or slope region. The shelf edge can for instance be taken as the 200 m isobaths. Along the slope from the Eurasian shelf towards the Arctic Ocean basins the boundary includes the upper slope covered with Atlantic water flowing as a slope current from the inflow through the Fram Strait. The transition between the Atlantic water and the cold Arctic deep-water is approximately at 1000 m depth. These boundaries can be drawn as convoluted lines following the 200 m or 1000 m isobaths taken from bathymetric datasets. Alternatively they can be

drawn as straight line segments to approximate the features they are intended to represent, e.g. the shelf edge or the transition zone along the slope between Atlantic and Arctic Ocean deep-water. While the former option may appear to be more accurate, this may not be the case since a given isobath (e.g. 200 m) would itself be an approximation of the feature it is intended to reflect. Straight lines do not give the impression of higher accuracy than what they are: somewhat arbitrary boundaries between adjacent LMEs. Straight lines are also simpler from a practical scientific perspective, e.g. for calculating fluxes of water, plankton and contaminants across the boundaries, as well as from a practical management perspective.

LME boundary issues

Boundary between the Iceland Sea and Shelf LME and the Greenland Sea and Eastern Greenland Shelf LME

It was considered the best solution to leave the boundary between these two LMEs as they were on the working map. Thus the Greenland Sea, with southeastern and eastern boundaries following the Mohn and Knipowich ridges, is linked with the Southeast Greenland shelf. The boundary between the SE Greenland shelf portion and the Iceland Sea and Shelf LME is through the Denmark Strait. The main justification for this boundary is the hydrography with the cold and arctic East Greenland Current running along the East Greenland Shelf, separated from the warmer Atlantic water of the Irminger Current flowing north along the western side of Iceland.

Boundary between the Norwegian Sea LME and the Barents Sea LME

The boundary on the working map follows the shelf edge between the deep Norwegian Sea basin and the Barents Sea which sits on the shelf. It was suggested to adjust the southern portion of this boundary to include the Lofoten archipelago with the Barents Sea LME. The justification for this would be primarily to include the main spawning grounds of the Barents Sea cod stock (Northeast Arctic cod stock) with the Barents Sea LME in which cod is one of the major ecosystem components.

Boundary between the Kara Sea LME and the Laptev Sea LME

The current boundary of the working map is at about 105^{o}E and includes most of the Severnaya Zemlya archipelago with the Kara Sea LME. A polynya along the northeastern and eastern side of Severnaya Zemlya is an important spring staging and early season feeding area for seabirds (mainly little auks or dovekies and black-legged kittiwakes) that breed in colonies along eastern Severnaya Zemlya. Later in the season the ice edge and shelf edge off the archipelago are main feeding area for seabirds from these colonies. The area northeast of Severnaya Zemlya is also important for belugas that migrate into the western Laptev Sea to feed in summer. One option could be to move the boundary somewhat to the west and bend it to run through the Severnaya Zemlya archipelago so that the (south)western side would be part of the Kara Sea LME and the (north)eastern side would be part of the Laptev Sea LME. The justification for this boundary would be a clearer separation between the low productive northern Kara Sea and the more productive northwestern Laptev Sea with the polynya, shelf edge and ice edge as important ecological features.

Boundaries between the Laptev Sea, East Siberian Sea and Chukchi Sea LMEs

The current boundary between the Laptev Sea LME and the East Siberian Sea LME goes through the New Siberian Islands archipelago as a straight line along (about) the 140^{o}E longitude across the western entrances to the Sannikov and Dmitry Laptev straits to the mainland. This boundary is somewhat arbitrary set and cuts through important ecological features such as the polynya north of the New Siberian archipelago (part of the Great Siberian

Polynya system) which serves as an important spring staging and feeding area for eiders and other seabirds and a presumed wintering and feeding area for Laptev walrus. There is also not a clear hydrographical boundary in this area. The lower salinity water from the great Siberian rivers, notably Lena, is diverted eastwards and influences the western portion of the East Siberian Sea.

The boundary between the East Siberian Sea and the Chukchi Sea goes along the 180^{o} longitude through Wrangel Island. The waters around Wrangel Island are important for many birds and marine mammals such as Pacific walrus and polar bear. The Pacific water that flows north through the Bering Strait and covers the Chukchi Sea extends usually west of Wrangel Island into the eastern part of the East Siberian Sea.

There seems to be justification on ecological grounds to adjust the boundaries between these three LMEs. One option is to move the boundary between the Laptev Sea LME and East Siberian Sea LME further east so that all of the New Siberian Islands including the smaller De Long Islands to the northeast of the main archipelago and the New Siberian Islands Polynya would become part of the Laptev Sea LME, and to move the eastern boundary further west so that all of Wrangel Island and the waters around it would be part of the Chukchi Sea LME. In this case the East Siberian Sea would remain as a somewhat smaller LME, recognized as a transition zone between regions of the Siberian shelf influenced predominately by Atlantic and Pacific water masses.

A second option would be to remove the East Siberian Sea as a separate LME and place the boundary between the Laptev Sea LME and the Chukchi Sea LME around 165^{o}E longitude. This would correspond to the general location of the Ayon Ice Massif and the common position of the boundary between waters of Atlantic and Pacific origins on the East Siberian shelf. Such a boundary would include the deltas and estuaries of Indigirka and Kolyma rivers in the Laptev Sea LME and Chaun Bay in the Chukchi Sea LME. From an ecological point of view this would seem to be the best option (as suggested in the working paper to the workshop by Spridonov and Gavrilo). The seabed and coastal geomorphology as well as saltmarsh habitats and vegetation show a high degree of similarity between the eastern Laptev and western East Siberian seas while being different from those in the eastern part of the East Siberian Sea. Also for other biogeographical aspects, the central East Siberian Sea is a transition zone between fauna of Atlantic and Pacific origin.

<u>Boundaries between the East and West Bering Sea LMEs and the Chukchi Sea LME</u>

The boundary of the working map between the East and West Bering Sea LMEs follows the shelf edge of the wide eastern Bering shelf and then turns northeast through the outer Gulf of Anadyr to St. Lawrence Island and further north through Chirikov Basin to the Bering Strait. This boundary is justified by hydrography and productivity, separating the nutrient-rich and highly productive Anadyr water on the Russian side from the less productive Alaska Coastal Water on the Alaskan side. The boundary between the East and West Bering LMEs and the Chukchi Sea is defined across the Bering Strait.

The boundary between the East and West Bering Sea LMEs in the northern Bering Sea cuts through some important ecological features, notably the wintering habitats for marine mammals including Pacific walrus, beluga and bowhead whales, and sea ducks including spectacled and king eiders and long-tailed duck. Thus, while justified to some extent by hydrography and productivity, the boundary is less supported by the criterion on trophic couplings since major populations are somewhat arbitrarily divided by the line. One option which could be more in line with distributions of animal populations and the trophic coupling criterion could be to include the northern shelf of the Bering Sea with the Gulf of Anadyr and

Chirikov Basin as part of the East Bering LME. In this case the boundary could continue along the shelf edge west to Cape Navarin (or somewhat south of here).

