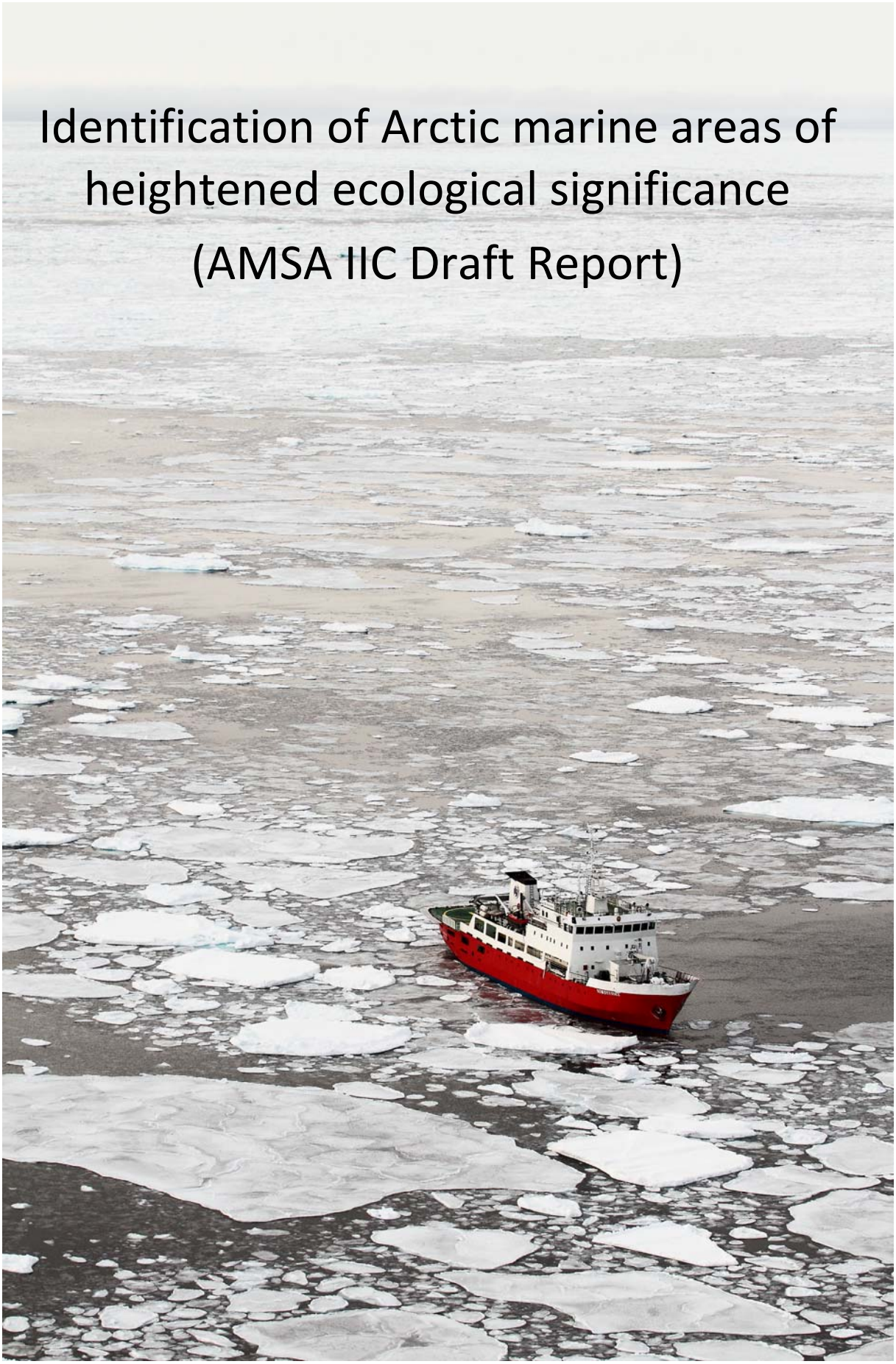
Identification of Arctic marine areas of heightened ecological significance (AMSA IIC Draft Report)



AMAP Arctic Monitoring and Assessment Programme

CAFF

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IDENTIFICATION OF ARCTIC MARINE AREAS OF HEIGHTENED ECOLOGICAL SIGNIFICANCE 1

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Executive Summary

The Arctic Marine Shipping Assessment (AMSA) 2009 Report reviewed environmental impacts and threats from current and future Arctic marine shipping. AMSA Recommendation IIC called for the Arctic states to identify areas of heightened ecological and cultural significance in light of changing climate conditions and increasing multiple marine uses, and, where appropriate, to encourage implementation of measures to protect these areas from the impacts of Arctic marine shipping. An AMSA IIC project was established with Norway, Canada, Denmark/Greenland, and the United States of America as lead countries, and with assistance from AMAP, CAFF and SDWG. A group of core-drafters were selected to carry out the work of identifying and describing the areas of heightened significance. The present report includes the identified areas of heightened ecological significance. The areas of heightened cultural significance have been identified in a different process and are reported as a separate part of the final AMSA IIC report.

Areas of heightened ecological significance have been identified for each of the 16 Large Marine Ecosystems (LMEs) within the Arctic area. Three different approaches have been used to identify the areas. Areas identified as vulnerable areas in the AMAP Assessment of oil and gas activities in the Arctic (OGA) have been used as a basis for the identified AMSA IIC areas in 12 LMEs (located in the Northeast Atlantic sector, in the Russian Arctic, Bering and Chukchi seas, and the Central Arctic Ocean). Canada and Denmark/Greenland have had separate national processes to identify areas of heightened ecological significance for their waters (5 LMEs, from the Beaufort Sea to the Greenland Sea).

AMSA identified oil spills as the most significant threat associated with Arctic marine shipping. Other potential impacts from Arctic ships include ship strikes on marine mammals, disruption of migratory patterns, noise disturbance, and introduction of alien species. Aggregations of fish, birds and mammals, for purposes such as migration, staging, breeding, feeding, and resting, are to varying degree sensitive and potentially vulnerable to oil spills and disturbances. Such areas would also generally be considered to be ecologically important and thus of heightened ecological significance. While an area can be ecologically important without necessarily being particularly sensitive or vulnerable, there is a broad correspondence between ecological importance and sensitivity (and potential vulnerability) for areas that are used by aggregations of animals. Areas with high production (such as polynyas) or rich benthic communities could be considered to be ecologically important in their own right. However, these types of areas would generally also be used for feeding by aggregations of birds and mammals and would therefore be identified as ecologically important from that perspective.

A total of about 99 areas of heightened ecological significance have been identified throughout the Arctic LMEs. The areas were identified based primarily on their ecological importance to fish, birds and/or mammals, as these species are the most widely studied Arctic groups. The majority of areas identified are used by birds (87) and marine mammals (79), with a lower number used by fish (38,

most of them spawning areas). About 70 areas are used both by birds and mammals, and only 3 of the identified areas are not used by bird or mammals but only by fish.

The areas of heightened ecological significance comprise a total area of about 12 million km^2, or more than half the total area of the ice-covered part of the marine Arctic. The areas are generally not homogenous but are composed of subareas used by fish, birds or mammals. Based on the approach used, subareas were identified separately for fish, birds, and mammals, or information on the use of the larger areas by these groups was summarized. The subareas often overlap and are also often used by two or more species of birds or mammals, e.g. for breeding in seabird colonies, or for staging by waterfowl and shorebirds. Information on species and the times and purposes of use are given in summary tables of the identified areas for each LME. Thus while the identified areas of heightened ecological significance cover a large total area, this is the aggregate area used over all seasons throughout the year. The area used at any one time is lower due to the strong seasonal pattern in the annual migratory cycles of fish, birds and mammals.

The areas are essentially stationary habitats (even if they feature a current flowing through an area) and the uses of the areas by aggregations of animals provide close links between species and habitats in a functional ecological sense. This aspect is important in relation to use of the information in the context of the ecosystem approach to management.

The report builds on a large amount of information that has been used in identifying and evaluating the areas of heightened ecological significance. This includes detailed information on species and populations and their seasonal migratory and ecological behavior in each of the LMEs. Such information may be necessary and useful for assessing the vulnerability of areas to specific shipping activities and evaluating the need for protective measures in relation to future Arctic marine shipping.

Background

The Arctic Marine Shipping Assessment 2009 Report (AMSA 2009) was approved at the Arctic Council's ministerial meeting in Tromsø in 2009. AMSA focused on current and future Arctic marine activity and included a number of recommendations under three broad themes to guide future action by the Arctic Council, Arctic States and others.

Under theme II, "Protecting Arctic People and the Environment", recommendation C concerns "Areas of Heightened Ecological and Cultural Significance" and states:

That the Arctic states should identify areas of heightened ecological and cultural significance in light of changing climate conditions and increasing multiple marine use and, where appropriate, should encourage implementation of measures to protect these areas from the impacts of Arctic marine shipping, in coordination with all stakeholders and consistent with international law.

An AMSA IIC project was established with Norway, Canada, Denmark/Greenland, and the United States of America as lead countries. PAME had requested assistance from AMAP, CAFF and SDWG in responding to the AMSA IIC recommendation, and the work was over-seen by a group of co-leads from the lead countries (Hanne Aronsen, Francine Mercier, Inge Thaulow, and Dennis Thurston). A group of core-drafters were selected to carry out the work of identifying and describing the areas of heightened significance.

This (Final Draft) Report deals with the identification and description of areas of heightened ecological significance. The areas of heightened cultural significance have been identified in a separate process led by SDWG and are reported in a separate part of the final AMSA IIC report. The identified areas of heightened ecological significance reported here were primarily sites where large numbers of individuals of one or several species concentrate during particular times of the year, such as for breeding (i.e., colonies, rookeries, spawning areas), feeding, staging or during migrations. The report focuses on birds, marine mammals and fish species in situations and habitats where they are potentially vulnerable to the effects from vessel activity, such as oil spills, noise and physical disturbance. It provides summary information on areas of heightened ecological significance based on existing and published information.

The AMSA IIC (Draft) Report only addresses the first portion of recommendation IIC, the identification of areas of heightened ecological and cultural significance. It documents Arctic marine areas that would be vulnerable or sensitive to activities associated with shipping activities, notably oil spills and physical disturbance including noise and ship strikes (collisions). The (Draft) Report compares these areas to criteria for determining Particularly Sensitive Sea Areas (PSSAs) from the International Maritime Organization (IMO) as a guidance tool for PAME, Arctic State experts and Permanent Participants to use in the discussion, formulation, and conduct of follow-up project proposals, particularly AMSA IID dealing with Specially Designated Arctic Marine Areas. The AMSA IIC

(Draft) Report has been reviewed by countries and the three Arctic Council Working Groups (AMAP, CAFF and SDWG).

AMSA (2009) used a break-down of the Arctic area into Large Marine Ecosystems (LMEs) to summarize shipping activities and to evaluate environmental impacts. LMEs are used as geographical units to show identified areas of heightened significance also in this report. The Arctic area covered here includes subarctic, open-water areas south of the ice-covered areas. In the Pacific sector it extends south to include the Aleutian Islands and the East coast of Kamchatka. In the Atlantic the area extends south the northern coast of Labrador in the west and to the Faroe Isles and the boundary to the North Sea at 62^{o}N in the east.

Environmental impacts and ecological sensitivity

Environmental impacts from shipping

The various types of environmental impacts from shipping in the Arctic were reviewed and summarized in AMSA (AMSA 2009), with more extensive and detailed information provided in the scientific assessment document underpinning the AMSA report (Skjoldal et al. 2009). With sea ice melting at an unprecedented rate in the Arctic in recent years, resulting in longer periods of open water in the summer, more Arctic areas are likely to be open to shipping. The two main types of environmental effects from shipping considered in this Draft Report are pollution from discharges and emissions and disturbances from ships and shipping activity (Table 1). Introduction of alien invasive species was also recognized in AMSA as a serious problem that could lead to loss of native biodiversity through a wide range of specific effects. However, the pervasive nature of the introduction of invasive species does not readily lend itself to the identification of sensitive and ecologically important areas.

Table 1. Environmental Impacts. Overview of the various types of environmental impacts associated with Arctic marine shipping (based on AMSA 2009).

Category	Activities/pressures	Impacts
Pollution	Accidental discharges of oil and toxic chemicals	Physical oiling and death of birds and fur-bearing mammals due to impaired thermal insulation Toxicological effects
	Regular discharges to water (including garbage and illegal discharges)	Oiling (primarily from illegal discharges) Entanglement of whales and other wildlife (ropes, nets and other garbage) Ingestion of plastics by birds and mammals
	Emissions to air	Climate change (CO_2 and other GHGs) Ozone and haze (NOx) Local air quality Ice conditions (black carbon)
Disturbance	Sound and noise disturbance	Disruption of feeding, breeding or other vital activities for birds and mammals Interference with communication among whales
	Ice breakers and disturbance	Effects on behavior and communication between mammals Disturbance of wintering, migrating or

		staging birds and mammals in leads and polynyas Disruption of migration routes for terrestrial mammals crossing sea ice (e.g. caribou) Ice entrapment of whales in artificial leads
	Vessel strikes	Injury and death of whales by collision
	Light disturbance	Injury and death of birds attracted to lighted ships
Introductions	Introduction of invasive species through ballast water, hull fouling and cargo	Various biological and ecological effects including detrimental changes to food webs and displacement and potential loss of native species. Impacts on breeding birds by introduced predators, notably "rat spills" associated with ship accidents on islands

In AMSA it was recognized that oil spills, either from accidents or illegal discharges, were the most significant threat to the Arctic marine ecosystems. Ship strikes of whales and other marine mammals were noted as being of concern in areas where shipping routes coincide with seasonal migration and areas of aggregation. Migration corridors through systems of leads and polynyas used by mammals and birds on their northward migration in spring from wintering areas were noted as particularly important features, with their location broadly corresponding to the current main shipping routes and travel through geographic chokepoints. Areas of heightened ecological significance at risk from current and/or increased shipping identified in AMSA included the Bering Strait, Hudson Strait, Lancaster Sound and the Pechora Sea. AMSA recognized that with a longer shipping season in the future, there is an increased possibility of interaction between migrating (and calving) species and ships.

Ecological sensitivity and use of areas by fish, birds and mammals

The ecological sensitivity of an area is reflected in the way and extent by which it is used by animals or animal populations. We have distinguished between the use of areas by fish, birds, and mammals. The various uses of areas by these three groups of organisms are summarized in Table 2 along with indicated sensitivity to the two main impact factors associated with marine shipping - accidental oil spills and disturbances, including vessel strikes of whales (see Table 1). The estimated sensitivity builds on the 'Oil and gas assessment' (AMAP 2008, Macdonald et al. 2010, Skjoldal et al. 2012) and AMSA (AMSA 2009, Skjoldal et al. 2009).

Spawning areas of fish can be sensitive to oil spills. This is the case for small cod fishes that spawn their eggs under the ice in winter where they incubate for a rather long period before hatching in spring. Polar cod (*Boreogadus saida*) in particular is a key species in Arctic food webs and ecosystems, and negative impacts on this species could have large ecological implications. Other species spawn their eggs at the seafloor as capelin and herring do. Their spawning beds could be

impacted by sinking oil. Populations of Pacific herring and capelin which spawn in shallow waters and on beaches could be particularly sensitive to stranding of drifting oil (as was demonstrated in the 'Exxon Valdez' accident in Prince William Sound). Pelagic spawners are considered to be less sensitive to oil spills. However, the main spawning areas for major fish populations, such as Atlantic cod in the Barents Sea and around Iceland and walleye pollock in the Bering Sea, are still considered potentially vulnerable in light of the great ecological importance of these stocks in the marine ecosystems. Spawning aggregations of fish are considered to be less sensitive to disturbances from shipping activities in general due to the limited scope of such disturbances.

Seabirds and seaducks like eiders migrate to their northern breeding areas in spring when they may use leads and polynyas as staging areas before they move onto their breeding grounds as they clear of snow and ice. The birds have spent much energy on the long migrations and they are critically dependent on feeding to replenish their depleted energy stores and to accumulate energy for the reproduction. Concentrations of spring staging birds in openings in the ice where there is access to food are very sensitive to both oil spills and disturbances. Other birds that may use openings in the ice to feed in spring are the species of divers or loons and the swimming phalaropes among the shorebirds.

Seabird breeding colonies can be huge aggregations of birds that feed and rest on the sea adjacent to the colonies. The foraging range out from the colonies vary by species, from a few 10s of km for small auks (such as least auklet and little auk) to 100 km or more for species such as northern fulmar. We have used a range of 50 km to indicate the sensitive zones around seabird colonies. The seabird colonies with the foraging zones around them are considered to be highly sensitive to oil spills and they may also be sensitive to disturbances in their vicinity. In addition to feeding around colonies, there may also be areas with feeding aggregations of seabirds and seaducks associated with features such as physical fronts, productive zones, and schooling fish. Such areas may be used by non-breeding birds (immatures and failed breeders) during the breeding season in summer and by adults and juveniles in late summer and autumn after the breeding season. Areas with feeding aggregations of birds would generally have high sensitivity to oil spills but may have lower sensitivity to disturbances due to the more dynamic and shifting characteristics of such areas.

Seaducks and many auks among the seabirds molt their flight feathers in late summer or fall when they are flightless for a period of about 4 weeks. Eiders and other seaducks (such as longtailed duck and scoters) aggregate at favorable sites where they are protected and have access to food at diving range during the molt period. In this situation they are highly sensitive to oil spills and also to disturbances. Common and thick-billed murres among the auks perform a swimming migration during the molt period when the young chicks are accompanied by their fathers. During this time they are potentially vulnerable to oil spills and disturbances. Geese also molt their flight feathers and remain flightless when they aggregate at molt sites often close to water. The association with marine coastal habitats varies among species and therefore the sensitivity also varies in relation to marine oil spills and activities. The circumpolar brent goose is the most marine of the geese, along with the emperor goose which is found in the Pacific sector of the Arctic.

Prior to the fall migration to wintering areas often far south of the Arctic, many birds will aggregate at favorable fall staging areas where they feed and fatten for the long southbound journey. This is the case for many seabirds such as common and thick-billed murres, eiders and other seaducks, geese, and many species of shorebirds. Aggregations of staging birds at coastal and marine areas may be highly sensitive to oil spills and disturbances that disrupt their foraging and may negatively affect their energy balance prior to migration. There are also important stop-over and staging areas that are used by birds during the fall migration. Prime examples are the Yukon-Kuskokwim Delta and lagoons along the northern side of the Alaska Peninsula in the Bering Sea, and coastal habitats in the southwestern Hudson Bay and James Bay.

Several Arctic seabirds and seaducks move south to spend the winter in the marginal ice zone or in open sub-Arctic waters south of the ice. This is the case for ivory gull, and common and thick-billed murres among the seabirds, and common and king eiders among the seaducks. Areas where seabirds and seaducks aggregate during winter may be sensitive to oil spills and also to disturbances dependent on the specific situations. One particular case is the wintering area of spectacled eiders where the total world population is concentrated in a relatively small area in the marginal ice zone south of St. Lawrence Island in the northern Bering Sea. This is probably one of the most sensitive areas in terms of both oil spills and disturbances.

Among the marine mammals, whales, walrus and adult seals are considered to have low sensitivity to oiling from oil spills, whereas seal pups with lanugo fur, polar bear, sea otter, and fur seals have high sensitivity. However, in the oil and gas assessment it was considered that whales and walrus that migrated and used openings in ice-covered waters were potentially sensitive to oil spills as well as to disturbances. Bowhead, beluga, narwhal and walrus spend the winter in drifting pack ice or in polynyas. In spring they migrate north through systems of leads to their summer feeding grounds in the Arctic. During this time (late winter or spring) they reproduce by giving birth to their calves and mating. When they are in ice, these species are considered to have high sensitivity to oils spills and disturbances. As the ice clears from their feeding areas in late summer and autumn their sensitivity is reduced. With the slowly moving bowhead, vessel strike (collision) is a particular issue which tends to make them vulnerable also in open water. Walrus are wary animals and may have high sensitivity to disturbances when they are feeding off coasts or from the ice. This is also the case when they are hauling-out and resting on land or on ice floes between feeding bouts.

Ice-breeding seals give birth to their pups when they may occur in dense breeding aggregations on drifting sea ice. This is the case for harp and hooded seals in the Atlantic sector and spotted and ribbon seals in the Pacific. The pups are borne with lanugo wool to keep them warm until they develop sufficient layers of blubber, and at this stage they are very sensitive to oiling from oil spills. Breeding aggregations of seals are also sensitive to disturbances. Ringed seals breed more scattered usually in the fast ice zone and they are generally less sensitive and vulnerable to oil spills and disturbances. Breaking of ice and waves generated by ships may, however, cause flushing of their dens with resulting mortality of the exposed ringed seal pups. The ice-associated seals winter in the marginal ice zone and they move north with the receding ice in summer. They tend to occur dispersed in smaller groups and in relatively open pack ice. They are therefore considered to have

moderate or moderate to low sensitivity to oil spills and disturbances outside the breeding season in late winter or spring.

Polar bears are sensitive to oiling from oil spills. They tend to occur dispersed but may be more concentrated in some areas during migration from breeding and wintering areas to summer feeding areas and also in favorable feeding areas such as along leads and polynyas where prey may be more abundant than elsewhere.

The large baleen whales (including blue, fin, sei and humpback) spend the winter at lower latitudes and come north in spring to feed in boreal and sub-Arctic waters during the summer season. These whales are considered to have low sensitivity to oil spills and moderate to low sensitivity to disturbances. Atlantic and Pacific right whales are endangered species occurring each with global populations of 400-500 individuals. They may come north in summer to feed in sub-Arctic waters off southern Greenland and in the Bering Sea. Due to their low numbers and slow swimming, they are considered sensitive to ship strikes, where the loss of even a few individuals may be significant at the population and species levels.

Table 2. Ecological use of areas by groups and/or species of fish, birds and mammals, and the associated sensitivity to oil spills and disturbances from shipping activities.

Type of area	**Group/species**	**Sensitivity**	
		Oil spill	**Disturbance**
Fish			
Spawning	Small cods spawning in winter under ice (Arctic cod, polar cod, navaga, saffron cod) Demersal spawners (capelin, Atlantic and Pacific herring, Pacific cod) Pelagic spawners (Atlantic cod, walleye pollock, Greenland halibut)	High Moderate-high Moderate-low	Low
Nursery	Pacific salmons, eulachon, coregonid whitefishes	Moderate	Low
Migration	Arctic char	Low	Low
Wintering	Pacific herring, capelin	Moderate/low	Low
Birds			
Spring staging	Seabirds (thick-billed and common murres, little auk, black guillemot, glaucous gull, ivory gull) Seaducks (common, king, spectacled and Steller's eiders, long-tailed duck, scoters) Divers (red-throated, Arctic, Pacific, great northern, white-billed) Shorebirds (red-necked and red phalaropes)	High	High
Breeding	Seabirds (colonial breeders, including thick-billed and common murres, little auk, least, crested and parakeet auklets, black-legged kittiwake, northern fulmar, and others) Seaducks (common eider) Shorebirds (spoon-billed sandpiper)	High	High-moderate

Feeding	Seabirds (Non-breeding and post-breeding concentrations, including thick-billed and common murres, little auk, least, crested and parakeet auklets, black-legged kittiwake, short-tailed shearwater, short-tailed albatross) Seaducks Divers	High	Moderate-low
Moulting	Seabirds (thick-billed and common murres) Seaducks (common, king, spectacled and Steller's eiders, long-tailed duck, scoters) Geese (brent, barnacle, emperor, cackling, white-fronted, pink-footed, snow)	High High to moderate/low	High High to moderate/low
Fall staging	Seabirds (thick-billed and common murres, others) Seaducks (common, king, spectacled and Steller's eiders, long-tailed duck, scoters) Geese (brent, barnacle, emperor, cackling, white-fronted, pink-footed goose, snow) Shorebirds (red-necked and red phalaropes, others)	High	High
Wintering	Seabirds Seaducks Geese		
Mammals			
Migration	Bowhead, beluga, narwhal, walrus (spring migration) Seals (spotted, ribbon, harp) Polar bear Baleeen whales (blue, fin, sei, humpback)	High Moderate/low High Low	High Moderate/low Moderate/low
Breeding	Bowhead, beluga, walrus (spring migration) Seals (ice-breeding species - harp, hooded, spotted, ribbon) Ringed seal Seals (harbor, grey)	High High Moderate Moderate	High High Moderate/high Moderate/low
Feeding	Bowhead, beluga, narwhal, walrus Polar bear Right whales (Atlantic and Pacific) Baleeen whales (blue, fin, sei, humpback)	Moderate/low High Moderate/high Low	High/moderate Moderate/low High Moderate/low
Resting	Walrus (haul-outs on ice and land) Seals (harp, hooded, spotted, ribbon, harbor, grey)	Moderate	High/moderate Moderate/low
Wintering	Bowhead, beluga, narwhal, walrus Seals (ice-associated - harp, hooded, spotted, ribbon)	High Moderate	High Moderate

Identification of ecologically important areas

Ecological importance versus ecological sensitivity and vulnerability

'*Areas of heigthened ecological significance*' are taken to mean that the areas are ecologically important. All areas of Nature play some ecological function for the animals, plants and microbes that occupy or use the areas either permanently or seasonally. 'Heightened ecological significance' and 'ecologically important' are understood in a relative sense, as areas that are more important than other areas. This does not mean that those other areas are not ecologically significant or ecologically unimportant, only that they are less significant and less important than the identified 'important' areas.

Ecological sensitivity of an area is not strictly the same as ecological importance. An area may be ecologically important without necessarily being ecologically sensitive. However, the two aspects of sensitivity and ecological importance are often related in reality. This is particularly the case where the ecological sensitivity is reflected in the use of areas by animals for biological or ecological purposes such as breeding, feeding, migration, wintering, etc. This is illustrated by Table 2 in the preceding section where the sensitivity to oil spills and disturbances from shipping activities is related to the various ecological uses of areas by fish, birds and marine mammals. Aggregations of fish, birds or mammals at particular geographical locations will often convey an ecological significance to those locations in that they may serve as important or critical habitats during the annual or life cycles of the animals.

Vulnerability is related to sensitivity but the two are not the same. Vulnerability relates to specific pressures or threats. If there are no activities or threats, an area may be considered sensitive but not vulnerable. The properties of sensitivity and vulnerability of areas may be seen as comprising three levels. The first relates to the intrinsic properties of organisms or habitat features that reflect whether they are sensitive or fragile to external disturbances. Animal species may be sensitive to disturbances through changes in behavior or other biological effects, and they may be slow to recover should they be impacted due to low rates of reproduction. Habitat features may be physically fragile and easily impacted by physical stress, e.g. cold-water corals being impacted by bottom trawling. The second level relates to the ecological setting. An area where many sensitive organisms or habitat features occur concentrated is more sensitive or fragile than a comparable area where they occur more scarce and dispersed. The third level relates to the presence of pressures and impacts from human activities. Whether an area identified as sensitive also should be considered as vulnerable depends on whether there are direct or potential threats.

Aggregations of seabirds at sea may be very sensitive to oiling, and such areas of aggregations may have high vulnerability to oil spills which could reach the sites from far away (1000 km or more). The aggregations may also be sensitive to disturbances from human activities, but the spatial range of such factors would be much shorter than in the case of an oil spill. Activities would generally have to

be carried out fairly close to the animal aggregations in order to cause disturbance. If there are no activities and none are planned, an ecologically important area might be considered not to be vulnerable and no protective measures would be required, at least in the short run. However, protective measures may also be put in place on a precautionary basis, to prevent future activities and threats to develop. Thus vulnerability can be considered both in a specific context of threats from existing or planned activities, and in a more proactive and hypothetical context of *potential vulnerability* should activities occur in the future. Such potential vulnerability is particularly relevant in the case of oil spills (from marine shipping or other activities) which could travel long distances between where an accident took place and where impacts could potentially occur.

The close relationship between sensitivity or vulnerability and ecological importance is reflected in sets of criteria for identification of areas, as we describe in the next section. This report uses the IMO PSSA criteria (Particularly Sensitive Sea Areas) to evaluate the importance of the areas identified as being of heightened ecological significance.

Criteria for sensitive and ecologically important areas

There are several sets of criteria to identify sensitive and ecologically important areas. Of particular relevance and importance in the present case are the IMO criteria for 'Particularly Sensitive Sea Areas' (PSSA) (IMO 2002), which is mentioned as an appropriate tool in AMSA Recommendation IID. Another set of criteria has been adopted by the UN Convention on Biological Diversity (CBD) for identifying 'Ecologically and Biologically Significant Areas' (EBSAs). The International Union for the Conservation of Nature (IUCN) has also proposed criteria for identifying Marine Protected Areas (MPAs).

The PSSA criteria are part of the revised guidelines for the identification and designation of Particularly Sensitive Sea Areas that was in adopted in December 2005 (Resolution A.982(24); http://www.imo.org/Environment/mainframe.asp?topic_id=1357 . The guidelines consist of a set of 11 ecological, 3 socio-economic, and 3 scientific criteria. The ecological criteria are included here as Annex 2.

A comparison of the various sets of criteria shows that they are broadly the same (Table 3; Skjoldal and Tolopova 2010). One reason for the high degree of similarity between the sets of criteria is that the IUCN criteria for MPA, published in 1992, has been used as model in the development of the other two sets. The fact that the criteria are similar for identifying 'sensitive areas' and 'ecologically significant areas' reflects the coincidence of these features; areas are considered sensitive because they support aggregations of wildlife or other features which also are ecologically significant.

Table 3. Comparison of criteria for identifying 'Ecologically and Biologically Significant Areas' (EBSAs), Marine Protected Areas (MPAs) and 'Particularly Sensitive Sea Areas' (from Skjoldal and Toropova 2010).

CBD EBSA	IUCN MPA	IMO PSSA
Uniqueness or rarity - Species, populations, communities - Habitats or ecosystems - Geomorphological or oceanographic features	Rare biogeographic qualities Unique or unusual geological features Rare or unique habitat	Uniqueness or rarity
Special importance for life-history stages of species - Breeding grounds, spawning areas, nursery areas, juvenile habitat, etc - Habitats of migratory species	Presence of nursery or juvenile areas Presence of feeding, breeding or rest areas	Spawning, breeding and nursery grounds Migratory routes Critical habitat for the survival, function, or recovery of fish stocks
Importance for threatened, endangered or declining species and/or habitats	Presence of habitat for rare or endangered species Rare or unique habitat for any species	Critical habitat for rare or endangered marine species
Vulnerability, fragility, sensitivity, or slow recovery - Sensitive habitats, biotopes or species that are functionally fragile or with slow recovery		Fragility
Biological productivity	Ecological processes or life-support systems	Productivity
Biological diversity - Ecosystems, habitats, communities - Species - Genetic diversity	The variety of habitats Degree of genetic diversity within species	Diversity
Naturalness	Naturalness	Naturalness
	Integrity	Integrity
		Dependency
	Representative of a biogeographic "type" or types	Representativity - Bio-geographic importance, representative of a biogeographic "type" or types

Use of the IMO PSSA criteria

The PSSA criterion (4.4.1) on ***uniqueness or rarity*** relates to areas or habitats that are 'the only one of its kind' or that occur only in a few locations. They may be habitats of rare or threatened species, or habitats used for feeding or breeding. Use of this criterion is scale dependent. An area may be unique or rare at the scale of the whole Arctic. Since the Arctic itself is globally unique, this would generally mean that an area would be unique or rare also at the global scale. Within the Arctic, an area may be unique or rare at a smaller scale, e.g. nationally, or regionally in a biogeographic sense. At this scale, unique or rare may reflect two very different aspects. It may be that a species (or ecological feature) is unique or rare in a country or region because its occurrence there represents the periphery of the distributional area of the species. It may thus be common or abundant in other Arctic regions or countries. In the opposite case, a species (or feature) may be genuinely unique or rare, occurring only (or mainly) in that region or country. In this situation the significance of unique or rare becomes much larger than in the former case. To this picture must be added the fact that many common Arctic species of birds and mammals with circumpolar distribution are not homogenous but occur with different populations and subspecies in different parts of the Arctic (e.g. between the Atlantic and Pacific sectors, or between the Eurasian and North American sides).

In using the 'uniqueness or rarity' criterion, we have generally scored this according to the overall pan-Arctic scale. However, we have also given weight to the occurrence of different subspecies or clearly defined migratory populations when using the criterion in several cases. For example, we have considered the major polynyas (North water, North-East Water, Great Siberian, St. Lawrence Island) as unique features that are of great ecological importance. We have also considered the migration route of bowheads and belugas up though the lead system along northwestern Alaska as a unique ecological feature. Also the main spawning area for Atlantic cod in the Lofoten area is an example of an area we have considered unique due to the great ecological (and economical) importance of this cod stock in the Barents Sea ecosystem.

Criterion (4.4.2) on ***critical habitat*** relates to areas that 'may be essential for the survival, function, or recovery of fish stocks or rare or endangered marine species, or for the support of large marine ecosystems'. We have taken this criterion to not only relate to fish stocks and rare or endangered species, but also to apply to areas that are essential for marine mammals and marine and coastal birds. Since many areas have been identified as ecologically important because they are used by fish, birds and mammals for various purposes (such as staging, migration, breeding, and feeding) during their life or annual migratory cycles, most of the areas qualify on this criterion.

There is considerable overlap between the criterion on critical habitat and criterion (4.4.7) on ***spawning or breeding grounds***. This latter criterion specifies that it may apply to areas that are critical spawning or breeding grounds or nursery areas for marine species, and also areas that are recognized as migratory routes for fish, birds, mammals, or invertebrates. Thus this criterion has a broader applicability than just spawning or breeding grounds. We have included staging areas that are used by birds in preparation for breeding or migration as relevant for this criterion. Most of the

identified areas of heightened ecological significance that score on the 'critical habitat' criterion we have scored also on the criterion on 'spawning or breeding grounds'.

Criterion (4.4.3) on ***dependency*** is specified to apply to areas where ecological processes are highly dependent on biotically structured systems such as coral reefs and kelp forests. It also includes migratory routes of fish, birds, mammals, and invertebrates. We have interpreted this criterion to also apply to areas where there is a dependency on sea ice. This include polynyas and ice edge habitats, and also whelping areas for seals on sea ice and spawning areas for polar cod under ice. We have not included breeding colonies of seabirds in the criterion although there is also here dependency on cliffs in many cases that offer the combination of safe breeding conditions (from terrestrial predators) and access to food in nearby sea areas.

Criterion (4.4.4) on ***representativeness*** applies to areas that are outstanding and illustrative examples of specific biodiversity features in a broad sense (including ecological processes, habitats, etc). We have used this criterion to very limited extent. It would require a careful and detailed analysis to choose areas that would make up a *representative selection* among all the areas that would be outstanding and representative examples of specific biodiversity features in the Arctic. The criterion could also have been applied more liberally in that many or most of the identified areas of heightened ecological significance could also be seen as good examples of Arctic biodiversity features.

Criterion (4.4.5) on ***diversity*** specifies areas that 'may have an exceptional variety of species or genetic diversity or includes highly varied ecosystems, habitats, and communities'. We have also used this criterion to limited extent. The Arctic is generally thought of as poor in species numbers compared to other biomes. This notion may not be entirely correct as suggested by fairly large number of benthic invertebrates. However, it applies to many groups such as fish, where the species number declines from the subarctic into the High Arctic (Mecklenburg et al. 2011). Higher number of species in some areas may reflect biogeographical transition zones where e.g. boreal and arctic species overlap in the peripheries of their distributions. We have used the diversity criterion in a few cases where there is particular richness of species or diversity of ecological features such as in the Aleutian Islands and in the Bering Strait region.

Criterion (4.4.6) on ***productivity*** applies to areas that have a particular high rate of natural biological production as a net result of biological and physical processes. Examples that are given are oceanic fronts and upwelling areas. We have used this criterion where the rate or magnitude of basic primary production is enhanced such as in polynyas and in the Bering Strait region. We have also used the criterion for spawning areas for fish that provide a food source for consumers such as seabirds and seals. Large seabird breeding colonies are often located near spawning areas or drift routes for fish larvae and juveniles or where there is an abundant supply of zooplankton due to the physical regime (such as currents or fronts). Feeding areas for polar bears and seals in the marginal ice zone are characterized by concentrated occurrence of prey and are considered to qualify for the productivity criterion.

