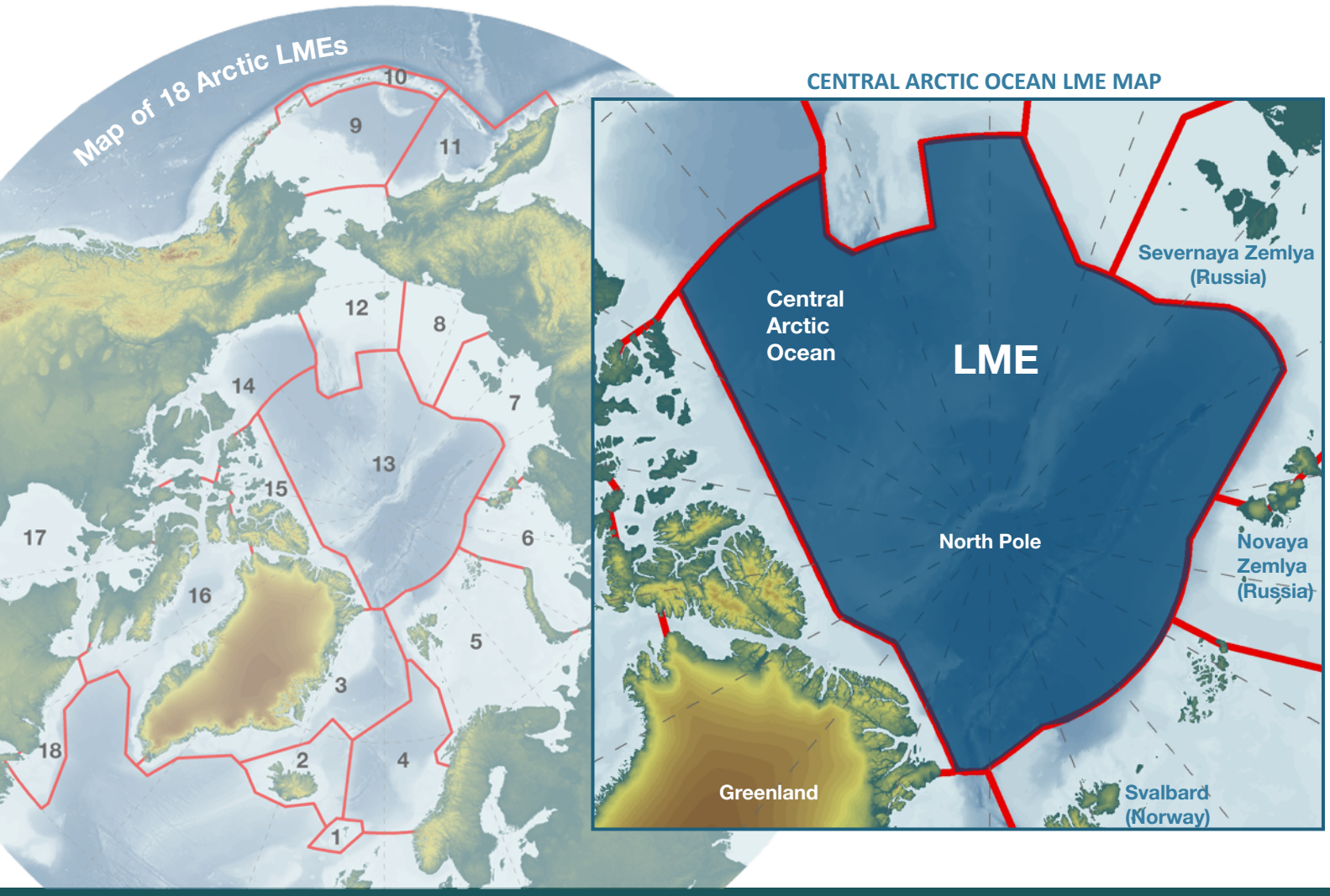
CENTRAL ARCTIC OCEAN LME



13

PAME

Protection of the Arctic Marine Environment

ARCTIC LMEs

Large Marine Ecosystems (LMEs) are defined as regions of ocean space of 200,000 km² or greater, that encompass coastal areas from river basins and estuaries to the outer margins of a continental shelf or the seaward extent of a predominant coastal current. LMEs are defined by ecological criteria, including bathymetry, hydrography, productivity, and tropically linked populations. PAME developed a map delineating 17 Arctic Large Marine Ecosystems (Arctic LME's) in the marine waters of the Arctic and adjacent seas in 2006. In a consultative process including agencies of Arctic Council member states and other Arctic Council working groups, the Arctic LME map was revised in 2012 to include 18 Arctic LMEs. This is the current map of Arctic LMEs used in the work of the Arctic Council in developing and promoting the Ecosystem Approach to management of the Arctic marine environment.

Joint EA Expert group

PAME established an Ecosystem Approach to Management expert group in 2011 with the participation of other Arctic Council working groups (AMAP, CAFF and SDWG). This joint Ecosystem Approach Expert Group (EA-EG) has developed a framework for EA implementation where the first step is identification of the ecosystem to be managed. Identifying the Arctic LMEs represents this first step.

This factsheet is one of 18 in a series of the Arctic LMEs.

OVERVIEW: CENTRAL ARCTIC OCEAN LME

The Central Arctic Ocean LME is the largest Arctic LME with an area of about 3.3 million km². The LME is bounded by the surrounding Arctic shelf LMEs and the boundaries are set with justification primarily in relation to those LMEs.

The LME consists of two main basins, the Eurasian Basin and the Canadian Basin, separated by the Lomonosov Ridge, a prominent geological feature. It is about 1.800 km long and 60-200 km wide with fairly steep slopes including canyon structures on each side.