The boundary between the Bering Sea LMEs and the Chukchi Sea LME through the Bering Strait is a clear geographical boundary but is not so well supported on ecological grounds. The highly productive system generated by the combination of northwards flow of nutrient-rich slope water and the shallow topography of the northern Bering Sea, characterized as a horizontal upwelling system, continues into the southern Chukchi Sea. This system in the northern Bering and southern Chukchi seas provides important feeding areas for birds and mammals that feed on plankton and benthos. The northern Bering Sea with polynyas (notably the St. Lawrence and Sireniki polynyas) and drift ice is the main wintering habitat for several major populations of marine mammals (Pacific walrus, spotted seal, beluga, bowhead) that migrate north through the Bering Strait in spring and early summer to feeding areas in the Chukchi Sea (and further into the Beaufort Sea for the large migratory stocks of bowhead and beluga). Polar cod (*Boreogadus saida*) is an important species in the food webs of the northern Bering and Chukchi seas with probably a large migratory population that moves south in late autumn to spawn under ice possibly in the northern Bering Sea.

One option could be to move the boundary between the Bering Sea LMEs and the Chukchi Sea LME south from the Bering Strait to a line roughly from Cape Navarin in Russia (or somewhat further south on the Koryak coast) to St. Matthew and Nunivak islands. This boundary would correspond to the typical position of the southern extent of winter ice and would include the main wintering habitats in the northern Bering Sea together with the Chukchi Sea (Northern Bering-Chukchi LME).

Boundaries of the Beaufort Sea LME

The current boundaries of the working map are along 75^{o}N in the Canada Basin in the north and along the shelf edge between the Canada Basin and the Canadian Arctic Archipelago in the east. The northern boundary at 75^{o}N includes a large portion of the deep Canada Basin in the Beaufort Sea LME. This boundary is set to approximate the average position of minimum dense sea ice cover in late summer or fall with seasonally open (or partly open) water to the south of the boundary. While the boundary in reality is fuzzy and of variable location dependent on climatic conditions, it represents a transition from relatively high annual primary production in the open-water part of the Beaufort Sea and very low annual production in the dense pack ice further north in the Canada Basin. The relatively high seasonal production in the open-water part of the Beaufort Sea is a basis for the rich feeding grounds for bowheads (feeds largely on zooplankton) and belugas (feeds presumably to a large extent on polar cod) of the large migratory Bering-Chukchi-Beaufort stocks.

The eastern boundary along the shelf break is justified from bathymetry but is otherwise not clearly justified on ecological grounds. It separates ecologically important areas in the eastern Beaufort Sea from the Beaufort Sea LME and includes them with the Canadian Arctic Archipelago. This is the case for the Cape Bathurst Polynya in the outer part of Amundsen Gulf and the lead system west of Banks Island which are important early season feeding areas for bowheads, belugas, eider and other seabirds. The fast ice in inner Amundsen Gulf is important breeding habitat for ringed seal and this region is important breeding and spring feeding habitat for polar bears of the East Beaufort subpopulation. The Amundsen Gulf with Franklin Bay could be important wintering and spawning habitat for a large stock of polar cod which is likely to be a key element in the Beaufort Sea ecosystem. The shelves and the adjacent deep waters of the eastern Beaufort Sea is considered to constitute an integrated ecological system according to the LME criteria.

An option is to move the eastern boundary further east, to the Union and Dolphin Strait between the Amundsen Gulf and Coronation Gulf (or even further east to Queen Maud Gulf) and into McLure Strait or Viscount Melville Sound north of Banks and Victoria islands. This would include important habitats for major populations of fish, mammals and birds which belong to the Beaufort Sea system as seasonal visitors or permanent residents.

Boundaries of the Canadian Arctic Archipelago

The working map has this as one LME with the western boundary along the shelf edge in the eastern Beaufort Sea (as described above), the northern boundary along the shelf edge to the Arctic Ocean east to northern Greenland (including the northwesternmost part of Greenland in this LME), and eastern boundaries along western Ellesmere Island and across the entrances from Baffin Bay to Jones Sound and Lancaster Sound. The boundary to the Hudson Bay Complex is at Fury and Hecla Strait (between southern Gulf of Boothia and northern Foxe Basin).

The Canadian Arctic Archipelago is a very important seasonal breeding and feeding area for migratory birds and mammals that arrive from both the Atlantic and Pacific sides. Migratory species with Atlantic and Pacific populations or stocks include bowhead, beluga, king eider and long-tailed duck. Atlantic populations include Atlantic walrus and narwhal. The dividing line between Atlantic and Pacific populations is in the area of Viscount Melville Sound north of Victoria Island, corresponding to the heaviest ice conditions with ice usually not clearing in summer except in warm years as experienced recently. The areas in inner Lancaster Sound and into Barrow Strait, Prince Regent Inlet and Peel Sound in the central part of the archipelago are main summer feeding grounds for large Atlantic migratory populations of bowhead, beluga and narwhal that winter in Baffin Bay and the Davis Strait region. These migratory populations tie Lancaster Sound and the central part of the Canadian Arctic Archipelago together with Baffin Bay with close ecological relationships. This is particularly the case for the North Water region in northern Baffin Bay where the migratory populations feed early in the season before they proceed into the Archipelago through Lancaster Sound as ice starts to break up.

As suggested in the previous section, the western boundary between the Canadian Arctic Archipelago and the Beaufort Sea LME could be placed further east (to Union and Dolphin Strait and McLure Strait or western Viscount Melville Sound) to include important habitat for Beaufort stocks with the Beaufort Sea LME.

For the eastern boundary the workshop felt that it should remain at the western entrances to Jones and Lancaster sounds. While this somewhat arbitrarily cuts through important early season staging, feeding and migration areas for mammals and birds, it was considered not to be sufficiently clear where the boundaries should be and how other parts of the Archipelago should be considered from an LME perspective.

Boundaries in the Baffin Bay area

Baffin Bay is divided into two LMEs on the working map: The West Greenland Shelf LME in the east and Baffin Bay-Davis Strait LME for the western part. The boundary to the Canadian Arctic Archipelago is at the western entrances to Jones and Lancaster sounds in the northeastern Baffin Bay region. In the southeastern end, the boundary of the Baffin Bay-Davis Strait LME to the Hudson Bay Complex LME is at the western entrance to Hudson Strait, while the boundary to the Labrador Shelf-Newfoundland LME is between northern and central Labrador coast.