Criterion (4.4.8) on ***naturalness*** has been used for nearly all the identified areas of heightened ecological significance. The Arctic in general and the identified areas in particular have relatively low levels of human presence, activities and disturbances. We have not considered the general pollution situation, which may be serious in some cases (e.g. with Persistent Organic Pollutants; AMAP 2010a), nor climate change to represent a significant deviation from naturalness. The Arctic environment is clearly not pristine with respect to contaminants and adverse health effects on Arctic top predators such as polar bears have been documented with potential effects at animal population level (AMAP 2009). Climate change is likely to be ongoing (in addition to natural climate variability) but it is as yet difficult to ascribe observed changes to climate change rather than as expressions of the effects of natural climate and ecosystem variability. Climate change represents clearly a threat as it becomes more clearly expressed and pronounced in the future.Fisheries and hunting are other activities that have effects on subarctic and arctic ecosystems. Fisheries have clear effects on the targeted stocks and are likely to have indirect effects through food-web interactions on other dependent parts of the marine ecosystems. Nevertheless we have considered that the ecosystems are operating in a natural mode and manner, even if there are disturbances from fisheries and other exploitation.

The criterion on naturalness relates to the criterion on fragility (see below), where the issue of stress from natural and anthropogenic causes are considered. This includes in a general sense the stresses from pollution, climate change and fisheries.

The criterion (4.4.9) on ***integrity*** applies to an area that constitutes a biologically functional unit, or 'an effective, self-sustaining ecological entity'. Few areas we have identified qualify according to this criterion. The majority of areas are habitats used by fish, birds, and/or mammals at some stage during the life or annual migratory cycles. These areas would generally not be considered as 'self-sustaining ecological entities' in isolation, but rather being habitat entities that contribute to the integrity of the larger ecosystem of which they are functionally important parts.

The criterion (4.4.10) on ***fragility*** applies to areas that are highly susceptible to degradation by natural events or by the activities of people. This is an important criterion that relates to the relationship between ecological importance and sensitivity or vulnerability that was disussed in a previous section. The criterion recognizes the cumulative effects or stresses from natural variation and events and those resulting from human activities. In the explanation of the criterion, it is stated that "an area already subject to stress from natural and/or human factors may be in need of special protection from further stress, including that arising from international shipping activities".

The fragility criterion reflects the intrinsic properties of species or habitats and the specific ecological setting which determines whether sensitive or fragile species or habitats occur concentrated in a given area. It also reflects the potential vulnerability in relation to oil spills and disturbances from shipping activities, should such activities take place in or near an area. It is <u>not</u> vulnerability as would be reflected in the outcome of a risk analysis. The IMO PSSA guidelines contain a set of criteria (under Section 5 - Vulnerability to impacts from international shipping) that are to be applied to anlyse the risk posed by international shipping activities for a given area that qualifies according to

the ecological criteria that we consider here. The criteria for the vulnerability assessment include vessel traffic characteristics and natural (hydrographical, meteorological, and oceanographic) factors.

Nearly all the areas of heightened ecological significance that we have identified score on the fragility criterion. This is because of the nature of the areas, being habitats used by fish, birds and/or mammals during critical or important stages in their life or migratory cycles. As we have discussed in a previous section, there is a close relationship between the ecological importance and sensitivity to oil spills and disturbances, and therefore also between the scores on the criteria on 'critical habitats' and 'spawning or breeding grounds' (including seasonal migrations) and on the fragility criterion.

The criterion on ***bio-geographic importance*** applies to areas that either contains rare biogeographic qualities, or is representative of biogeographic types, or contains unique or unusual features (biological, chemical, physical or geological). We have used this criterion in a restricted sense for areas that are important for endangered species or contain some special features. For example, this include areas that are important for the critically endangered Spitsbergen stock of bowheads in the Greenland Sea, areas used by the Laptev walrus, some of the High Arctic breeding areas for birds e.g. on Severnaya Zemlya, and the spring migration corridor for bowheads and belugas along northwestern Alaska. We have also used this criterion for areas that are important staging areas for migratory birds (e.g. on Iceland) and for ecologically dominant species (e.g. spawning areas for major fish stocks that play particularly large roles in the ecosystems).

Approaches for identification of areas

The ecologically important areas have been identified by three different routes or approaches. For many areas we have used the information compiled and used to assess vulnerable areas in the 'Oil and gas assessment' (AMAP 2007, 2010b). This has been the case for 11 of the 17 Arctic LMEs which have been used as geographical units for the identification of areas.

Canada and Denmark/Greenland have had national processes whereby they have identified ecologically important areas for their waters. For Canada these have been areas identified as 'Ecologically and Biologically Significant Areas' (EBSAs).

The three approaches are described in some more detail in following sections. While there are some differences among the approaches, the outcome is broadly comparable. In all three cases, the emphasis has been on the use of areas by fish, birds and marine mammals.

Assessment of Oil and Gas Activities in the Arctic

The Assessment of Oil and Gas Activities in the Arctic (OGA 2007, 2010) has been a major activity and product under the Arctic Council with the work lead by AMAP. The OGA Summary report, *Arctic Oil and Gas 2007*, was published in 2008. Work on the full scientific report has continued since then,

filling in gaps and editing the material. Two volumes (on the industry, chemistry and effects) were published in 2010. The third volume (Chapter 6 *Status and vulnerability of Arctic ecosystems*) is now undergoing final editing and is expected to be published in summer 2013. Draft versions of the scientific OGA 2010 report are available from the AMAP webpage (http://www.amap.no/oga/).

The OGA report (AMAP 2008) identified oil spills as the largest threat to the Arctic marine environment and recognized a number of potential effects from disturbances associated with oil and gas activities including ship traffic. The OGA results on effects and identified vulnerable areas to oil spills and disturbances were used as a source of information for the environment section of AMSA. Due to the similarity of environmental threats and impacts from oil and gas activities and from shipping, with oil spills recognized as a major threat in both cases, the OGA 2007/2010 is particularly relevant to the AMSA IIc project work.

The OGA 2007/2010, and particularly the information compiled for its Chapter 6 'Status and vulnerability of Arctic ecosystems' (in prep), was a major source of information for the identification of areas of heightened ecological significance in this Report. The Report also benefited from new and relevant information provided by various Arctic States.

OGA Chapter 6 has summarized information on species (and subspecies and populations where relevant) both at the general pan-Arctic scale and for each of 17 Arctic LMEs. The information on use by species of fish, mammals and birds of areas for purposes such as wintering, migration, staging, breeding, feeding, molting, and resting was used to identify areas that were ecologically important and assessed to be vulnerable to oil spills and disturbances from activities associated with oil and gas development.

OGA Chapter 6 contains 4 linked elements for each of the Arctic LMEs:

- A *description* of the LME with emphasis on species of birds and mammals. This part is fully referenced to the sources of the compiled and used information.
- An assessment with *identification of vulnerable areas* based on ecologically important aggregations of species considered sensitive to oil spills and disturbances.
- A *summary table* of the identified vulnerable areas with information on dominant species and time of the year when the areas are used (and therefore are vulnerable).
- One or more *maps* showing the geographical locations of vulnerable areas for fish, mammals and birds.

We have used the tables and maps of vulnerable areas as a basis for identification of areas of heightened ecological significance in the present IIc project. We have combined overlapping and/or adjacent 'OGA areas' into larger areas but kept reference to the 'OGA areas' in our tables. In order to keep this report relatively short, we have not repeated the basic information on species or the assessments leading to the identification of the ecologically significant areas. Instead we have provided short descriptions of each area that give the justification for why the area is considered to

be of heightened ecological significance. Further documentation and references to sources of basic information is given in OGA 2010.

We have used other sources of information additional to OGA 2010 where relevant and available.

Process used in the identification of "areas of heightened ecological significance" for Canadian waters

A scientific advisory process was held in June 2011 to peer-review existing information in order to identify marine Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. This advisory process included 32 experts from Canadian federal departments, academia, Inuit organisations, and environmental non-governmental organisations with a wide range of expertise (e.g. cetaceans, pinnipeds, polar bears, seabirds, corals and sponges, zooplankton, etc.). EBSAs were identified based on the National Framework for the Identification of EBSA (DFO 2004), which uses criteria very similar to those used for identifying EBSA in marine areas as defined in Annex I of Decision IX/20 of the 9th Conference of Parties of the Convention on Biological Diversity (CBD).

The scientific peer-review process produced a report titled 'Identification of ecologically and biologically significant areas in the Canadian Arctic' (DFO 2011) as well as a primary background paper (Cobb 2011) that considered an extensive list of reference material to support their conclusions. Similar scientific peer-reviews were previously conducted exclusively for the Beaufort Sea (Paulic et al. 2009) and northern Foxe Basin (DFO 2010). The Canadian submission to the AMSA IIC exercise is based primarily on these four documents (and the references cited therein) and represents the scientific advice on the identification of marine EBSAs in the Canadian Arctic.

The EBSAs presented here are not meant to represent a general strategy for protecting all the identified habitats and marine communities identified. Rather, they intend to call attention to areas with particularly high ecological or biological significance in order to facilitate provision of a higher degree of risk aversion in management actions, where and when appropriate. A threat assessment for identified Canadian Arctic marine EBSAs has not yet been conducted so vulnerability cannot yet be confidently reported. A scientific process to determine threats will be carried out by Canada and will be the primary source for input into decisions in Canadian waters. Such a process would take AMSA IIC into account.

Traditional Ecological Knowledge (TEK) was considered where available. Through a series of formal consultation processes, the identified EBSAs have been formally communicated to Inuit and their input solicited.

Identification of "areas of heightened ecological significance" for Greenland waters

The identification and delineation of the sites presented is based on the best available information. Over the last decade considerable effort has been invested in identifying marine areas and coastlines vulnerable to oil spills as well as key habitats, migration routes, population size and ecology of sensitive species and resources in Greenland, resulting in a number of strategic environmental assessments (SEIAs) for hydrocarbon exploration and exploitation activities. The SEIAs are made for the Greenland Bureau of Minerals and Petroleum by scientific environmental institutions (Danish Center for Environment and Energy, Århus University (previously called NERI) and Greenland Institute for Natural Resources). These SEIAs builds on peer reviewed scientific literature and supplementary scientific studies. In each SEIA the sources to primary literature can be found. In early 2011 the Danish Ministry of the Environment requested Aarhus University - Danish Center for Environment and Energy (previously Danish National Environmental Research Institute, NERI) to compile a technical report identifying ecologically valuable and sensitive marine areas in relation to increased shipping activities in Greenlandic water (Christensen *et al.* 2012). This technical report to a large extent builds on the SEIAs mentioned above, and identifies the areas of heightened ecological significance in Greenland waters.

The Areas of Heightened Ecological Significance proposed for the Greenland waters are presented for two Large Marine Ecosystems: Greenland Sea LME and Baffin Bay-Davis Strait LME. For each identified area, a brief description of the ecological significance is given, focussing on key areas for fish, seabirds and marine mammals, as these are the taxa most likely to be directly affected by shipping-related activities. The proposed boundaries of the areas are illustrated on the attached maps along with information on the species that use the areas ().

Use of references

A large body of primary scientific literature has been used in the processes to identify and document the areas of heightened ecological significance. OGA Chapter 6 provides the detailed information for the areas and should be consulted for primary references. We have extracted and populated the text in the present report for the Chukchi Sea LME (we may attempt to do this also for other areas). For the Canadian areas the main references are the background document and report from the scientific peer-review process in June 2011 (Cobb 2011, DFO 2011), which provides a lead to the more detailed information. For the Greenland areas, references to the information have been included. In many cases this is to strategic environmental impact assessments (SEIAs) which provide the primary literature for the information.

The basic sources of information should be consulted for further details when it comes to consider the need for and types of protective measures for the identified areas. We have facilitated the tracking of such information by providing references to systems of indexes which provide the links to sections of the basic documents where more information can be found. This includes indexes to

vulnerable areas in OGA, EBSAs in the Canadian submission, and identified areas in Greenland waters.

Key features and species of Arctic marine ecosystems

Physical constraints for marine life

The physical environmental conditions set the stage for marine life in the Arctic. The low temperature at the freezing point for seawater (-1.8^{o}C) requires that cold-blooded animals (invertebrates and fish) have physiological mechanisms such as anti-freeze substances in their body fluids. For those that have this as an adaptation to life in the Arctic, temperature as such is not a major challenge. It does not get colder than -1.8^{o}C, which is relatively warm compared to the bitter cold temperature in the air. Warm-blooded animals (mammals and birds) need insulation in the form of blubber, fur or feathers. The biggest challenge is the ice which may prevent access to air for breathing in the case of the marine mammals, or access to food for both mammals and birds.

There is very large seasonality in the environmental conditions and the basic productivity of Arctic waters between winter and summer. Sea ice (particularly if covered with snow) limits the light for primary production by algae. In spring and summer when the ice melts, there is a burst of production by phytoplankton in the water column and by ice algae in and on the underside of ice. This fuels reproduction and growth of zooplankton, which again is the food for small fish, many seabirds, and large baleen whales. In areas with seasonal ice cover, there is often an ice edge phytoplankton bloom that follows the northwards retreat of the ice as it melts away. In the central parts of the Arctic with persistent pack ice, ice algae play a larger relative role for the seasonal and annual production. The productive period may last about 6 months (April-September) in the southern extent of ice, while being much shorter (2-3 months) in the High Arctic. Ice edge blooms are important not only for zooplankton and other life in the water column but also for benthos since much of the blooms sinks ungrazed as an input of food and energy to the bottom communities on Arctic shelves.

Polynyas

Polynyas are areas of open water in the ice. Some of them remain open throughout winter while others open or expand in extent in late winter and spring. Polynyas are of two main types. Mechanical or 'latent heat' polynyas are driven by persistent winds that carry ice away and thus keep the water open. Such polynyas occur on the lee side of islands, peninsulas, ice-bridges or landfast ice. 'Sensible heat' polynyas are kept open by transport of warm water (warm means not at freezing temperature). The energy flux from open water in polynyas under arctic winter conditions can be formidable with rates of about 1 kW per m^2. This flux goes to generate ice (down-stream in sensible polynyas) and the cumulative ice formation per unit area may be up to 30 m or more during a winter season. Through such mechanisms, polynyas greatly influence the formation and melting of sea ice.

They are called «factories of ice», highlighting the fact that up to 70% of the total volume of sea ice developing in the Arctic seas may be produced in polynyas. In contrast to this role in winter, the open waters of polynyas are accumulating heat and become centers of seasonal sea ice decay in spring and summer. Polynyas also influence the hydrography of Arctic waters by causing an increase in the salinity of surface water when ice forms, leading to convection.

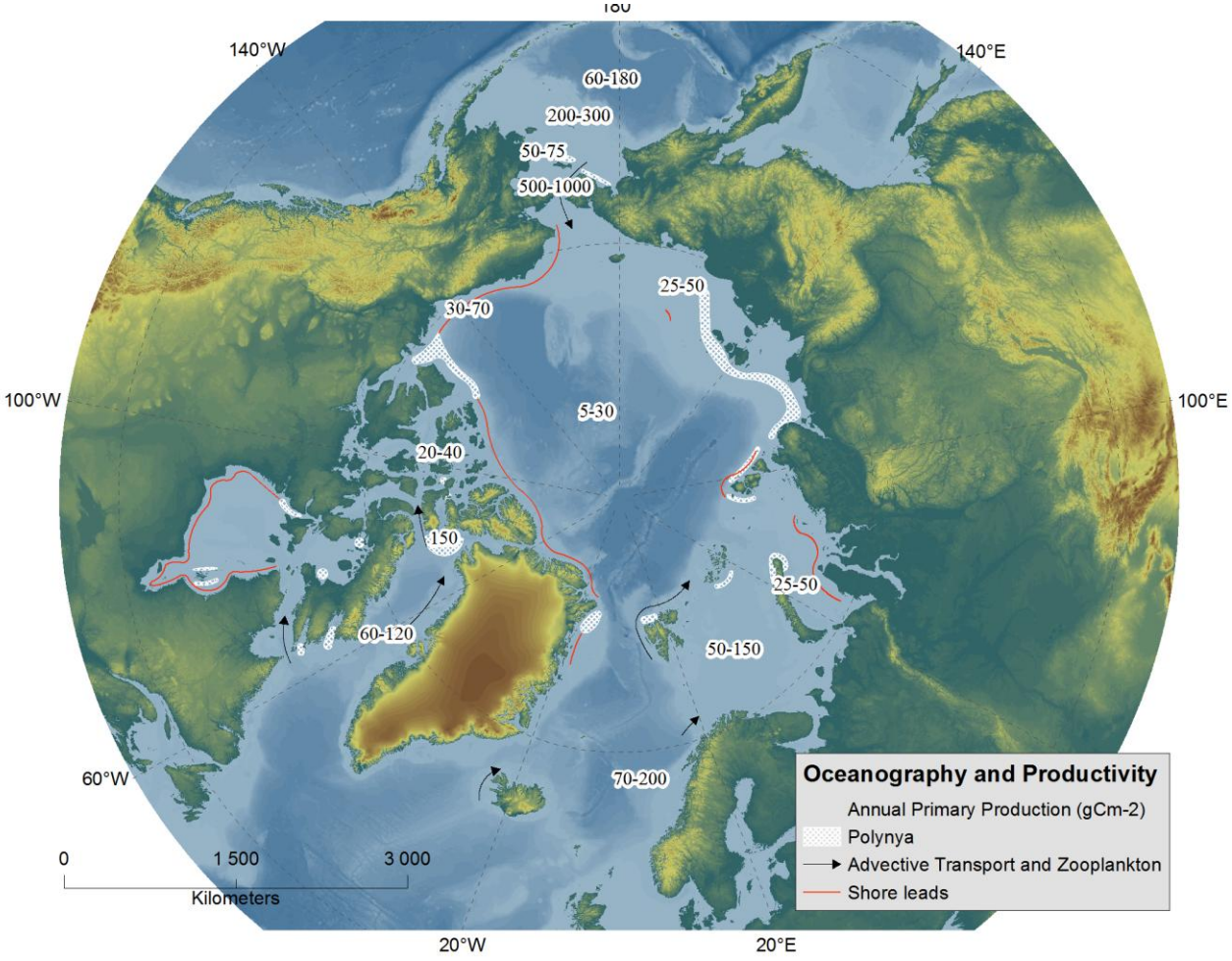

Figure 1: General oceanography and biological production of the Arctic Ocean

Polynyas play important ecological roles (Stirling and Cleator 1981, Stirling 1997). They are associated with earlier and higher plankton production which attracts plankton-feeding fish (e.g. polar cod) and other predators, including marine mammals and seabirds. They may have a particular importance for recruitment of polar cod which is a key food item for most of the top predators in the high Arctic ecosystems. Benthic communities of polynya areas are also characterized by increased biomass and species diversity due to enrichment of near bottom layers and sediments with organic matter. Polynyas may serve as wintering areas for marine mammals and birds. They play also an important role as stop-over sites for seabirds and sea ducks during spring migration when they feed in the

polynyas prior to breeding (Figure 1). The largest seabird colonies in the high Arctic are typically associated with polynyas.

Shorelead systems or flaw leads open up along the edge of landfast ice where wind blows the drifting pack ice away. Landfast ice as a 'rule-of-thumb' extends out to about the 20-m isobath, but this may vary dependent on the presence of islands, skerries and other topographic features. Shorelead systems may be very extensive and provide migration corridors for the arctic whales and walrus, and stop-over and feeding sites for seabirds, sea ducks and phalaropes.

The indigenous Arctic peoples have for millennia used recurring polynyas due to the presence of open water in winter and the abundance of seabirds and marine mammals associated with them. This has also been the case for the first polar explorers in more recent centuries. The locations of ancient and contemporary settlements of the indigenous people and the routes of early exploratory expeditions correspond well to the distribution of polynyas.

Productivity

Ice limits the production in Arctic waters. It restricts the light for photosynthesis and limits the length of the season for production. When ice melts, a surface layer of relatively light water of lower salinity is formed which effectively restricts the transport of nutrient-rich water from deeper layers. The basic productivity as phytoplankton primary production spans two orders of magnitude variation over the Arctic area. The highest production is found in the northern Bering Sea and southern Chukchi Sea where the annual production may exceed 500 g C per m^2. On the other end of the spectrum, the annual production in the central Arctic Ocean with dense pack ice may be <5 g C per m^2.

The North Pacific is much more nutrient-rich than the North Atlantic. Therefore the productivity in the Pacific sector of the Arctic is considerably higher than in the Atlantic sector. In the slope waters of the Bering Sea the annual primary production is 200-300 g C m^{-2} compared to 100-150 g C m^{-2} per year in the subarctic waters in the North Atlantic. This high primary production is the basis for the very rich animal life in this area with large populations of plankton-feeding seabirds and of benthic feeding mammals. In contrast, the productivity of the wide Siberian shelves and the Canadian Archipelago is typically rather low, in the range of 20-50 g C m^{-2} per year.

Arctic species

More than 250 species of fish inhabit arctic and subarctic marine ecosystems. There are 35 species of marine mammals that occur within the Arctic area. Most of them are found in the southern sub-arctic parts where many occur as seasonal visitors from lower latitudes (9 species of baleen whales, 13 species of toothed whales, and 11 species of seals including walrus. Two species classified as terrestrial carnivores are also important Arctic species: polar bear and sea otter.

There are about 200 species of birds that regularly occur in marine and coastal areas in the Arctic. There are about 70 species of Seabirds (i.e. auks, gulls, terns, skuas, cormorants, storm-petrels, petrels and shearwaters, and albatrosses), most of them (about 50 species) restricted to the sub-arctic region in the southern parts of the Arctic area (south of areas with sea ice and tundra). Waterfowl (ducks, geese and swans) occur with 50 or so species in the Arctic area, about 20 of them breeding in the true Arctic. A total of about 70 species of shorebirds or waders occur within the Arctic area, with almost 40 of them breeding in the true Arctic.

More information on important Arctic species is given in Appendix 1.

Species of marine mammals and birds in the Arctic area that are globally listed as threatened species on the IUCN Red List (IUCN 2012) are shown in Tables 4 and 5.

Table 4. Red-listed species (IUCN) of marine mammals in the Arctic area. The Red List evaluation is done at the species level, i.e. for the total global population of the species (IUCN 2012). The conservation status may differ among specific populations or subpopulations within species.

Category of Threatened	Species	Latin name
Endangered	North Atlantic right whale	*Eubalaena glacialis*
	North Pacific right whale	*Eubalaena japonica*
	Blue whale	*Balaenoptera musculus*
	Fin whale	*Balaenoptera physalus*
	Sei whale	*Balaenoptera borealis*
	Steller sea lion	*Eumetopias jubatus*
	Sea otter	*Enhydra lutris*
Vulnerable	Sperm whale	*Physeter macrocephalus*
	Hooded seal	*Cystophora cristata*
	Northern fur seal	*Callorhinus ursinus*
	Polar bear	*Ursus maritimus*
Near Threatened	Beluga	*Delphinapterus leucas*
	Narwhal	*Monodon monoceros*

Table 5. Red-listed species (IUCN) of arctic or arctic breeding seabirds, waterfowl and shorebirds. See legend to Table 4.

Category of Threatened	Species	Latin name
Critically endangered	Eskimo curlew [1]	*Numenius borealis*
	Kittlitz's murrelet	*Brachyramphus brevirostris*
	Spoon-billed sandpiper	*Eurynorhynchus pygmeus*
Endangered	Black-footed albatross	*Phoebastria nigripes*
	Marbled murrelet	*Brachyramphus marmoratus*
	Red-breasted goose	*Branta ruficollis*
Vulnerable	Laysan albatross	*Phoebastria immutabilis*

	Short-tailed albatross	*Phoebastria albatrus*
	Pink-footed shearwater	*Puffinus creatopus*
	Red-legged kittiwake	*Rissa brevirostris*
	Lesser white-fronted goose	*Anser erythropus*
	Baikal teal	*Anas formosa*
	Steller's eider	*Polysticta stelleri*
	Bristle-thighed curlew	*Numenius tahitiensis*
Near threatened	Sooty shearwater	*Puffinus griseus*
	Ivory gull	*Pagophila eburnea*
	Long-billed murrelet	*Brachyramphus perdix*
	Emperor goose	*Anser canagicus*
	Yellow-billed diver	*Gavia adamsii*
	Great snipe	*Gallinago media*
	Black-tailed godwit	*Limosa limosa*
	Buff-breasted sandpiper	*Tryngites subruficollis*

Areas of heightened ecological significance

We have identified areas of heightened ecological significance through three approaches as described in a previous section of this report. One approach is based on the areas identified in the AMAP Assessment of Oil and Gas Activities in the Arctic (OGA), while the other two were national processes in Canada and Greenland/Denmark to identify areas for their waters.

In the following texts the identified areas of heightened ecological significance are briefly described, organized by the Arctic LMEs. Each identified area is characterized by a brief text that highlights why the area is important. The areas are summarized in a set of tables and shown in a series of maps, one for each of the Arctic LMEs.[1]

The identified areas of heightened ecological significance are in many cases composed of area components or subareas. With the 'OGA approach' we have identified separately areas that are used by fish, birds, and marine mammals. Overlapping or adjacent areas for fish, birds and mammals have been grouped into larger areas. These areas are numbered consecutively (1, 2, 3, etc) for each of the LMEs, and the numbers are used to identify the areas on the maps and in the accompanying tables. In some cases, the specific areas do not fill the space of the larger areas, but are grouped nevertheless for convenience and comparability in the presentations.

[1] Although LMEs are used in this report for consistency across the entire Arctic, Canada, through a peer-review process, has selected similar, but not identical, biogeographic units as the basis of identifying their EBSAs and for planning and management in domestic waters. Canada will continue to use its own domestic system for domestic activities and in fulfilling commitments under the Arctic Council and other international fora.

The subareas within each area are shown on the maps with different symbols for different use categories (e.g. breeding area, migration corridor, etc) as explained in legends on each of the maps. These subareas are numbered in three series with F for fish, B for birds, and M for marine mammals. The subarea numbers (e.g. F1, B1, M1, etc) are shown on the maps and included in the accompanying tables. The subarea numbers correspond to the index numbers used in OGA Chapter 6 and are identified in our tables under the column heading 'OGA No.'. This provides cross-reference to the OGA Chapter 6 tables and texts that provide more information on the major species of fish, mammals and birds and the time of the year when the areas are used by them and therefore are of heightened ecological significance.

This system (the 'OGA approach') has been used for the following LMEs: Iceland Shelf and Sea, Faroe Plateau, Norwegian Sea, Barents Sea, Kara Sea, Laptev Sea, East Siberian Sea, Chukchi Sea, East and West Bering Sea, and the Alaska portion of the Beaufort Sea LME.The areas identified in the Canadian waters are EBSAs (Ecologically and Biologically Significant Areas). They have been grouped or linked into larger areas and numbered consecutivily for each of the Canadian LMEs, in a manner similar to that used with the 'OGA approach'. The individual EBSAs that make up the larger areas are shown separately on the maps and listed in the tables with a numbering system for each area (1.1, 1.2, 2.1, 2.2, etc.). The original index numbers used to identify the EBSAs in Canada (e.g. B-3.14) have been included in a column in the tables for easy cross-reference to the information in basic documents. Separate subareas or area components withing each EBSA have not been identified. However, information on the use of the EBSAs by fish, birds and marine mammals, similar to that for the 'OGA areas', have been included in the tables for the Canadian areas. The Canadian waters include the Canadian Arctic Archipelago LME, Hudson Bay Complex LME, and the Canadian parts of the Beaufort Sea and Baffin Bay-Davis Strait LMEs.

For the Greenland waters, the identified areas have been numbered in an A series for areas in East Greenland (within the Greenland Sea LME) and in B and C series in West Greenland in the Baffin Bay-Davis Strait LME. The B areas are located along the coast on the inner shelf, while C areas are located (or include) offshore areas on the outer shelf and slope. The identified areas are shown on maps for the Greenland Sea and Baffin Bay-Davis Strait LMEs and listed in the accompanying tables for those LMEs. Separate subareas for fish, birds and mammals have not been identified but information on the use of the areas by these groups is provided in the text and tables for the Greenland waters. In addition, *core areas* have been identified within the larger areas and are shown on the maps. The core areas are areas of highest importance within the larger areas, which all are considered to be ogf heightened ecological significance.

The Baffin Bay-Davis Strait LME includes Canadian and Greenland waters and the identified areas are somewhat different according to the two approaches used to identify and document them, as described above. Nevertheless, the information is comparable as illustrated by the entires in the table (see Table 20) that provide details on the use of the areas by various groups of animals.

Iceland Shelf and Sea LME (Figure 2, Table 6)

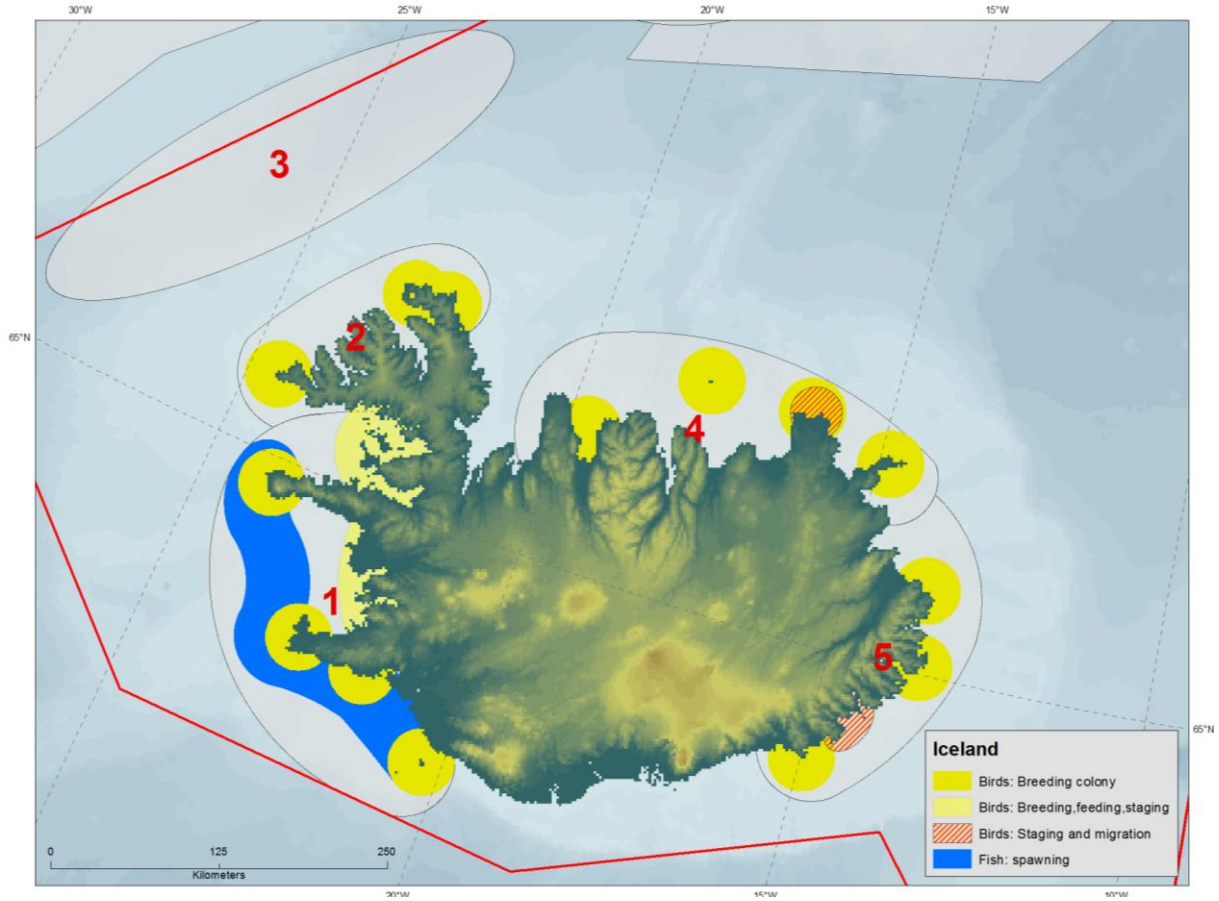

Figure 2. Areas of heightened ecological significance in the Iceland Shelf and Sea LME

Area 1 - Southwest/West Iceland

Coastal banks

Capelin and herring have demersal spawning areas on sandy bottoms along the southwestern and western coasts of Iceland, in the area southeast of the Reykjanes Peninsula to Vestmannaeyjar and in Faxofloi Bay between the Reykjanes and Snæfellness peninsulas. Capelin forms a large migratory population that feeds in the Iceland Sea north of Iceland in summer and it is a key component of the marine ecosystem around Iceland. Herring of the Iceland summer spawning stock is also important both ecologically and commercially. This area contains also the main pelagic spawning grounds for cod of the large migratory Iceland cod stock.

Vestmannaeyjar

There are several important seabird breeding colonies on these islands off the coast of southwestern Iceland. Species include common murre, razorbill and Atlantic puffin.

Reykjanes Peninsula

There are several seabird colonies along the southern and western side of this peninsula (that extends southwest from Reykjavik). These colonies are of moderate size and contain various species of seabirds including auks and gulls.

Snæfellness Peninsula

This peninsula (between Faxaflói Bay and Breidafjördur) in western Iceland holds several smaller and moderate sized colonies of seabirds on its western end.

Faxaflói Bay

This wide bay between Reykjanes and Snæfellness along western Iceland contains large shallow areas in the inner part with many islets and skerries. This is an important breeding, feeding, molting, and wintering area for common eiders. The area contains also large intertidal flats that are used as feeding and staging areas for shorebirds, including stop-over sites for migratory species such as red knot (subspecies *islandica*), dunlin (subspecies *arctica*), and common ringed plovers (subspecies *psammodroma*) between breeding areas in Greenland and wintering areas in western Europe and Africa. Important areas for shorebirds include Alftanes-Akrar, Alftanes-Skoganes, Hvalfjordur, Instavogsnes-Grunnafjördur, and Longafjörur.

Breidafjördur

This broad bay north of Snæfellness also contains large shallow areas with many islands and islets in the inner part. This area provides very important breeding, feeding, molting and wintering habitat for common eiders in Iceland.

Area 2 - Northwest Iceland

Latrabjarg

Latrabjarg is located on Bjargtangar on the westernmost point in Iceland and holds one of the largest seabird colonies here. Both common and thick-billed murres breed in large numbers at this colony and use the adjacent sea areas for feeding and resting during the breeding season.

Hornbjarg and Hælavikubjarg

These are two large seabird colonies located on the northernmost part of the peninsula north of Isafjordur. Hornbjarg holds the largest numbers of breeding common and thick-billed murres in Iceland

Area 3 - Denmark Strait

Offshore waters

The Denmark Strait is a migration corridor for seabirds such as thick-billed murre and ivory gull between breeding areas further north in the northeastern Atlantic sector and wintering areas along southern Greenland, Labrador and Newfoundland. The area is also part of the wintering area for some seabirds such as ivory gull. The endangered North Atlantic right whale which is found mainly along the US east coast may extend its summer feeding range north to the Denmark Strait. The Denmark Strait area is also part of the feeding area for hooded seals of the population that breeds on ice in the Greenland Sea and that has declined markedly during the recent decades.

Area 4 - North Iceland

Drangey, Grimsey, Langanes

There are several large seabird colonies in northern Iceland. Drangey is located in Skagafjördur in the western part and hold moderate numbers of common and thick-billed murres. Grimsey is an island on the shelf off the coast and holds the largest seabird colony in northern Iceland with a relatively large number of thick-billed murres. Langanes is located on the easternmost peninsula in northern Iceland.

Melrakkasletta

Mellrakkasletta is the northernmost peninsula in Iceland and along its northern end there are intertidal areas that are important feeding and staging areas for many shorebirds. It is used as a stop-over area for migratory populations of red knot (subspecies *islandica*) and ruddy turnstone that breed in northern Greenland and the northeasternmost part of Canada.

Area 5 - East Iceland

Skrudur

Skrudur is located at the island Papey off the east coast of Iceland. This is the largest seabird colony in East Iceland. There are in addition several smaller colonies located along the coast north of Skrudur and also to the south at Stokksnes east of Höfn.