In terms of physical oceanography the Arctic Ocean with its deep basins is seen as part of the Arctic Mediterranean Sea which includes the Nordic Sea (Norwegian, Greenland and Iceland seas) north of the ridge between Scotland and Greenland. Atlantic water (part of it originating from the Gulf Stream) flows into this high latitude sea area where it is cooled and modified and returned as cold over-flow water into the deep North Atlantic as part of the meridional overturing and global 'conveyor belt' circulation. This is an important part of the global climate system, and processes in the Arctic Ocean and Nordic Seas have received much attention in the context of climate variability and global climate change.

The most prominent feature of this LME is the drifting polar pack ice that covers the whole area during most summers except for some of the more recent warm years with especially low ice cover. The sea ice constitute habitat for a very special biota made up of ice algae and a partly endemic fauna of ice amphipods and other small animals. Shrinking ice cover due to global warming is probably changing some ecological features of this ecosystem.

Central Arctic Ocean LME map. *Source: AMSA IIC report.*

The Arctic Ocean consists of four vertical layers of waters or water masses.

1. *A surface layer about 50 m thick of low salinity water that is seasonally modified by ice formation and melting (polar mixed layer).*
2. *A gradient layer (halocline) with strong increase in salinity and density between the surface layer and the next layer of Atlantic water below, located typically from about 50 to about 200 m depth.*
3. *3. An intermediate thick layer of relatively warm (temperature above 0oC) Atlantic water below the halocline down to about 1.000 m.*
4. *4. Deep water of relatively uniform character (temperature between -0.5 and -1.0oC and salinity around 34.9) filling the deep basins below the Atlantic layer.*

MARINE MAMMALS

Seven species of marine mammals can be found in the Central Arctic Ocean: ringed seal, bearded seal, harp seal, beluga whale, narwhal, bowhead whale, and polar bear. Of these, the ringed seal and polar bear are the most common and widespread. Bearded seal is mainly a benthic feeder and is only occasionally seen beyond the shelf edge. Bowhead, beluga and narwhal may seasonally move into the fringes of the central pack ice during summer, as may also harp seal.