In discussion it became clear that the 2 LMEs in the Baffin Bay region could be subdivided into 6 subregions:

- ✓ The North Water and adjacent areas in the northern Baffin Bay. The North Water Polynya and adjacent polynyas (at the entrances to Jones and Lancaster sounds) play important roles as wintering area for beluga (Baffin Bay stock) and Atlantic walrus (Baffin Bay-eastern Canadian Arctic population), as spring staging and feeding area for seabirds and marine mammals (e.g. migratory bowheads), and as a summer feeding area for perhaps the largest concentration of seabirds in the world (dominated by 50-100 million plankton-feeding dovekies).
- ✓ West Greenland shelf (between about 66 to 76^{o}N). This area has a relatively wide shelf and is typically ice-covered in winter. Relatively warm Atlantic water flows north over the coastal banks which are rich with shrimp and fish (capelin, Greenland halibut, Atlantic cod) which support commercial fisheries. It is an important molting, staging and wintering area for birds and wintering and migration area for marine mammals (beluga and bowhead).
- ✓ Southwest Greenland. This is generally open water with no ice in winter. The area serves as important wintering grounds for seabirds from both sides of Greenland.
- ✓ Central Baffin Bay and Davis Strait. This area is generally covered with seasonal pack-ice and is the wintering area of the majority of narwhals that dive deep to feed on Greenland halibut and the squid *Gonatus fabricii*.
- ✓ Eastern Baffin coast. This is an ice-swathed coast with transport of ice with the southbound Baffin Current (that continues further south as part of the Labrador Current). It is open water only in a short period in late summer or fall when it serves as a migration corridor for seabirds and mammals.
- ✓ Eastern Davis Strait-northern Labrador shelf. This area is a main wintering area for bowheads (Baffin Bay stock), beluga and Atlantic walrus, and an important spring staging and migration area for many seabirds.

There is no clear answer to what would be the best way to combine these subareas into two or more LMEs. The working map use an East-West division where the second and third of the subareas listed above (West and Southwest Greenland shelf) are grouped as one LME, the West Greenland Shelf LME, with the remainder making up the Baffin Bay-Davis Strait LME. Another option could be to divide the area along the North-South axis, with a northern Baffin Bay LME centered on the North Water and a southern LME centered on Davis Strait. A division into three LMEs could also be envisioned (e.g. West Greenland, North Water-Baffin Bay, and Davis Strait-North Labrador). A third option would be to consider the whole area with the 6 subareas as on LME - the Baffin Bay-Davis Strait LME. At the workshop it was felt that this would be the preferred option with the possibility to divide the area into two or more LMEs as more knowledge becomes available.

Revised working map of Arctic LMEs

Based on the discussions at the workshop, a revised working map with options for boundary changes has been prepared (Fig. 5). The workshop did not conclude on a set of recommended changes but rather envisioned that further consultations with national experts were required before conclusions could be reached. This pertains particularly to the northern Bering Sea region and the East Siberian Sea in Russia. There is also a need to consult with Faroese experts on the boundaries of the Faroe Isles LME.

The consultations should take place over the next 6 months with the aim to produce a recommended revised LME map that can be forwarded for consideration at the next meeting *of PAME in the autumn 2011.*

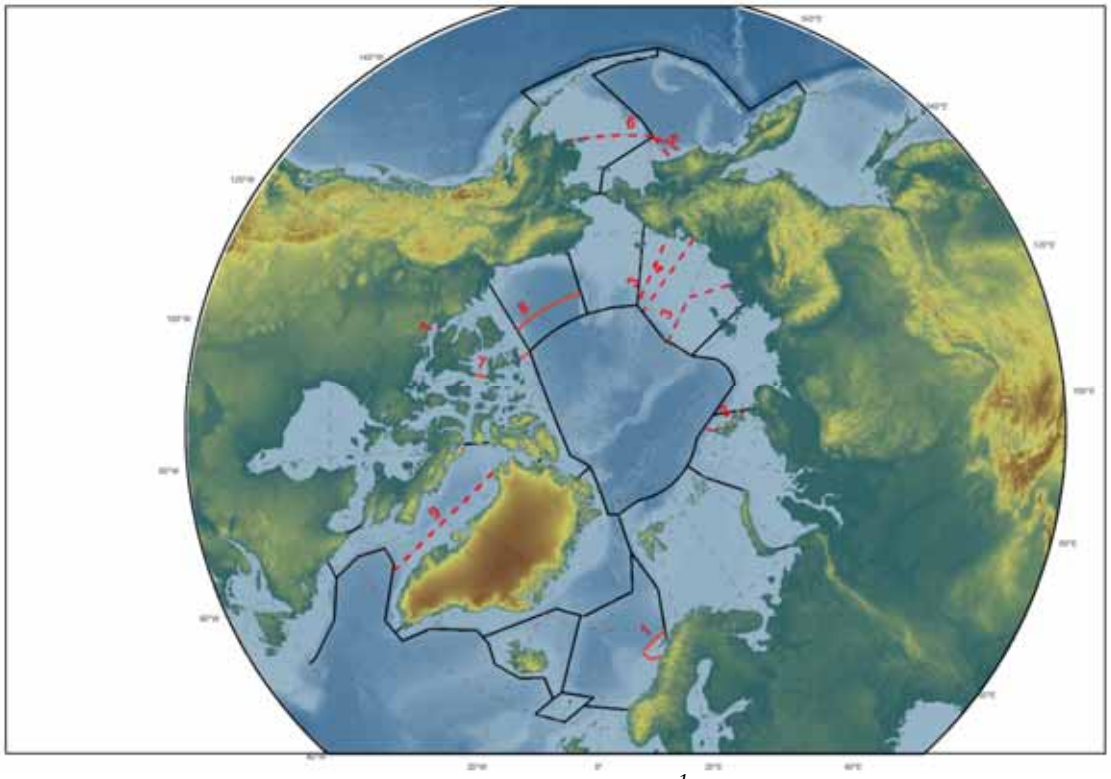

Figure 5 - Working map of Arctic LMEs under revision[1]

[1]The black lines are a simplified version (with straightened border lines) of the existing working map of the 17 Arctic LMEs. Red lines show suggested changes or options for changes of LME boundaries.

1. suggested change to include the Lofoten archipelago with the Barents Sea LME.
2. option for moving the boundary between the Kara Sea and Laptev Sea LMEs.
3. option for moving the boundary between Laptev and E Siberian seas further east to include the New Siberian Islands (including De Long Islands) with the Laptev Sea LME, and moving the boundary between Chukchi and E Siberian seas further west to include the waters around Wrangel Island with the Chukchi Sea LME.
4. option for (approximate location of) a new boundary between Laptev Sea LME and Chukchi Sea LME where the E Siberian Sea would no longer be recognized as a separate LME.
5. option for a new boundary between the East and West Bering Sea LMEs where the Gulf of Anadyr and the northern Bering Sea would be part of the East Bering Sea LME.
6. option for a new boundary between the Bering Sea and Chukchi Sea LMEs where the ice-covered parts of the northern Bering Sea would be part of the Chukchi Sea LME.
7. suggested change to include the Amundsen Gulf and McLure Strait with the Beaufort Sea LME.
8. suggested change of the northern boundary of the Beaufort Sea LME to 75^{o}N to correspond approximately to the average minimum sea ice distribution (50 %) in late summer.
9. suggested removal of boundary so that the West Greenland LME is included as part of the Baffin Bay-Davis Strait LME.

Status reporting for Arctic LMEs

The aim is to produce an overview of existing or planned reports on status, trends and pressures on the Arctic LMEs that are linked to management and can support the further development and implementation of the Ecosystem Approach to management of Arctic LMEs.

Information on such reports is summarized below. This will be further consolidated and developed into a tabular list or inventory with links to existing reports where available. Workshop participants will supplement with additional relevant information from their own countries or areas.