Skardsfjördur

Intertidal areas are used as feeding and staging areas for shorebirds. Migratory dunlin from breeding areas at Iceland and Greenland use this site for stop-over and staging.

Greenland Sea LME (Figure 3, Table 7)

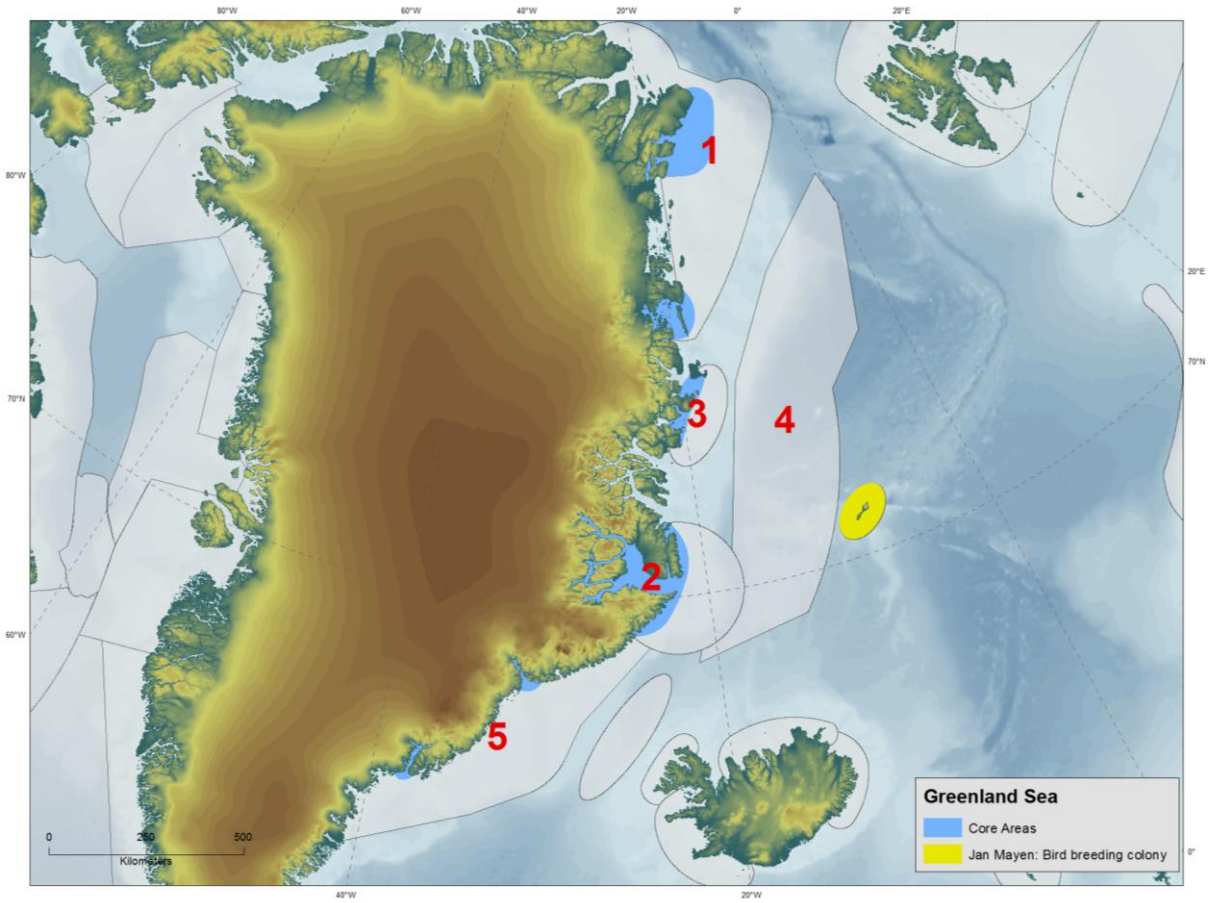

Figure 3. Areas of heightened ecological significance in the Greenland Sea LME.

Area 1. Northeast Water polynya area and Peary Land

The very large (~45,000 km^2) and remote Northeast Water (NEW) polynya is located off the northeastern corner of Greenland. The polynya is kept more or less open a major part of the year by the southward current from the Fram Strait forming a large local gyre (latent heat polynya). The ice edges and currents contribute to an early primary production important for several species. The coastlines and fjords north and south of the polynya contain important areas for seabirds and marine ammals:

- The northernmost breeding colonies, albeit small, of black-legged kittiwake and northern fulmar are found along the coastline of the polynya (Christensen et al. 2012).

- The biggest known breeding colony of ivory gull (approx. 300 birds) in Greenland is found on Henrik Krøyer Holme. Other ivory gull colonies are found on Kronprins Christians Land and Peary Land (Boertmann and Mosbech 2011b).

- Ross's gull (in low numbers), Sabine's gull and arctic tern breed on Henrik Krøyer Holme. Sabine's gull and arctic tern also breeds in relatively large numbers along the coastline of Kilen (Boertmann and Mosbech 2011b).

- The northern part is used as staging and foraging area by Ross's gull in July – September (Falk et al. 1997, Meltofte et al. 1981).

- The polynya is a pre-breeding staging area for sea ducks and also serves as a feeding area during the breeding period. Especially the banks in the northern part of the polynya (off Kilen) are important spring staging areas for king and common eiders (Boertmann and Mosbech 2011b).

- New observations indicate that relatively large numbers of bowhead whales from the critically endangered Spitsbergen stock reside in the area in the summer months (Boertmann et al. 2009b).

- Narwhal is common especially in the southern part of the area (Merkel et al. 2010).

- The NEW is a very important walrus habitat: the majority of the females of the NE Greenland stock occur here all year round and the major part of the calfs are born and raised here. The area is also a very important winter habitat and males from the entire NE Greenland population migrate to the area. The number of animals in the NEW was estimated at 873 animals (on the ice) in 2009; the whole population was estimated to be 1500 animals (Born et al. 2009).

- A significant proportion of the global polar bear population is utilizing the entire NE Greenland, including NEW and the pack ice between Greenland and Svalbard, although with shifting core areas during the year. Data from satellite telemetry indicate that denning areas can be found along the coastlines of the NEW.

Area 2. Scoresby Sound fjord and adjacent fjord areas on Blosseville coast

- The fjords and the surrounding sea areas in the Scoresby Sund area are very important to several species. A polynya with a well defined ice edge occurs close to the mouth of the fjord. Also a shear zone may occur (with open cracks and leads) between the land-fast ice and the drift ice. In summer the adjacent fjords and coastlines, including the Blosseville Coast, are important for some species.

- Narwhals of the Northeast Atlantic stock (or stocks) have summering areas in fjords in the Scoresby Sund area and further south along the Blosseville Coast. The population in the southern part of East Greenland (Scoresby Sound, Kangerlussuaq and Tasiilaq) was estimated at 6444 animals (Heide-Jørgensen et al. 2010) in 2008. Narwhals are numerous at the ice edge at the mouth of the Scoresby Sound in spring until the fjord opens.

- The water east of Scoresby Sund is probably an important foraging area for the critically endangered Spitsbergen stock of bowhead whale (Gilg and Born 2005).

- Polar bear frequently occur in the polynya at the entrance to Scoresby Sound and the Blosseville Coast, and the inner parts of the Scoresby Sound fjord complex are regularly used for maternity denning (Boertmann and Mosbech 2011b).

- The polynya at the mouth of Scoresby Sund is an important seabird habitat where high concentrations of seabirds may be found in spring and summer, including common and king eiders and millions of little auks. The polynya is also important staging habitats for migrant waterfowl (some of which breed inland) in spring. The largest concentrations of breeding colonial seabirds in East Greenland are found on the coasts of the Scoresby Sound polynya, where an estimated 3.5 million little auks breed in a large number of colonies, several thousand thick billed murres breed in two colonies (the only colonies in East Greenland), and a few thousand black legged kittiwakes are also breeding in this area (Boertmann and Mosbech 2011b).

- Ivory gull breeds in small numbers on nunataqs at the Blosseville Coast (Christensen et al. 2012).

- The coastline along the Blosseville Coast is important as moulting and staging area for common and king eiders (Merkel et al. 2010).

Area 3. Sirius Water/Young Sund Polynya

This relatively small polynya is located further north from Scoresby Sound in Northeast Greenland. It creates conditions for a relatively diverse and productive ecosystem and the area is an important breeding and staging area for many species:

- The polynya is important as staging area for spring migrating waterbirds with common eider as the most important species; app. 14,000 common eiders, 200 king eiders and 1500 long-tailed ducks were counted here during a survey in spring 2008. It is also important for breeding seabirds with Arctic tern, Sabine's gull, kittiwake and common eider as the most important (Boertmann et al. 2009a). Approx. 3000 pairs of common eider breed in this area (Boertmann and Mosbech 2011b).

- Sabine's gull concentrations occur along the coast, including one of the largest colonies in Greenland (approx. 300 birds) together with Arctic terns in Young Sound (Christensen et al. 2012).

- High numbers of ivory gull migrate through the area in spring and autumn (Christensen et al. 2012).

- The coastal waters and banks in this area are important feeding grounds for walrus. The East Greenland stock (about 1500 animals) use several haul-outs along the coast during the summer season, north from about 75°N (Born et al. 2009, NAMMCO 2009).

- The coast serves as a denning area for polar bears which also occur in the ice-covered waters off the coast (Born et al. 2009, NAMMCO 2009).

- Bowhead whales from the critically endangered Spitsbergen population occur regularly (Boertmann and Mosbech 2011b).

- Climate change baseline research site (Jensen and Rasch 2010).

Area 4. Sea ice in the western Greenland Sea

The drift ice zone in the general areas northwest and west of Jan Mayen contain early spring foraging conditions for migrant seabirds and mammals. The area is significant because:

- Harp and hooded seals from the "West Ice" populations assemble in a common whelping area in March and April. Approximately 600,000 – 700,000 adult harp seal (and approx. 100,000 pups) and 70,000 adult hooded seal (and approx. 15,000 pups) are dependent on the ice here. The female seals remain with their pups on the ice for a period of about 12 and 4 days, respectively, before the pups are left alone. The seals aggregate some months later to moult on the pack ice to the north of the whelping areas (Aastrup and Boertmann 2009).

- The western Greenland Sea is a wide migration corridor in late summer and autumn for large numbers of seabirds from breeding areas in the Barents Sea on their way to winter quarters in Davis Strait and the northern Labrador Sea. These birds include thick-billed murres (more than 1.5 million adults and several hundred thousands flightless chicks) and little auks (more than one million); the major part of the global population of ivory gulls follows this route. The first weeks of the migration is for the murres a swimming migration, when the adult birds are flightless due to moult and the chicks are not yet able to fly (Boertmann and Mosbech 2011b).

- The entire drift ice zone is an important polar bear habitat. Densities vary across the area and over the year, largely governed by fluctuations in the distribution and density of ice and prey (Boertmann and Mosbech 2011b).

Area 5. South East Greenland and Denmark Strait

The East Greenland Current carries cold and low salinity polar surface water and the polar pack ice southwards along the East Greenland coast which is strongly influenced by the drift ice ("storis") during spring and summer. A branch of the warmer North Atlantic Current turns west and southward towards Greenland, flowing parallel to the East Greenland Current. Here a relatively productive area occurs around Dohrn Bank. The area contains:

- In the central parts of Denmark Strait (Dohrn Bank etc.) the critically endangered North Atlantic right whale has been observed several times and the area is regarded as a critical habitat for this species (Boertmann and Mosbech 2011b).

- The Iceland-East Greenland-Jan Mayen capelin stock undertakes extensive feeding migrations into the Denmark Strait Sea during summer. Also Greenland halibut as well as Atlantic cod (trawling) fishing grounds occur in the area (Boertmann and Mosbech 2011b).

- Large numbers of summering narwhals is known to occur in some of the fjords, particularly Kangerlussuaq (Boertmann and Mosbech 2011b).

- Other toothed whales (primarily sperm whale and northern bottlenose whale) are known to occur in the eastern part of the area, and also the baleen whales blue-, fin- and seiwhales are frequent (Boertmann and Mosbech 2011b).

- The area is part of the general wintering range for walrus (Boertmann and Mosbech 2011b).

- The pack ice along the entire SE Greenland coast is an important moulting area for hooded seal in June – September (Andersen et al. 2009).

- The area around Kangerlussuaq holds polar bear maternity dens (Laidre et al. 2010a).

- The coastline and the ice edge along SE Greenland are important for ivory gull. During the summer months the Blosseville Coast (including the northern part of this area) is used by foraging breeders, whereas the same area is used for staging migrating birds from the NE Greenland and Svalbard breeding populations. The southern part of the area is an important winter quarter (Gilg et al. 2010).

- The entire coastline (and further south to Cape Farewell) is used by common eiders in spring and summer (more than 18,000 birds have been recorded): Staging and moulting birds occur in small flocks with the highest concentrations in the fjords of the Blosseville Coast. Some may be from the Icelandic breeding population. Also a local breeding population (approx. 3,200 pairs) is dispersed in many colonies along the coast (Merkel et al. 2010).

- The little auks breeding in Scoresby Sund and Svalbard (millions) and thick-billed murres from Svalbard, Jan Mayen and Iceland use the Irminger current through this area during their migration to wintering grounds in West Greenland and eastern Canada (Boertmann).

- From August to November (most in August immediately after the breeding season) a proportion of the black-legged kittiwakes in the North East Atlantic occur in the eastern part of this area between Iceland and Greenland (Christensen et al. 2012).

Faroe Plateau LME (Figure 4, Table 8)

Area 1. Faroe Islands

The waters around the Faroe Islands are important areas for birds that breed and visit this area. The Faroes Islands are home to about 1.7 million breeding pairs of seabirds with northern fulmar, Atlantic puffin, European storm-petrel, black-legged kittiwakes and common murres as the most numerous species. There are 18 major breeding colonies, all of them of international importance. The waters around the archipelago are used as foraging areas for the breeding birds as well as by large numbers of non-breeding birds. Common eider breeds at the Faroe Isles with a separate and endemic subspecies (*faeroeensis*) which is resident around the islands year-round. The sensitivity to oil spills and disturbances is largest during the breeding season in summer, but the waters around the Faroes Isles hold large numbers of seabirds also outside the breeding season, including wintering birds from breeding colonies further north.

Norwegian Sea LME (Figure 4, Table 9)

Area 1. Norwegian coast and shelf - Møre-Helgeland

The main spawning grounds for the large Norwegian spring spawning herring stock are on coastal banks off the county of Møre adjacent to the southeastern Norwegian Sea (F1). This is an area where the shelf is relatively narrow with a steep slope to the deep-water. There are large seabird colonies in this area, notably on the island of Runde just off the coast (B1). There are also important seabird colonies further north on archipelagoes at the coasts of Trøndelag and Helgeland (B2, B3). Atlantic puffin is a major species along with gulls, cormorants and others. There are also many common eiders along this coast.

Harbor and grey seals occur along the coast with larger colonies at the Froan archipelago in Trøndelag and at the coast of Helgeland further north (M1).

There are several large reefs or reef complexes of the cold water coral *Lophelia* on the shelf along the eastern Norwegian Sea (BH1).

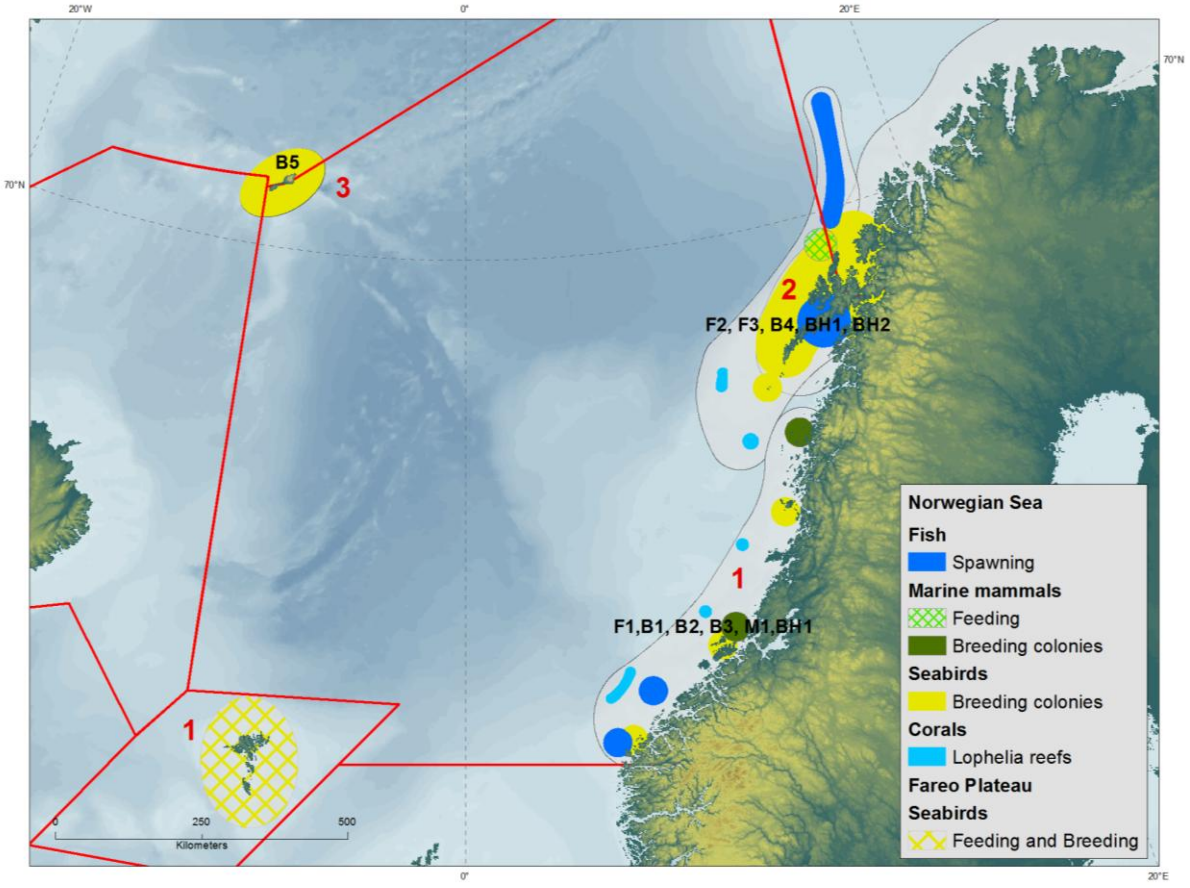

Figure 4. Areas of heightened ecological significance in the Norwegian Sea LME and the Faroe Plateau LME.

Area 2. Lofoten area

Lofoten is the main spawning area for the large stock of Atlantic cod in the Barents Sea. Spawning takes place both on the inner side of the Lofoten archipelago in Vestfjorden and on the shelf outside in Vesteraalen (F2). Greenland halibut of the Barents Sea stock spawns along the steep slope in this area (F3).

The Lofoten area is important for seabirds, particularly in the outermost part of the Lofoten archipelago where there are large colonies at the island of Røst (B4). Atlantic puffin is particularly abundant here along with many other species of seabirds.

The largest known *Lophelia* reef (Røst-revet) lies at the shelf edge west of Røst (BH1). Further north where the shelf is very narrow off Andøya, there is a pronounced canyon (Bleiksdjupet) running down the continental slope (BH2). This area is an important feeding area for whales, notably sperm whales that dive to feed on deep-water squid and fish.

Area 3. Jan Mayen Island

Important habitats of conservation concern for seabirds in this LME include the seabird breeding areas on the island of Jan Mayen (B5), the most remote island in the Arctic in terms of distance to other land.

Barents Sea LME (Figure 5, Table 10)

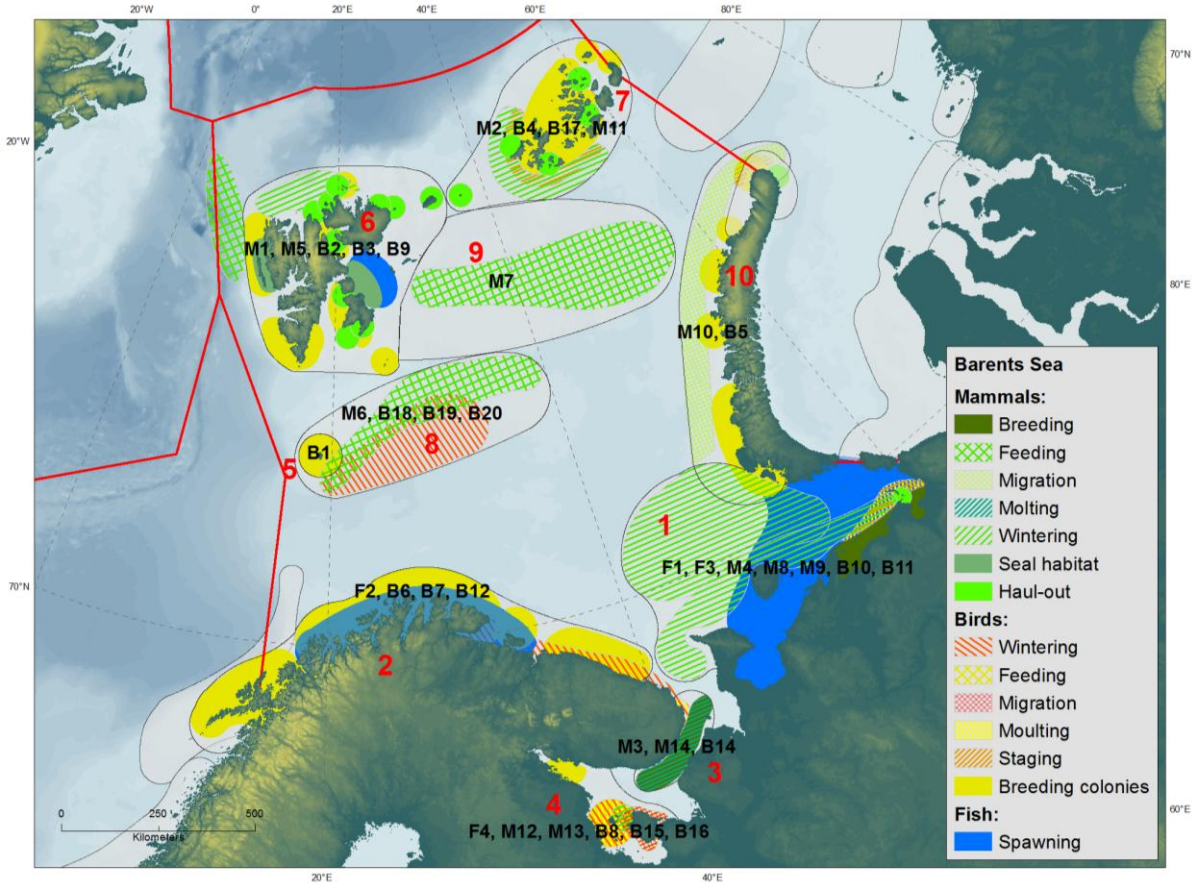

Figure 5. Areas of heightened ecological significance in the Barents Sea LME.

Area 1. Pechora Sea

Polar cod (*Boreogadus saida*) is widely distributed in the cold water masses of the northern and eastern Barents Sea and Kara Sea. The main polar cod stock has its spawning area in the Pechora Sea where the fish aggregate to spawn under the ice in winter (mainly in January-February) (F1). Herring of the Chesh-Pechora stock spawn demersal eggs in shallow waters in Cheskaya Bay (F3).

The shallow waters from the Cheskaya Bay east of the Kanin Peninsula and along the southern shore of the Pechora Sea have fast ice in winter and is an important breeding area for ringed seals from the eastern Barents Sea as well as from the western Kara Sea (M4). The pack ice in the southeastern Barents Sea is presumably important for young ringed seals that aggregate to feed on polar cod that spawns under the ice in this area.

The main wintering areas for walrus of the 'Kara Sea-southern Barents Sea-Novaya Zemlya' stock and for beluga whale of the large Karskaya stock are in the pack ice in the Pechora Sea region (M8).

Some walrus remain in this area during summer with main haul-outs on Vaigach and Dolgy islands and adjacent small islands (M9).

The coastal lowlands and intertidal zone along the southern shore of the Pechora Sea contains important molting and staging areas for geese (dark-bellied brent goose, barnacle goose and others) and many shorebirds (B10). The shallow waters along these coasts are also molting and staging areas for sea ducks including king eiders and scoters, and staging area for thick-billed murre for birds from a wider breeding area further east and north (B11). Rich benthos communities support the abundant seaducks and also walruses in these waters.

Pechora Bay is an important feeding area for several species of coregonid whitefish, and the coastal waters including Pechora Bay is important for large migratory populations of wild Atlantic salmon.

Area 2. Norwegian and Murman coasts

The Barents Sea capelin stock has its spawning grounds on coastal banks along the coast of northern Norway (Troms and Finnmark counties) and the Murman coast (F2).

The coasts of northern Norway and Murman hold large breeding colonies of seabirds including Atlantic puffins, razorbills, common and thick-billed murres, black-legged kittiwakes, great cormorants and European shag, and common eiders (B6, B7). These coasts which are largely ice-free are also wintering areas for some seabirds and sea ducks, notably common and king eiders, long-tailed duck, and also the western population of the 'Vulnerable' Steller's eider (B12).

Area 3. Entrance and northern White Sea

Harp seal has its whelping and molting areas on the pack ice in late winter and early spring (February-April) at the entrance region (Funnel) and further into the northern White Sea (M3). Here the whole adult population of the large Barents Sea/White Sea stock occurs concentrated at this time of the year. The seals aggregate later in spring to molt on the ice north of the main breeding areas.

The White Sea beluga population has its wintering area in the Voronka and Gorlo (Funnel and Throat) area at the entrance to the White Sea (M14). In spring the belugas migrate into the White Sea to feed during summer when they occur most frequently in the Dvina and Onega Bays (M13). The spring migration route before ice clearance could be a vulnerable area as could some of the summer feeding areas with concentrations of belugas.

Inshore waters of the Tersky coast (along eastern Kola Peninsula) is a molting and wintering area for sea ducks including all three species of eiders (common, king and Steller's) (B14).

Area 4. White Sea (Kandalaksha, Onega and Dvina bays)

Herring of the White Sea stock (belongs to Pacific herring) has its main spawning area in the northern part of Onega Bay (F3).

Beluga in the White Sea may belong to 3 or more stocks with distinct summer feeding areas in Dvina and Onega bays (M13). Beluga may also winter in leads and polynyas in northern Onega Bay (M12).

There are breeding colonies of common eiders, herring and lesser black-backed gulls, Arctic terns and other species in Kandalaksha and Onega bays (B8). Onega Bay is an important molting and wintering area for common eiders (B15). Onega and Dvina bays provide important staging habitat for ducks, geese and swans using the White Sea-Baltic branch of the East-AtlanticFlyway during spring and fall migrations (B16).

Area 5. Bear Island

Bear Island (Bjørnøya), which is the southernmost island of Svalbard, is an important area for seabirds with large mixed breeding colonies of thick-billed and common murres and black-legged kittiwake (B1). Razorbill, little auk, northern fulmar and glaucous gull also breed on this island. Barnacle geese and light-bellied brent geese stage on Bear Island before they continue their southward migration in the autumn.

Area 6. Svalbard Archipelago

There is a separate stock or stock component of polar cod (*Boreogadus saida*) in the Svalbard area. The location of the spawning area is not well known but is likely to be east of Svalbard in the area between Nordaustlandet, Kong Karls Land and Edgeøya (F5).

The Whalers Bay Polynya north of Svalbard is a potential wintering area for narwhal and bowheads of the critically endangered Spitsbergen stock (M1). Walrus winter in leads and polynyas along northern and eastern Svalbard, and belugas are also wintering in the Svalbard area. The northern and eastern parts of Svalbard contain important haul-outs and summer feeding areas for walrus (M11b).

The waters off northwestern Spitsbergen used to be a major early season feeding area for the large Spitsbergen stock of bowheads that was hunted to near extinction. The area is still important for this stock which is now very low and critically endangered. The area is also used as a summer feeding area by the endangered blue whale (M16).

The eastern part of Svalbard including Kong Karls Land is an important denning area for polar bear (M5b).

Harbor seal occurs with a resident population in western Svalbard, mainly on Prins Karls Forland (M5). This population numbers about 1000 animals and is the northernmost occurrence of harbor seal (to about 80°N).

Ringed seal breeds in fast ice in many fjords around the Svalbard archipelago. The largest area of fast ice is in eastern Svalbard between Nordautslandet, Kong Karls land and the Barents Island. This is in the same general area as the assumed location of the spawning area for the Svalbard polar cod stock component and is possibly an important breeding habitat for ringed seals (M15).

Svalbard holds large numbers of seabirds in the summer season. The largest breeding aggregations of seabirds are found in the northwestern (B3a) and southwestern parts of the archipelago (B2a). There are also sea bird breeding aggregations along westen and southern Edgeøya (B2b), at Hopen (B2c), in the Hinlopenstredet (B3b) and north of Nordaustlandet (B3c). Major species in these colonies are dovekie, thick-billed murre, northern fulmar, Atlantic puffin, and black-legged kittiwake.

Sea ducks and geese molt at several locations along the coasts of Svalbard mainly on the western and southern sides (B9). Important molting areas for common eider are found at the outer part of the west coast, at Prins Karls Forland and south of the Isfjord. King eider males aggregate and migrate after breeding to molting areas along the southwest coast between Hornsund and Sørkapp.

Area 7. Franz Josef Land

Polynyas at Franz Josef Land, particularly on the southwest side, constitute wintering habitat for walrus of the Svalbard-Franz Josef Land stock and bowheads of the critically endangered Spitsbergen stock (M2). Narwhals may also possibly winter in this area. They are commonly seen at Franz Josef Land during the summer season with most observations in the deep water of Cambridge Channel. Franz Josef Land is an important part of the feeding area for walrus, particularly for females and young animals, and there are many haul-outs on land used by walrus in late summer and autumn (M11). Victoria Island to the west of Franz Josef Land is another major haul-out for Atlantic walrus.

There are many seabird colonies on this archipelago, with dovekie (subspecies *polaris*), thick-billed murre and black-legged kittiwake as the major species (B4). The Franz Josef Land polynyas are used as spring staging areas for seabirds prior to breeding (B17). There are important breeding colonies of the rare ivory gull on the islands, the largest in the Barents Sea.

Area 8. Western and central Barents Sea

The polar front and ice edge in spring largely coincide in the western and central Barents Sea. This general area is also the wintering location for the Barents Sea capelin stock which provides an important food resource for harp seals and other consumers in the ecosystem.

Polar bears occur concentrated in the marginal ice zone during spring and early summer when they migrate east and north with the receding ice (M6).

The polar front and the ice edge zone is an important feeding area in summer for seabirds that breed at Bear Island and southern Svalbard as well as for non-breeding birds (B18). This region is also an important wintering area for seabirds, particularly thick-billed murres that feed on wintering capelin (B19). The area is also likely to be part of the swimming migration route of thick-billed murres (males and juveniles) on their way from northern breeding colonies towards wintering areas (B20).

Area 9. Northern Barents Sea - marginal ice zone

The sea ice in the marginal ice zone in the northern and northeastern Barents Sea is a feeding area for polar bears in late summer and autumn (M7). The marginal ice zone is also used by seals and seabirds. The location of this area can be variable among years dependent on climatic and ice conditions.

Area 10. Western Novaya Zemlya

The system of shore leads and drift ice up along the west coast of Novaya Zemlya is supposed to constitute a spring migration route for beluga of the Karskaya stock and possibly also for walrus (M10).

Western Novaya Zemlya holds many fairly large seabird colonies with thick-billed murre and black-legged kittiwake as the major species (B5). Thick-billed murres perform a swimming migration south along Novaya Zemlya towards the Pechora Sea region (B20).

Kara Sea LME (Figure 6, Table 11)

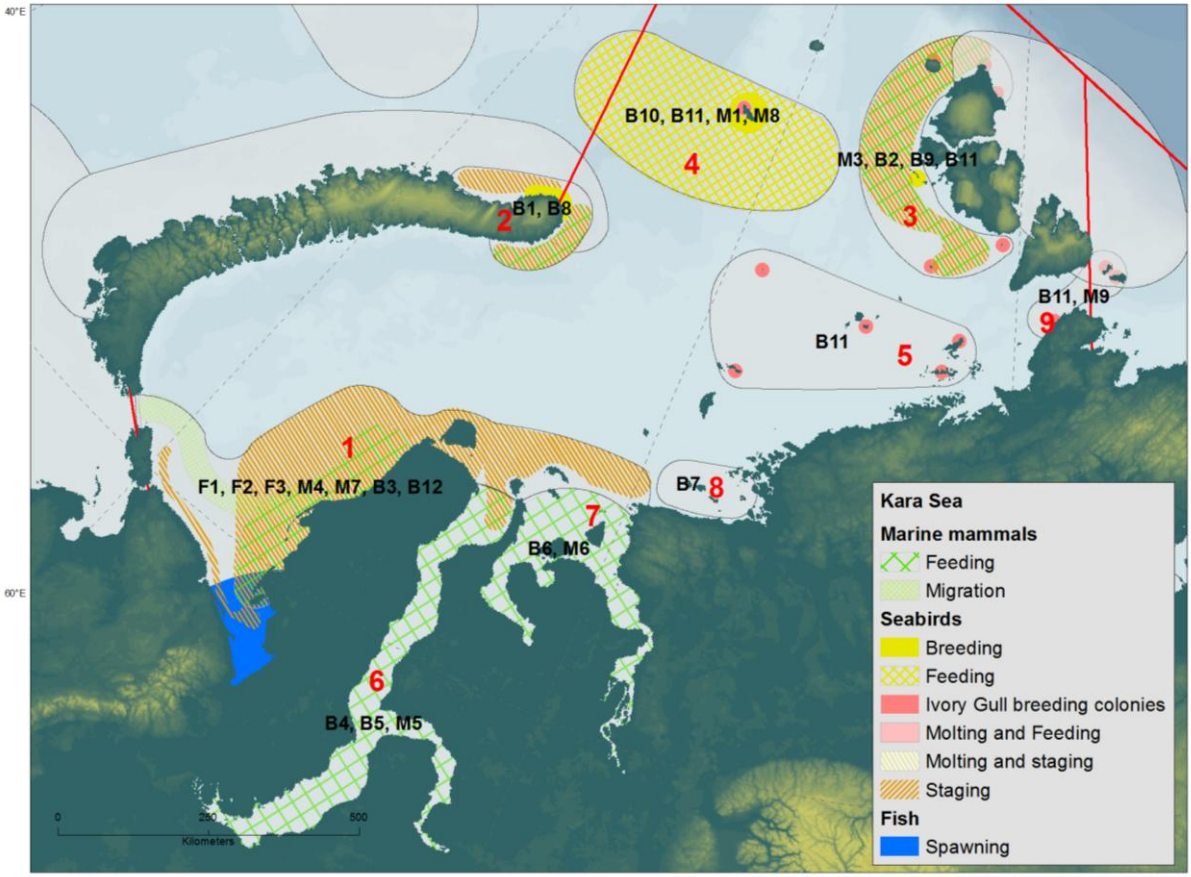

Figure 6. Areas of heightened ecological significance in the Kara Sea LME.

Area 1. Baydaratskaya Inlet - Western Yamal

Baydaratskaya Inlet is a spawning area for the codfish navaga that spawns in winter under the ice (F1). The fast ice zone in the southwestern Kara Sea is possible spawning area for polar cod (*Boreogadus saida*) (F2) (Kashkina, 1962). Herring (of the Pechora herring type) also spawn on shallow sandy bottoms during May-July in the coastal waters of the southwestern Kara Sea (F3).

The fast ice zone is breeding habitat for ringed seal (M4). Leads and polynyas in the southwestern Kara Sea form a migration area for walrus ('Kara Sea-southern Barents Sea-Novaya Zemlya' stock) and beluga (Karskaya population) on their way from wintering areas in the Pechora Sea region to summer feeding areas in the Kara Sea (M2). Walrus has important feeding areas in the shallow productive waters up along western Yamal with rich benthos communities (M7).

The leads and polynyas in this area form also a spring migration and staging habitat for seaducks, notably king eiders and long-tailed duck (B3). In late summer and autumn the productive shallows west of Yamal constitute important staging area for sea ducks on their way from breeding areas in western Siberia to wintering areas further west and south (B12).