Polar bear occurs with 19 recognized subpopulations. It was once considered to be a circumpolar nomad species wandering around in the vast spaces of the ice-covered Arctic (1945). However, through the mechanisms of homing and strong site fidelity, combined with barriers or discontinuities created by land masses and sea ice conditions, polar bears are found in more or less distinct and segregated populations. Six of the recognized subpopulations occur on the shelves surrounding the Arctic Ocean basins; these are the Barents Sea, Kara Sea, Laptev Sea, Chukchi Sea, and Southern and Northern Beaufort Sea subpopulations. Bears of these subpopulations may follow the retreating ice north into the peripheral areas of the pack ice of the Central Arctic Ocean in summer. In addition, there is an Arctic Basin subpopulation which may reside in the Central Arctic Ocean, possibly mainly on the western side toward northern Canada and Greenland.

Ringed seal has a wide circumpolar Arctic distribution with the Arctic ringed seal subspecies (two more marine subspecies occur in the Sea of Okhotsk and the Baltic Sea, and two subspecies occur in freshwater in Finland and northwestern Russia. Arctic ringed seals are considered to be widely distributed, probably all over the Central Arctic Ocean. They are regularly seen from icebreakers going through the Arctic Ocean pack ice, even at the North Pole. Ringed seals have also been observed regularly from Soviet/Russian ice-drift stations and aerial ice surveys.

Ringed seals are assumed to be the main prey for polar bears in the Central Arctic Ocean. Ice amphipods and Arctic and polar cod can in turn be assumed to be the main prey items available for

ringed seals. These fauna components are widely distributed in the ice-covered waters of the Central Arctic Ocean. The generally low productivity in the pack ice areas of the Arctic Ocean limits ringed seals (and polar bears) to scarce occurrence at low density. Little is known about areas of higher production and/or higher aggregation of prey which could lead to aggregations of ringed seals. There is also little knowledge about the spatial ecology of ringed seals in the Central Arctic Ocean.

Ringed seals have been found to move up to 2.000 km or more on a seasonal basis between different areas and habitats. The distance to the North Pole from the northern archipelagos (Svalbard, Franz Josef Land, Severnaya Zemlya) and northern Greenland is around 1.000 km, while the distance from the southern Beaufort and northern Chukchi seas is of the order of 2.000 km. This means that ringed seals are capable of moving into and out of the drift ice of the Cental Arctic Ocean.

Ringed seals reproduce in shore-fast ice where they maintain breathing holes and give birth to the single pups in lairs in snow drifts. They can also breed on stable drifting pack ice as has been shown to occur in Baffin Bay and the central Barents Sea and possibly also in the Greenland Sea. It is not known whether ringed seals breed on pack ice in the Central Arctic Ocean but the possibility is there.

SEA ICE

Sea ice is a very important part of the Central Arctic Ocean ecosystem. All of the Arctic Ocean is ice-covered in winter (except for smaller areas of polynyas and leads which are mostly located in the periphery over the shelves surrounding the Arctic Ocean basins). During the summer season, sea ice generally melts away and disappears from the surrounding shelves while remaining in most of the area of the Central Arctic Ocean. The maximum ice cover is generally reached in March while the minimum ice cover is found in September.

The annual ice grows to a thickness of around 2 m in the High Arctic while the thickness of the perennial ice is typically 3-4 m.

The sea ice drifts in two broad patterns in the Arctic Ocean: in a counter-clockwise manner in the Beaufort Gyre in the Canadian Basin, and as the Trans Polar Drift from the East Siberian and Laptev seas across the central Arctic Ocean towards the Fram Strait. The transit time for sea ice is around 2-3 years in the Trans-Polar Drift, while the transit time (and age) of perennial ice can be 5-6 years or more for ice in the Beaufort Gyre.

The heaviest ice conditions are found on the Canadian side of the Arctic Ocean (north of the Queen Elisabeth Islands) where the average draft is 4-7 m, consisting of heavily deformed ice with ridges and keels generated by pressure and shear from the movement of ice in the Beaufort Gyre.

Sea ice exits from the Arctic Ocean with the Trans-Polar Drift through the Fram Strait. The amount of ice leaving annually has been estimated to be about 2.500 km^3. This amount is equivalent to an area of around 1.1 million km^2 of sea ice with a mean ice thickness of 2.7 m.