Arctic Council

Under the Arctic Council there have been produced a number of comprehensive assessment reports on pollution, climate change, oil and gas activities, shipping, and biodiversity. AMAP and CAFF have produced most of these assessment reports, sometimes jointly. This is a list of the major reports:

- Arctic Pollution Issues in 1998 (AMAP)
- Arctic Pollution 2002 (AMAP)
- Arctic Pollution 2006 (AMAP), including
    - Acidifying Pollutants, Arctic Haze, and Acidification in the Arctic
- Arctic Pollution 2009 (AMAP), including separate reports on:
    - Persistent Organic Pollutants in the Arctic
    - Radioactivity in the Arctic
    - Human Health in the Arctic
- Arctic Climate Impact Assessment in 2005 by AMAP, CAFF and IASC
- The Greenland Ice Sheet in a Changing Climate (a component of Snow, Water, Ice and Permafrost in the Arctic - SWIPA) 2009
- Arctic Report Card: Update for 2010 (AMAP, CAFF, NOAA)
- Arctic Fauna and Flora in 2001 (CAFF)
- Arctic Biodiversity Trends 2010 (CAFF)
- Arctic Oil and Gas 2007 (Overview report), and
- Assessment of Oil and Gas Activities in the Arctic in 2010/2011 (AMAP)
- Arctic Marine Shipping Assessment in 2009 (PAME)

Arctic Report Card is produced annually by the US NOAA in collaboration with AMAP and CAFF. It summarizes the climatic and oceanographic conditions and includes also information on populations and other biological and ecological conditions. This report holds the potential to become an important source of information on physical drivers for ecosystem fluctuations and changes at the scale of LMEs (possibly in collaboration with ICES; see below).

United Nations

Assessment of Assessments (AoA) was a major effort undertaken as a start-up phase towards a 'Regular Process' for global reporting and assessment of the state of the marine environment. The work included many UN agencies such as IMO, FAO and WMO and was lead by UNEP and IOC-UNESCO (Intergovernmental Oceanographic Commission). The report was delivered in 2009 and includes a section on assessments of the Arctic. The AoA report is found here: http://www.unga-regular-process.org/index.php?option=com_content&task=view&id=18&Itemid=20

GIWA (Global International Water Assessment) included reports on the Barents Sea, and waters around Greenland.

ICES (International Council for the Exploration of the Sea)

ICES produces annual assessment reports for status of commercial fish stocks in the Northeast Atlantic, including stocks in the Faeroe, Iceland, Norwegian and Barents LMEs. These reports

are published in the ICES Advice series as Books for each regional ecosystem (http://www.ices.dk/products/icesadvice.asp).

ICES also produces annual reports on status and trends for the climate and zooplankton in the ICES area in the North Atlantic, including Arctic areas north to the Fram Strait and Svalbard:

- **ICES Report on Ocean Climate 2009**
  http://www.ices.dk/pubs/crr/crr304/IROC%202010-s.pdf
- **ICES Zooplankton Status Report 2006/2007**
  http://www.ices.dk/pubs/crr/crr292/ICES292-SCREEN.pdf

Iceland

The Marine Research Institute in Iceland produces two annual reports, one on the status of fish stocks and one on the environmental conditions in Icelandic waters. Both reports are in Icelandic but with English abstracts and legends.

- **State of Marine Stocks in Icelandic Waters 2009/2010**
- **Environmental conditions in Icelandic waters 2009**

Norway

Norway has developed management plans for the Barents Sea and Norwegian Sea LMEs. As part of the development of these plans, a series of reports were prepared on the status of living resources and environmental conditions, environmental impacts, and identification of valuable and vulnerable marine areas.

http://www.regjeringen.no/en/dep/md/Selected-topics/hav--og-vannforvaltning/integrated-management-of-the-barents-sea.html?id=87148

http://www.regjeringen.no/en/dep/smk/press-center/Press-releases/2011/updated-version-of-the-integrated-manage.html?id=635620

As part of the management plan, there is an annual report on the changing conditions in the ecosystems, including information on climate, plankton, benthos, fish stocks, marine mammals, seabirds, and contaminants. The report is produced by the 'Monitoring group' with participation of a large number of Norwegian agencies and is in Norwegian.

- **Forvaltningsplan Barentshavet - rapport fra overvakingsgruppen 2010**
  http://www.imr.no/filarkiv/2010/02/alt7.pdf/nb-no

Institute of Marine Research produces annual reports on the environmental conditions (climate, plankton, to some extent benthos) in the Barents and Norwegian seas http://www.imr.no/publikasjoner/andre_publikasjoner/havforskningsrapporten/nb-no

Norway-Russia

As part of the bilateral cooperation between Norway and Russia, a joint status report on the Barents Sea ecosystem was produced in 2008. The report was produced under the Joint Russian - Norwegian Commission on Environmental Cooperation in co-operation with the Joint Russian-Norwegian Fisheries Commission. A large number of Norwegian and Russian experts and agencies contributed to the report. The main objective was to provide a comprehensive description of the Barents Sea ecosystem using relevant scientific knowledge from both Russian and Norwegian scientists. The report will contribute to the scientific basis for development of an ecosystem-based management plan for the Russian part of the Barents

Sea and contribute to the further development of ecosystem-based management in the Norwegian Territories within the area, via the Norwegian Barents Sea Management Plan.

The report is in two parts, a short version and a complete version, and is available from the IMR webpage (given below) and from http://www.barentsportal.com :

- **Joint Norwegian-Russian environmental status 2008 Report on the Barents Sea Ecosystem Part I – Short version** http://www.imr.no/filarkiv/2009/12/imr-pinro_2009-2_til_web.pdf/nb-no

- **Joint Norwegian-Russian environmental status 2008 Report on the Barents Sea Ecosystem Part II – Complete report** http://www.imr.no/filarkiv/2009/12/imr-pinro_2009-3_til_web.pdf/nb-no

IMR in Norway and PINRO in Russia have a joint report series (published in English) with results from the joint work in the Barents Sea LME (http://www.imr.no/publikasjoner/andre_publikasjoner/imr-pinro_samarbeidsrapporter/2009/nb-no). Several of these reports contain relevant information on the status of the Barents Sea ecosystem, e.g. this report on benthos:

- **Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results from the joint Russian-Norwegian benthic programme 2006-2008** http://www.imr.no/filarkiv/2010/05/imr-pinro_1-2010_til_web.pdf/nb-no

Canada

In Canada there have been considerable activities in recent years to divide the Canadian marine Arctic areas into ecoregions based on biogeographic classification, identify Ecologically and Biologically Significant Areas (EBSAs), provide ecosystem overviews and status and trends assessments, identify protected areas, and other related aspects. A list of many reports and publications relevant to ecosystem status reporting is given below. These reports are available from the password protected area of the PAME webpage (under PAME Workshop on Ecosystem).

DEVELOPMENT OF A FRAMEWORK AND PRINCIPLES FOR THE BIOGEOGRAPHIC CLASSIFICATION OF CANADIAN MARINE AREAS

DFO. 2009. Development of a Framework and Principles for the Biogeographic Classification of Canadian Marine Areas. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/056.