Area 2. Northeastern Novaya Zemlya

Sebirds breed in colonies along the northern tip of Novaya Zemlya (B8). Black-legged kittiwake is the major species but also some thick-billed murres breed here. Polynyas off northern Novaya Zemlya are important spring staging areas for seabirds prior to breeding (B1).

Area 3. Western Severnaya Zemlya

There are some colonies of seabirds on the western part of the high arctic Severnaya Zemlya archipelago, notably of black-legged kittiwake. The threatened ivory gull breeds here with the largest colonies globally and is the most prominent feature of the regional biodiversity (B9). These colonies are dependent in spring and early summer on western Severnaya Zemlya flaw polynya. Its northernmost portion off northern Severnaya Zemlya is used as spring staging areas and early season feeding areas for seabirds including dovekie, black-legged kittiwake, and black guillemot breeding in large colonies in eastern Severnaya Zemlya (B2).

The fast ice edge and polynya west of Severnaya Zemlya are also a feeding area for polar bears in spring and summer (M3).

Area 4. Northern Kara Sea - marginal ice zone

The ice edge zone is a feeding area for seabirds including ivory gulls, black-legged kittiwakes, black guillemots, skuas and gulls (B10). The threatened ivory gull aggregates to breed on islands in this area (B11).

The drift ice in the northern Kara Sea is a migration area for beluga of the Karskaya population in spring and early summer when they move north and east towards the Laptev Sea (M1). The ice edge zone is a summer and autumn feeding area for polar bears (M8).

Area 5. Northeastern Kara Sea islands

Vize and Uedinenia islands located in the northern Kara Sea between Franz Joseph Land and Severnaya Zemlya hold colonies of the threatened ivory gull (B11). There are recently, under conditions of little summer sea ice, established Atlantic walrus rookeries on these islands.

Areas 6-8. Ob (6), Yenisey (7) and Pyasina (8) estuaries.

Ob Gulf is a major estuary, nearly 1000 km long from the Ob Delta to the opening to the south-central Kara Sea in north. There are summer aggregations in this gulf of belugas that are considered to be of a separate stock (M5).

The Ob Delta is a molting and autumn staging area for dabbling and diving ducks, geese and waders (B4). The estuary also provides molting and feeding areas for ducks, geese and swans, including long-tailed duck, scoters, dark-bellied brent goose and Bewick's swan (B5).

Yenisey Gulf has summer aggregations of belugas possibly constituting a separate stock (M6). Like the Ob estuary, it also provides important molting and feeding areas for ducks, geese and swans (B6).

Large stocks of different coregonid white fishes as well as the threatened Ob stock of Siberian sturgeon have feeding and nursery areas in the Ob and Yenisey estuaries.

The smaller Pyasina Estuary to the northeast has a well developed delta and is also an important molting and feeding area for ducks and geese including dark-belied brent goose, as well as for waders (B7).

Area 9. Vilkitskij Strait

The threatened ivory gull breeds on islandsin this area (B11). The Vilkitskiy Strait is also used as migration corridor for beluga on their return migration from the Laptev Sea in autumn (M9).

Laptev Sea LME (Figure 7, Table 12)

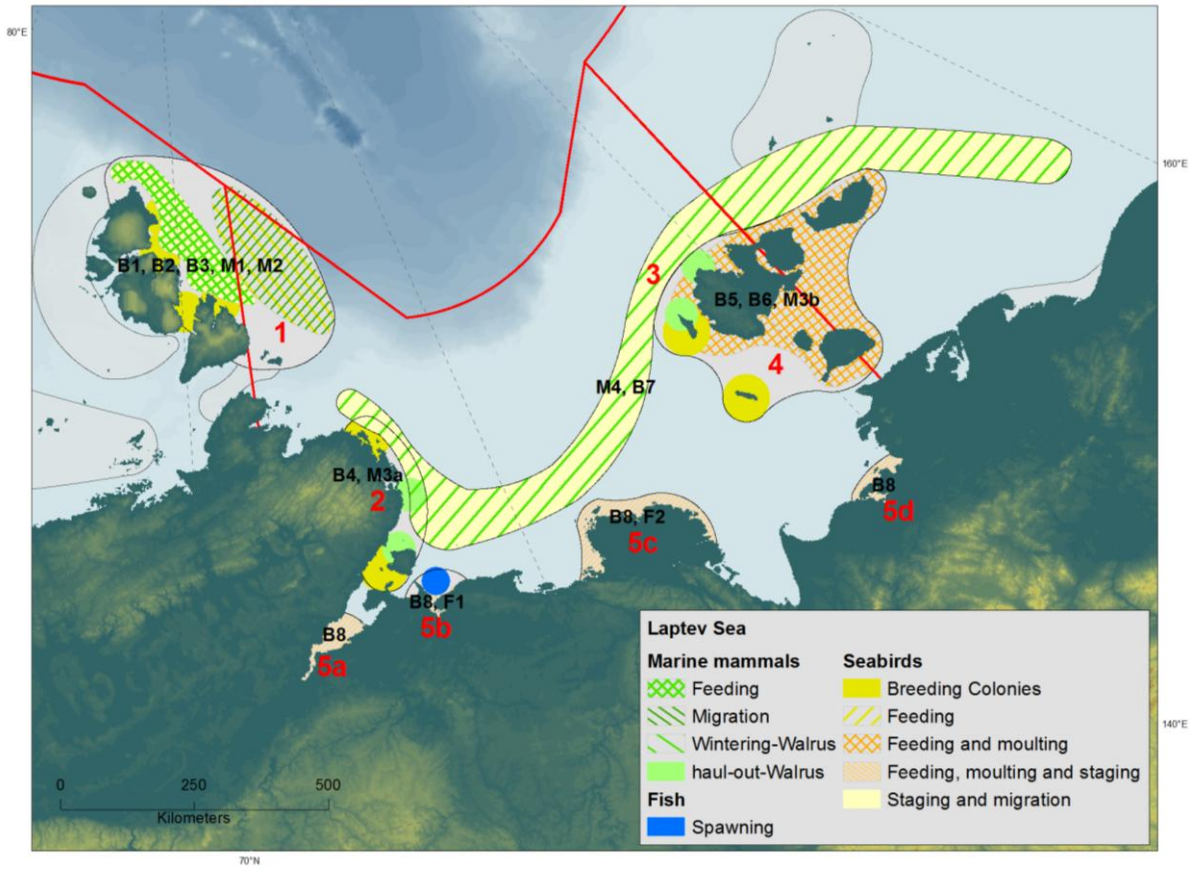

Figure 7. Areas of heightened ecological significance in the Laptev Sea LME.

Area 1. NW Laptev Sea (including polynyas N and NE of Severnaya Zemlya)

Belugas presumably of the Karskaya population occur regularly in fairly high abundance in the western Laptev Sea during summer. They migrate into the Laptev Sea mainly north of the Severnaya Zemlya in spring, probably using leads and polynyas north and east of the archipelago (M1). This area is also used for summer feeding by belugas (M2). Narwhals possibly also occur in this region.

Dovekies of the *polaris* subspecies breed in colonies on Severnaya Zemlya, mainly on the eastern side foraging out in the NW Laptev Sea (B2). Dovekies, along with ivory gull and black guillemots which also breed on these islands, make extensive use of polynyas off Severnaya Zemlya where they arrive in spring as early as April (B1). These species use the sea areas in the northwestern Laptev Sea along the ice edge and shelf break as foraging areas in late summer and autumn (B3). This is a particularly important post-breeding staging area for all ivory gulls of East Atlantic breeding populations from Greenland to Severnaya Zemlya.

Area 2. Northeast Taimyr and Preobrazheniya Island

Seabird breeding colonies primarily of black-legged kittiwakes are located at the northeastern Taimyr Peninsula and at Preobrazheniya Island in outer Khatanga Bay at the base of Taimyr where also thick-billed murres breed (B4).

There are haul-outs on land for walrus of the Laptev population along the eastern Taimyr coast and on small islands (M3a), and adjacent areas provide important summer feeding grounds for Laptev walrus.

Area 3. Great Siberian Polynya System

A major lead polynya system forms off the fast ice edge north and west of the New Siberian Islands. This polynya overlying relatively productive shallows constitute the main winter habitat for the Laptev population of walrus (sometimes considered a separate subspecies). Walruses reside in this area year-round and use it also for summer feeding (M4).

The polynya is also a major spring staging and migration area for seabirds and waterfowl including thick-billed murre, black-legged kittiwake, long-tailed duck, and king eiders (B7).

Area 4. New Siberian Islands

There are seabird breeding colonies on the westernmost Stolbovoy and Belkovsky islands with thick-billed murre, black-legged kittiwake and black guillemot as the dominant species (B5). The shallow waters around the New Siberian Islands are an important feeding and molting area for various waterbirds including king and Pacific eiders, long-tailed duck and red phalarope (B6).

There are known haul-outs for walrus on the northwestern side of the archipelago with important adjacent summer feeding areas (M3b).

Area 5. Deltas and estuaries - Khatanga (5a), Anabar (5b), Lena (5c), Yana (5d)

The large Lena Delta along with the Yana Delta further east and the Khatanga and Anabar deltas to the west constitute extensive and important habitats for feeding, molting and staging of waterfowls and waders (B8). The species which use these deltas and estuaries include king, spectacled and Steller's eiders, long-tailed duck, black scoter, dark-bellied and black brent, tundra swan, divers, red phalarope and many other shorebirds.

These estuaries form nursery and feeding areas for several species of coregonid whitefishes as well as the Lena stock of Siberian sturgeon (F2). Polar cod (*Boregadus saida*) is the most important marine

fish species in the Laptev Sea. This stock feeds in the open parts of the sea and winters and spawns in the coastal zone. The area of the Anabar Bay is possibly a main spawning area (F1).

East Siberian Sea LME (Figure 8, Table 13)

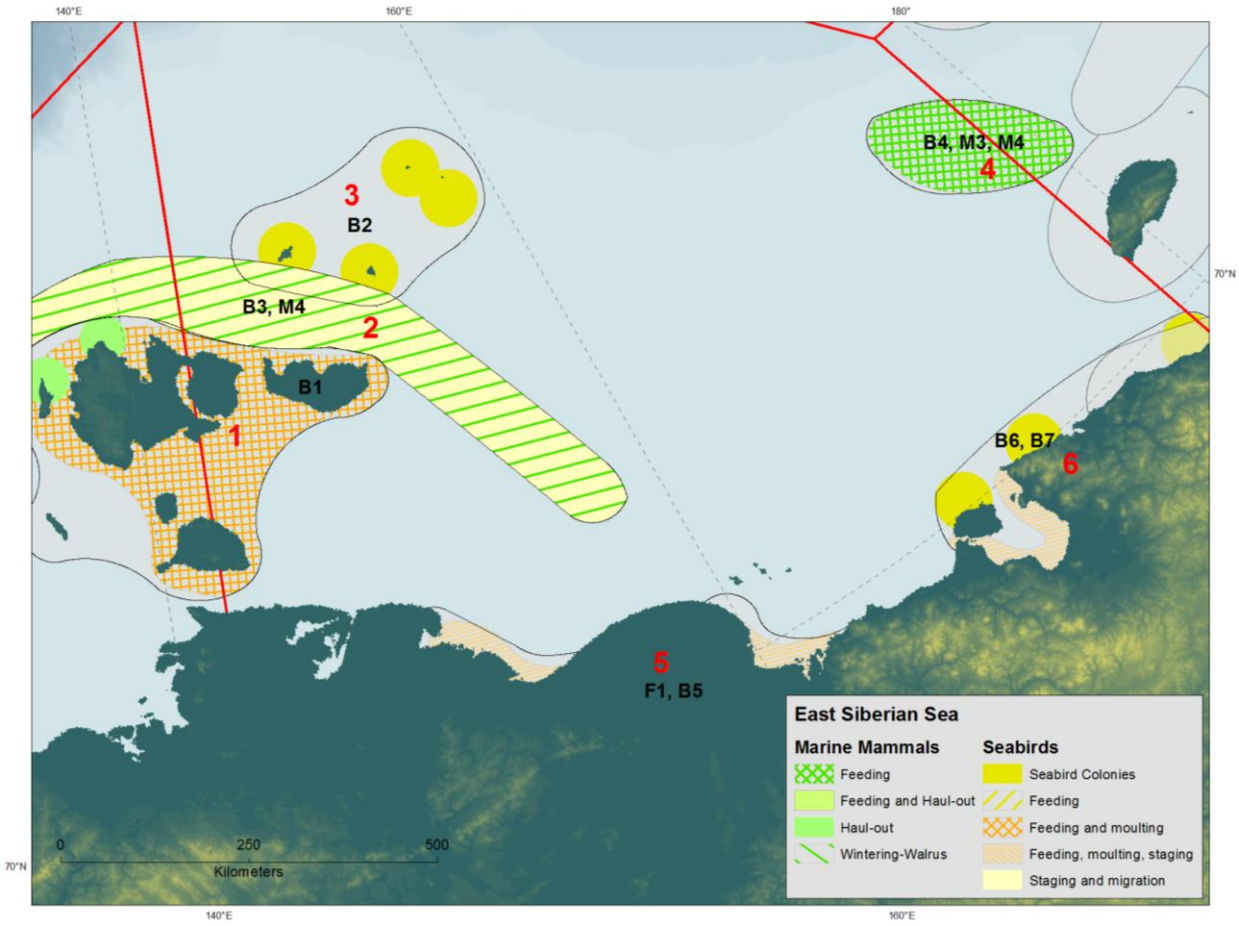

Figure 8. Areas of heightened ecological significance in the East Siberian Sea LME.

Area 1. New Siberian Islands

This area lies in the boundary zone between the Laptev and East Siberian seas and has been included in both LMEs. . The shallow waters around the New Siberian Islands are an important feeding and molting area for various waterbirds including king and Pacific eiders, long-tailed duck and red phalarope (B1).

Area 2. Great Siberian Polynya System

The polynya is an important spring staging and feeding area for seabirds and waterfowl including thick-billed murre, black-legged kittiwake, long-tailed duck, and king eiders (B3).

The polynya and the shallow waters around the New Siberian Islands are year-round habitat for the Laptev walrus population.

Area 3. De Long Islands

This is a group of relatively small and remote islands located on the outer shelf northeast of the New Siberian Islands. There are seabird colonies on these islands with black-legged kittiwakes, black guillemots and thick-billed murre as the major species (B2).

Area 4. Ice zone on the northern shelf

The pack ice and ice edge zone over the central and northern East Siberian shelf is a feeding area for ringed seals and Pacific walrus in late summer and autumn (M4). This zone is also used for feeding in the post-breeding period by seabirds including ivory and Ross's gulls, thick-billed murre, black-legged kittiwakes and skua species (B4).

Belugas of the large Beaufort Sea stock and possibly also the eastern Chukchi stock use the northeastern part of the East Siberian Sea for feeding in late summer and autumn before they return south towards the wintering areas in the northern Bering sea (M3).

Area 5. Indigirka and Kolyma deltas and estuaries

The deltas and estuaries of these relatively large Siberian rivers are important feeding, molting and staging areas for waterfowl such as king, spectacled and Steller's eiders, black brants and tundra swans, and feeding and staging area for many shorebirds including red and red-necked phalaropes, short-billed dowitchers and others (B5).

These estuaries are also nursery and feeding areas for amphidromous and anadromous whitefishes and Siberian sturgeon (F1).

Area 6. Chaun Bay

Long-tailed ducks have breeding grounds located mostly within southern tundra on the mainland with the highest density found in Kolyma delta and in the Chaun Lowland. Chaun Bay and adjacent areas along the Chukotka coast contain feeding, molting and staging areas for waterfowl and shorebirds (B6). There are seabird colonies dominated by thick-billed murres, black-legged kittiwakes, and black guillemots (B7).

Chukchi Sea (Figures 9a and 9b, Table 14)

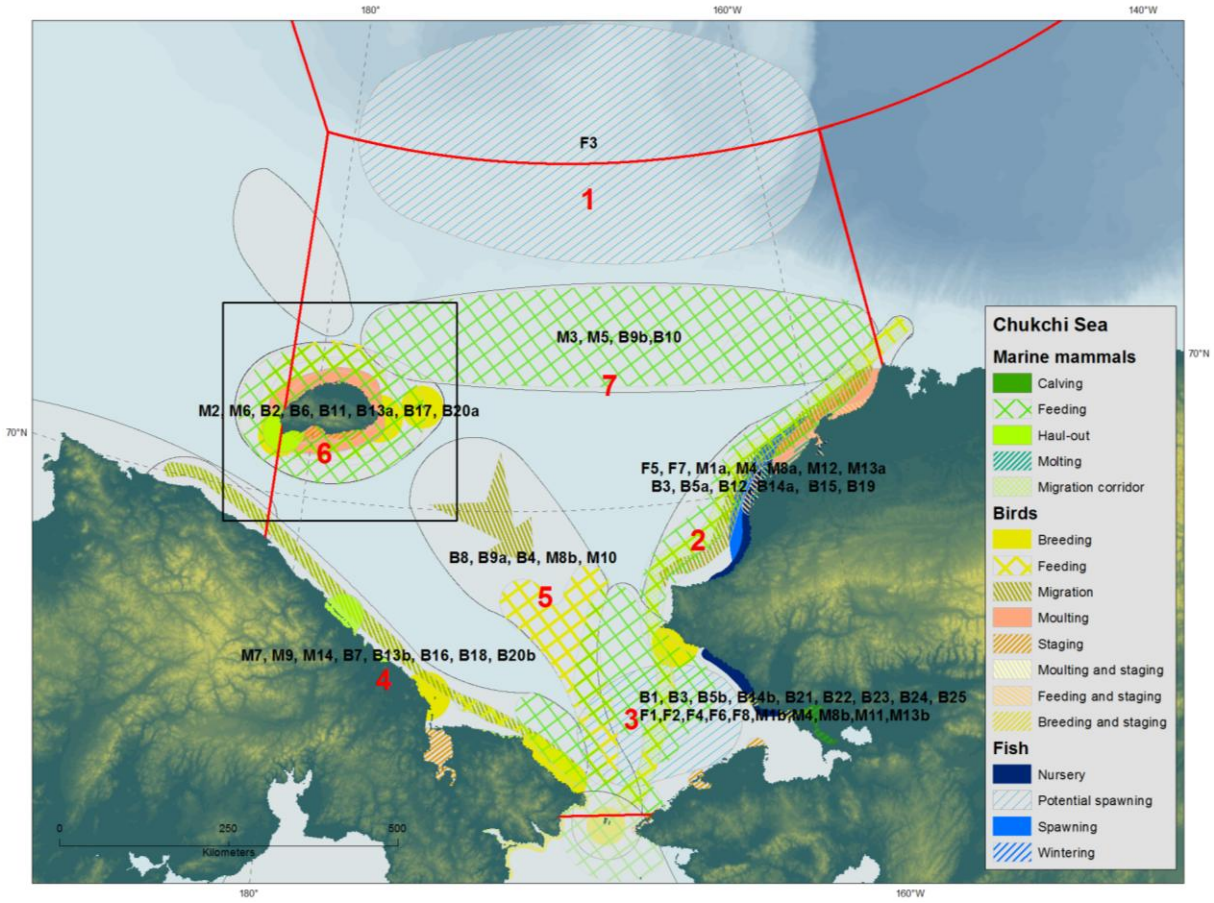

Figure 9a. Areas of heightened ecological significance in the Chukchi Sea LME.

Area 1. Chukchi Rise (Plateau, Borderland)

Chukchi Rise area

Arctic cod (*Arctogadus glacialis*) is possibly an important species in the northern Chukchi Sea LME in the slope and deep water beyond the shelf (F3). It has been suggested (Walters 1961; Andriyashev et al. 1980) that they undertake a winter migration, possibly to spawn over the Chukchi Rise. The location of the spawning area is not known and is therefore hypothetical at present.

Area 2. Northeast Coastal (Alaska)

Nearshore areas in northwestern Alaska

Capelin is known to spawn in summer along the sandy seaward beaches of barrier islands in the area of Point Lay and also near Point Barrow (F5). There is limited information on capelin in the Chukchi Sea where it appears to be mainly a coastal species.

Estuaries and lagoons along the coast of Alaska

In addition to the estuaries and lagoons in the Kotzebue Sound area, there are several other estuaries and lagoons along the Alaskan Chukchi coast (F7) that serve as nursery areas for juvenile whitefish (Mecklenburg et al. 2002) and as migration corridors for juvenile and adult whitefish (humpback and broad whitefish, least and Bering ciscos).

Belugas of the Eastern Chukchi Sea stock move into Kasegaluk Lagoon in northwestern Alaska (M12) where they stay for a few weeks from late June or early July (Frost and Lowry 1990, Frost et al. 1993, Huntington et al. 1999). The area is probably used primarily for molting, when the belugas use the gravel bottoms to rub off the old layer of skin (Frost et al. 1993).

Kasegaluk Lagoon in northwestern Alaska is an important summer feeding and staging area for geese, with black brant and greater white-fronted goose as the main species (B15). The lagoon is also used for breeding and as spring and fall staging area for shorebirds, notably dunlin (subspecies *arcticola*) and red phalarope (B26).

Coastal waters along Alaska

Coastal waters off northwestern Alaska, in particular Peard and Ledyard bays, are important molt areas for several species of sea ducks, including common and king eiders and long-tailed duck and Ledyard Bay in particular is used by tens of thousands of spectacled eiders during their flightless fall molt (Petersen et al. 2000, Oppel et al. 2009) (B12). These species are flightless for about 4 weeks during molt of their wing feathers when they occur concentrated at favorable feeding areas in relatively shallow and productive waters. Ledyard Bay is of particular importance to female spectacled eiders that have bred on Alaska's Arctic Coastal Plain, along with their broods and is designated as spectacled eider critical habitat under the U.S. Endangered Species Act.

Peard Bay in northwestern Alaska is a summer feeding and fall staging area for red phalaropes from breeding areas in northern Alaska (B19).

Sea ducks and divers (or loons) use migration corridors along the coasts during the southbound autumn migration (B14a). These corridors are usually centered around the 20 m isobaths where these birds can dive to feed on bottom-living animals (sea ducks) or fish (divers). Species that use this corridor include common and king eiders, long-tailed duck, black scoter, and red-throated, black-throated and white-billed divers.

Sites on the Lisburne Peninsula hold large breeding colonies of seabirds (B5a). The main species that breed here are thick-billed and common murre, horned puffin and black-legged kittiwake. This area holds some of the major seabird colonies in the eastern Chukchi Sea and the birds feed out from them in the rich waters around Cape Lisburne (Piatt and Springer 2003). They are also among the northernmost major colonies of common murre and horned puffin in the Pacific sector (Ainley et al. 2002, Piatt and Kitaysky 2002).

The coastal areas near Point Lay have increased in importance for Pacific walrus, which are now hauling out there in groups of up to 10-15,000 when sea ice retreats northwards of the continental shelf during the open water season (M15). Walrus are particulary vulnerable to disturbance, and deaths occur from stampedes that happen in response to disturbance events. Calves are particuilary vulnerable.

Gray whales of the large migratory eastern population (about 20-25,000 animals) (Rugh et al. 2005, Angliss and Outlaw 2008) have main benthic feeding grounds in offshore areas in the eastern Chukchi Sea, primarily in areas located southwest of Point Hope, along the coast between Icy Cape and Point Barrow, and further offshore from Barrow towards Hannah Shoal (M13a) (Moore and DeMaster 1998, Moore et al. 2000. 2003). The gray whale population has recovered and may now be at its carrying capacity (Moore et al. 2001, 2003, Rugh et al. 2005). There has been a trend in recent years that the feeding grounds in the Chukchi Sea have become relatively more important, probably related to warming with less summer ice in the Chukchi Sea.

Flaw lead system along the coast of Alaska

The predominant northerly winds over the Chukchi Sea in winter open a lead system at the transition between the landfast and drifting ice. This lead system is used as a major migration corridor in spring (April-May) for the large stocks of bowhead (about 10,000) (Moore and Reeves 1993, George et al. 2004) and beluga (about 40,000) (Angliss and Outlaw 2008) on their way from wintering areas in the northern Bering Sea to summer feeding areas in the eastern Beaufort Sea (M8a). The whales mate and give birth to the young during the spring migration. These migratory “trains” of whales moving into the Arctic in spring are of very high ecological significance.

The system of leads along Alaska is also a major migration corridor and feeding area for polar bears of the Bering-Chukchi subpopulation (M1a) (Durner and Amstrup 2000; Amstrup et al. 2006 as they retreat north in spring prior to ice break-up. Somewhat later in the season, Pacific walrus move north from the Bering Strait through the same area (M4) towards their feeding grounds in the northeastern Chukchi Sea (M4)(Fay 1982, Ray and Hufford 1989).

The lead system is also used as an important migratory route and feeding area during spring migration for common and king eiders and red phalaropes (B3). Ledyard Bay north of Cape Lisburne is particularly important for king eiders in spring and is designated as critical habitat for spectacled eiders under the U.S. Endangered Species Act.

Area 3. Southeastern Chukchi Sea (Chukchi Bight, Kotzebue Sound)

Southern Chukchi Sea

Polar cod (*Boreogadus saida*) is a key species in the Chukchi Sea ecosystem. Although not well documented, there is likely a large migratory stock that migrates south in autumn to spawn in winter under the ice in the southern Chukchi Sea and/or the northern Bering Sea (F1) (Ponomarenko, 1968; Lowry and Frost, 1981). The location of spawning area(s) is not known and the area is therefore hypothetical at present.

Kotzebue Sound

Kotzebue Sound, located in western Alaska north of the Bering Strait and the Seward Peninsula, is a potential spawning area for saffron cod which spawns under the ice in winter (F2). Pacific herring occurs possibly with a separate stock which is resident year round in Kotzebue Sound and the adjacent Chukchi Bight (Wespestad and Barton 1981). Herring spawns along the north shore of the Seward Peninsula and in Kotzebue Bay after ice clearance in summer (F4).

Estuaries in Kotzebue Sound are nursery areas for juvenile chum and pink salmon that spawn in the rivers in the area (F6) (McPhail and Lindsey 1970; Craig and Haldorson 1986; Stephenson 2006). The juveniles move down-river to spend the first summer in estuaries and tidal wetlands near their natal streams where they may form schools and occur in large aggregations (NMFS 2005; MMS 2007 (Chukchi EIS)). The estuarine nursery areas used by chum and pink salmon are considered essential fish habitat by the US National Marine Fisheries Service (NMFS 2005). Estuaries and plumes of brackish water that extends from them in shallow coastal waters and lagoons serve as nursery areas for juvenile whitefish and as migration corridors for juvenile and adult whitefish. There are four species of coregonid whitefishes that occur with amphidromous populations in the Chukchi Sea area: humpback whitefish, broad whitefish, least cisco, and Bering cisco. They spawn in freshwater, and juveniles and adults move to estuaries and brackish coastal waters to feed in summer, before retreating back into rivers as winter approaches. These areas provide important ecological links between the marine and freshwater environments.

The estuaries of the major rivers discharging to the Kotzebue Sound area are probably important wintering habitat for herring in the southeastern Chukchi Sea (F8) (Wespestad and Barton 1981). Herring is an important prey species for many predators in the ecosystem.

Belugas of the Eastern Chukchi Sea stock (about 4,000 individuals) use areas in the Kotzebue Sound as early summer feeding areas and possibly as calving grounds (M11) (Frost and Lowry 1990; Huntington et al. 1999). They stay in this area for some weeks in June before they continue further north to Kasegaluk Lagoon and beyond.

Cape Thompson and Cape Lisburne

These two sites on the Lisburne Peninsula hold large breeding colonies of seabirds (B5b). The main species that breed here are thick-billed and common murres, horned puffin and black-legged

kittiwake (Fadely et al. 1989, Gaston and Hipfner 2000, Dragoo et al. 2004). These are the major seabird colonies in the eastern Chukchi Sea and the birds feed out from them in the rich waters around Cape Lisburne. They are also among the northernmost major colonies of common murre and horned puffin in the Pacific sector.

Noatak River Delta

Noatak River Delta is located north of Kotzebue at the entrance to Kotzebue Sound. This is an important breeding and spring and fall staging area for shorebirds (B21). Major species are dunlin, western and semipalmated sandpipers and long-billed dowitcher.

Coastal sites in the southeastern Chukchi Sea (Shishmaref Inlet, Cape Espenberg, Lopp Lagoon, Krusenstern Lagoon)

Lopp Lagoon (B24), Shismaref Inlet (B22) and Cape Espenberg (B23) are lagoons and inlets along the north shore of Seward Peninsula in western Alaska just north of the Bering Strait. These sites are used as autumn staging areas for migratory shorebirds, notably western sandpiper, semipalmated sandpiper, dunlin and Pacific golden plover.

Krusenstern Lagoon (B25) is located northwest of Kotzebue outside the entrance to Kotzebue Sound. This area is a breeding and autumn staging area for shorebirds, including red-necked phalarope, long-billed dowitcher, and western, semipalmated and pectoral sandpipers.

Offshore areas in the eastern Chukchi Sea

Gray whales of the large migratory eastern population (about 20-25,000 animals) (Rugh et al. 2005; Angliss and Outlaw 2008) have main benthic feeding grounds in offshore areas in the eastern Chukchi Sea, including in areas located southwest of Point Hope (M13b) (Moore and DeMaster 1998; Moore et al. 2000, 2003). The gray whale population has recovered and may now be at its carrying capacity. There has been a trend in recent years that the feeding grounds in the Chukchi Sea have become relatively more important, probably related to warming with less summer ice in the Chukchi Sea.

Sea ducks and divers (or loons) use migration corridors along the coasts during the southbound autumn migration (B14b). These corridors are usually centered around the 20 m isobaths where these birds can dive to feed on bottom-living animals (sea ducks) or fish (divers). Species that use this corridor include common and king eiders, long-tailed duck, black scoter, and red-throated, black-throated and white-billed divers.

Flaw lead system along the coast of Alaska

The predominant northerly winds over the Chukchi Sea in winter open a lead system at the transition between the landfast and drifting ice. This lead system is used as a major migration corridor in spring (April-May) for the large stocks of bowhead (about 10,000) (Moore and Reeves 1993; George et al. 2004) and beluga (about 40,000) (Frost and Lowry 1990; Huntington et al. 1999) on their way from wintering areas in the northern Bering Sea to summer feeding areas in the eastern Beaufort Sea (M8b). The whales mate and give birth to the young during the spring migration (Koski et al. 1993,

Reese et al. 2001; Koski et al. 2004). These migratory "trains" of whales moving into the Arctic in spring are of very high ecological significance.

The system of leads along Alaska is also a major migration corridor and feeding area for polar bears of the Bering-Chukchi subpopulation as they retreat north in spring prior to ice break-up (M1b) (Durner and Amstrup 2000; Amstrup et al. 2006). Somewhat later in the season, Pacific walrus move north from the Bering Strait through the same area towards their feeding grounds in the northeastern Chukchi Sea (M4) (Fay 1982; Ray and Hufford 1989).

The lead system extending north from Bering Strait along western Alaska and persistent polynyas in this area provide an important migratory route and feeding areas during spring migration for seabirds, sea ducks and phalaropes (B1). This is the case for thick-billed and common murres (Hunt et al. 1981; Fadely et al. 1989, Gaston and Hipfner 2000), common (Pacific) and king eiders, long-tailed duck, and red and red-necked phalaropes.

Area 4. Northern Chukchi Peninsula

Waters off northern Chukotka

Pacific walrus feed in the waters off Chukotka and use coastal haul-outs during late summer and autumn (M7) (Kochnev 2004). With less ice in recent years, the use of coastal haul-outs in this area has increased. This may be associated with less favorable feeding conditions due to unavailability of offshore feeding grounds when there is no ice to use for resting between feeding bouts (Tynan and DeMaster 1997; Kochnev 2004; Cooper et al. 2006).

Leads along the northern coast of Chukotka provide a migration corridor in spring or early summer for bowhead and beluga (M9) (Braham et al. 1984, Melnikov et al. 2004). The belugas are considered to be a separate stock (Western Chukchi stock) Frost and Lowry 1990, O'Corry-Crow et al. 1997; Mymrin et al. 1999) which is also possibly the case for bowhead (Moore and Reeves 1993; Bogoslovskaya, 2003).

Some gray whales of the large migratory eastern population move northwest from the Bering Strait to feeding grounds along Chukotka west to Cape Serdtse-Kamen (M14) (Bogoslovskaya et al. 1982, Miller et al. 1985; Belikov and Boltunov 2002).

Kolyuchin Island

Kolyuchin Island outside Kolyuchin Bay in northern Chukotka holds seabird breeding colonies, with thick-billed murre and horned puffin as important species (B7) (Konyukov et al. 1998; Kondratyev et al. 2000)

Kolyuchin Bay

Kolyuchin Bay on the northern Chukchi Peninsula is a major staging area for black brant prior to fall migration for birds that breed in northern Chukotka (B16).

Coastal habitats in northern and eastern Chukotka

Spooned-billed sandpiper has a restricted breeding range along the coasts of southwestern Chukchi Sea and northwestern Bering Sea south to northern Kamchatka (B18). It nests on coastal habitats with sparsely vegetated sandy ridges near lakes and marshes and also on dry and gravely tundra. Spooned-billed sandpiper is listed as 'Critically endangered' and their number is estimated to be <1,000 individuals and declining (IUCN). The breeding area includes coastal habitats along the eastern and northeastern Chukchi Peninsula.

Molt areas for sea ducks (common and king eiders and long-tailed duck) are found in relatively shallow and productive waters around Wrangel Island and along northern Chukotka (B13b). Coastal habitats along Chukotka are also summer feeding and fall migration areas for large numbers of red and red-necked phalaropes that breed on tundra in northeastern Siberia (B20b).

Area 5. South-Central Chukchi Sea (including Bering Strait)

Bering Strait region

This area harbors seabird breeding colonies of least auklet, crested auklet, parakeet auklet, thick-billed murre, common murre, and black-legged kittiwake (Hunt et al. 1981, Konyukhov et al. 1998, Gaston and Hipfner 2000, Kondratyev et al. 2000, Piatt and Springer 2003, Dragoo et al. 2004) (B4). Dovekie also breed in this region, far from its main breeding areas in the Atlantic sector of the Arctic.

Large numbers of bowheads, belugas and Pacific walrus move through the Bering Strait in spring (late March-June; Frost and Lowry 1990, Moore and Reeves 1993, Melnikov et al. 1997, 2004, Angliss and Outlaw 2008). Depending on ice conditions they may linger in the Bering Strait region for some time before they proceed north through the lead systems they use for the spring migration (M8c).

In the previous whaling period, many bowheads were hunted in the Bering Strait region in summer (Townsend 1935, Braham et al. 1980, Bockstoce and Burns 1993). These whales were possibly of a more resident stock component that did not migrate north to the Beaufort Sea or the northern Chukchi Sea (M10) (Bogoslovskaya 2003). The Bering Strait region could possibly still be summer feeding grounds for recovering remnants of such a stock component.

'Plume' area north from Bering Strait

The highly productive Anadyr-Bering shelf waters transport rich amounts of zooplankton (Springer et al. 1989, Piatt and Springer 2003) and also small fish north through the Bering Strait and continuing as a plume of rich waters through Hope Sea Valley in the southern and central Chukchi Sea (Woodgate et al. 2005). This 'plume' area is an important feeding area for seabirds in late summer

and early autumn, including least, crested and parakeet auklets from the breeding colonies in the northern Bering Sea and the Bering Strait, black-legged kittiwakes, and summer-visiting short-tailed shearwaters from the southern hemisphere (B8).

Juvenile thick-billed murres accompanied by their male parents swim away from the breeding colonies in the Chukchi Sea (Wrangel and Herald islands and Cape Lisburne and Cape Thompson) towards feeding areas presumably in the south-central parts of the Chukchi Sea (B9a) (Hatch et al. 2000). The males are flightless due to molt of wing feathers for about 4 weeks during this period. This swimming migration is not well documented but represents an ecologically important and sensitive phase in the life history of thick-billed murres in the Chukchi Sea.