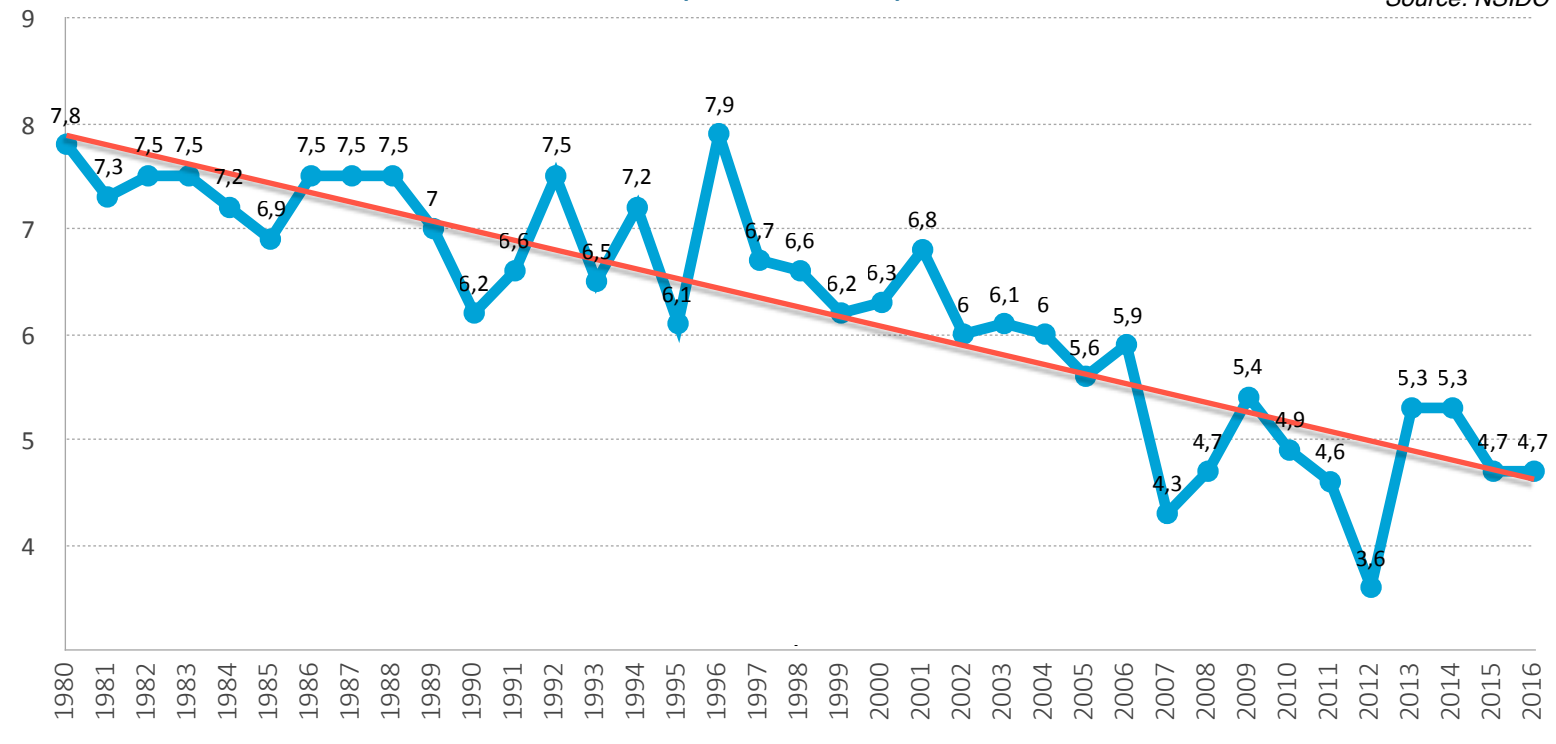
There has been a substantial decrease in sea ice extent and area during the last three decades. This has been associated with a decline in the fraction and age of the thick perennial pack ice and a shift to more newly formed first-year ice.