2010 CANADIAN MARINE ECOSYSTEM STATUS AND TRENDS REPORT

DFO. 2010. 2010 Canadian Marine Ecosystem Status and Trends Report. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/030(Revised).

Review of Selected Biogeographic Classification Systems with Relevance to the Canadian Marine Environment

O'Boyle, R. 2010. Review of selected Biogeographic Classification Systems with a relevance to the Canadian marine environment. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/066. vi + 81 p.

Beaufort Sea Large Ocean Management Area: Ecosystem Overview and Assessment Report

Cobb, D., H. Fast, M.H. Papst, D. Rosenberg, R. Rutherford and J.E. Sareault (Editors). 2008. Beaufort Sea Large Ocean Management Area: Ecosystem Overview and Assessment Report. Can. Tech. Rep. Fish. Aquat. Sci. 2780: ii-ix + 188 p.

Ecosystem status and trends report: Arctic Marine Ecozones

Niemi, A., Paulic, J. Cobb and D. 2010. Ecosystem status and trends report: Arctic Marine Ecozones. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/066. viii + 66 p.

Proceedings for the Identification of Ecologically and Biologically Significant Areas in the Beaufort Sea Large Ocean Management Area

Paulic, J.E., Papst, M.H., and Cobb, D.G. 2009. Proceedings for the Identification of Ecologically and Biologically Significant Areas in the Beaufort Sea Large Ocean Management Area. Can. Manuscr. Rep. Fish. Aquat. Sci. 2865: ii + 46 p.

ADVICE RELEVANT TO IDENTIFICATION OF EASTERN CANADIAN ARCTIC BOWHEAD (*BALAENA MYSTICETUS*) CRITICAL HABITAT

DFO. 2009. Advice relevant to identification of Eastern Canadian Arctic Bowhead (*Balaena mysticetus*) critical habitat. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/060.

Proceedings of the workshop to select Ecologically and Biologically Significant Areas (EBSA) in northern Foxe Basin, Nunavut

DFO. 2010. Proceedings of the workshop to select Ecologically and Biologically Significant Areas (EBSA) in northern Foxe Basin, Nunavut; 29 June 2009, 10 September 2009, 19 November 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/037.

Information in Support of Indicator Selection for Monitoring the Tarium Niryutait Marine Protected Area (TNMPA)

Loseto, L., T. Wazny, H. Cleator, B. Ayles, D. Cobb, L. Harwood, C. Michel, O. Nielsen, J.Paulic, L. Postma, P. Ramlal, J. Reist, P. Richard, P.S. Ross, S. Solomon, W. Walkusz, L.Weilgart and B. Williams. 2010. Information in support of indicator selection for monitoring the Tarium Niryutait Marine Protected Area (TNMPA). DFO Can. Sci. Advis. Sec. Res, Doc. 2010/094. vi + 47 p.

Proceedings of the Central and Arctic Regional Science Advisory Process to Select Indicators for the Tarium Niryutait Marine Protected Area (TNMPA)

DFO. 2010. Proceedings of the Central and Arctic Regional Science Advisory Process to Select Indicators for the Tarium Niryutait Marine Protected Area (TNMPA); 30-31 March and 13 April 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/038.

MONITORING INDICATORS FOR THE TARIUM NIRYUTAIT MARINE PROTECTED AREA (TNMPA)

DFO. 2010. Monitoring indicators for the Tarium Niryutait Marine Protected Area (TNMPA). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/059.

The Arctic Marine Workshop

Stephenson, S.A., and L. Hartwig. 2010. The Arctic Marine Workshop: Freshwater Institute Winnipeg, Manitoba, February 16-17, 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934: vi+67p.

SUMMARY OF THE HUDSON BAY MARINE ECOSYSTEM OVERVIEW

Stewart, D.B., and W.L. Lockhart. 2004. Summary of the Hudson Bay Marine Ecosystem Overview. Prepared by Arctic Biological Consultants, Winnipeg, for Canada Department of Fisheries and Oceans, Winnipeg, MB. Draft vi + 66 p.

Hudson Bay – full report link: http://www.dfo-mpo.gc.ca/Library/314704.htm

EXAMINING THE HEALTH OF THE HUDSON BAY ECOSYSTEM. PROCEEDINGS OF THE WESTERN HUDSON BAY WORKSHOP, WINNIPEG, MB, OCTOBER 25-26, 2000

Cobb, D.G., S. Eddy and O. Banias. 2001. Examining the Health of the Hudson Bay Ecosystem. Proceedings of the Western Hudson Bay Workshop, Winnipeg, MB, October 25-26, 2000. Can. Manuscr. Rep. Fish. Aquat. Sci. 2589: xvii + 37 p.

Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories

Mallory, M.L. and A.J. Fontaine 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper Number 109, Canadian Wildlife Service. 93 p.

Arctic Marine Biodiversity Monitoring Plan - Determining Canadian Focal Marine Areas

By Jill Watkins, Fisheries and Oceans Canada, rev. May 7, 2010

Mapping Traditional Knowledge Related to the Identification of Ecologically and Biologically Significant Areas in the Beaufort Sea

Hartwig, L. 2009. Mapping Traditional Knowledge Related to the Identification of Ecologically and Biologically Significant Areas in the Beaufort Sea. Can. Manuscript Rep. Fish. Aquat. Sci. 2895: iii+25p.

INVENTORY OF ECOSYSTEM INDICATORS IN CANADA'S NORTH FOR THE NORTHERN ECOSYSTEM INITIATIVE

Hardi, P. and M. Roy 2005. Inventory of ecosystem indicators in Canada's North for the Northern Ecosystem Initiative. Report prepared for Environment Canada, Northern Corporate Affairs, Yellowknife, NT

MARINE BIRDS AS INDICATORS OF ARCTIC MARINE ECOSYSTEM HEALTH: LINKING THE NORTHERN ECOSYSTEM INITIATIVE TO LONG-TERM STUDIES

Mallory, M.L., H. G. Gilchrist, B. M. Braune and A. J. Gaston 2006. Marine birds as indicators of Arctic marine ecosystem health: linking the northern initiative to long-term studies. Environmental Monitoring and Assessment (2006) **113:** 31–48.

FEDERAL MARINE PROTECTED AREA NETWORK PLAN AND COMMUNITY PERSPECTIVES. BAFFIN AND KITIKMEOT REGIONS – NUNAVUT 2009

Fast, H. and M. Healy 2010. Federal Marine Protected Area network plan and perspectives. Baffin and Kitikmeot regions - Nunavut 2009. Department of Fisheries and Oceans (DFO), Canada. 62 p.

Proceedings of the Canadian Marine Ecoregions Workshop

Powles, H., V. Vendette, R. Siron and B. O'Boyle. 2004. Proceedings of the Canadian Marine Ecosystems Workshop. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2004/016

The United States

National Marine Fisheries Service (NMFS) of NOAA produces annual stock assessment reports for commercial fish stocks in the Bering Sea. These reports are available from the regional office, the Alaska Fisheries Science Center: http://www.afsc.noaa.gov/refm/stocks/assessments.htm.

AFSC also produces an annual ecosystem report - ***Ecosystem Considerations for 2011*** http://access.afsc.noaa.gov/reem/ecoweb/Eco2010.pdf The summary page in the form a Report Card for the Eastern Bering Sea is included as an example and inspiration in Annex 3.