Area 6. Wrangel/Herald Islands Area

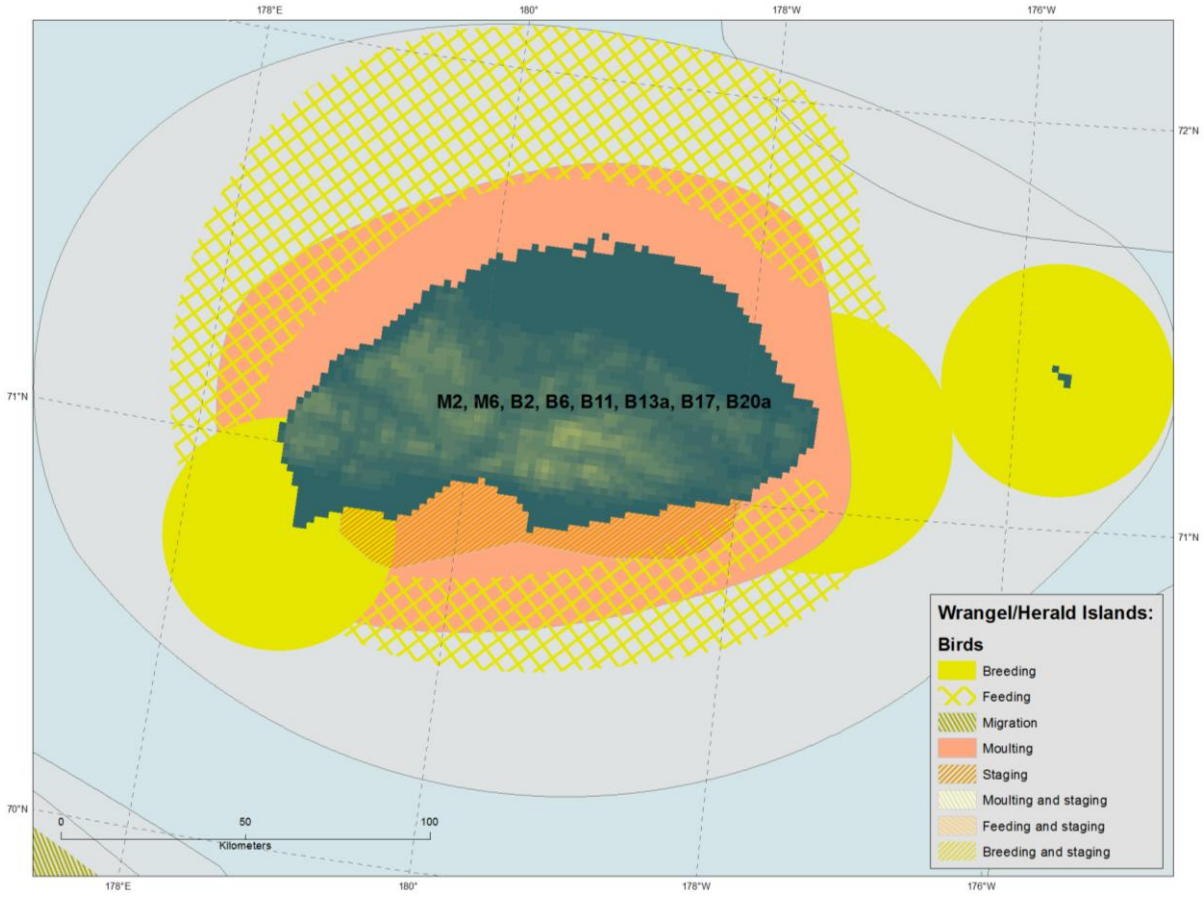

Figure 9b. Areas of heightened ecological significance in the Chukchi Sea LME, Wrangler Island.

Wrangel and Herald Islands

Lesser snow geese (subspecies *caerulescens*) breed with a population of about 60,000 individuals at Wrangel Island. Some of them aggregate in coastal habitats along estuaries and bays on the south shore of the island during molt and staging for the fall migration. Black brent (subspecies *nigricans*) is a more coastal species of geese and large numbers of non- and failed breeders appear to use coastal habitats on Wrangel Island as molting and staging area prior to fall migration (B17).

Wrangel Island and the sea areas surrounding it are important habitat for polar bears in spring and summer when they hunt seals in polynyas and leads in the pack ice (M2) (Aars et al. 2006, Schliebe et al. 2006). Many polar bears of the Bering-Chukchi subpopulation retreat north with the pack ice in summer, and the area around Wrangel Island is used by relatively large numbers of polar bears (Kochnev et al. 2003, Schliebe et al. 2005). Many of them come ashore when the ice clears away from the island in late summer or autumn (Kochnev 2002, Kochnev et al. 2003, Ovsyanikov 2003, Aars et al. 2006). Wrangel Island is an important denning area for the Chukchi population of polar bears.

The area around Wrangel Island is also important feeding ground for the large migratory population of Pacific walrus (females and young animals) that use haul-outs on the island (M6) (Kochnev 2004). The polar bear and walrus populations may both be declining and are considered to be stressed by more rapid ice melt due to warming (Kochnev 2004, Aars et al. 2006, Cooper et al. 2006).

There are relatively large breeding colonies of seabirds on the west and east coast of Wrangel Island and on the smaller Herald Island in the northwestern Chukchi Sea (B6). Main species are thick-billed murre (subspecies heckeri) (Gaston and Hipfner 2000), black-legged kittiwake and black guillemot. Horned puffin breeds in smaller numbers as the northernmost occurrence on Wrangel Island (Konyukov et al. 1998). Common murre has been extending its breeding range and breeds also now in low numbers at Wrangel and Herald Islands (Kondratyev et al. 2000). The seabirds feed out some 10s of km from the colonies during the breeding season.

Coastal waters in southern Chukchi Sea and around Wrangel Island

The 'Critically Endangered' (IUCN) Kittlitz's murrelet uses coastal waters in the southern Chukchi Sea (from the Bering Strait and north to beyond Cape Lisburne in Alaska and northwest along the northern coast of Chukotka) and around Wrangel Island as feeding habitats in summer and autumn after breeding (B11).

Molt areas for sea ducks (common and king eiders and long-tailed duck) are found in relatively shallow and productive waters around Wrangel Island (B13a). These areas are also summer feeding and fall migration areas for large numbers of red and red-necked phalaropes that breed on tundra in northeastern Siberia (B20a).

Leads and polynyas around Wrangel and Herald Islands

Leads and polynyas are used for spring feeding prior to breeding for birds that breed on Wrangel and Herald islands in the northwestern Chukchi Sea, including thick-billed murre (Gaston and Hipfner 2000), common eider and red phalarope (B2).

Area 7. Chukchi Shelf (Northern and Central parts)

The marginal ice zone in the northern Chukchi Sea

Polar bears of the Bering-Chukchi subpopulation retreat with the ice northwards and get concentrated in the marginal ice zone of the northern Chukchi Sea in late summer and autumn (Kochnev et al. 2003, Schliebe et al. 2005). This constitutes therefore an important feeding habitat for polar bear (M3) (Durner and Amstrup 2000; Amstrup et al. 2006). With the more rapid and extensive ice melt that has been witnessed in recent years, this habitat may not be available or be of much reduced quality as a feeding habitat for polar bear. This is a factor that adds stress to the polar bear subpopulation in the Chukchi Sea (Aars et al. 2006).

Hanna Shoal

Hanna Shoal is a shallow area located in the northeastern Chukchi Sea northwest of Barrow. This area is an important feeding ground for Pacific walrus during late summer and autumn (M5) (Kochnev 2004; MMS 2007). In addition to walrus, this area is also an important gray whale feeding area in some years.

South-central Chukchi Sea

Juvenile thick-billed murres accompanied by their male parents swim away from the breeding colonies in the Chukchi Sea (Wrangel and Herald islands and Cape Lisburne and Cape Thompson) towards feeding areas presumably in the south-central parts of the Chukchi Sea (B9b) (Hatch et al. 2000). The males are flightless due to molt of wing feathers for about 4 weeks during this period. This swimming migration is not well documented but represents an ecologically important and sensitive phase in the life history of thick-billed murres in the Chukchi Sea.

Drift ice in northern Chukchi Sea

The drifting pack ice and ice edge zone in the northern Chukchi Sea is a main feeding area for ivory and Ross's gulls and black guillemot in late summer and autumn after breeding (B10).

Bering Sea (East and West) (Figure 1, Table 15)

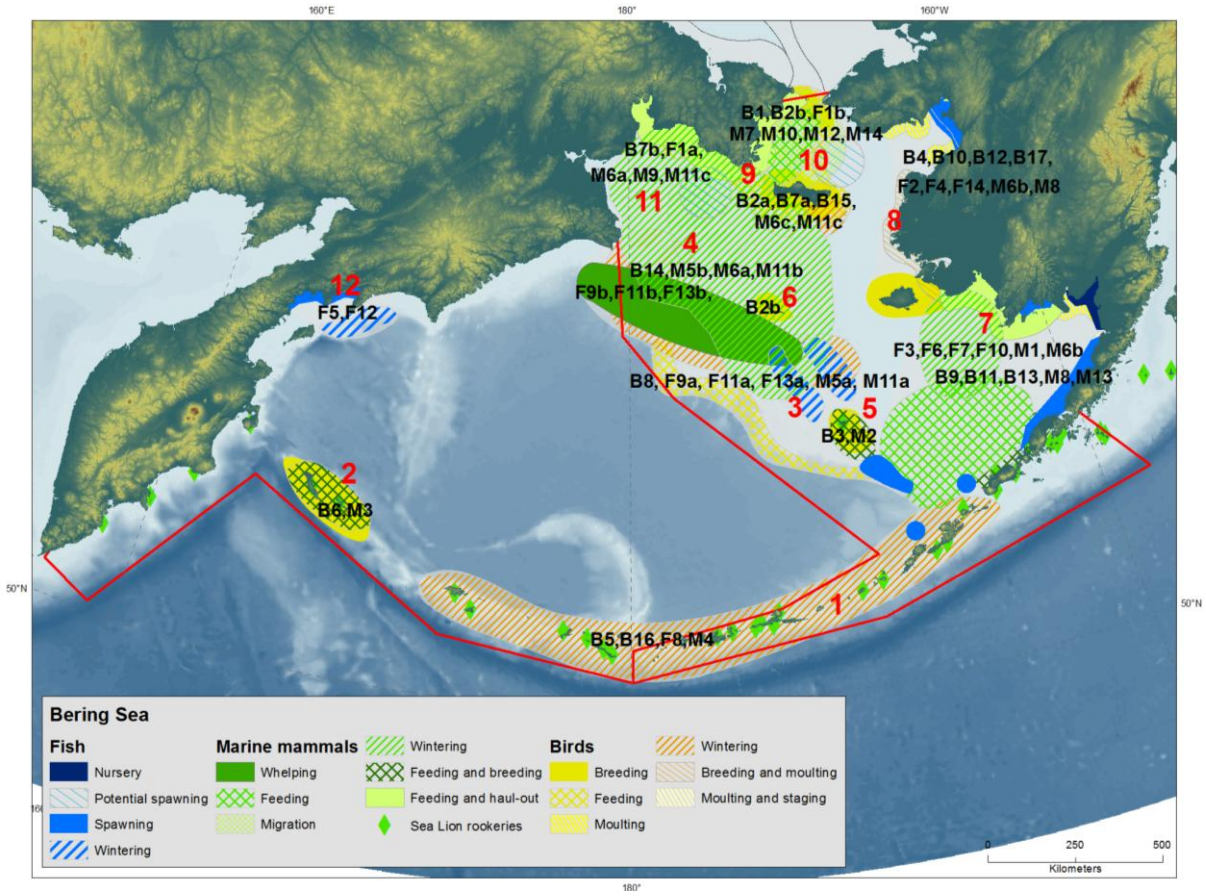

Figure 10. Areas of heightened ecological significance in the Bering Sea LME.

Area 1. Aleutian Islands

Bogoslov Island

The waters off Bogoslov Island (F8) and the slope region off Bristol Bay north to off the Pribilof Islands (F9) are main spawning areas of the large walleye pollock stock which is a key component in the East Bering Sea ecosystem. While pollock spawns over a wide area and an extended time period from late winter to early summer, the core areas of the spawning grounds are no doubt areas of ecological significance given the great ecological role of walleye pollock in the ecosystem.

Bogoslov Island is also one of two northern fur seal rookeries (the other being in the Pribilof Islands). In the last years more pups are produced at Bogoslov Island than at the Pribilof Islands.

Aleutian Islands

Steller sea lions breed on a number of rookeries throughout the Aleutians, on the Alaska Peninsula, and along the coast of Kamchatka (M4). The areas with the main rookeries are key sites in the life cycle and for the conservation of the species, which is a key component in the southern part of the Bering Sea ecosystem. The large Steller sea lion population in the Bering Sea (western population) has been declining rather dramatically in recent decades (Angliss and Outlaw 2008, Loughlin 2009) and is listed as 'Near threatened' by IUCN.

The chain of the Aleutian Islands provides important habitats for seabirds with many breeding colonies (Springer et al. 1999). There are many species of birds in these colonies, including large numbers of fork-tailed and Leach's storm-petrels, least and crested auklets, tufted puffin and northern fulmar. The Aleutians form part of the breeding area of marbled and Kittlitz's murrelets which are assessed as being 'Endangered' and 'Critically Endangered' by IUCN (B5). Rhinoceros auklet breeds presently only at Buldir Island in the western Aleutians but was formerly much more abundant in the southern Bering Sea. Along with several other seabirds it was drastically reduced and locally extirpated from parts of the Aleutians through introduction of mammals and harvesting. The Aleutian Islands are also breeding area for shorebirds, notably for subspecies couesi of rock sandpiper and for black oystercatcher.

The Aleutian Islands constitute important wintering habitats for many seabirds and waterfowl that breed further north in the Pacific sector of the Arctic. These include king and Steller's eiders, emperor goose, greater scaup and common teal (B16). Emperor goose is a Beringean endemic species that winters in large numbers in the Aleutian Islands.

Area 2. Komandorsky Islands

Waters around Komandorsky Islands

Northern fur seals breed on the Komandorsky Islands with most of the remaining part of the population that do not breed on the Pribilof Islands (M3). The colonies are occupied for about the same period of time, from spring to late autumn, and the females feed in a wide zone around the islands while they nurse the pups in the colonies.

Komandorsky Islands

The Komandorskiye Islands lie in the western Bering Sea in the continuation of the Aleutian Islands chain (B6). They hold large breeding colonies of seabirds, including red-legged kittiwake (assesses as 'Vulnerable' by IUCN) and ancient murrelet with subspecies *microrhynchos* restricted to these islands. Rock sandpiper of subspecies *quarta* (Commander sandpiper) breeds on the Kommandorsky islands and also in southern Kamchatka and on the Kurile islands. These birds are probably sedentary on the Komandorsky Islands where they are estimated to occur with 5.000 breeding pairs (Gill et al. 2002)

Area 3. Continental SE Shelf and Shelf Break

Slope region of the southeastern Bering Sea

The waters on the slope region off Bristol Bay north to off the Pribilof Islands are a main spawning area of the large walleye pollock stock which is a key component in the East Bering Sea ecosystem (F9a). While pollock spawns over a wide area and an extended time period from late winter to early summer, the core areas of the spawning grounds are no doubt areas of ecological significance given the great ecological role of walleye pollock in the ecosystem.

Outer shelf between Pribilofs and St. Matthews islands

Pacific herring of the large migratory eastern Bering Sea stock has (or used to have) its main wintering area on the outer shelf in the layer of warmer water that extends as a bottom layer under the colder water of the mid shelf (F11a). There is limited information on this wintering area, but it is expected that herring forms dense aggregations in a concentrated zone along the outer shelf.

Mid-shelf region northwest of Pribilof Islands

A major wintering area for capelin in the eastern Bering Sea is in the mid-shelf domain around the 100 m isobath in the 'cold pool' region in the area between Pribilof and St. Matthews islands (F13a). Capelin is expected to occur concentrated in this wintering area, from where the maturing part of the population move towards the coastal spawning grounds in spring.

Ice front zone on outer northern shelf

Ribbon seal and spotted seal are two ice-associated species that whelp on the southern extent of sea ice in late winter in the northern Bering Sea (M5a). Ribbon seal has its main whelping area in the central and western Bering Sea from south of St. Matthew Island and westward along the shelf to around Cape Olyutorski. Spotted seal has its whelping area overlapping with that of ribbon seal but with centres of abundance further south, in northwestern Bristol Bay near the Pribilof Islands, and in the Karaginskyi Bay on the western shelf. After breeding the seals move north with the ice in spring when they molt on ice in the northern Bering Sea (there is little information on molting for spotted seal). Both species may be vulnerable to climate change which might affect their ice habitats but they were recently assessed in the U.S. as not being at risk of extinction within the foreseeable future (Boveng et al. 2008, 2009); they have been assessed as 'Data deficient' by IUCN due to limited information

Pack ice on the SE shelf

Bowheads of the 'Bering-Chukchi-Beaufort stock' and belugas of several stocks including the large migratory 'Beaufort stock', winter in polynyas and pack ice of the northern Bering Sea, probably extending south onto the SE shelf (M11a). In spring they start to move north through leads in the ice, with some whales moving through the Bering Strait in April.

Shelf edge of the eastern Bering Sea

The shelf edge are of the eastern Bering Sea is a very productive region and constitute important feeding habitat for seabirds (B8). In addition to high rates of basic production, this area is also one where vertically migrating macrozooplankton, fish and squid from the deep basin and slope waters come close to the surface at night time. The species of seabirds which forage here include large numbers of fork-tailed storm-petrels and red-legged kittiwakes, and short-tailed albatross which is assessed as 'Vulnerable' by IUCN.

Area 4. Continental NE Shelf and Shelf Break

Ice front zone on outer northern shelf

The ice edge in the northern and central shelf regions of the Bering Sea constitute winter habitat for some Arctic seabirds, notably ivory and Ross's gulls and black guillemot that migrate south from breeding and summering areas in the Chukchi Sea and adjacent areas (B14).

Ribbon seal and spotted seal are two ice-associated species that whelps on the southern extent of sea ice in late winter in the northern Bering Sea (M5b). Ribbon seal has its main whelping area in the central and western Bering Sea from south of St. Matthew Island and westward along the shelf to around Cape Olyutorski. Spotted seal has its whelping area overlapping with that of ribbon seal but with centres of abundance further south, in northwestern Bristol Bay near the Pribilof Islands, and in the Karaginskyi Bay on the western shelf (Boveng et al. 2008, 2009). After breeding the seals move north with the ice in spring when they molt on ice in the northern Bering Sea (there is little information on molting for spotted seal). Both species may be vulnerable to climate change which might affect their ice habitats but they were recently assessed as not being at risk of extinction within the foreseeable future (Boveng et al. 2008, 2009).

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northern Bering Sea (M6a) (Fay 1982, Ray and Hufford 1989). One core area is in the northern Bering Sea including the St. Lawrence and Sireniki polynyas. In spring the females and young animals start to move north through Chirikov Basin towards Bering Strait. During this phase of early migration, the pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining (Smirnov et al. 2004, Cooper et al. 2006), and it is expected that climate change may have severe negative consequences for it (the species is assessed as being 'Data deficient' by IUCN).

Bowhead of the 'Bering-Chukchi-Beaufort stock' and belugas of several stocks including the large migratory 'Beaufort stock', winter in polynyas and pack ice of the northern Bering Sea (M11b). This includes the St. Lawrence and Sireniki polynyas. In spring they start to move north through leads in the ice, with some whales moving through the Bering Strait in April. Breeding takes place in late winter, and both species give birth to their calves during the northward spring migration.

Slope region of the northeastern Bering Sea

The waters on the slope region of the eastern Bering Sea are a main spawning area of the large walleye pollock stock which is a key component in the East Bering Sea ecosystem (F9b). While pollock spawns over a wide area and an extended time period from late winter to early summer, the core areas of the spawning grounds are no doubt areas of ecological significance given the great ecological role of walleye pollock in the ecosystem.

Outer shelf between Pribilofs and St. Matthews islands

Pacific herring of the large migratory eastern Bering Sea stock has (or used to have) its main wintering area on the outer shelf in the layer of warmer water that extends as a bottom layer under the colder water of the mid shelf (F11b). There is limited information on this wintering area, but it is expected that herring forms dense aggregations in a concentrated zone along the outer shelf.

Mid-shelf region northwest of Pribilof Islands

A major wintering area for capelin in the eastern Bering Sea is in the mid-shelf domain around the 100 m isobath in the 'cold pool' region in the area between Pribilof and St. Matthews islands (F13b). Capelin is expected to occur concentrated in this wintering area, from where the maturing part of the population move towards the coastal spawning grounds in spring.

Area 5. Pribilof Islands

Waters around Pribilof Islands

Northern fur seal breeds almost exclusively in the Bering Sea with about 3/4 of the population at large colonies on the Pribilof Islands on the outer shelf in the southeastern Bering Sea (M2). The colonies are occupied from late April to November, and the females feed in a wide zone around the islands during the time priod when they are nursing their pups in the colonies for about 4 months. Northern fur deal is numerous (0.7 million individuals) and an important species in the East Bering Sea ecosystem. The population has been declining reflecting changes in the ecosystem due probably to a combination of factors including climate, food and predation (notably by killer whales) (Angliss and Outlaw 2008, Gentry 2009).

Pribilof Islands

Pribilof Islands located on the outer southeastern Bering shelf hold major breeding colonies of seabirds, with large numbers of least auklet and thick-billed murre (Hunt et al. 1981) (B3). The majority of the total population of red-legged kittiwakes (about 80%) breeds on these islands. The Pribilof Islands are also important breeding and staging areas in spring and autumn for shorebirds, notably rock sandpiper (subspecies *ptilocnemis*).

Area 6. St. Matthew/Hall Islands

St. Matthew and Hall islands

St. Matthew and Hall islands are located on the shelf of the northern Bering Sea. Both islands hold large breeding colonies of seabirds with least auklet and thick-billed murre as particularly abundant species (Hunt et al. 1981) (B2b). The seabirds forage out from the colonies typically some 10s of km. These islands are also breeding and staging areas in spring and autumn for shorebirds, notably rock sandpiper (subspecies *ptilocnemis*) and red phalarope. Most of the global population of McCay's bunting breeds here.

Area 7. Bristol Bay and Southeast Bering Shelf/Northern Alaska Peninsula

Bristol Bay

The northern and inner parts of Bristol Bay in the southeastern Bering Sea contain important molting areas for several seaducks including Steller's eider and black and white-winged scoters (B13).

Pacific walrus males live segregated from the females and young animals for most of the year. They remain for the large part in the ice-free waters of the Bering Sea during summer. One major summering area is in the northern Bristol Bay where concentrations of male walrus occur on haulouts on islands within the Walrus Islands State Game Sanctuary (M8). Hagemeister Island outside the sanctuary is a haulout of emerging importance for male walrus during the non-breeding season. Boating and fishing restrictions have been placed around many of these haulout areas (but not Hagemeister) to protect walrus from human disturbance. Bristol Bay is an important area for beluga, which summer in the bay and are an important subsistence food.

Inner Bristol Bay

Rivers in the inner Bristol Bay area are important spawning habitat for Pacific salmon, in particular perhaps the largest sockeye run in the world as well as pink salmon (F10). Juvenile salmon move from the rivers into estuaries and nearshore coastal waters where they reside for some weeks or months before they continue to offshore feeding areas. Eulachon (a species of smelt) also spawns in rivers and the young juveniles have their nursery area in estuaries before they migrate further off to the outer shelf region.

Togiak Bay is located on the north side of Bristol Bay on the southeastern Bering shelf (F3). It is the main spawning area for Pacific herring in the East Bering Sea and also an important spawning area for capelin. These fishes spawn intertidally on beaches or in shallow sediments close to shore and both species are important as 'forage fish' in the rich food webs of the East Bering Sea.

North shore of the Alaska Peninsula

There are several sites along the north shore of the Alaska Peninsula in the southeastern Bering Sea where Pacific herring and capelin spawn intertidally on beaches or on shallow subtidal sediments

(F6). These are mainly local populations but they are important as prey for seabirds and other consumers in the food webs in this part of the East Bering Sea ecosystem.

There are several estuaries and lagoons along the northern shore of the Alaska Peninsula which are very important molting and staging areas for waterfowl and summer feeding and autumn staging areas for shorebirds (B11). The lagoons include Izembek, Nelson and several others. Among waterfowl species that use these estuaries and lagoons are Steller's eider, black scoter, northern pintail, cackling goose (subspecies *minima* and *taverneri*), black brant and emperor goose. The area is also important as a summer feeding and staging area in autumn for shorebird species including rock and western sandpipers, dunlin, and marbled, bar-tailed and Hudsonian godwits.

There is a walrus haul-out along the north shore of the Alaska Peninsula which is used by walrus feeding in Bristol Bay, especially male walrus during the non-breeding season. It is also a refugium for threatened Northern Sea Otters (M1), although sea otters are more common along the southern side of the Alaska Peninsula.

Unimak Island and the western Alaska Peninsula

Nearshore areas along Unimak Island and the western Alaska Peninsula are core habitat for sea otter (of subspecies *kenyoni*) in southwestern Alaska (M1). Sea otter was brought close to extinction due to harvest for their fur, but it has recovered in many parts of its former range. There was a dramatic decline by 80-90 % in the abundance of sea otters in the central Aleutian Islands during the 1990s, possibly caused by increased predation from killer whales and with consequences for sea urchin grazing on kelp beds. Sea otter is a keystone species in the coastal habitats of southwestern Alaska.

North of Unimak Pass

One of the tree main spawning areas of the East Bering stock of Pacific cod is located in a restricted area on the shelf north of Unimak Pass in the southeastern Bering Sea (F7). Pacific cod spawns demersal eggs (on the bottom substrate) that could be sensitive to sinking oil and other stressors.

Waters north of Unalaska and outer Bristol Bay

North Pacific right whale is an 'Endangered' species (IUCN) and the eastern population is believed to exist with some 10s of individuals. The waters north of Unalaska Island used to be an important summer feeding area of right whales (M13). In recent years there have been sightings of right whales in the southeastern Bering Sea (Wade et al. 2006). This area appears now to be a core area and has been designated as 'critical habitat' for North Pacific right whales (NOOA; http://www.nmfs.noaa.gov/pr/pdfs/fr/fr73-60173.pdf).

The outer Bristol Bay area on the southeastern shelf is an important feeding area for seabirds during summer (B9). Species which use this area include large numbers of short-tailed shearwaters which are austral winter visitors from the southern hemisphere.

Drifting pack ice on the eastern Bering shelf

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northeastern Bering Sea (Fay 1982, Ray and Hufford 1989) (M6b). One core area is in the eastern shelf in the area from northwestern Bristol Bay to south of Nunivak Island. In spring the females and young animals start to move north through Chirikov Basin towards Bering Strait. During this phase of early migration, the pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining (Smirnov et al. 2004, Cooper et al. 2006), and it is expected that climate change may have severe negative consequences for it (the species is assessed as being 'Data deficient' by IUCN).

Area 8. East Coast (Yukon and Kuskokwim Deltas to Norton Sound including Unimak Island)

Norton Sound

Norton Sound located south of the Bering Strait and Seward Peninsula contains spawning ground for saffron cod, Pacific herring and capelin. Saffron cod spawn under ice in winter and is an important species in the local food webs and for subsistence harvest (F2). Pacific herring and capelin spawn on beaches and in shallow subtidal sediments in inner parts of Norton Sound (F4). Herring is considered to belong to the migratory stock (or stock complex) on the eastern shelf where the majority spawns in Togiak Bay. The spawners in Norton Sound may be a separate spawning component or population. For capelin the stock structure is not well known. Herring and capelin are important species as 'forage fishes' in the food webs. The Norton Sound herring migrate out to feed on the shelf in summer but return in autumn to spend the winter in estuaries in Norton Sound (F14).

The eastern Norton Sound (located south of the Seward Peninsula in the northeastern Bering Sea) is an important molting area for spectacled eiders (Petersen et al. 2000) (B12). Coastal areas along northern and eastern Norton Sound (including Norton Bay, Safety Sound, Stebbins-St. Michael and Golovin Lagoon) provide summer feeding and autumn staging areas for shorebirds (B17). Species include dunlin, western and semipalmated sandpipers, red-necked phalarope, and long-billed dowitcher.

Much of the eastern two thirds of Norton Sound have been designated as critical habitat for Spectacled eiders under the U.S. Endangered Species Act. This species undergoes flightless molt here. It is especially important for breeding females and fledged broods from the Yukon-Kuskokwim Delta, the most imperiled of the spectacled eider populations.

Drifting pack ice on the eastern Bering shelf

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northeastern Bering Sea (M6b). One core area is in the eastern shelf in the area from northwestern Bristol Bay to south of Nunivak Island. In spring the females and young animals start to

move north through Chirikov Basin towards Bering Strait. During this phase of early migration, the pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining.

Nunivak Island and Cape Newenham

Nunivak Island on the inner shelf of the eastern Bering Sea and Cape Newenham in northern Bristol Bay are the locations of large seabird colonies (B4). Common murre is a dominant species and the spawning ground and nursery areas for Pacific herring and capelin in this area provide important food sources for the seabirds.

Yukon-Kuskokwim Delta

The Yukon-Kuskokwim Delta contains a very large intertidal area (about 10,000 km^2 including areas inundated during storm tides) which is of regional and hemispherical significance for migratory birds (B10). The area is a very important breeding and molting area for waterfowl including spectacled eider, black, white-winged and surf scoters, northern pintail, cackling goose (subspecies *minima* and *taverneri*), brent goose (subspecies black brant), emperor goose and snow goose. The delta is also important as a post-breeding and staging area during spring and particularly autumn for a number of shorebirds including dunlin, bar-tailed godwit, bristle-thighed curlew, western, rock and sharp-tailed sandpiper, red knot and black turnstone. Kuskokwim Shoals, off the mouth of the Kuskokwim delta, is designated as critical habitat for Steller's eiders under the U.S. Endangered Species Act. Tens of thousands of Steller's eiders congregate here to undergo flightless molt in the fall, and use the area during spring migration as well.

Area 9. St. Lawrence Island including St. Lawrence Polynya (South)

Drifting Pack ice, leads and polynyas in the northern Bering Sea

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northern Bering Sea (Fay 1982, Ray and Hufford 1989) (M6c). One of the core areas is in the northern Bering Sea including the St. Lawrence and Sireniki polynyas. In spring the females and young animals start to move north through Chirikov Basin towards Bering Strait. During this phase of early migration, the pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining (Smirnov et al. 2004, Cooper et al. 2006), and it is expected that climate change may have severe negative consequences for it (the species is assessed as being 'Data deficient' by IUCN).

Bowhead of the 'Bering-Chukchi-Beaufort stock' and belugas of several stocks including the large migratory 'Beaufort stock', winter in polynyas and pack ice of the northern Bering Sea (Ray and Hufford 1988, Moore and Reeves 1993, Angliss and Outlaw 2008). This includes the St. Lawrence and Sireniki polynyas (M11c). In spring they start to move north through leads in the ice, with some whales moving through the Bering Strait in April. Breeding takes place in late winter, and both species give birth to their calves during the northward spring migration.

The St. Lawrence Island Polynya south of St. Lawrence Island is a prominent and very important wintering habitat for waterfowl. The total world population of spectacled eiders resides in this area for about 6 months during the winter season each year in small open leads between Saint Lawrence and Saint Matthew islands and the area is designated as spectacled eider critical habitat under the U.S. Endangered Species Act (B15). This species does not use recurring polynas during the majority of the winter season. Rather, they crowd into small cracks and openings in the ice and hold them open by virtue of their presence at extremely high densities, as the ice drifts over areas of high clam density in the substrate beneath them. The area is also used by king eiders and long-tailed ducks. The leads and polynyas of the northern Bering Sea are used for resting and feeding by seabirds and waterfowl during spring migration (B7a). This is the case for large numbers of thick-billed and common murres and least and crested auklets.

St. Lawrence Island

St. Lawrence Island is located on the shelf of the northern Bering Sea (B2a). It holds large breeding colonies of seabirds with least auklet and thick-billed murre as particularly abundant species (Hunt et al. 1981). The seabirds forage out from the colonies typically some 10s of km. The island is also breeding and staging areas in spring and autumn for shorebirds, notably rock sandpiper (subspecies *ptilocnemis*) and red phalarope.

Area 10. Bering Strait (St. Lawrence Island north to Diomede Islands)

Northern Bering Sea – Chirikov Basin

Although not well documented, there is likely a large migratory stock of polar cod (*Boreogadus saida*) that migrates south in autumn to spawn in winter under the ice in the southern Chukchi Sea and/or the northern Bering Sea (F1b). The location of spawning area(s) is not known and the area is therefore hypothetical at present. Given the great ecological importance of polar cod in the food webs of the northern Bering and Chukchi seas, the spawning area(s) of this species are clearly of heightened ecological significance.

Gray whale uses the Chirikov Basin in the northern Bering Sea as one of its main feeding areas in summer (M14). It feeds on the bottom on the very rich benthic communities (particularly amphipods) in these highly productive shallow waters (Highsmith and Coyle 1992, Moore et al. 2003). Gray whale (eastern population) forms a large migratory population that has recovered from previous commercial whaling of the 19th and early 20th centuries and now may have reached its carrying capacity.

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northern Bering Sea. In spring the females and young animals start to move north through Chirikov Basin towards Bering Strait (M7). During this phase of early migration, the pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining (Smirnov et al.

2004, Cooper et al. 2006), and it is expected that climate change may have severe negative consequences for it (the species is assessed as being 'Data deficient' by IUCN).

Bowhead of the 'Bering-Chukchi-Beaufort stock' and belugas of several stocks including the large migratory 'Beaufort stock', winter in polynyas and pack ice of the northern Bering Sea. In spring they start to move north through leads in the ice, with some whales moving through the Bering Strait in April (M12). Breeding takes place in late winter, and both species give birth to their calves during the northward spring migration.

Eastern Chukchi Peninsula

Western Chirikov Basin and the adjacent coast of the eastern Chukchi Peninsula are important habitats for Pacific walrus (M10). Males use haulouts in this area during summer. Females and young animals also use coastal haulouts in autumn when they return south from the summer feeding areas in the Chukchi Sea.

Bering Strait region

There are major breeding colonies of seabirds on islands in the Bering Strait region (Big and Little Diomede and King islands (B1). Small auklets (least, crested and parakeet) that feed on the rich zooplankton transported north with the highly productive Anadyr-Bering shelf waters, are particularly abundant. The 'Critically endangered' Kittlitz's murrelet also feed in this area during and after breeding (it breeds inland in adjacent mountainous areas).

St. Lawrence Island (area B2b)

See St. Lawrence Island including St. Lawrence Polynya (South)

Area 11. Gulf of Anadyr

Northern Bering Sea –Anadyr Gulf

Although not well documented, there is likely a large migratory stock of polar cod (*Boreogadus saida*) that migrates south in autumn to spawn in winter under the ice in the southern Chukchi Sea and/or the northern Bering Sea (F1a). The location of spawning area(s) is not known and the area is therefore hypothetical at present. Given the great ecological importance of polar cod in the food webs of the northern Bering and Chukchi seas, the spawning area(s) of this species are clearly of heightened ecological significance.

Drifting pack ice on the northern shelf

The large population of Pacific walrus has its wintering area in polynyas and drifting pack ice over the shelves of the northern Bering Sea (M6a). One of the core areas is in the northern Bering Sea including the St. Lawrence and Sireniki polynyas. In spring the females and young animals start to move north through Chirikov Basin towards Bering Strait. During this phase of early migration, the

pregnant females give birth to their calves. Pacific walrus is still numerous but may be declining, and it is expected that climate change may have severe negative consequences for it (the species is assessed as being 'Data deficient' by IUCN).

Northern Gulf of Anadyr

The northern Gulf of Anadyr is a major summering area with haulouts for male Pacific walrus along the southern coast of the Chukchi Peninsula (M9).

Pack ice and polynyas in the northern Bering Sea

Bowhead of the 'Bering-Chukchi-Beaufort stock' and beluga whales of several stocks including the large migratory 'Beaufort stock', winter in polynyas and pack ice of the northern Bering Sea (M11c). This includes the St. Lawrence and Sireniki polynyas. In spring they start to move north through leads in the ice, with some whales moving through the Bering Strait in April. Breeding takes place in late winter, and both species give birth to their calves during the northward spring migration.