From 1980 to 2005 the summer minimum ice cover (extent) in September decreased by about 20 %, from about 8 to around 6 million km^2. In 2007 the sea ice extent dropped by another 20-25%, to a record low of 4.3 million km^2. The declining trend in summer ice has continued with another record low of about 4 million km^2 in 2011 and 2012.

ARCTIC SEA ICE EXTENT IN SEPTEMBER (1980-2016)

(Millions of km²)

Source: NSIDC



FISH

It is unlikely that the melting ice in the Arctic will lead to major changes in the fish patterns in the north. Cod and haddock have reached their northerly distribution limits, while redfish, capelin and herring can migrate into the Arctic Ocean to graze as they are pelagic species that swim freely in the water column.

There is unlikely to be any commercial fishing in the Central Arctic Ocean for many, many years.

There are many conditions that determine how and why fish change their migration pattern and expand their range and distribution.

The fish hunt for food and, providing the conditions are favourable, large fish stocks will disperse over a larger area than small fish stocks. There are many examples of this. The stocks of cod and haddock have grown in recent years and have dispersed over most of the Barents Sea. In autumn 2012, observations were of both these species further north than the previous record.

The Arctic Ocean is a deep marine area. Species such as cod and haddock are linked to shallow areas of the continental shelf such as the Barents Sea and the North Sea. These species are not found in the Norwegian Sea, even though there is sufficient food and good temperature conditions there. Therefore, these species will not disperse further north than the continental slope north of the Barents Sea. This means that the world record northern dispersal of cod and haddock from autumn 2012 is likely to stand.

The deep-water species Greenland halibut also lives near the seafloor and will not disperse further north than the continental slope, even though it is likely to go somewhat deeper than cod and haddock. However, the Greenland halibut has already been observed to the east past Franz Josef Land to the Kara Sea.

Consequently, only species that live freely in the Arctic water masses for all or part of their lives, such as capelin and redfish, have the potential to migrate into the actual Arctic Ocean.

The majority of species prefer to live in water masses with temperatures within a certain range. Even though more species can live in temperatures of down to nearly 0° C for shorter periods, and some Arctic species such as Polar cod right down to the freezing point for seawater (-1.8° C), the majority of species prefer water masses with temperatures of above 0° C. It is also important that food is present, whether it is plankton or fish, such as capelin. Incidentally, capelin is the pelagic species with the greatest potential to migrate into the Arctic Ocean to graze.

SEABIRDS

Only two seabird species have their natural habitat in the Arctic Ocean; they are the ivory gull and Ross's gull. Both are adapted to feed in ice-covered waters and both occur there with significant parts of their total populations during summer. According to observations at Soviet drifting stations during 1937-1938 and 1950 – 1954, ivory gulls were recorded in the pack ice of the Central Arctic basin from April to August while Ross's gulls only in June to August.

Altogether 20 seabird species, 3 waders and 4 passerines have been recorded in the Arctic Ocean . The most common seabirds are the northern fulmar, black-legged kittiwake, glaucous gull, skuas, dovekie, and black guillemot. These species are most common in the peripheral parts of the pack ice and are increasinging scarce as one moves north into the central parts of the Arctic Ocean. In general these birds occur scattered and in very low numbers during summer, and may be found throughout the ocean in cracks and leads in the ice. Black-legged kittiwake has been observed north of 86oN as has northern fulmar.

Other birds observed in the Arctic Ocean are waders like purple sandpiper, grey phalarope and ducks like long-tailed duck and eiders.

No quantitative data on distribution (besides references to flock size) are available for this LME.