NOAA Fisheries through the Office of Protected Resources produces stock assessment reports for marine mammals which are updated annually - http://www.nmfs.noaa.gov/pr/sars/region.htm

Annex 1 – Workshop Agenda

PAME Workshop on ecosystem approach to management (EA)

Agenda with Timeline and Annotation

Tromsø, Norway

22-23 January, 2011

The Ecosystem Approach (EA) Workshop will be held at the premises of Institute of Marine Research in the Tromsø Research Park ("forskningsparken"), Sykehusveien 23, 2nd floor,

The aim of this workshop is to consider the following two items:

- *Review and update the working map on Arctic LMEs and provide justification for the chosen boundaries based on ecological criteria.*
- *Prepare a synthesis of existing or planned reports on ecosystem status, trends and pressures for regional ecosystems in the Arctic area.*

Outcome of the workshop

A revised version of the map of the Arctic LMEs will be prepared including justification for the chosen boundaries in relation to the LME criteria. This will be part of the workshop report that will be sent to PAME. The report will also contain suggestions for how to proceed to achieve a regular reporting on the status of the Arctic LMEs that is linked to management of each ecosystem and that can contribute to the assessment and reporting of the state of the wider Arctic marine environment at the Pan-Arctic scale.

Saturday 22nd of January

09:30-10:00

Registration and Refreshments

10:00-12:00

Opening of the Workshop

Agenda Item 1 - Introduction on Background and Boundary Issues (length of presentations not to exceed 10-15 min)

- Presentation by Hein rune Skjoldal (Norway) – Background and boundary issues
- Presentation by Ken Sherman (USA) - Background and boundary issues on LMEs, US perspective
- Presentation by Professor Gennady Matishov - Ecological and Social-Economic Problems of the Arctic
- CBMP Arctic Marine Biodiversity Monitoring Plan and Focal Marine Areas (Kathy Crane and Reidar Hindrum)
- Towards Ecosystem Resilience-based Arctic Conservation - A Rapid Assessment of Arctic Places to Stay Ahead of Climate Change (RACER) - Martin Sommerkorn, WWF Global Arctic Programme
- Discussions

12:00-13:00 – Lunch Break

13:00-15:00

Agenda Item 2 - Boundary Issues

Participants are asked to look into the **boundary issues** for their respective areas with reference to relevant information on this agenda item in the Annotation.

15:00-15:15 – Coffee Break

15:15-17:00

Agenda Item 3 - Presentations on existing and planned status reports

Prepare a synthesis of existing or planned reports on ecosystem status, trends and pressures for regional ecosystems in the Arctic area.

Participants are asked to inform on existing and planned status reports for their areas and ecosystems and provide information on such reports to be complied prior to the workshop.

- Anders Mosbech – Greenland, Existing and planned status reports: *Ecosystem status, trends and pressures*
- Discussions

Sunday 23rd of January

09:00-11:00

Agenda Items 2 and 3 Continue

11:00-12:00

Agenda Item 4 - Work plan items for the period 2011-2013

- Stanislav Fomin/WWF Barents Sea Office (Russia) - Integrated management plan for Russian part of Barents Sea: public opinion
- Ingrid Berthinussen/Norway - perspectives from the Arctic Ocean Review (AOR) project
- Lars-Otto Reiersen/AMAP Executive Secretary - AMAP perspectives on the need for integrated assessments
- Discussions - The following elements were suggested in the progress report to PAME II-2010:
    1. Further development of ecosystem status reports for each LME, including temporal trends due to natural variability and climate forcing, and impacts from harvesting, pollution and other anthropogenic stressors.
    2. Determination of ecological objectives for species and habitats that can serve as a part of the management objectives for the ecosystem approach to management of Arctic LMEs.
    3. Arrangements for cost-effective monitoring and assessment that draw upon existing national and international programs (e.g. by AMAP and CAFF) and form an integral component of the ecosystem approach to management of the Arctic LMEs.
- Views and suggestions for other items

12:00-13:00 – Lunch Break

13:00-14:00

Agenda Item 4 Continues

14:00-15:00

Conclusions and Next Steps

Annotation to the Agenda

Agenda Item 1 - Introduction on Background and Boundary Issues

Agenda Item 2 – Boundary Issues

Participants are asked to look into the **boundary issues** for their respective areas. Below are some information on boundary issues as provide by Hein Rune Skjoldal (Norway) pointing to cases which should discuss at the workshop.

Boundary issues for discussion at the EA Workshop

The PAME working map delineating 17 LMEs in the Arctic area will be revisited. Below are listed some of the boundary issues we need to discuss at the workshop. A background document will be prepared with more details on the supporting information and suggestions for boundary options.

Boundary between East and West Bering Sea - The working map has the boundary running up through the northern Bering Sea to the Bering Strait, separating the Russian and Alaskan sides. This is justified to some extent by the oceanography (Anadyr Current and Alaskan Coastal Current), but splits on the other hand important wintering habitats for birds and mammals quite arbitrarily. Another option (used in the Oil and Gas assessment, OGA) is to include the whole northern shelf including Gulf of Anadyr with the East Bering Sea.

Boundary between Bering and Chukchi Sea LMEs - The current boundary is at the Bering Strait. This is an obvious geographical boundary but not so clear ecological boundary. An option that could be considered is whether the northern Bering Sea (roughly from Cape Navarin to St. Matthew Island) should be included with the Chukchi Sea as an Arctic LME including the major wintering habitat in drift ice and polynyas in the northern Bering Sea for major populations of beluga, bowhead and walrus.

Boundaries between Chukchi, East Siberian and Laptev seas LMEs - The current boundaries run through Wrnagel Island (180o) and the New Siberian Islands (140oE). These boundaries are somewhat arbitray. The influence of nutrient-rich Pacific (Anadyr) water extends west of Wrangel Island as do the feeding areas for Pacific walrus, beluga and bowhead. The boundary between Chukchi and E Siberian LMEs should therefore be placed further west. The Laptev walrus, which is a key component of the Laptev LME, is distributed along the northern side of the New Siberian Islands. The hydrographic influence of the Lena River includes the whole of the New Siberian archipelago. Therefore the boundary between Laptev and E Siberian seas LMEs should be moved further east so that all of the New Siberian Islands (probably also including De Long Islands) are included with the Laptev LME.

Another issue here is whether the East Siberian Sea should be considered an LME in itself. There are no very obvious ecological features that make it stand out as a clearly recognized ecosystem. If the boundaries to the Chukchi and Laptev seas LMEs are moved towards each other, the justification for keeping the central part of the East Siberian Sea as an LME becomes even more weakened.

Boundary between Beaufort Sea and Canadian Arctic Archipelago - The working map has the boundary out in the eastern Beaufort Sea, with the Amundsen Gulf and the Bathurst Polynya included with the CAA. This makes little sense and the boundary should be moved east to the Union and Dolphin Strait (or possibly further east to the Coronation Gulf) and into McLure

Strait or Viscount Melville Sound. This would include the important early season summer feeding areas for belugas and bowheads of the Beaufort stocks with the Beaufort Sea LME.