Leads and polynyas in the northern Bering Sea

The Sireniki Polynya south of the Chukchi Peninsula is used for resting and feeding by seabirds and waterfowl during spring migration (B7b). This is the case for large numbers of thick-billed and common murres and least and crested auklets.

Area 12. Northeast Coast of Kamchatka and offshore areas

Northern Karagin and Korf bays

Karagin and Korf Bays are located at the base of the Kamchatka isthmus in the western Bering Sea. Beaches and subtidal sediments in the inner parts of these bays are spawning areas for Pacific herring and capelin of West Bering Sea stocks (F5). As in the East Bering Sea, herring and capelin are important species in the food webs; they are eaten, as eggs on the spawning grounds by diving eiders and other species, as larvae and juveniles by murres and other seabirds, and as adults they are prey for seals, fish and other predators.

Outer shelf off Olyutorskiy and northern Karaginkiy bays

The main wintering area for the stock of Pacific herring in the West Bering Sea is on the outer shelf off Olyutorskyi and northern Karaganskiy bays (F12). In a similar manner as for the stock in the East Bering Sea, the herring occurs as a concentrated band along the outer shelf at depth of 100-150 m.

Beaufort Sea (Figure (11, Table 16)

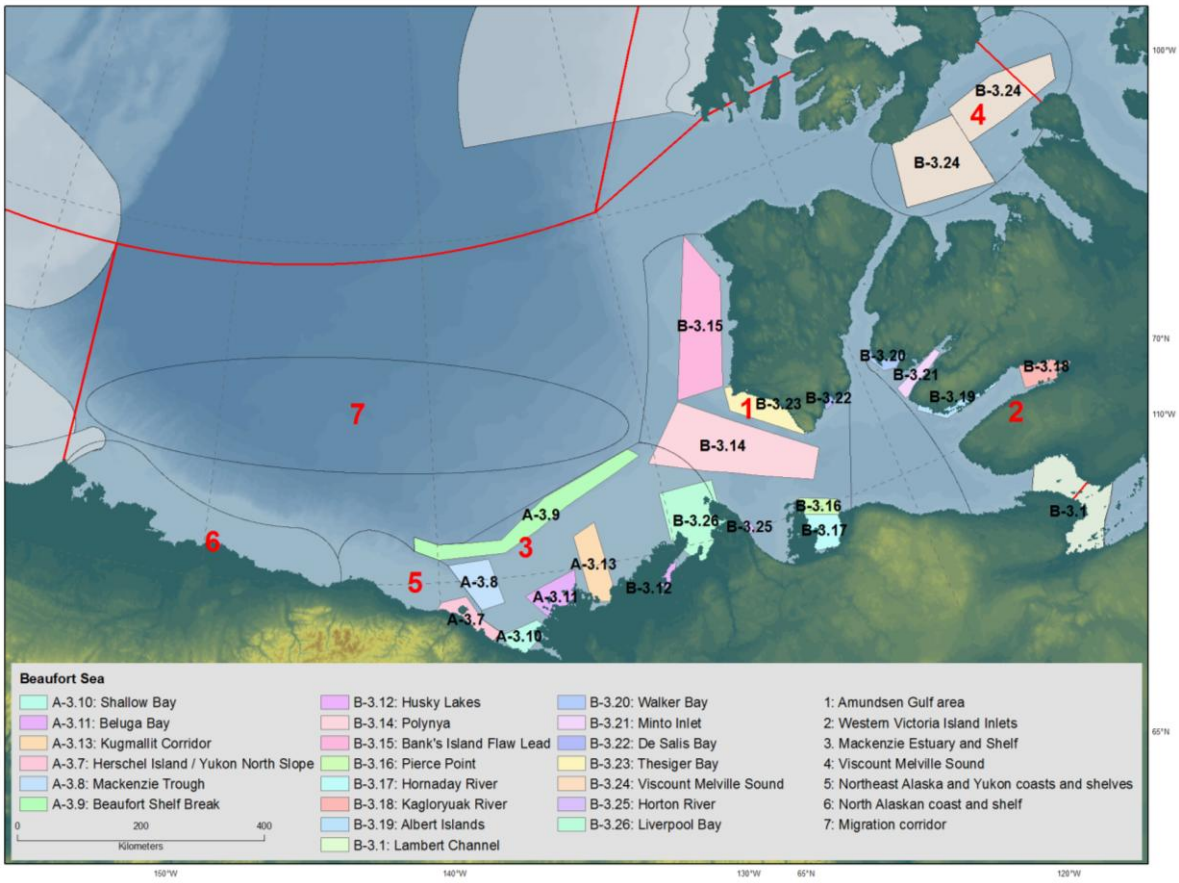

Figure 11. Areas of heightened ecological significance in the Beaufort Sea LME.

Area 1. Amundsen Gulf area

1.1 - Cape Bathurst Polynya

The recurrent polynya and ice-edge habitat make it an important beluga, bowhead, polar bear, and ringed seal feeding ground. Belugas (around 40.000 individuals) and bowheads (about 10.000 individuals) of the large migratory Beaufort Sea and Bering-Chukchi-Beaufort Sea populations, respectively, use the polynya area in the eastern Beaufort Sea as their main feeding grounds in the early part of the summer season (May-June). Polar bears of two subpopulations (northern and southern Beaufort Sea) also use this area as a migration corridor and for breeding purposes. Polar bears migrate into the inner reaches of the Amundsen Gulf area in fall to bays with fast ice that are prime breeding habitat for ringed seals. In spring they move back to the pack ice where they may occur concentrated around the Cape Bathurst Polynya and later in summer they may be found concentrated along the edge of the pack ice. The Cape Bathurst Polyna is also an important spring

staging and feeding area for seabirds and sea ducks (glaucous gull, king and common eiders, long-tailed duck).

1.2 - Banks Island Shorelead

This flaw lead system, which extends from the Cape Bathurst polynya, lies over relatively shallow waters, creating habitat important for spring staging and feeding seaducks, notably a large fraction of the western Canadian Arctic breeding population of king eiders which aggregate here in spring.This is also an important spring feeding area for beluga, bearded seal, ringed seal, and polar bear.

1.3 - Franklin Bay and 1.4 - Darnley Bay

Large aggregations of polar cod (*Boreogadus saida*; named Arctic cod in North America) have been recorded throughout winter under fast ice over relatively deep water in outer Franklin Bay. Franklin and Darnley bays (on both sides of the Parry Peninsula) are important prime breeding habitat for ringed seals and important winter and spring breeding and feeding areas for polar bears. Cape Parry is home to the only colony of thick-billed murres in the western Arctic, and the only colony of the Pacific sub-species (*arra*) in Canada. In addition, one of only two western Arctic black guillemot colonies is located here. Pearce Point, an important upwelling area, has aggregations of bowhead, Arctic char and capelin. Pacific herring aggregate in the Hornaday River area of Darnley Bay and kelp beds may be located along the coastline but have not yet been confirmed. The Horton River area of Franklin Bay has steep bathymetry and as a result includes an area of upwelling which supports diverse meiofauna communities. It is an important migration and feeding pathway for beluga, bowhead, and Arctic char, and polar bear are known to migrate through the area.

1.5 - De Salis Bay and Thesiger Bay

These two bays are located along southern Banks Island on the northern side of Amundsen Gulf. De Salis Bay includes an area of upwelling and marine mammals, such as bowhead, beluga, and various seals, feed and nurse here, as well as migrate through this area. Arctic char also use this area as a migration and feeding corridor, and a variety of seabirds and sea ducks aggregate here to feed and nest. Thesiger Bay is characterised by the presence of a flaw-lead polynya. The possible presence of kelp beds is a unique feature of this area which also includes benthic communities and a migration and feeding corridor for Arctic char. Beluga, polar bear, and ringed and bearded seals aggregate on these feeding grounds. Capelin are also known to occur in this area.

Area 2. Western Victoria islands inlets

2.1 - Prince Albert Sound

This relatively shallow and long inlet in the inner Amundsen Gulf (into western Victoria Island) is prime breeding habitat for ringed seals and is also an important area for bearded seals. Prince Albert Sound is also used as a feeding area for sea ducks and seabirds. The estuary of the Kagloryuak River

and the coastlines of the sound, particularly into the Albert Islands/Safety Channel area are important migration and feeding areas for Arctic char in the summer.

2.2 - Minto Inlet

Minto Inlet and Walker Bay (located north of Prince Albert Sound) provide prime breeding habitat for ringed seals, and are also used by bearded seals. Polar bear may aggregate here to nurse and rear their cubs. The area is also used as an important feeding and migration corridor for Arctic char, and as a feeding area for seabirds and seaducks.

2.3 - Union and Dolphin Strait

This strait connects inner Amundsen Gulf with Coronation Gulf south of Victoria Island. The area contains a recurrent polynya that is located at the mouth of Lambert Channel which is an area of enhanced biological productivity. This polynya is a very important spring staging and feeding area for common eiders, yellow-billed loons and other birds during spring migration. It is also used by Arctic char for migration and feeding. The fast ice at the western entrance to the strait is prime breeding habitat for ringed seal and a winter and spring feeding area for polar bear.

Area 3. Mackenzie Estuary and Shelf

3.1 - Herlinvaux/Mackenzie Lake

In winter a floating lake forms off the Mackenzie Delta by the Mackenzie River water being dammed by the stamukhi ice zone. This is a globally unique feature and although little studied, is probably an important winter habitat for anadromous or amphidromous fish.

3.2 - Shallow Bay, Beluga Bay and Kugmallit Bay

These three bays form the inner part of the Mackenzie Estuary and constitute important nursery areas for juvenile anadromous/amphidromous coregonid whitefishes and seasonal feeding areas for adult fish (Arctic cisco, least cisco, broad whitefish, lake whitefish, inconnu). These bays are also important molting, feeding and migration areas for belugas and feeding areas for ringed seals, as well as important feeding, brood rearing and molting areas for various seabirds, sea ducks and geese including Arctic tern, common eider, scoters, and brant goose.

3.3 - Kugmallit Corridor

This area extends north across the shelf from Kugmallit Bay. It includes a deep trough where upwelling occurs and is influenced by plumes of freshwater from the Mackenzie River. The Kugmallit Corridor has a high food supply for the benthos and is important to ringed seal for migration and feeding.

3.4 - Mackenzie Trough

This area includes a deep trough where upwelling occurs and is influenced by plumes of freshwater from the Mackenzie River. It has a high benthic diversity and production. Bowhead, beluga, and ringed seal migrate through the area and polar bear come here to feed and breed.

3.5 - Mackenzie Shorelead

The shorelead off the fast ice on the eastern Mackenzie Shelf (off the Tuktoyaktuk Peninsula) is an important spring staging and feeding area for sea ducks, particularly for common eider but also for king eider and long-tailed duck. This lead is typically connected to the Cape Bathurst Polynya but the location over the relatively shallow shelf allows access for the sea ducks to relatively rich benthic communities. The shallow waters off the Tuktoyaktuk Peninsula are also used by common eiders, long-tailed ducks and other waterfowl during brood rearing and molting in the ice-free period in late summer.

3.6 - Outer Mackenzie Shelf

Similar to the characteristics of the Mackenzie Trough, this area has steep bathymetry associated with the continental shelf edge and areas of upwelling. High benthic diversity and production are found here and marine fish aggregate in this area. Polar bear feed and migrate throughout the area, as do beluga and bowhead.

3.7 - Husky Lakes

The Husky Lakes form a unique brackish water transitional area from fresh to marine located inland from Tuktoyaktuk Pensinsula. It is characterised by strong tidal flows and a complex coastline with the Fingers area forming a ‘labyrinth’ in the outer part. The area is important for ringed seal and lake trout spawning, nursing, and feeding. Arctic seabirds and sea ducks also use this area for migration and feeding, and beluga are known to aggregate here in some years. Pacific herring are known to spawn in the Fingers area.

3.8 - Liverpool Bay

Liverpool Bay lies between the Tuktoyaktuk and Cape Bathurst peninsulas. It includes an area of upwelling and has significant tides and potentially kelp beds. The area is used as feeding and nursery grounds for polar bear, and for migration and feeding by bowhead. It is also an important feeding, nesting, and staging area for seabirds and sea ducks. The Anderson River estuary is a nursery area for juvenile coregonid whitefishes and a molting and staging area for ducks and geese.

Area 4. Viscount Melville Sound

4.1 - Viscount Melville Sound

This area is primarily characterised by the late summer presence of feeding beluga in the deep offshore basin. The area is also an important feeding ground and rearing area for polar bear. A separate subpopulation of polar bears is recognized in this area numbering around 200 individuals.

Area 5. Northeast Alaska and Yukon coasts and shelves

5.1 - Coastal areas and lagoons

This area is characterised by the presence of a freshwater corridor in summer that is used as a migration and feeding corridor by fish species such as Arctic char, Arctic cisco and Dolly Varden. It is also used as post-breeding feeding and molting areas for waterfowl such as common eider, long-tailed duck, surf scoter and red-breasted merganser. The area serves also as post-breeding feeding and staging areas for shorebirds such as red and red-necked phalaropes, dunlin and semipalmated sandpiper.

5.2 - Herschel Island and adjacent waters

Herschel Island is one of only two sites where black guillemot breeds in the western Canadian Arctic. The waters adjacent to the island constitute the feeding areas for this small colony. The area is also used as feeding and molting areas for waterfowl. Capelin have been reported to spawn along coastal beaches at Herschel Island.

5.3 - Shelf areas

The narrow and relatively shallow Beaufort shelf west of the Mackenzie Trough is an important feeding area for bowheads in early autumn (August) before they continue further west on their seasonal migration.

Area 6. North Alaskan coast and shelf

6.1 - Colville and Sagavanirktok river deltas and estuaries

The Colville River Delta is an important winter habitat for coregonid whitefishes, notably Arctic and least ciscos that support a fishery in this area. Both the Colville and Sagavanirktok estuaries are important summer feeding and migration habitat for coregonid whitefishes and Dolly Varden. The deltas with associated wetlands and salt marshes provide summer nesting, feeding, brood-rearing and molting habitat for geese such as lesser snow goose and black brant. They also provide post-breeding feeding and staging areas for shorebirds such as dunlin, and semipalmated and pectoral sandpipers.

6.2 - Simpson Lagoon and Stefansson Sound

The barrier islands bounding the lagoons provide breeding and brood-rearing habitat for common eiders and seabirds such as Arctic tern and glaucous gull. The lagoons provide molting habitat for long-tailed duck and other sea ducks. They are also used as summer feeding area and migration corridor for anadromous/amphidromous whitefishes and Dolly Varden. The Boulder Patch in Stefansson Sound is a very special and rare hard-bottom habitat with kelp beds and associated fauna on the mostly soft-bottom Beaufort shelf.

6.3 - Elson Lagoon and Dease Inlet

Elson Lagoon and the waters around Plover Islands are important autumn feeding, staging and migration areas for seabirds, waterfowl and some shorebirds. This area is used by Ross's gull, king and common eiders, long-tailed duck, and red and red-necked phalaropes. The shelf area off the Plover Islands (east of Point Barrow) is an important feeding area for bowheads in autumn. Dease Inlet is a summer feeding area for amphidromous coregonid whitefishes such as least cisco and humpback whitefish.

6.4 - Shoreline and barrier islands

The shoreline and barrier islands are important polar bear denning areas for bears of the Southern Beaufort Sea stock, and polar bears are often concentrated near Cross and Barter Islands in fall after bowhead whaling season. This stock numbers around 1500 polar bears. The shallow waters off shore of the coast are important ringed seal habitat including winter breeding areas.

Area 7. Offshore pack ice

Bowheads (about 10,000 individuals) and belugas (about 40,000 individuals) of the large populations that winter in the northern Bering Sea migrate east towards the Amundsen Gulf and the Cape Bathurst Polynya through leads in the offshore pack ice in the southern Beaufort Sea. This migration takes place during May and June. There is a return migration through offshore areas in the fall.

Central Arctic Ocean LME (Figure 12, Table 17)

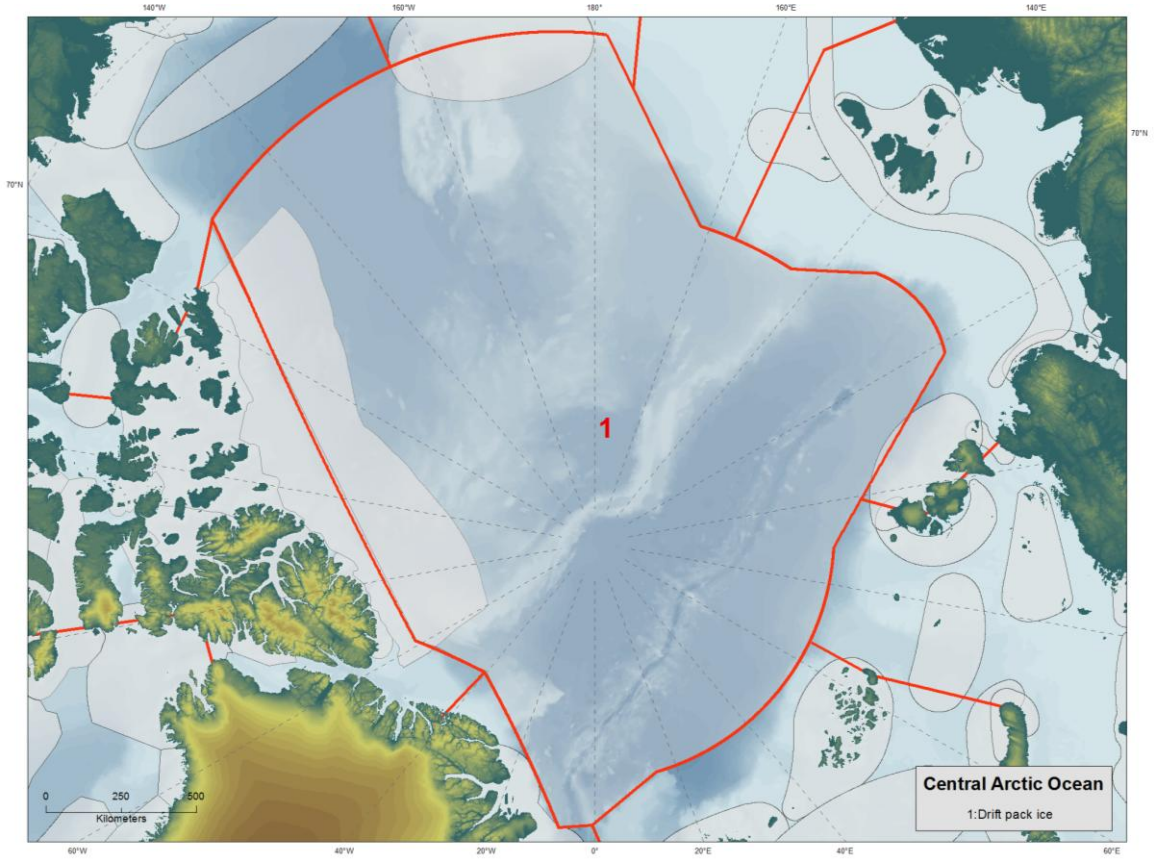

Figure 12. Area of heightened ecological significance in the Central Arctic Ocean LME.

Pack ice

The drifting pack ice of the Central Arctic Ocean is a globally unique environment characterised by very low primary productivity by specially adapted ice algae and phytoplankton in the water column below the ice (Sakshaug 2003, von Quillefeldt et al. 2009). In addition to ice algae, the sea ice biota contains an endemic fauna component including sea ice amphipods that live in association with the ice. The sea ice (or sympagic) fauna includes forms that live permanently in association with sea ice (so-called autochthonous species). The large amphipod *Gammarus wilkitzkii* (up to 6 cm) and the smaller (1.5 cm) *Apherusa glacialis* belong to this group, and they are abundant and dominant species in Arctic sea ice habitats, particularly in multiyear ice (Melnikov 1997, Melnikov et al. 2002, Arndt and Lønne 2002, Arndt et al. 2009). Autochthonous species are also found in other groups such as copepods. The ice amphipods including *Gammarus wilkitzkii* are important prey for polar cod (*Boreogadus saida*) and Arctic cod (*Arctogadus glacialis*), and also for ringed seals. They also support

directly or indirectly other species that live in ice-covered waters including polar bear, ivory gull and Ross's gull.

The multi-year pack ice may be of particular importance for maintenance of the special autochthonous ice biota. The reduced ice cover in summer in recent years has been associated with a pronounced loss of multiyear ice (AMAP 2012). With climate change, future projections suggest that the current area of multi-year pack will shrink further, and the areas north of the Canadian Arctic Archipelago and Greenland may be the last refugia for multi-year ice, the endemic sea ice biota and for many ice-dependent species, such as ringed seals, polar bears and other species (Anon 2011a, DFO 2011). The pack ice of the Central Arctic Ocean ecosystem may therefore be considered a threatened habitat in light of climate change. The endemic fauna associated with the drifting pack ice is sensitive to potential oil spills. The large extent of the pack ice would tend to lower the vulnerability of this habitat to an oil spill. However, shrinking ice cover would increase the vulnerability due to the lesser extent of the habitat combined with greater mobility of spilled oil with more open water in summer.

Polar bears from several subpopulations use the peripheral areas of the pack ice of the Central Arctic Ocean as part of their summer feeding habitat. Ivory gull and Ross's gull also use this habitat for foraging during the post-breeding period in late summer and fall. These species are also sensitive to oil spills.

Canadian Arctic Archipelago LME (Figure 13, Table 18)

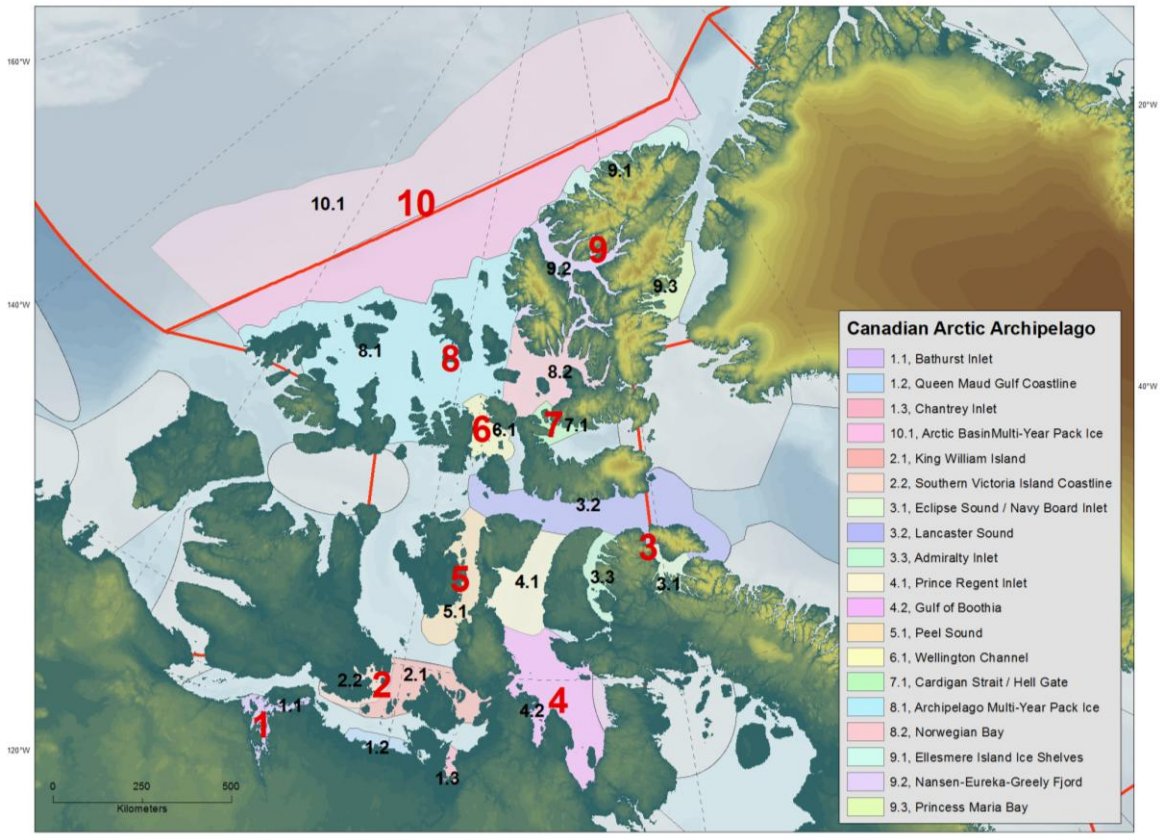

Figure 13. Areas of heightened ecological significance in the Canadian Arctic Archipelago LME.

Area 1. Coronation Gulf/Queen Maud Gulf - coasts and inlets

1.1 - Bathurst Inlet

With depths of 100-200 m, and with the influence of the Burnside River, Bathurst Inlet is an important summer habitat for ringed seal and marine fish communities, particularly Arctic char; seabird colonies are found on small islands near the mouth of the inlet where they feed. Based on the occurrence of a polynya there may be productive benthic epifauna communities, however no data is currently available.

1.2 - Queen Maud Gulf Coastline

The relatively shallow (<100 m) waters along the coast of the Queen Maud Gulf are heavily influenced by freshwater inputs from four major rivers, the Armak, Ellice, Perry and Simpson rivers. Nutrients from these rivers and those released from sediments lead to enhanced primary

productivity in this area. The area is an important marine feeding ground and migration corridor for Arctic char, and ringed seal are common throughout the area.

1.3 - Chantrey Inlet

Chantrey Inlet is a shallow (<100 m), heavily protected, and enclosed ecosystem that is intensely influenced by the Black River which results in very low salinities. These conditions present a unique ecosystem that is very productive and utilized by Arctic char for migration and feeding. This area also includes prime ringed seal summer habitat and a key migratory bird terrestrial habitat site.

Area 2. King William and southern Victoria islands

2.1 - King William Island

The marine area around West King William Island includes several islands around which strong tidal currents flow, resulting in tidal mixing zones. These currents enhance the productivity of the area and a high food supply for the benthos results in increased benthic diversity and production in this area. Ringed seal and a depleted polar bear population (M'Clintock Channel) aggregate in the area to feed.

2.2 - Southern Victoria Island Coastline

The nearshore Arctic char migratory and feeding corridor that is present in this area was deemed an EBSA since the ecological properties here are different than those in the King William Island EBSA.

Area 3. Lancaster Sound and adjacent inlets

3.1 - Eclipse Sound – Navy Board

This area was selected as an EBSA based on its importance to seabirds, narwhal, beluga, killer whale, ringed seal, and harp seal. The relatively deep waters (maximum depth of 200 m) surrounding Bylot Island and its connection to Lancaster Sound are very important migration routes and summer feeding areas for beluga and approximately 20,000 narwhal. Cape Hay on the northwest end of Bylot Island supports colonies of thick-billed murre and black-legged kittiwake which forage 30-60 km offshore; northern fulmar use this area as a staging area. In addition, Cape Graham Moore on the southeast point of Bylot Island is home to thick-billed murre and black-legged kittiwakes.

3.2 - Lancaster Sound

Lancaster Sound contains a recurrent polynya and associated sea ice-edge habitats. This area is a major migration corridor for marine mammals (e.g. bowhead, narwhal, beluga, killer whale, and seals) and contains the highest density of polar bear in the world. The area is very productive, has a high export of sea-ice algae, and has high benthic diversity, production, and re-mineralisation – likely owing to the high quality food supply for the benthos. Over 1,000,000 seabirds and sea ducks (e.g.,

thick-billed murre, black-legged kttiwake, northern fulmar, and black guillemot) use this area as a nesting, breeding, and feeding area. Walrus haul-out sites are located here and polar cod (*Boreogadus saida)* is abundant in all stages of its life cycle.

3.3 - Admiralty Inlet

This is an area of local nutrient enrichment and the high productivity is reflected in its extensive use by seabirds and marine mammals, particularly bowhead and narwhal, but also beluga, ringed seals, and harp seals. The presence of these mammals, which feed primarily on marine fish, is suggestive of a substantial marine fish population. Approximately 18,000 narwhal spend the summer in Admiralty Inlet and migrate to southern Baffin Bay for winter. TEK suggests significant seabird feeding in the marine areas of Admiralty Inlet, and Baillarge Bay on Admiralty Inlet is occupied by northern fulmar and glaucous gull.

Area 4. Prince Regent Inlet and Gulf of Boothia

4.1 - Prince Regent Inlet

This area is characterised by strong currents and a recurrent polynya in Bellot Strait owing to tidal currents in the area. Prince Regent Inlet is an important feeding area, migration route, and/or nursery ground for marine mammals (e.g. bowhead, narwhal, beluga) and seabirds (such as black-legged kittiwake, northern fulmar, king eider and common eider), while Arctic char use the nearshore waters.

4.2 - Gulf of Boothia

The Gulf of Boothia is an important migration corridor and feeding ground for narwhal and bowhead, while Arctic char concentrate in nearshore waters. Bowhead also use it as a nursery area. Polar bear den, feed, and raise their young here.

Area 5. Peel Sound

5.1 - Peel Sound

Peel Sound contains a polynya and is a highly productive area. The largest Canadian summering aggregation of narwhal (about 45,000 individuals) frequents this area, which likely supports large populations of marine fish owing to its use as a feeding ground for narwhal as well as beluga. In addition, Peel Sound has areas of high benthic diversity and production.

Area 6. Wellington Channel

6.1 - Wellington Channel

Strong currents maintain a polynya in Penny Strait/Dundas Island area and this is an important haul-out and wintering ground for walrus. The Cheyne Islands located in Wellington Channel support the largest known nesting population of Ross's gull in the Canadian Arctic.

Area 7. Cardigan Strait-Hell Gate

7.1 - Cardigan Strait – Hell Gate

A recurrent polynya occurs in this area owing to strong currents flowing from Norwegian Bay. The area is frozen during October and November, with open water reappearing in December through to July; however this area does not usually become ice-free during the summer owing to ice flowing south from Norwegian Bay. Cardigan Strait – Hell Gate is used year-round for feeding and haul-out by an aggregation of approximately 300-500 walrus, which represent a distinct stock. The area is also used during the summer by beluga, killer whale, and seals. In addition, several major seabird colonies use this area for feeding, breeding, and nesting, the most numerous being black guillemot, although northern fulmar, common eider, and glaucous gull are also found here.

Area 8. Northern Archipelago/Norwegian Bay

8.1 - Archipelago Multi-year Pack Ice

The multi-year pack ice present in this area supports different communities than those within the Arctic Basin (see area 10.1 below) and constitutes the largest remaining island pack ice refugium in the world. This EBSA includes interesting under-ice communities and is important for seabird nesting and foraging, particularly ivory gull, a species at risk in Canadian waters. In addition, polar bear aggregate in this area as a summer refuge for denning, feeding, and rearing their young.

8.2 - Norwegian Bay

Although marine mammal aggregations and current concentrations/densities appear to be low compared to other regions of the Arctic, this is a regionally-important area for a number of marine mammals. It is also an important feeding and rearing area for the most genetically differentiated polar bear population in the world.

Area 9. Ellesmere Island

9.1 - Ellesmere Island Ice Shelves

The largest and most significant glaciers flow from Ellesmere Island into fjords as ice shelves. This area is relatively shallow (< 200 m) and is covered by greater than 90% old-year ice which likely supports unique under-ice communities. A total absence of biological data makes this area unique.

9.2 - Nansen-Eureka-Greely Fjord

The Nansen-Eureka-Greely Fjord marine complex separates Ellesmere and Axel Heiberg islands. At the outer end of the fjords, shallower sills inhibit water transport and this lack of exchange creates unique water masses which support unique fish communities and aggregations of polar bear and ringed seal; these unique ecosystems are poorly understood.

9.3 - Princess Maria Bay

A number of important walrus feeding and haul-out sites are located in this EBSA which is considered highly productive; various seal species and narwhal use this area as a feeding ground.

Area 10. Arctic Basin pack ice

10.1 - Multi-year Pack Ice

The region of the Canadian Arctic Ocean between M'Clure Strait and Nares Strait is the source of the thickest multi-year ice in the Arctic Ocean. This multi-year ice is a unique habitat whose community structure is not well known. It is thought to be particularly important for long-lived (i.e. 6+ years) autochthonous amphipods (e.g. *Gammarus wilkitzkii*) and the mat-forming centric diatom *Melosira arctica* that is generally associated with Arctic under-ice communities. This region is also likely a core habitat for a variety of ice-adapted heterotrophic microbes and zooplankton. In addition, the edge of the multi-year pack ice is an important summer refuge for a significant proportion of individuals from the Beaufort Polar Bear populations. The Beaufort Gyre is also an important and unique physical feature in this EBSA as it contains a globally significant accumulation of freshwater from North American and Eurasian rivers.

Hudson Bay LME (Figure 14, Table 19)

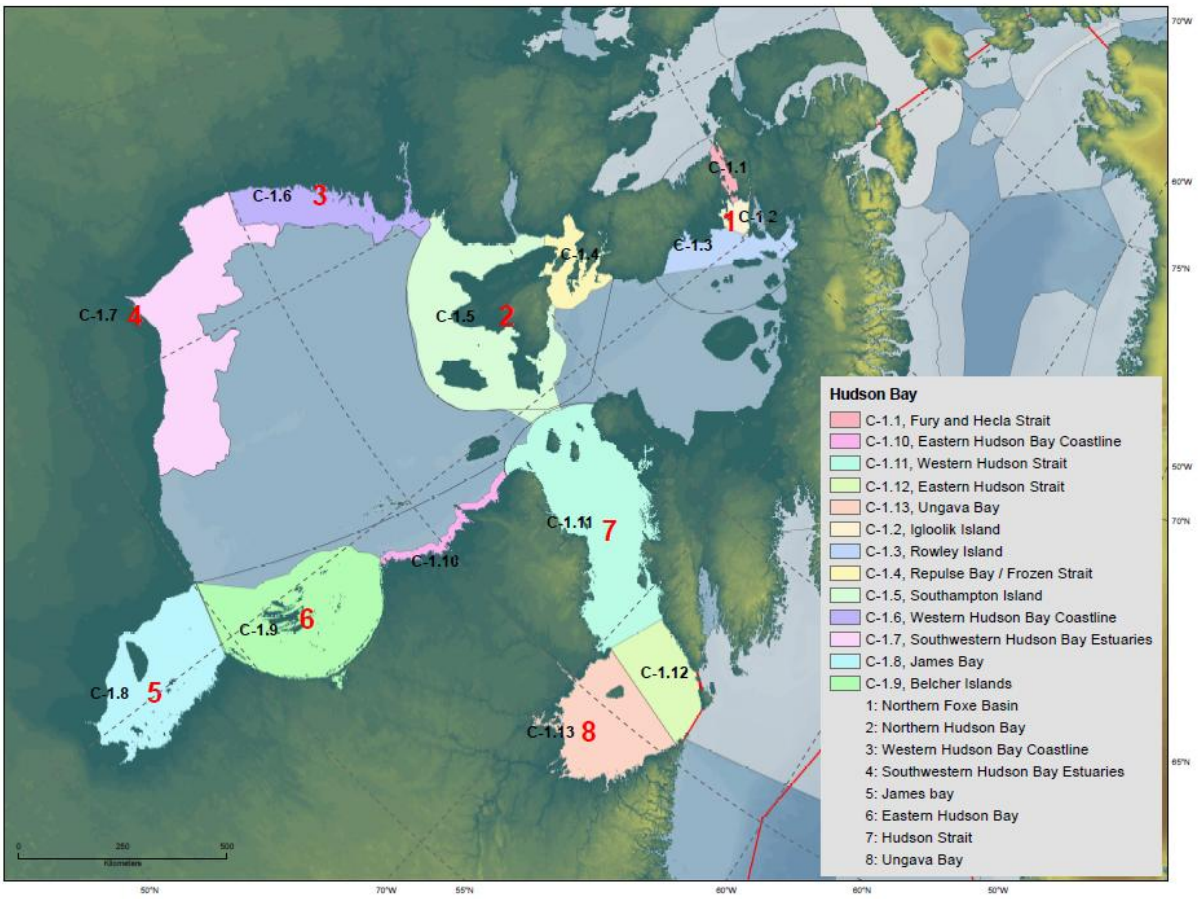

Figure 14. Areas of heightened ecological significance in the Hudson Bay LME.