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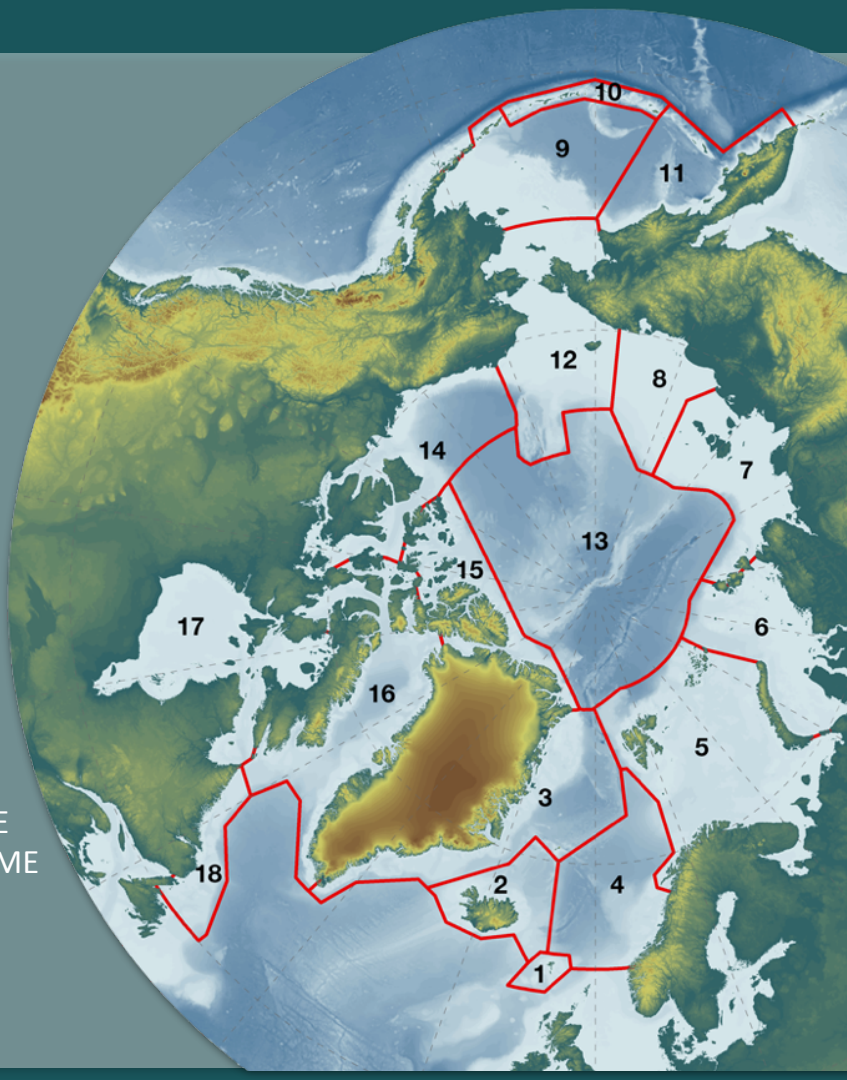
ARCTIC LMEs

1. Faroe Plateu LME
2. Iceland Shelf and Sea LME
3. Greenland Sea-East Greenland LME
4. Norwegian Sea LME
5. Barents Sea LME
6. Kara Sea LME
7. Laptev Sea LME
8. East Siberian Sea LME
9. East Bering Sea LME
10. Aleutian Islands LME
11. West Bering Sea LME
12. Northern Bering-Chukchi Sea LME
13. **Central Arctic Ocean LME**
14. Beaufort Sea LME
15. Canadian High Arctic - North Greenland LME
16. Canadian Eastern Arctic - West Greenland LME
17. Hudson Bay Complex LME
18. Labrador-Newfoundland LME



LITERATURE REFERENCES

- *The 2007 assessment of Oil and Gas in the Arctic (OGA) - AMAP (2007)*
- *Arctic Ocean – an ocean without fishery: Institute of Marine Research (Norway): http://www.imr.no/nyhetsarkiv/2013/februar/ikke_noe_fiskerieventyr_i_polhavet/en*
- *Arctic Marine Areas of Heightened Ecological and Cultural Significance: Arctic Marine Shipping Assessment (AMSA) IIC - AMAP/CAFF/SDWG (2013)*
- *Large Marine Ecosystems (LMEs) of the Arctic area Revision of the Arctic LME map - PAME (2013)*

Acknowledgements

PAME gratefully acknowledges the financial support provided to this project by the Nordic Council of Ministers and the OAK Foundation.

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2016