Boundaries in Baffin Bay - The working map has a boundary running N-S through Baffin Bay separating West Greenland Shelf and Baffin Bay-Davis Strait LMEs. There is some justification to this as the West Greenland shelf contains important fish populations such as capelin stocks. However, in other respects it may be an artificial boundary for migratory species that move across Baffin Bay during their annual cycles. It is possible that the W Greenland Shelf should be considered a subsystem within a larger Baffin Bay-Davis Strait LME rather than as an LME by itself.

The northern Baffin Bay with the North Water Polynya has system characteristics with major populations of beluga and walrus residing here year round. One option that could be considered is to split the large Baffin Bay-Davis Strait area into northern and southern portions. The Lancaster Sound region is tied closely to the northern Baffin Bay through the seasonal movements of mammals and seabirds from the North Water area into Lancaster Sound in summer. With the option to consider the northern Baffin Bay as a separate LME, it is possible that this LME should include the Lancaster Sound area.

Boundary between Iceland and Greenland - The working map has the waters around Iceland as an LME including the Iceland Sea north to the island of Jan Mayen, separate from the Greenland Sea-East Greenland Shelf LME. This boundary may require some further consideration.

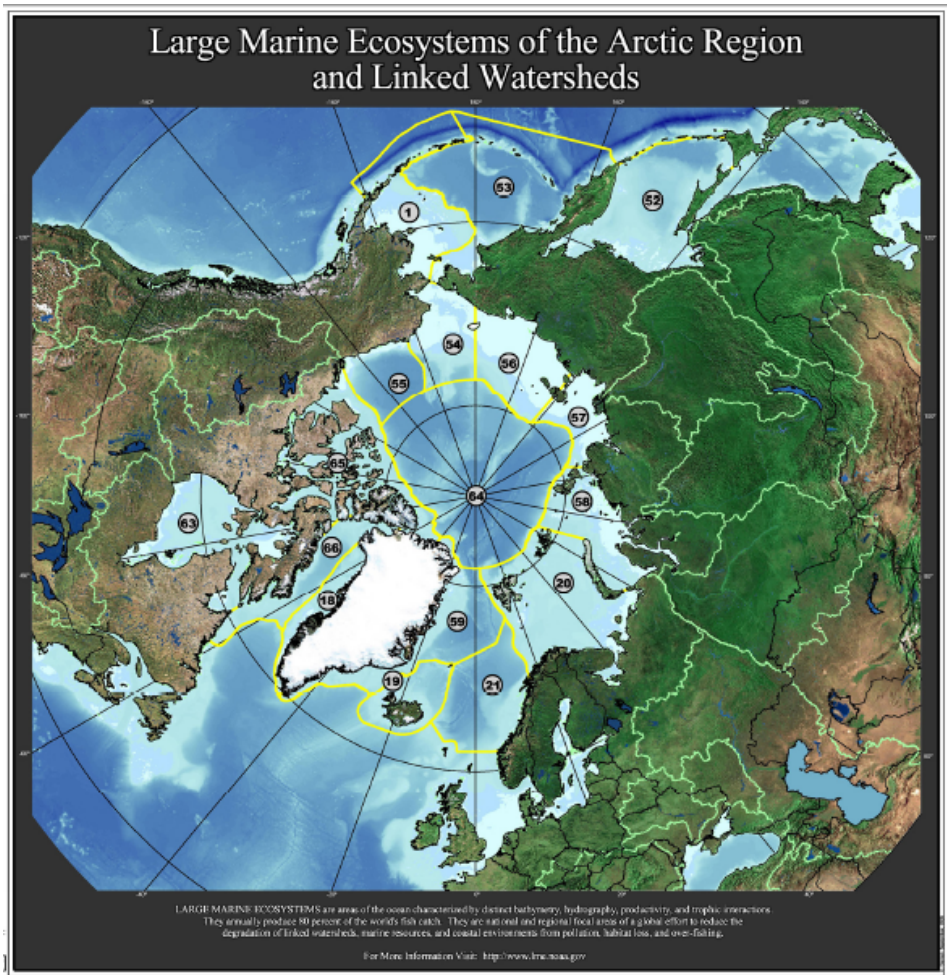

Fig. 1. PAME working map of 17 Arctic LMEs.

Agenda Item 3 - Presentations on existing and planned status reports

Status reporting

EA to management focuses on the status of the ecosystem, both in terms of assessment of the current status and trend, and in relation to defining what 'good', desirable or acceptable status is as a basis for setting ecological objectives for management.

We are interested to learn what are currently being done or planned to produce status reports for various parts of the Arctic. Some of the activities of AMAP on climate and pollution and of CAFF on biodiversity may provide relevant and important contributions into a system for ecosystem status reporting. The Arctic Report Card (new issue in October 2010) is an interesting product in this regard.

There are also national and bilateral reports that are relevant building blocks for a future system for status reporting. The Joint Norwegian-Russian environmental status on the Barents Sea Ecosystem (2008) is a good example of such reports, aimed at supporting EA to management of the Barents Sea ecosystem (http://www.barentsportal.com).

Agenda Item 4 - Work plan items for the period 2011-2013

The following elements were suggested in the progress report to PAME II-2010:

1. Further development of ecosystem status reports for each LME, including temporal trends due to natural variability and climate forcing, and impacts from harvesting, pollution and other anthropogenic stressors.

2. Determination of ecological objectives for species and habitats that can serve as a part of the management objectives for the ecosystem approach to management of Arctic LMEs.

3. Arrangements for cost-effective monitoring and assessment that draw upon existing national and international programs (e.g. by AMAP and CAFF) and form an integral component of the ecosystem approach to management of the Arctic LMEs.

We welcome any views on these work program items as well as suggestions for other items that could be considered.

Annex 2 - List of participants

PAME Workshop on Ecosystem approach to management (EA)

22-23 January, 2011, Tromsö, Norway

PAME Secretariat	
Soffia Gudmundsdottir Executive Secretary PAME International Secretariat Borgir Nordurslod 600 Akureyri Iceland Tel: +354 461 1355 Fax: +354 462 3390 Email: pame@pame.is	
CANADA	***DENMARK/GREENLAND/FAROE ISLANDS***
Jim Reist Fisheries and Oceans Canada 501 University Crescent Winnipeg, MB, Canada R3T 2N6 204 983 5032 (t) 204 984 2403 (f) jim.reist@dfo-mpo.gc.ca	**Anders Mosbech** Email: amo@dmu.dk
FINLAND	***ICELAND***
Hermanni Kaartokallio PhD, Senior Research Finnish Environment Institute (SYKE) Helsinki Email: Hermanni.Kaartokallio@ymparisto.fi	**Héðinn Valdimarsson** oceanography Marine Environment Section Marine Research Institute Iceland Email: hv@hafro.is
NORWAY	
Ingrid Berthinussen Senior Advisor Climate and Pollution Agency (Klif) Tel: +47 22 57 34 83 Email: ingrid.berthinussen@sft.no	**Hein Rune Skjodal** Institute of Marine Research Tel: + 47 55 23 8500 Email: hein.rune.skjoldal@imr.no
Cecilie H. von Quillfeldt Norwegian Polar Institute, Svalbard Email: quillfeldt@npolar.no	**Alf Håkon Hoel** Regional Director Institute of Marine Research Tel: +47 77 64 55 42 Email: ahhoel@gmail.com/Alf.Haakon.Hoel@imr.no