Area 1 Northern Foxe Basin

1.1 - Fury and Hecla Strait

The main features of the Fury and Hecla Strait are its importance as a migratory corridor for bowhead, narwhal, beluga, and killer whale as well as the availability of polar bear denning sites. There is a high proportion of bowhead juveniles and calves present in the eastern mouth of the Fury and Hecla Strait which suggests this is an important nursery area.

1.2 - Igloolik Island

The Igloolik Island area features the Fury and Hecla polynya and increased nutrients and productivity compared to other areas. The area is an important migration corridor and feeding area for marine

mammals (i.e., bowhead, narwhal, beluga, killer whale), as well as Arctic char and other marine fish. The Igloolik Island EBSA also includes walrus haul-out areas and polar bear denning sites.

1.3 - Rowley Island

A migratory pathway for bowhead, narwhal, beluga, and killer whales, the Rowley Island EBSA is also a preferred year-round walrus habitat providing haul-out sites, calving areas, and feeding grounds for this species. The presence of islands and sea ice-edge habitat are important physical features of this EBSA.

Area 2 Northern Hudson Bay

2.1 - Repulse Bay and Frozen Strait

With a complex oceanography resulting from bathymetry and strong currents (including two recurrent polynyas), the Repulse Bay and Frozen Strait area is considered an important area for a number of marine mammals, seabirds and Arctic char. The only summering aggregation for the genetically distinct Northern Hudson Bay narwhal population occurs in Repulse Bay, Frozen Strait, western Foxe Channel and Lyon Inlet. This area is also important summering habitat for bowhead. In addition, walrus use this area year-round and the presence and seasonal migration of narwhal through the area has been documented. A significant proportion of the Canadian population of Iceland gulls occurs in Frozen Strait.

2.2 - Southampton Island (including Coats Island)

Southampton Island is the largest island in Hudson Bay and is situated near the confluence of Hudson Bay and Foxe Basin waters which results in dynamic oceanographic mixing and fairly high marine productivity. The waters surrounding Southampton Island are important spring and fall migration routes for beluga and bowhead. The area is also used during summer and winter by walrus, with important haul-out sites on Bencas, Coats and Walrus islands. Coats Island is an important nesting area for seabirds such as thick-billed murre, common eider, and black guillemot which feed on aggregations of marine fish, particularly capelin and polar cod. The largest single colony of common eider in Nunavut occurs in this EBSA in East Bay. Southampton, Coats and Mansel Islands are also considered important for polar bear denning and as important summer refuge habitat for the Foxe Basin polar bear population. The bears also frequent the land-fast ice adjacent to the islands during the winter.

Area 3. Western Hudson Bay

3.1 - Western Hudson Bay Coastline

The western Hudson Bay coastline (from Whale Cove to Arviat) is an important aggregation area for beluga, a fall migration area for polar bear, and a migration corridor and feeding area for Arctic char. Dense kelp beds occur along this coastline and provide important habitat for marine fish. One of the

defining physical features of this area is the winter shorelead and persistent sea-surface temperature front that exists during summer.

Area 4. Southwestern Hudson Bay

4.1 - Southwestern Hudson Bay Estuaries

The Nelson, Churchill, and Seal River estuaries provide important habitat for a number of marine mammals (particularly beluga and harbour seal), seabirds, polar bear, caribou, and fish. The world's largest summering aggregation (about 70,000 individuals) of beluga occurs in the Nelson River estuary, with smaller numbers aggregating in the Churchill River estuary which is also a key migration corridor, denning, feeding, and rearing area for polar bear and important for Ross's gull. The Seal River estuary is considered globally significant for migrating black scoter and is also an important migration route for harbour seal. This estuary also supports summer and fall concentrations of polar bear and a population of approximately 3,000 beluga that use the area as a nursery and feeding ground.

Area 5. James Bay

5.1 - James Bay

James Bay is defined by shallow waters and low salinity and supports a variety of warm-water species that are relicts of an earlier connection with the Atlantic and Pacific oceans, many of which have disconnected distributions and are rare or absent elsewhere in Canadian Arctic waters. Approximately 8,000-16,000 beluga, which may be a distinct stock, aggregate here during the summer and there are indications based on TEK that some may remain year-round. The area is also important for walrus haul-out and feeding, as well as for polar bear denning and feeding, particularly near the Belcher Islands where prime ringed seal habitat exists. The sub-tidal eelgrass (*Zostera* spp.) beds that occur along the east coast of James Bay and along the coasts of Akimiski Island provide a unique habitat feature used by waterfowl and juvenile sculpins. Anadromous fish species such as cisco (*Coregonus* spp.) and broad whitefish use this area for migration and feeding. James Bay is also very important for staging, foraging, feeding, and moulting by a variety of seaducks, shorebirds, and waterfowl such as Hudsonian godwit, red knot and black scoter.

Area 6. Eastern Hudson Bay

6.1 - Belcher Islands

The Belcher Islands area includes several polynyas and small estuaries, and cooler water temperatures than surrounding waters in Hudson Bay. The currents that move around the islands and the presence of land-fast ice make this area particularly important to walrus, common eider, beluga, bearded seal, and polar bear. The area houses the entire population (about 100,000 to

200,000 individuals) of the Hudson Bay subspecies (*sedentaria*) of common eider in summer and winter. The Belcher Islands area represents important beluga habitat as the Eastern Hudson Bay stock aggregates here in the summer and possibly during the winter as well. Ringed seal and polar bear are common in this region and summer and winter walrus haul-out sites are located here. A diversity of habitats, including eelgrass beds, are found in the waters surrounding the Belcher Islands and result in high benthic diversity and productivity, including invertebrates such as sea urchins, sea cucumbers, and bivalves that form traditional Inuit diets.

6.2 - Eastern Hudson Bay Coastline

This area is an important migration pathway for the Eastern Hudson Bay beluga, an endangered population in Canada. It is also an important feeding area for a significant proportion of the thick-billed murres breeding at the very large Digges Sound colony.

Area 7. Hudson Strait

7.1 - Western Hudson Strait

The Western Hudson Strait is characterised by strong currents as it is a conduit for Arctic waters via Foxe Basin, the outflow of Hudson Bay water, and also periodic intrusions of Atlantic water into northeastern Hudson Bay. It is a major seasonal migration route for all marine mammals that spend the summer feeding and nursing in the Hudson Bay LME and Arctic Archipelago LME (e.g., killer whale, walrus, beluga, narwhal, bowhead). In addition, this is an overwintering ground for beluga, bowhead, and walrus. This area is highly productive and there are a number of important seabird colonies and sea duck nesting and foraging areas located here. There are also important walrus haul-out sites on Mills, Salisbury and Nottingham islands. Twenty percent of the North American population of thick-billed murres and a small colony of Atlantic puffins are found near Digges Sound and 10% of the Canadian population of common eiders breed and feed near Markham Bay. This area covers important epibenthic habitat, including sponge beds.

7.2 - Eastern Hudson Strait

In addition to the same factors that contribute to the ecological significance of West and Central Hudson Strait, the Eastern Hudson Strait is heavily influenced by oceanographic conditions from Davis Strait. This area is a migration corridor to summer feeding and nursery grounds for marine mammals (e.g., walrus, beluga, bowhead). It is an important area for northern shrimp (*Pandalus borealis*) and the western extent of Greenland halibut habitat exists within this area. The area is a significant overwintering area for beluga and approximately 5000-8000 bowhead also overwinter here. There are relatively significant occurrences of cold water corals in the deeper waters of the Strait. The area represents important nesting and foraging sites for seabirds, particularly the endangered ivory gull.

Area 8. Ungava Bay

8.1 - Ungava Bay

Ungava Bay is characterised by small islands and very high tides. There are relatively significant occurrences of coldwater corals in the deeper waters of Ungava Bay, and the stock of beluga in this area has been reduced to approximately 50 individuals and may be extirpated. Two large colonies of thick-billed murre occur on Akpatok Island. Collectively, these colonies constitute the largest number of breeding thick-billed murre in Canada (>20% of the Canadian population). Black guillemot also nest along the Akpatok Island coast. In addition, a large portion of the breeding population of common eider aggregate on the islands of the western shore of Ungava Bay. Approximately 80-100 polar bear (about 5% of the Davis Strait population) den and rear their young along the southern shore of Akpatok Island during summer.

Baffin Bay-Davis Strait LME (Figure 15, Table 20)

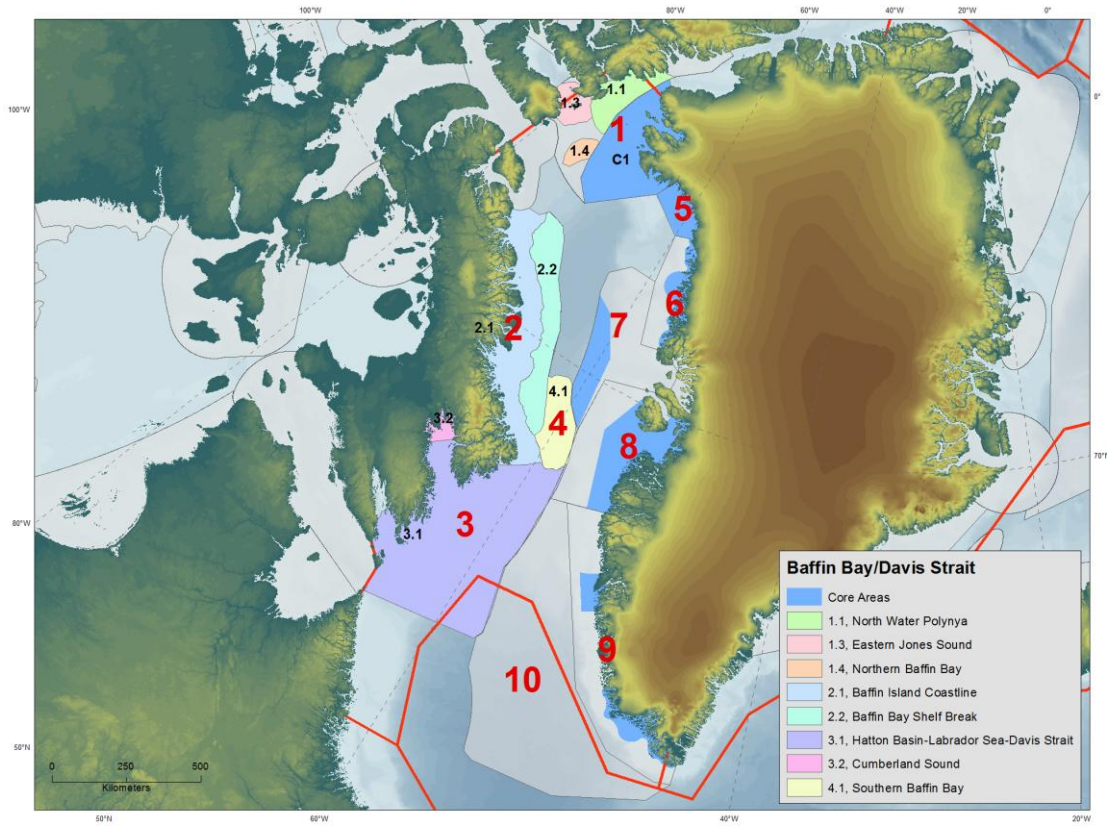

Figure 15. Areas of heightened ecological significance in the Baffin Bay-Davis Strait LME.

Area 1. North Water-Northern Baffin Bay

1.1 - North Water Polynya (Canadian side)

The North Water Polynya is the largest and most productive polynya in the Canadian Arctic. In addition to the tremendous marine bird resources in this area, the North Water is of significance to more species of marine mammals than any other polynya in the Canadian Arctic. For example, it is used by beluga during the summer and winter, bowhead and narwhal during the summer, migratory walrus, and ringed, bearded, and harp seals throughout the year. In addition, polar bear feed on ringed seal here during the winter and into the spring, and walrus use the area as a haul-out and migration corridor. Millions of seabirds (e.g., black-legged kittiwake, thick-billed murre, ivory gull, black guillemot, and dovekie) breed in the vicinity of the North Water Polynya. Most of them feed here during the summer season, while some birds also use the area for overwintering.

1.2 - North Water Polynya (Greenland side; C1)

The North Water (NOW) is the most productive polynya in the Arctic (Deming et al. 2002) and globally unique. Especially in the eastern parts along Greenland, upwelling of nutrient-rich waters and the associated high biological production provides favorable foraging conditions for seabirds and mammals, mostly in the summer, but even some marine mammal populations winter here.

- More than 80% of the world population of little auks is dependent on NOW from May to September, when about 30 million pairs are estimated to nest along the Greenland coast (Egevang et al. 2003).

- Over half of Greenland's breeding population of thick-billed murres are nesting in five colonies with a total of approx. 200,000 breeding pairs (Boertmann et al. 1996). They are dependent on the north-eastern parts of the area from mid-May to late August, and during the fall migration in August – September also on the western (Canadian) side (Falk et al. 2001).

- The endangered ivory gull occurs scattered throughout the NOW in summer and breed on adjacent Ellesmere Island (Gilchrist and Mallory 2005; Gilchrist et al. 2008; Boertmann and Mosbech 2011a).

- Sea duck moulting areas, especially for king eiders, occur along the Greenland coast (Boertmann and Mosbech 2011a).

- NOW is critical habitat for belugas: an estimated 14,000 animals (Heide-Jørgensen 2010) migrate from the Lancaster Sound in Canada to NOW and adjacent waters, a large proportion of them winter in mainly the western parts of NOW.

- The northernmost parts of NOW and Inglefield Bredning are important summer areas for discrete summer populations of narwhals. An estimated population of 8,368 individuals (Heide-Jørgensen

et al. 2010) exploits Inglefield Bredning. The Melville Bay (see Area B4) is the only other summer range in West Greenland.

- Bowhead whales utilize the southern parts of NOW in spring, and an unknown number are wintering here (Boertmann and Mosbech 2011a).

- The northern parts of NOW – Kane Basin – holds a population of a couple of hundred polar bears; they are linked to larger sub-populations in Baffin Bay (about 1600 animals) and Lancaster Sound (2500 bears). The ice edges anywhere in NOW and around Cape York in the southern part of the area are particularly important for wintering polar bears (Boertmann and Mosbech 2011a).

- NOW is also an important wintering area for young ringed seals (an important prey for polar bears) benefitting from the relatively thinner ice in the eastern (Greenland) parts of NOW (Born et al. 2004).

- At least 1500 walruses (2009 estimate; Born *et al.* 2009, and NAMMCO 2009) are summering in NOW, mainly in the western parts along Ellesmere, while wintering occurs mainly in the eastern parts. The entire Baffin Bay population was estimated at 2100 animals in 2009.

1.3 - Eastern Jones Sound

This area is characterised by open water in the vicinity of Coburg Island which remains a separate feature for some months before joining the North Water Polynya in May or June. The recurrent polynya of Eastern Jones Sound provides productive summer habitat for Atlantic walrus, beluga, ringed seal, and is identified as an important maternity area for polar bear. Over 500,000 breeding marine birds are found in this area, including the largest colony of black-legged kittiwakes as well as thick-billed murres, northern fulmars, ivory gulls, black guillemots, and glaucous gulls. This is one of the few known breeding sites for Atlantic puffins in Nunavut.

1.4 - Northern Baffin Bay

This EBSA contains significant aggregations of sea pens (Penatulacea spp.) and is considered important epibenthic habitat.

Area 2. Eastern Baffin Island coast and shelf

2.1 - Baffin Island Coastline

This area is characterised by the presence of deep-sea troughs which house coldwater corals and a floe-edge. The area provides important feeding and nursing areas for bowhead and serves as a migration pathway for marine mammals such as bowhead and narwhal, as well as marine and anadromous fish. TEK indicates that dolphins, killer whale, and minke whale also migrate through this area. Ringed seals utilise the fjords and coastal areas, walrus haul-out along the complex coastline, and this is an important feeding, denning, and nursery area for polar bear. Key seabird

colonies are located along the Baffin Island coastline including glaucous gull, Iceland gull, black guillemot, black-legged kittiwake, thick-billed murre and possibly Atlantic puffin; the largest Canadian colonies of northern fulmar are also found in this area.

2.2 - Baffin Bay Shelf Break

Along eastern Baffin Island, a distinct steep-faced continental shelf break occurs where marine fish aggregate and marine mammals such as bowhead, narwhal, and seals (i.e., harp, hooded, ringed, and bearded) migrate and feed; aggregations of corals and sponges are also found here.

Area 3. Hatton Basin-Labrador Sea-Davis Strait

3.1 - Hatton Basin-Labrador Sea-Davis Strait

This is a large area characterised by the continental shelf, a deep basin, mixing waters, and recurrent polynyas in outer Cumberland Sound and Frobisher Bay. As such, this area is highly productive and contains a diversity of deep-water corals and sponges, marine fish, and invertebrates, including a productive shrimp population. The highest recorded biomass of corals was taken here and is the only area containing abundant *Primnoa resedaeformis* and *Paragorgia arborea* north of the Stone Fence off Nova Scotia. The area supports bowhead, beluga, and walrus during the winter, and is an important summer feeding ground for polar bear, beluga, killer whale, harp seal, and hooded seal, which also use this area for whelping. It is an important feeding, staging, and breeding area for more than 15 species of seabirds, including thick-billed murre, black-legged kittewake, black guillemot, Iceland gull, and dovekie.

3.2 - Cumberland Sound

Cumberland Sound (including Millut Bay) is the only summer aggregation area for the Cumberland Sound beluga population which use this area for feeding and nursing. Common eider aggregate here during the summer and the islands of western Cumberland Sound support what may be the largest breeding concentration of Iceland gull in Canada. This area also provides habitat for Greenland halibut.

Area 4. Southern Baffin Bay

4.1 - Southern Baffin Bay

Southern Baffin Bay is at an oceanographic area that marks a break between the warmer southern Labrador Current and the cold Arctic outflow. This area is an overwintering area for narwhal and bowhead and several species of coldwater corals (including black corals; *Antipatharians*) occur in significant concentrations in this area. Productive Greenland halibut fishing grounds are also found in southern Baffin Bay.

Area 5. Melville Bay

5.1 - Melville Bay (B4)

Melville Bay area is critical habitat for narwhal in summer, for polar bear winter and spring, and a migration corridor for whales and seabirds.

The shelf area in Melville Bay is one of just two West Greenland summering areas (June to end of October) for the Baffin Bay population of narwhal; an estimated population of 6,024 (2007) narwhals utilizes the area (Heide-Jørgensen et al. 2010). Narwhals have high site fidelity to migration routes and summering and wintering grounds, and generally use the same areas year after year. The summer stock from Melville Bay has a narrow migration corridor along the continental shelf south to the winter quarters in central Baffin Bay. In spring they move north through the ice shear zone between Disko Bay and Melville Bay (Boertmann et al. 2010).

Some polar bears from the Baffin Bay population (total estimate approx. 1600 animals) occur in this area. Denning is probably rare along the Melville Bay coastline, but in late winter and spring some bears of the Baffin Bay population forage along the ice edge and in the drift ice in the western parts of the area. However, satellite tracking have revealed that the fast ice edge is not used much in spite of good foraging options, probably because the bears to some extent try to avoid the zone most frequented by hunters, and therefore tend to remain out in the drift ice. However, in recent decades bears have more frequently been taken / hunted in the coastal areas, which is interpreted as a shift in home range induced by the shrinking ice cover and earlier ice break up in Baffin Bay (Born et al. 2008).

The inner parts of Melville Bay are important breeding areas for ringed seals serving as the principal prey for polar bears in the spring (Rosing-Asvid, pers. com. 2011).

In early spring the partially open water in Baffin Bay (outer parts of the area) is an extension of the ice break-up zone in the area, and important as part of the general migration corridor for thick-billed murres and other seabirds on their way to breeding grounds in the NOW.

One of Greenland's largest colonies of Sabine's gull is situated in this area (Boertmann et al. 1996).

Area 6. Northwest Greenland Shelf

6.1 - Northwest Greenland Shelf (B3)

The shelf and ice shear zone along the coast of northwest Greenland is critical habitat for whales as well as an important migration corridor and breeding and staging area for seabirds.

Both common and king eider species are dependent on several undisturbed late summer moulting areas in some inner fjord areas, in particular in the southern parts of the area (Boertmann and Mosbech 2011a).

In early spring, the open water in the ice shear zone along the entire coastline serves as an important migration corridor for thick-billed murres and other seabirds (Boertmann and Mosbech 2011a).

The area contains a large and diverse seabird fauna. Thick-billed murres from some of Greenland's largest colonies (around 126,000 pairs) are dependent on the region from May to late August (Boertmann and Mosbech 2011a).

The common eider is dispersed in many colonies (total population about 11,500 nests, increasing) along the outer coast as well as in the fjords in the central parts of the area (Merkel, pers. com.) based on data from 2007 in Merkel (2010a).

Beluga and narwhal both depend on the area as a migration corridor (Boertmann and Mosbech 2011a).

Polar bears from the Baffin Bay population (total estimate 1600 bears) roam the area when ice is present (Boertmann and Mosbech 2011a).

Area 7. Central Baffin Bay

7.1 - Central Baffin Bay (and mouth of Uummannaq Fjord) (C2)

In the westernmost parts of the Greenland Exclusive Economic Zone (EEZ) and adjacent areas in Canadian waters, the pack ice and leads are especially important for some species for parts of the year.

- Wintering narwhal (from the population summering in Melville Bay as well as from Canada) areas are found within the 500-1500 isobaths where they appear to utilize the Greenland halibut stock (Boertmann et al. 2010).

- In fall and winter, the entire area is critical habitat for migrating and wintering narwhals and belugas; both species obtain a good part of their annual food intake in the wintering grounds (Boertmann and Mosbech 2011a).

- A small part of the walruses wintering in West Greenland occur within this area; the specific sites may shift with ice conditions (Boertmann and Mosbech 2011a).

- Bowhead whales migrate through the area in spring (Boertmann and Mosbech 2011a).

- Polar bears from the Baffin Bay population occur in this area, mainly from October to June (Boertmann and Mosbech 2011a).

Area 8. Disko Bay and Store Hellefiske Banke

8.1 - Disko Bay and Store Hellefiske Banke (B2)

The Disko Bay and Store Hellefiskebanke area has complex oceanographic and bathymetric conditions where a tide-induced upwelling forms the basis for high biological spring production, although with large inter-year variation. The production provides favorable foraging and breeding conditions for seabirds and mammals and a range of species are dependent on the resources on the banks on the shelf, in particular on Store Hellefiskebanke. Capelin and sandlance are most important prey for seabirds and mammals.

- The entire area, but especially Store Hellefiskebanke is critical habitat for the walruses that winter in West Greenland, estimated at 3240 animals in 2008 (Born et al. 2009, NAMMCO 2009). In late winter (February-May) they rely on foraging areas within the 100 m isobath; satellite-tagged individuals utilized a fairly limited area of the northern part of the bank.

- The entire area is part of the beluga winter range (December) in West Greenland, where about 7,000 animals rely entirely on the ice edge and marginal ice zone (Heide-Jørgensen 2010); the whales follow the marginal ice zone as it retreats northward in spring (Heide-Jørgensen et al. 2009).

- In summer and autumn this area (like the more southern areas) serves as foraging grounds for harbour porpoise and a range of baleen whales (blue, sei, minke, fin, and humpback whales). Evidence suggests that in particular the western part of the area – off the shelf break – is important to the baleen whales (Laidre et al. 2010b).

- The bowhead whale has its main spring (March to June) staging area in and just west of Disko Bay, which is used by perhaps about 1000 whales of the Baffin Bay population. Apparently, the Disko Bay area serves as foraging and staging area primarily for female bowhead whales without calfs (Mosbech et al. 2000). There are results suggesting that in addition to foraging, Disko Bay serves as a mating area for the bowhead whales (Stafford et al. 2008, Tervo et al. 2009).

- Sea ducks – mostly king eider, but also common eider, harlequin duck and red-breasted merganser – have important moulting areas (July-September) in coastal areas and the fjords (Boertmann and Mosbech 2001, Merkel et al. 2010); during wing moult, the birds are flightless and extremely shy.

- Narwhals are abundant in the deeper basins of the area during November through May. Narwhals winter in the dense pack ice west of Disko as well as in the coastal areas close to the southern entrance to Disko Bay (Mosbech et al. 2000).

- Belugas are abundant on the banks of the area from November through May. They arrive from the Canadian summer grounds in November and stay until May (Mosbech et al. 2007).

- Store Hellefiskebanke – specifically within the 50 m isobath – is critical staging and wintering habitat for half a million king eiders, which is a major proportion of the flyway population.

- Store Hellefiskebanke is also a significant winter/spring area – incl. whelping grounds – for bearded seals (Boertmann pers com.).

- Kitsissunnguit / Grønne Ejland in Disko Bay holds the largest Arctic tern colony in Greenland (about 21,800 pairs in 2006); a number of other colonies in the bay is home to up to 5800 pairs – with large inter-year fluctuations (Egevang and Frederiksen 2011).

- Disko Bay has a high diversity of seabirds including thick-billed murre (one colony), black-legged kittiwake (several colonies), cormorants (several colonies), common eider (several colonies), fulmar (one of Greenland's largest colonies) and small populations of Atlantic puffins and little auks. Finally, the rare Ross's gull occasionally nests here (Mosbech et al. 2007).

- The high productivity is also reflected in the rich commercial fisheries in the area, including Greenland halibut, snow crab, shrimp and scallops.

- The area is part of the wintering area for the ivory gull (Gilg et al. 2010).

- Capelin spawning areas occur in the tidal zone several places along the coastline (Mosbech et al. 2000).

Area 9. Southwest Greenland Shelf

9.1 - Southwest Greenland Shelf (B1)

Due to upwelling at the shelf break, the banks along West Greenland are highly productive. The shelf area serves as a resource-rich migration corridor for marine mammals and seabirds during their northwards migration in spring, and during summer it serves as a foraging area. The 'open water area' north to around Sisimiut remains largely ice free all year, and from October the shelf area and the ice free fjord turns into a major wintering area for a huge number of seabirds from Greenland, Iceland and Svalbard. A large proportion of Greenland's commercial fisheries rely on the productive areas at the shelf.

- Along with coastal areas off Newfoundland in Canada, the 'open water area' along SW Greenland is the main wintering area for thick-billed murres from Svalbard, Jan Mayen, Iceland and parts of Greenland; from October to April at least 1.5 million murres (Merkel et al. 2012) are dependent on the fish and zooplankton in the shelf area and fjords.

- More than half of Greenland's populations of razorbill and Atlantic puffin are distributed in many small colonies along the coast, and Kitsissut Avalliit holds Greenland's largest colony of common murres. The common eider breeds in scattered colonies (Boertmann and Mosbech 2010) along the coast (Rasmussen 2010).

- In addition to the murres, the entire 'open water area' is wintering area for common and king eiders (>500,000 and >300,000, respectively), long-tailed duck (>100,000), red-breasted merganser (<20,000), black guillemot (>250,000), and Iceland gull (>300.000) (Boertmann et al. 2004).

- Large numbers of auks from the NE Atlantic pass by the southern tip of Greenland in the autumn – that includes all those on their way to wintering in this area, and those continuing onwards to Newfoundland: thick-billed murres (at least 1 million), little auks (several million) and Atlantic puffin (unknown number, but recent observations suggest that many birds migrate through the area on their way to unknown wintering grounds). Furthermore, hundreds of thousands of black-legged kittiwakes are passing Cape Farewell on the way to winter quarters in the Labrador Sea and other areas (Frederiksen et al. 2012).

- Harlequin ducks (approx. 7000 (Boertmann and Mosbech 2001) from the small Greenlandic breeding population, and from eastern Canada, are dependent on moulting areas along the outer coast of SW Greenland from Nuuk southwards and with a core area around Arsuk; at least 10,000 harlequins winter in the area.

- The coastline in the southern parts is staging and spring/summer foraging areas for common eiders (Merkel et al. 2010). The whole area including the fjords, are winter quarters for both eider species; up to half a million eiders from both Greenland and Canada are estimated to winter in the entire SW Greenland (Merkel et al. 2012).

- Outside the breeding season, adult black-legged kittiwakes (juveniles not studied) from colonies across the North Atlantic are staging/foraging in this area; in August to November mainly the western parts are used (Frederiksen et al. 2012).

- In summer and autumn the southern part of West Greenland (from area B3 southwards) serves as foraging grounds for harbour porpoise and a range of baleen whales (blue, sei, minke, fin, and humpback whales). Evidence suggests that the areas right off the shelf break in particular is important to the baleen whales (Frederiksen et al. 2012).

- The Western Atlantic harbour seal is critically endangered in Greenland and has its stronghold at the coast of the southern tip of Greenland (Rosing-Asvid and Ugarte 2009). In addition, the grey seal has recently been found in this area.

- Greenland's isolated breeding population of Atlantic salmon is dependent on access to a single river near Nuuk. During summer, shelf and fjord areas all along the coast north to Disko Bay are key foraging areas for the Atlantic salmon stock from spawning areas in the rivers of eastern Canada, northeastern U.S. and northern Europe (NOAA Fisheries: http://www.nmfs.noaa.gov/pr/species/fish/atlanticsalmon.htm).

- The fjords in this area hold local stocks of Atlantic cod; a very large stock of off shore cod disappeared from the shelf areas in the 1970s. Cod egg and larvae from the Iceland stock drift into the area, but this has not yet given rise to a new offshore stock (Storr-Paulsen and Wieland 2006).

- Capelin spawning areas occur in the tidal zone several places along most of the coastline and in the fjords (Mosbech et al. 2000).

Area 10. Davis Strait marginal ice zone and Labrador Sea

10.1 - Davis Strait marginal ice zone and Labrador Sea (C3)

This area extends beyond the Baffin Bay-Davis Strait LME into the Labrador Sea. The area, including the marginal ice zone/ ice edge, is important as staging and migration area for some species.

- The ice edge and marginal ice zone in the central Labrador Sea is whelping area for hooded seal in March – April ((Frederiksen et al. 2012).

- The entire area is part of the general wintering area and early spring migration corridor for a range of seabirds, including thick-billed murres and black-legged kittiwakes (Frederiksen et al. 2012, Merkel et al. 2012).

- New evidence suggest that the central Labrador Sea is an important wintering area (August-February) for adult black-legged kittiwakes from colonies all over the North Atlantic, including Greenland (Frederiksen M. 2011); the number of birds utilizing these offshore areas is unknown, but judged from the proportion of geo-locator-tagged kittiwakes residing here in autumn and spring, it may amount to several hundred thousands adults.

Tables of Areas of Heightened Ecological Significance and PSSA Criteria Met

Table 6. Ecologically important areas - Iceland Sea/Shelf LME

Area		Ecological function	season	PSSA Criteria										
No	Location			Uniq. rare	Crit. hab	Dep-end	Rep-res	Div.	Prod	Spawn/ breed	Natural	Integr	Fragil	Biogeogr
1	Coastal banks	Fish spawning areas; Capelin, herring, cod		X	X				X	X	X		X	X
	Vestmannaeyjar	Seabird breeding colonies, summer feeding areas			X				X	X	X		X	
	Reykjanes Peninsula	Seabird breeding colonies, summer feeding areas			X				X	X	X		X	
	Snæfellness Peninsula	Seabird breeding colonies, summer feeding areas			X				X	X	X		X	
	Faxaflói Bay	Waterfowl breeding, feeding, molting and wintering; common eider. Shorebirds feeding and staging areas		X	X	X		X	X	X	X		X	X
	Breidafjördur	Waterfowl breeding, feeding, molting and wintering; common eider Shorebirds feeding and staging areas		X	X	X		X	X	X	X		X	X
2	Latrabjarg	Seabird breeding colonies, summer feeding areas		?	X		?		X	X	X		X	X
	Hornbjarg and Hælavikubjarg	Seabird breeding colonies, summer feeding areas		?	X		?		X	X	X		X	X
3	Offshore waters	Seabird migration and wintering; ivory gull, thick-billed murre. Summer feeding, North Atlantic right whale. Feeding area, hooded seal			X	X		X	X		X		X	
4	Drangey, Grimsey, Langanes	Seabird breeding colonies, summer feeding areas			X				X	X	X		X	
	Melrakkasletta	Shorebirds feeding and staging areas		X	X						X		X	X
5	Skrudur	Seabird breeding colonies, summer			X					X	X		X	

		feeding areas												
	Skardsfjördur	Shorebirds feeding and staging areas			X					X	X		X	X

Table 7. Ecologically important areas - Greenland Sea LME

Ecological function		Ecological function	season	PSSA criteria										
No.	Location			Uniq.rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Bio. gr.
1	Northeast Water polynya area and Peary Land	Important walrus and polar bear habitat		X	X	X		X	X	X	X	X	X	
		Pre-breeding staging area for sea ducks and a feeding area during the breeding period for seabirds and sea ducks.												
2	Scoresby Sound fjord and adjacent fjord areas on Blosseville coast	Narwhals of the Northeast Atlantic stock (or stocks) have summering areas. Foraging area for the critical endangered Spitsbergen stock of bowhead whale.		X	X	X	X	X	X	X	X	X	X	X
		Moulting and staging area for seabirds												
3	Sirius Water/ Young Sund Polynya	Feeding grounds for walrus, polar bears and Bowhead whales habitat			X	X				X	X		X	
		Staging area for spring migrating water birds												
4	Sea ice in the Western Greenland Sea	Whelping area for harp and hooded seals from the “West Ice” populations and polar bear habitat		X	X	X				X	X		X	

		Seabirds migration corridor in late summer and autumn												
5	South East Greenland and Denmark Strait	Narwhal summering area, walrus wintering area, hooded seal moulting area			X					X	X		X	
		Staging, breeding and moulting area for seabirds												
		Migration corridor for seabirds.												