Gunnar Sander Senior Advisor Norwegian Polar Institute Email: gunnar.sander@npolar.no	**Ingolf Røttingen** Institute of Marine Research Bergen, Norway Tel: +47 55 23 84 04 Mobile phone : +47 91 56 18 43 Email: ingolf@imr.no

Lis Lindahl Jörgensen Institute of Marine Research Email: lis.lindahl.jorgensen@imr.no	**Lars-Henrik Larsen** Akvaplan-niva, Tromsø Email: Lars@akvaplan.niva.no
Reidar Hindrum Norwegian Directorate for Nature Management Email: Reidar.Hindrum@dirnat.no	
RUSSIA	
Professor Gennady G. Matishov Director Murmansk Marine Biological Institute of the Russian Academy of Sciences (MMBI RAS) 17 Vladimirskaya Street 183010 Murmansk, Russia Tel.: (+7)(8152)253963 Fax: (+7)(8152)253994 Email: icd@mmbi.info	**Roman G. Mikhalyuk** International Communications Department Southern Scientific Centre of the Russian Academy of Sciences 41 Chekhov Street 344006 Rostov-on-Don, Russia Tel.: +7 (863) 266-64-26 Fax: +7 (863) 266-56-77 Email: icd@mmbi.krinc.ru
SWEDEN	
Mark Marissink Ministry of the Environment Email: Mark.Marissink@naturvardsverket.se	
UNITED STATES	
Kenneth Sherman Director Narragansett Laboratory 28 Tarzwell Drive Narragansett, TI 02882 United States Tel: +1 401 782 3211 Email: ksherman@mola.na.nmfs.gov	**Kathleen Crane** Arctic Research, CPO NOAA 1100 Wayne Avenue Silver Spring, MD 20910 USA Tel: +1 301 427 2471 kathy.crane@noaa.gov
ICC Canada	***AMAP***
Duane Smith ICC Canada Email: inuvialuk@northwestel.net	**Lars-Otto Reiersen** Executive Secretary AMAP Secretariat Stromsveien 96 P.O. Box 8100 Dep. N-0032 Oslo Norway Tel: + 47 23 24 16 32 Fax: + 47 22 67 67 06 Email: lars-otto.reiersen@amap.no

Grid Arendal	*WWF - Russia*
Tiina Kurvits North American Co-ordinator, Polar Programme UNEP/GRID-Arendal 360 Albert Street, Suite 1710 Ottawa, Ontario, K1R 7X7 CANADA Tel: + 1 (613) 943-8643 Fax: +1 (613) 943-8607 Email: Tiina.Kurvits@grida.no **Jean-Nicolas Poussart** Marine Prgramme / Data management and visualization UNEP/GRID-Arendal, Norway Tel: +47 92 04 76 26 Fax: +47 37 03 50 50 Email: jean-nicolas.poussart@grida.no	**Stanislav Fomin, PhD (econ)** Marine Programme Coordinator Barents Sea Programm Office WWF Russia Email: sfomin@wwf.ru
WWF	***Saami Council***
Dr. Martin Sommerkorn Senior Climate Change Advisor WWF Global Arctic Programme Oslo, Norway Email: msommerkorn@wwf.no	**Camilla Brattland** PhD Candidate Norwegian College of Fishery Science/Centre for Sami Studies www.sami.uit.no/favllis Email: camilla.brattland@uit.no
EEA	***ICC Alaska***
Nikolaj Bock Special Advisor on International Affairs Executive Directors Office European Environment Agency Kongens Nytorv 6 1050 Copenhagen K Denmark Email: Nikolaj.Bock@eea.europa.eu	**James Stotts** 429 L. Street Anchorage, Alaska 99501 Tel: +1 (907) 344-6286 Email: jimmy@iccalaska.org

Annex 3 - Summary from *Ecosystem considerations 2011* for the Eastern Bering Sea produced by NOAA/NMFS/AFSC

EBS Report Card

- ✓ A strong la Ni~na has formed on the equator as reflected in the recent downward trend in NPI.
- ✓ The prediction for the Bering Sea is above average sea-ice extent and duration in winter and spring 2011. This would result in a fifth year of extensive ice over the southern Bering Sea shelf.
- ✓ The euphausiid biomass index increased more than three fold from 2004 to 2009 and then decreased in 2010 by ca. 30%. Large copepod biomass increased 10 fold from very low values during the recent 2002-2005 warm period to 2009. This suggests that overall food availability for planktivorous species is high. Age-0 pollock and other planktivorous species may be dependent on the availability of sufficient prey to generate enough depot lipids to survive their first winter. Thus, we predict that the survival of this particular year class of fishes might be better than average.
- ✓ Current (2005-2010) mean biomass, catch, and exploitation rates of motile benthic epifauna and benthic foraging fish have been within one standard deviation of 1977-2010 levels. No trend is apparent in recent years for these foraging guilds.
- ✓ There is a concern with two of the commercial crab stocks in the mobile benthic epifauna guild which are overfished. However, this guild appears stable because the guild is dominated by non-target fish and invertebrate biomass.
- ✓ There are no apparent trends in benthic forager catch and exploitation rate. The benthic foragers guild appears stable and may not require further management action.
- ✓ Pelagic foragers have biomass below mean and exploitation rate above mean, but increasing trends in biomass and decreasing trends in catch and exploitation rates. The pelagic foragers guild biomass has been at a historic low, which has been a recent management concern. However, there are signs of recovery within the guild, as well as increased forage and positive physical conditions to support recovery. Continued caution with the management of species in this guild and continued monitoring may be necessary, but the outlook is improved from last year.
- ✓ The recent increasing trend in the apex predator guild biomass is driven largely by a decrease in Pacific cod biomass being offset by an increase in arrowtooth flounder biomass. The fish apex predators guild appears stable and may not require additional management action.
- ✓ Thick-billed murre reproductive success has increased during the past five years, concurrent with a colder Bering Sea, later ice retreat, and increased biomass of zooplankton on the outer shelf. Continued cold conditions in the Bering Sea will likely lead to favorable conditions for thick-billed murres nesting on St. George Island and a continued trend of higher reproductive success in 2011.

- ✓ Northern fur seal pup production on St Paul Island has been declining since the mid-1990s, while it has been relatively stable on St George since 2002. Estimated pup production on both Pribilof Islands in 2008 was similar to the level observed in 1916; however the population trends are different. In 1916, the northern fur seal population was increasing at approximately 8% per year following the cessation of extensive pelagic sealing, while currently (1998 through 2008), northern fur seal pup production on both Pribilof Islands is decreasing at approximately 6% per year.

PAME
Protection of the Arctic Marine Environment
Borgir, Nordurslod / 600 Akureyri / ICELAND
Tel: +354 461 1355 / Fax: +354 462 3390
Email: pame@pame.is / Homepage: www.pame.is