Table 8. Ecologically important areas - Faroe Plateau LME

	Area	OGA	Ecological function	Month/Season	PSSA criteria										
No.	Location	No.			Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog.gr
1	Faroe Islands	1	Seabirds breeding and feeding areas		X	X	X		X	X	X	X	X	X	X

Table 9. Ecologically important areas - Norwegian Sea LME

	Area	OGA	Ecological function	Month/Season	PSSA criteria										
No.	Location	No.			Uniq. rare	Crit. hab.	Dep end	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog.gr
1	Norwegian coast	F1	Herring spawning area	II-III	X	X	X				X	X		X	X

	and shelf-Møre-Helgeland	B1-3	Seabird breeding colonies		X	X	X			X	X	X		X	X
		M1	Seal colonies			X					X	X		X	
		BH1	Cold-water *Lophelia* reefs	I-XII	X	X	X	X	X	X			X	X	X
2	Lofoten area	F2	Spawning area for Barents Sea cod	II-IV	X	X	X			X	X	X		X	X
		F3	Spawning area Greenland halibut	winter		X					X	X			
		B4	Seabird breeding colonies	summer	X	X	X			X	X	X		X	X
		BH1	Cold-water *Lophelia* reefs	I-XII		X	X		X	X			X	X	
		BH2	Canyon (Bleiksdypet)	Spring-summer	X	X	X					X			
3	Jan Mayen	B5	Seabird breeding colonies		X	X	X			X	X	X	X	X	X

Table 10. Ecologically important areas - Barents Sea LME

Area		OGA	Ecological function	Month/Season	PSSA criteria										
No.	Location	No.			Uniq.rare	Crit. hab	Depend	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog gr
1	Pechora Sea	F1	Spawning area polar cod	I-II	X	X	X				X	X		X	X
		F3	Spawning area herring			X	X				X	X		X	
		F4	Spawning area herring			X	X				X	X		X	X
		M4	Ringed seal breeding area	winter		X	X				X	X		X	
		M8	Walrus wintering area	Winter		X	X				X	X		X	

			Beluga wintering area	Winter		X					X	X		X	
		M9	Walrus feeding and haul-out	Summer		X	X			X		X		X	
		B10	Molting and staging areas for waterfowl		X	X	X			X	X	X		X	X
		B11	Molting and staging area for sea ducks, staging area for auks		X	X	X				X	X		X	X
2	Norwegian and Murman coasts	F2	Spawning area capelin	II-IV	X	X	X			X	X	X		X	X
		B6	Seabird breeding colonies			X					X	X		X	
		B7	Seabird breeding colonies			X					X	X		X	
		B12	Wintering area sea ducks	Winter		X					X	X		X	
3	Entrance and northern White Sea	M3	Harp seal whelping and molting areas	Winter-early spring	X	X	X				X	X		X	X
		M14	Beluga wintering area	winter		X					X	X		X	
		B14	Sea ducks molting and wintering area			X					X	X		X	
	White Sea (Kandalaksha, Onega, Dvina bays)	M12	Beluga wintering area	winter		X	X				X	X		X	X
		M13	Beluga summering area	summer	X	X					X	X		X	X
		B8	Breeding colonies seabirds and eiders			X			X		X	X		X	
		B15	Sea ducks molting and wintering area			X	X				X	X		X	
		B16	Ducks - staging area during spring migration	spring		X	X				X	X		X	X
5	Bear Island	B1	Seabirds breeding colonies			X					X	X		X	

6	Svalbard Archipelago	F5	Spawning area for polar cod	winter		X	X				X	X		X	
		M1	Potential wintering area narwhal and bowhead		X	X	X				X	X		X	X
		M5	Harbor seal habitat year-round		X	X				X	X	X		X	X
		M11B	Walrus feeding and haul-out			X	X			X	X	X		X	
		M15	Ringed sela breeding area			X	X			X	X	X		X	
		M16	Feeding area for bowhead, blue whale, minke whale		X	X	X			X	X	X		X	X
		B2 a,b,c	Seabird breeding colonies	summer		X				X	X	X		X	
		B3 a,b,c	Seabird breeding colonies	summer	X	X				X	X	X		X	X
		B9	Molting areas sea ducks and geese			X	X			X		X		X	
7	Franz Josef land	M2	Wintering area bowhead and walrus	winter	X	X	X				X	X		X	X
		B4	Seabird breeding colonies		X	X	X				X	X		X	X
		M11	Walrus feeding and haul-out			X				X		X		X	
		B17	Staging area for seabirds	spring		X	X				X	X		X	X
8	Western and central Barents Sea	M6	Feeding area - polar bear and harp seal	Spring-early summer		X	X			X		X		X	
		B18	Feeding area for seabirds	summer		X	X			X		X		X	
		B19	Seabird wintering area	winter	X	X					X	X		X	
		B20	Molting area and swimming migration auks			X					X	X		X	

9	Northern Barents Sea - marginal ice zone	M7	Polar bear feeding area	summer		X	X				X	X		X	
10	W Novaya Zemlya	M10	Spring migration corridor for beluga and possibly walrus			X					X	X		X	
		B5	Seabird breeding colonies			X					X	X		X	

Table 11. Ecologically important areas - Kara Sea LME

Area		OGA No.	Ecological function	Month/Season	PSSA criteria										
No.	Location				Uniq. rare	Crit. hab.	Depend	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog.gr
1	Baydaratskaya Inlet - Western Yamal	F1	Spawning area navaga	XII-II		X	X				X	X		X	
		F2	Spawning area polar cod	I-III		X	X				X	X		X	
		F3	Spawning area Chesk-Pechora hering	V-VII		X	X				X	X		X	
		M2	Spring migration area beluga and walrus	Spring		X	X				X	X		X	
		M4	Ringed seal breeding area			X	X				X	X		X	
		M7	Walrus summer feeding and haul-out	Summer		X				X		X		X	
		B3	Spring staging and migration area for seaducks	Spring		X	X				X	X		X	
		B12	Autumn staging area for seaducks	Autumn		X				X	X	X		X	
2	Northeastern Novaya Zemlya	B1	Spring staging area for seabirds	Spring		X	X				X	X		X	
		B8	Seabird breeding colonies			X					X	X		X	
3	Western Severnaya Zemlya	M3	Polar bear feeding area	Spring/ summer		X	X					X		X	
		B2	Spring staging area for seabirds	Spring		X	X				X	X		X	

		B9	Seabird breeding colonies			X					X	X		X	X
4	Northern Kara Sea - marginal ice zone	M1	Spring migration area for beluga whale	Spring		X	X				X	X		X	
		M8	Summer feeding area polar bear	Summer/ fall		X	X			X		X		X	
		B10	Breeding area for seabirds			X					X	X		X	
5	Northern Kara Sea islands	B11	Seabird breeding colonies	III-IV	X	X					X	X		X	X
6-8	Ob (6), Yenisey (7) and Pyasina (8) estuaries	M5	Summer feeding area beluga whale	Summer		X					X	X		X	X
		B5	Molting and feeding areas for ducks and geese			X			X	X		X		X	X
		B4	Molting and fall staging areas for ducks, geese and waders	Autumn		X				X	X	X		X	
		M6	Summer feeding area beluga whale	Summer		X						X		X	
		B6	Molting and feeding area for ducks and geese			X						X		X	
		B7	Molting and feeding area for ducks and geese			X						X		X	
9	Vilkitskij Strait	B13	Sea birds breeding area			X					X	X		X	

Table 12.Ecologically important areas - Laptev Sea LME

Area		OGA No.	Ecological function	Month/Season	PSSA criteria										
No	Location				Uniq. rar	Crit. hab.	Depend	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogg r.
1	NW Laptev Sea including polynyas N and NE of Severnaya	M1	Beluga whale summer feeding area, possibly also for narwhal	summer		X	X					X		X	
		M2	Beluga whale migration and	Spring		X	X				X	X		X	

	Zemlya		feeding area in spring, possibly also for narwhal												
		B1	Spring staging and migration area for seabirds	Spring	X	X					X	X		X	
		B2	Seabird breeding colonies		X	X					X	X		X	
		B3	Feeding area for seabirds	summer/ autumn		X	X					X		X	
2	NE Taimyr and Preobrazheniya Island	B4	Seabird breeding colonies			X					X	X		X	
		M3a	Walrus feeding and haul-out			X	X					X		X	X
3	Great Siberian Polynya system	M4	Walrus wintering and feeding area		X	X	X					X		X	X
		B7	Spring staging and migration area for seabirds and waterfowl			X	X				X	X		X	X
4	New Siberian Islands	B5	Seabird breeding colonies			X					X	X		X	
		B6	Feeding and molting area for waterbirds			X	X			X		X		X	
		M3b	Walrus summer and haul-outarea			X	X					X		X	X
5	Estuaries and deltas-Khatanga (5a), Anabar (5b), Lena (5c), Yana (5d)	B8	Waterfowl feeding, molting and staging area. Shorebird feeding and staging area		X	X	X		X	X	X	X		X	X
		F2	White fish and sturgeon feeding areas		X	X	X			X	X	X	X	X	X
		F1	Possible spawning area polar cod			X	X				X	X		X	

Table 13.Ecologically important areas - East Siberian Sea LME

Area		OGA No.	Ecological function	Month/Season	PSSA criteria										
No	Location				Uniq. rar	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogr.
1	New Siberian Islands	B1	Feeding and molting area for waterbirds			X	X				X	X		X	
2	Great Siberian Polynya	B3	Seabird spring feeding and migration area, spring stopover area for waterfowl			X	X				X	X		X	
		M4	Feeding area for walrus and ringed seals			X	X			X		X		X	
3	De Long Islands	B2	Seabird colonies		X	X						X		X	
4	Ice zone on the northern shelf	M4	Seals and walrus feeding area	VIII-X		X	X			X		X		X	
		M3	Beluga and bowhead feeding area late summer/fall			X				X	X	X		X	
		B4	Feeding area for seabirds			X						X		X	
5	Indigirka and Kolyma deltas and estuaries	B5	Waterfowl feeding, molting and staging area. Shorebird feeding and staging area			X	X		X		X	X		X	X
		F1	Feeding and nursery areas for anadromous and amphi-anadromous fishes			X					X	X		X	
6	Chaun Bay	B6	Waterfowl feeding, molting and staging area. Shorebird feeding and staging area			X	X				X	X		X	
		B7	Seabird colonies			X					X	X		X	

Table 14. Ecologically important areas – Chukchi Sea LME

Area		OGA No.	Ecological function	PSSA criteria										
No.	Location			Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogr.
1	Chukchi Rise	F3	Potential spawning Area on the slope and deep water beyond the shelf; Arctic cod (*Arctogadus glacialis*)		X	X				X	X		X	X
2	Northeast Coastal area (Alaska)	F5	Fish spawning areas along the coast; capelin		X	X				X	X		X	
		F7	Nursery areas for fish in estuaries and lagoons; humpback whitefish, broad whitefish, least cisco, Bering cisco		X					X	X		X	
		M1a,	Spring Polar Bear feeding area in ice leads along the coast		X	X					X		X	
		M4	Pacific walrus migration area in spring		X	X				X	X		X	
		M13a	Summer feeding areas; Gray whale		X				X		X		X	
		M8a	Spring migration corridor in leads along the coast; bowhead whale and Beaufort Sea stock of beluga whale	X	X	X				X	X		X	X
		B3	Spring staging and feeding in leads along the coast; common eider, king eider, red phalarope		X	X				X	X		X	
		B5a	Seabird breeding colonies at Cape Lisburne; thick-billed murre, common murre, horned puffin, black-legged kittiwake		X				X	X	X		X	
		M12	Molting area for Beluga whale of the Chukchi stock in Kasegaluk lagoon		X					X	X		X	
		B12	Molt area for seaducks, Peard Bay,		X	X			X	X	X		X	

			Ledyard Bay; common eider, king eider, spectacled eider, long-tailed duck											
		B14a	Migration corridor for seaducks and divers Coastal waters along Alaska; common eider, king eider, long-tailed duck, black scoter, red-throated diver, black-throated diver, white-billed diver		X	X			X	X	X		X	
		B26	Kasegaluk lagoon: summer feeding and staging area for geese; black brant, greater white-fronted goose		X	X			X	X	X		X	
		B15	Kasegaluk lagoon: breeding and spring and fall staging area for shorebirds; dunlin, red phalarope		X	X		X	X	X	X		X	X
		B19	Summer feeding and fall staging area for shorebirds in Peard Bay; red phalarope		X					X	X		X	
		M15	Walrus haul out		X						X		X	
3	Southeastern Chukchi Sea (Chukchi Bight, Kotzebue Sound area)	F1	Potential fish spawning area; Polar cod (*Boreogadus saida*)		X	X				X	X		X	
		F2	Potential fish spawning area, Saffron cod		X	X				X	X		X	
		F4	Fish spawning area; Pacific herring		X	X				X	X		X	
		F6	Nursery areas for fish in estuaries; chum and pink salmon		X					X	X		X	
		F8	Wintering area for fish in estuaries; Pacific herring		X	X					X		X	
		M4	Spring Migration corridor north of Bering Strait; Pacific walrus	X	X	X				X	X		X	X
		M1b	Spring Polar Bear feeding area in ice leads along the coast		X	X			X		X		X	
		M8b	Spring migration corridor in leads along the coast; Bowhead whale and Beaufort Sea stock of beluga whale		X	X				X	X		X	X
		M11	Kotzebue Sound: early summer habitat for beluga whale		X	X				X	X		X	

		M13b	Summer feeding areas, offshore; Gray whale		X				X				X	
		B1	Migration route and spring feeding by seabirds, seaducks and phalaropes in Leads and polynyas; thick-billed murre, common murre, common (Pacific) eider, king eider, long-tailed duck, red phalarope, red-necked phalarope		X	X			X	X	X		X	X
		B5b	Seabird breeding colonies at Cape Thompson; Thick-billed murre, common murre, horned puffin, black-legged kittiwake		X				X	X	X		X	
		B14b	Migration corridor for seaducks and divers Coastal waters along Alaska; common eider, king eider, long-tailed duck, black scoter, red-throated diver, black-throated diver, white-billed diver		X	X			X	X	X		X	
		B21	Breeding, and spring and fall staging area for shorebirds in the Noatak River Delta; dunlin, western sandpiper, semipalmated sandpiper, long-billed dowitcher		X	X				X	X		X	
		B22	Autumn staging of shorebirds in Shishmaref Inlet; western sandpiper, dunlin, pacific golden-plover		X	X				X	X		X	
		B23	Autumn staging of shorebirds near Cape Espenberg;western sandpiper, semipalmated sandpiper, dunlin		X	X				X	X		X	
		B24	Autumn staging of shorebirds in Lopp Lagoon; western sandpiper, semipalmated sandpiper, dunlin		X	X				X	X		X	

		B25	Breeding and autumn staging of shorebirds at Krusenstern Lagoon; red-necked phalarope, long-billed dowitcher, western sandpiper, semipalmated sandpiper, pectoral sandpiper		X	X				X	X		X	
4	Waters off northern Chukchi Peninsula	M7	Autumn haulouts on the north coast of Chukotka Peninsula; Pacific walrus		X				X		X		X	
		M9	Spring Migration corridor in ice leads of Northern Chukotka; Bowhead whale and Western Chukchi stock of beluga whale		X	X				X	X		X	
		M14	Summer feeding areas, offshore;Gray whale		X					X	X		X	
		B7	Seabird breeding colonies at Kolyuchin Island, thick-billed murre, horned puffin		X					X	X		X	
		B16	Staging area in Kolyuchin Bay; black brant goose		X	X				X	X		X	
		B18	Shorebird breeding and feeding area in the Coastal habitats in northern and eastern Chukotka; critically endangered spoon-billed sandpiper		X	X			X	X			X	
		B13b	Molt area for seaducks along northern Chukotka; common eider, king eider, long-tailed duck		X					X	X		X	
		B20b	Summer feeding and migration area for shorebirds in waters along northern Chukotka; red phalarope, red-necked phalarope		X					X	X		X	
5	South-Central Chukchi Sea (including Bering Strait region)	B8	Summer/autumn feeding area for seabirds in the “Plume” area north from Bering Strait; least auklet, crested auklet, parakeet auklet, black-legged kittiwake, short-tailed shearwater		X				X		X		X	
		B9a	Molt migration; Thick-billed murre		X					X	X		X	

			(Juveniles and males are flightless, swimming from colonies)											
		M8c	Spring migration corridor for bowhead and beluga whales and Pacific walrus	X	X	X				X	X		X	X
		M10	Potential summer feeding area in the Northern Bering Strait for Bowhead whale (possibly individuals from resident stock component)		X						X		X	
		B4	Seabird breeding colonies; least auklet, crested auklet, parakeet auklet, thick-billed murre, common murre, dovekie, black-legged kittiwake		X				X	X	X		X	X
6	Wrangel/Heral Islands Area	M2	Feeding area in summer; Polar bear	X	X	X			X		X		X	X
		M6	Feeding area in summer, Pacific walrus		X				X		X		X	X
		B2	Spring feeding by seabirds, seaducks and phalaropes in leads and polynyas; thick-billed murre, common eider, red phalarope		X	X				X	X		X	
		B6	Seabird breeding colonies; thick-billed murre, black guillemot, horned puffin, black-legged kittiwake		X				X	X	X		X	
		B11	Summer/autumn feeding area for seabirds in coastal waters; critically endangered Kittlitz's murrelet		X						X		X	X
		B13a	Molt area for seaducks in waters around Wrangel Island; Common eider, king eider, long-tailed duck		X	X			X	X	X		X	
		B17	Molting and staging area in coastal habitats; black brant goose, snow goose		X	X				X	X		X	
		B20a	Summer feeding and migration area for shorebirds in waters around Wrangel Island; red phalarope, red-necked phalarope		X	X				X	X		X	

7	Chukchi Shelf (Northern and central parts)	M3	Marginal ice zone in northern Chukchi, feeding area in summer and autumn for Polar bear		X	X			X		X		X	
		M5	Hannas Shoal: feeding area in summer for Pacific walrus		X				X		X		X	
		B9b	Molt migration from colonies at Wrangel and Herald islands; thick-billed murre (Juveniles and males are flightless, swimming from colonies)		X					X	X		X	
		B10	Summer/autumn feeding area for seabirds in Drift ice in northern Chukchi Sea; black guillemot, ivory gull, Ross's gull		X	X					X		X	

(Note: subdivisons of area designation such as B2a and B2b refer to habitat or ecological regions that cross the somewhat arbitrary geographical boundaries)

Table 15 Ecologically important areas – Bering Sea LME

Area		OGA No.	Ecological function	season	PSSA criteria										
No.	Location				Uniq.rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog. gr.
1	Aleutian Islands	F8	Spawning area fish (pelagic) off Bogoslof Island; walleye pollock	Winter-summer		X					X	X		X	
		M4	Seal feeding and breeding area Aleutian Islands; Steller's sea lion			X					X	X		X	X
		B5	Seabird breeding colonies in the Aleutian Islands; marbled murrelet, rhinoceros auklet		X	X				X	X	X		X	X
		B16	Seabirds and waterfowl wintering habitat in the Aleutian Islands; king		X	X	X			X		X		X	X

			eider, Steller's eider, greater scaup, common teal												
2	Komandorsky Islands	M3	Seal feeding and breeding area in waters around Komandorsky Islands; northern fur seal	Spring-late autumn		X					X	X		X	
		B6	Seabird breeding colonies Komandorsky Islands; red-legged kittiwake, ancient murrelet			X				X	X	X		X	X
3	Continental SE Shelf and Shelf Break	F9a	Spawning area fish (pelagic) on the Slope, SE Bering Sea; walleye pollock	Winter-summer		X				X	X	X		X	X
		F11a	Wintering area fish on the outer shelf between Pribilofs and St. Matthews islands; Pacific herring	winter		X						X		X	
		F13a	Wintering area fish on the mid shelf NW of Pribilofs; capelin	winter		X						X		X	
		M5a	Seal whelping area Ice front zone on outer Northern shelf; ribbon seal, spotted seal		X	X	X				X	X		X	X
		M11a	Whale wintering area in pack ice and polynyas in Northern Bering Sea; bowhead whale, beluga whale	winter	X	X	X				X	X		X	X
		B8	Seabird feeding area near shelf edge of the East Bering Sea; short-tailed albatross, fork-tailed storm-petrel, red-legged kittiwake			X	X			X		X		X	
4	Continental NE Shelf and Shelf Break	M5b	Seal whelping area Ice front zone on outer Northern shelf; ribbon seal, spotted seal		X	X	X				X	X		X	X
		M6a	Walrus wintering area in drifting pack ice on Northern and Northeast shelf; Pacific walrus	winter	X	X	X				X	X		X	X
		M11b	Whale wintering area in pack ice	winter	X	X	X				X	X		X	X

			and polynyas in Northern Bering sea, Bowhead, beluga												
		B14	Seabird wintering habitat at the ice edge in the Northern Bering Sea; ivory gull, Ross's gull, black guillemot	winter		X	X					X		X	
		F9b	Spawning area fish (pelagic) on the Slope, SE Bering Sea; walleye pollock	Late winter-summer		X					X	X		X	
		F11b	Wintering area for Pacific herring on the outer shelf between Pribilofs and St. Matthews islands			X						X		X	
		F13b	Wintering area fish on the mid shelf NW of Pribilofs; capelin			X						X		X	
5	Pribilof Islands	M2	Seal feeding and breeding area in waters around Pribilof Islands; Northern fur seal		X	X				X	X	X		X	X
		B3	Seabird breeding colonies, breeding, spring and autumn staging of shorebirds; least auklet, red-legged kittiwake, thick-billed murre, rock sandpipers (*ptilocnemis* race)		X	X				X	X	X		X	X
6	St Matthew/Hall Islands	B2b	Seabird breeding colonies, breeding, spring and autumn staging of shorebirds; least auklet, Thick-billed murre, rock sandpipers (*ptilocnemis* race), red phalarope			X				X	X	X		X	
7	Bristol Bay and Southeast Bering Shelf/Northern Alaska Peninsula	F3	Spawning area fish (demersal, beach and shallow subtidal) in Togiak Bay; pacific herring, capelin			X	X				X	X		X	
		F6	Spawning area fish (demersal, beach and shallow subtidal) in Northern shore of the Alaska			X	X				X	X		X	

			Peninsula; pacific herring, capelin												
		F7	Spawning area fish (demersal) North of Unimak Pass; pacific cod			X					X	X			
		F10	Nursery area fish in Inner Bristol Bay -estuaries and coastal waters; sockeye salmon, pink salmon, eulachon			X	X			X	X	X		X	X
		M1	Sea otter feeding and breeding area Unimak Island and western Alaska Peninsula, sea otter refugium and Pacific walrus male haulout northern Alaska Peninsula			X	X			X	X	X		X	X
		M6b	Walrus wintering area in drifting pack ice on N and NE shelf; pacific walrus			X	X				X	X		X	
		M8	Walrus feeding and haulout in Northern Bristol Bay; pacific walrus			X	X			X		X		X	X
		M13	Whale feeding area in waters off Unalaska and into outer Bristol Bay; critically endangered North Pacific right whale		X	X				X		X		X	X
		B9	Seabird feeding area, Southeast Bering Shelf; short-tailed shearwaters			X				X		X		X	
		B11	Waterfowl molting and staging area, summer feeding and autumn staging of shorebirds in N Alaska Peninsula with lagoons (Izembek, Nelson, Mud Bay, Cinder, Hook, Ugashik, Egegik, Kvichak, Nushagak, Nanvak, Chagvan, Goodnews, Carter); Steller's eider, black scoter, northern pintail,cackling goose,		X	X	X		X	X	X	X		X	X

			black brant, rock sandpiper, dunlin, western sandpiper, marbled godwit,bar-tailed godwit, hudsonian godwit												
		B13	Molting area N and inner Bristol Bay; Steller's eider, black scoter, white-winged scoter			X	X			X	X	X		X	
8	East Coast (Yukon and Kuskokwim Deltas to Norton Sound) including Unimak Island	F2	Under ice spawning area for saffron cod			X	X				X	X		X	
		F4	Spawning area fish (demersal, beach and shallow subtidal); pacific herring, capelin			X	X				X	X		X	
		F14	Wintering area fish in estuaries;v pacific herring			X	X				X	X		X	
		M6b	Walrus wintering area in drifting pack ice on NE shelf, pacific Walrus			X	X				X	X		X	
		B4	Seabird breeding colonies Nunivak Island and Cape Newenham; common murre			X				X	X	X		X	
		B10	Waterfowl breeding and molting area, summer use, and spring and autumn staging area for shorebirds; Yukon-Kuskokwim Delta		X	X	X		X	X	X	X		X	X
		B12	Molting area of waterfowl in Eastern Norton Sound; spectacled eider			X					X	X		X	X
		B17	Summer feeding and autumn staging of shorebirds in Safety Sound, Norton Bay, Stebbins-St. Michael, Golovin Lagoon; western sandpiper, semipalmated sandpiper, dunlin, red-necked phalarope, long-billed dowitcher			X	X				X	X		X	

9	St Lawrence Island Area including St Lawrence Polynya (south)	M6c	Walrus wintering area in drifting pack ice on Northern and Northeast shelf; pacific walrus		X	X	X				X	X		X	X
		M11c	Whale wintering area in pack ice and polynyas in Northern Bering Sea; bowhead whale, beluga whale		X	X	X				X	X		X	X
		B2a	Seabird breeding colonies, breeding, spring and autumn staging of shorebirds Near St. Lawrence Island; least auklet, thick-billed murre, rock sandpipers (*ptilocnemis* race), red phalarope			X	X			X	X	X		X	X
		B7a	Resting and feeding areas for seabirds and waterfowl during spring migration in North Bering Sea -leads and polynyas; thick-billed murre, common murre, least auklet, crested auklet			X	X			X	X	X		X	
		B15	Waterfowl wintering habitat St. Lawrence Island polynya; king eider, long-tailed duck, and total world population of Spectacled eider		X	X	X			X	X	X		X	X
10	Bering Strait (St Lawrence Island north to Diomede)	F1b	Likely a large migratory stock of Polar cod (*Boreogadus saida*) that migrates south in autumn to spawn in winter under the ice in the southern Chukchi Sea and/or the northern Bering Sea in Northern Chirikov Basin			X	X				X	X		X	
		M7	Walrus breeding and migration area in drifting pack ice in Northern Bering Sea, pacific walrus			X	X				X	X		X	X
		M10	Walrus feeding and haulout in			X	X			X	X	X		X	

			Eastern Chukotka Peninsula, pacific walrus												
		M12	Whale migration area in lead system in northern Bering Sea; bowhead whale and beluga whale		X	X	X				X	X		X	X
		M14	Whale feeding area in Chirikov Basin; Gray whale		X	X	X			X		X		X	X
		B1	Seabird breeding colonies in Bering Strait region; least auklet, crested auklet, parakeet auklet, Kittlitz's murrelet			X				X	X	X		X	X
		B2b	Seabird breeding colonies; breeding, spring and autumn staging of shorebirds; least auklet, thick-billed murre, rock sandpipers (*ptilocnemis* race), red phalarope			X				X	X	X		X	X
11	Gulf of Anadyr	F1a	Potential spawning area for migratory stock of polar cod			X	X				X	X		X	
		M6a	Walrus wintering area in drifting pack ice on Northern and Northeast shelf, pacific walrus		X	X	X			X	X	X		X	X
		M9	Walrus feeding and haulout in Northern Gulf of Anadyr; pacific walrus			X	X			X		X		X	X
		M11c	Whale wintering area in pack ice and polynyas in Northern Bering Sea; bowhead whale, beluga whale		X	X	X				X	X		X	X
		B7b	Resting and feeding areas for seabirds and waterfowl during spring migration in North Bering Sea -leads and polynyas; thick-billed murre, common murre, least auklet, crested auklet			X	X			X	X	X		X	X

12	Northeast Coast of Kamchatka and offshore areas	F5	Spawning area fish (demersal, beach and shallow subtidal) in Northern Karagin and Korf bays; pacific herring, capelin			X	X				X	X		X	
		F12	Wintering area fish in Outer shelf off Olyutorsky and the northern Karagin Bay; pacific herring			X					X	X		X	

(Note: subdivisons of area designation such as B2a and B2b refer to habitat or ecological regions that cross the somewhat arbitrary geographical boundaries)

Table 16. Ecologically important areas – Beafort LME

Area			Ecological function	Season	PSSA criteria										
No.	Location	Nr.			Uniq.rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogr gr.
1	Cape Bathurst Polynya	B-3.14	Migration routes and summer feeding areas for bowhead, beluga, ringed seal, and polar bear Migration route, spring staging and summer feeding areas for seabirds and sea ducks	summer	X	X	X			X	X	X		X	X
	Banks Island Shorelead	B-3.15	Spring feeding area for beluga, bearded seal, ringed seal, and polar bear Spring staging and feeding area for sea ducks, in particular king eiders			X	X			X	X	X		X	

	Franklin Bay, Darnley Bay	B-3.16 B-3.17 B-3.25	Wintering and spawning area for polar cod, migration and feeding area for Arctic char Winter and spring breeding and feeding area for ringed seal and polar bear; migration and feeding area for beluga and bowhead Breeding and feeding area for thick-billed murre and black guillemot	summer		X	X			X	X	X		X	X
2	Prince Albert Sound	B-3.18 3.19	Migration and feeding areas for Arctic char Breeding and feeding area for ringed seal and bearded seal. Polar Bear den, feed, and raise their young here. Feeding area for sea ducks and seabirds			X	X			X	X	X		X	
	Minto Inlet	B-3.20 B-3.21	Migration and feeding area for Arctic char Breeding and feeding area for ringed seal, bearded seal and polar bear Feeding area for sea ducks and seabirds. High benthic diversity			X	X			X	X	X		X	
	De Salis Bay and Thesiger Bay	B-3.22 B-3.23	Capelin spawning area; migration and feeding area for Arctic char			X	X				X	X		X	

			Migration, feeding and nursing areas for bowhead, beluga, ringed seal, bearded seal and polar bear												
			Nesting, breeding, and feeding area for seabirds and sea ducks												
	Union and Dolphin Strait	B-3.1	Migration and feeding area for Arctic char		X	X	X			X	X	X		X	X
			Breeding area for ringed seal; winter and spring feeding area for polar bear												
			Spring staging and feeding area for common eider, loons and other birds												
3	Herlinvaux/Mackenzie Lake		Winter habitat for anadromous or amphidromous fish	Winter	X	X	X					X		X	
	Shallow Bay, Beluga Bay and Kugmallit Bay	A-3.10 A-3.11 A-3.13	Fish nursery and feeding areas.	Summer		X	X				X	X		X	
			Molting, feeding and migration areas for beluga; feeding area for ringed seal.												
			Feeding, rearing and molting areas for seabirds, sea ducks and geese												
	Kugmallit Corridor	A-3.13	Migration and feeding area for ringed seal			X					X	X		X	
	Mackenzie Trough	A-3.8	Migration area for bowhead, beluga and ringed seal; polar bear feeding and breeding area			X				X	X	X		X	

	Mackenzie Shorelead	3.5	Spring staging and feeding area and summer feeding, rearing and molting area for sea ducks (common eider, long-tailed duck and others)			X	X			X	X	X		X	
	Outer Mackenzie Shelf	A-3.9	Important area for marine fish. High benthic diversity.			X	X					X		X	
			Feeding and migration area for polar bear, beluga and bowhead												
	Husky Lakes	B-3.12	Spawning area for Pacific herring; feeding area for fish such as lake trout			X	X				X	X		X	X
			Sea mammals nursing, and feeding areas.												
			Migration and feeding area for seabirds and sea ducks												
	Liverpool Bay	B-3.26	Nursery area for coregonid whitefish			X	X				X	X		X	
			Feeding and migration area for bowhead and polar bear												
			Feeding, nesting, and staging area for seabirds and sea ducks and geese												
4	Viscount Melville Sound	B-3.24	Beluga feeding area and polar bear feeding ground and rearing area	late summer		X	X					X		X	
5	Coastal areas and lagoons	A-3.7	Fish migration corridor and feeding area (Arctic char, Dolly Varden and coregonid whitefishes)			X	X				X	X		X	
			Post-breeding feeding, molting and staging areas for waterfowl and shorebirds												

	Herschel Island and adjacent waters	A-3.7	Capelin spawning area												
			Black guillemot breeding and feeding areas. Feeding and molting areas for waterfowl.			X	X				X	X		X	
	Shelf areas	5.3	Feeding area for bowhead	August		X				X		X		X	
6	Colville and Sagavanirktok river deltas and estuaries	6.1	Winter habitat and summer feeding and migration habitat for coregonid whitefishes and Dolly Varden	Winter - summer		X	X				X	X		X	
			Summer nesting, feeding, brood-rearing, molting and staging habitat for geese and shorebirds												
	Simpson Lagoon and Stefansson Sound	6.2	Summer feeding area and migration corridor for whitefishes and Dolly Varden.	Summer		X	X			X	X	X		X	
			Breeding and brood-rearing habitat for common eiders and seabirds. Molting habitat for long-tailed duck and other sea ducks												
	Elson Lagoon and Dease Inlet	6.3	Summer feeding area for whitefishes	Summer-autumn		X	X			X	X	X		X	
			Autumn feeding, staging and migration areas for seabirds (Ross's gull), waterfowl (common and king eiders) and some shorebirds (phalaropes)												
			Autumn feeding area for bowheads												

7	Offshore pack ice		Spring migration area for bowheads and belugas of large migratory populations (Bering-Chukchi-Beaufort)			X	X				X	X		X	

Table 17. Ecologically important areas – Central Arctic Ocean LME

	Area	OGA	Ecological function	Month /Season	PSSA criteria										
No	Location	No.			Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biog. gr
1	Pack ice	1	Unique environment with very low primary productivity, however the multi-year pack ice biota contains an endemic fauna component		X	X	X					X	X	X	X

Table 18. Ecologically important areas – Canadian Arctic Archipelago LME

Area		OGANo.	Ecological function	season	PSSA criteria										
No.	Location				Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogeogr.
1	Bathurst Inlet	1.1 (B-3.2)	Marine fish communities Summer habitat for Ringed Seal			X				X	X	X		X	

			Seabird colonies/feeding												
	Queen Maud Gulf Coastline	1.2 (B-3.3)	Marine feeding ground and migration corridor for Arctic Char			X	X					X		X	
	Chantrey Island	1.3 (B-3.4)	Arctic Char migration and feeding area.			X	X					X		X	
			Ringed Seal summer habitat/feeding												
2	King William Island	2.1 (B-3.5)	Ringed seal and polar bear feeding area			X	X		X	X		X		X	
			Benthic diversity												
	Southern Victoria Island Coastline	2.2 (B-3.6)	Arctic Char migratory and feeding corridor				X					X		X	
3	Eclipse Sound – Navy Board	3.1 (B-2.1)	Migration routes and summer feeding areas for Narwhal, Beluga, Killer Whale, Ringed Seal, and Harp Seals			X	X			X	X	X		X	
			Staging, breeding and feeding areas for seabirds												
	Lancaster Sound	3.2 (B-2.6)	Arctic cod aggregations		X	X	X		X	X	X	X		X	X
			Major migratory route for Beluga, Bowhead, Narwhal; high Polar bear denning/feeding												
			Major foraging area for staging and breeding seabirds/seaducks;												

			Ivory Gull aggregation												
	Admiralty Inlet	3.3 (B-2.2)	Summering/feeding narwhal, bowhead, ringed seals, harp seals			X	X			X	X	X		X	
			Breeding/feeding seabirds												
4	Prince Regent Inlet	4.1 (B-2.3)	Arctic Char migration and feeding												
			Migrating and feeding Narwhal, Bowhead and Beluga; Bowhead nursery area;		X	X	X			X	X	X	X	X	X
			Seaduck, molting; seabird/seaduck feeding												
	Gulf of Boothia	4.2 (B-2.4)	Arctic Char migration and feeding												
			Migratory corridor for Narwhal and Bowhead; Bowhead nursery area; Polar bear denning, rearing, feeding		X	X	X			X	X	X		X	
5	Peel Sound	5.1 (B-2.5)	Marine fish aggregation												
			Large Narwhal summer aggregations; Narwhal and beluga feeding		X	X	X			X		X		X	
6	Wellington Channel	6.1 (B-2.7)	Haul-out and wintering ground for Walrus												
			Ross's Gull nesting; seabird and seaduck breeding and feeding			X	X			X	X	X		X	
7	Cardigan Strait – Hell Gate	7.1 (B-2.16)	Year-round haul-outs, and feeding for distinct stock of walrus; summering beluga, killer whales and seals.			X	X			X	X	X		X	

			Seabird breeding and feeding												
8	Archipelago Multi-year Pack Ice	8.1 (B-5.3)	Polar bear denning, feeding, and rearing area; likely refugium for ice dependent species Ivory gull nesting and foraging		X	X	X				X	X		X	
	Norwegian Bay	8.2 (B-5.4)	Feeding and rearing habitat for genetically differentiated polar bear			X	X				X	X		X	
9	Ellesmere Island Ice Shelves	9.1 (B-5.1)	Shallow (< 200 m) area covered by old-year ice, with under ice communities. Refugium for ice-dependent species		X	X	X					X		X	
	Nansen-Eureka-Greely Fjord	9.2 (B-5.2)	Aggregations of unique fish communities Aggregations of Polar Bear and Ringed Seal.		X	X	X				X	X		X	
	Princess Maria Bay	9.3 (B-5.5)	Feeding narwhal and seals; walrus feeding and haul-outs			X	X			X		X		X	
10	Multi-year Pack Ice	10.1 (B-5.3)	Feding area for polar bears		X	X	X				X	X		X	

Table 19. Ecologically important areas – Hudson Bay LME

Area		Id.N°.	Ecological function	season	PSSA criteria										
No.	Location				Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Nat ural	Int egr	Fra gil	Biog gr.
1	Fury and Hecla Strait	1.1 (C-1.1)	Migratory corridor for Bowhead, narwhal, killer whale and beluga; nursery area for bowhead; Polar bear denning		X	X	X			X	X	X		X	X
	Igloolik Island	1.2 (C-1.2)	Arctic char feeding and migration												
			Migration corridor and feeding area for bowhead, narwhal, killer whale and beluga. Walrus feeding and haul-out areas			X	X			X	X	X		X	
	Rowley Island	1.3 (C-1.3)	Migratory corridor for bowhead, narwhal, beluga and killer whale; year-round habitat for walrus including haul-out sites, calving areas, and feeding grounds			X	X			X	X	X		X	
2	Repulse Bay and Frozen Strait	2.1 (C-1.4)	Arctic char												
			Summering and feeding bowhead, and genetically distinct narwhal; year-round walrus			X	X			X	X	X		X	
			Important summering and feeding habitat for seabirds; Iceland Gull breeding aggregation												
	Southampton Island	2.2 (C-1.5)	Aggregations of capelin and Arctic cod			X	X			X	X	X		X	

	(including Coats Island)		Spring and fall migration routes for bowhead and beluga; polar bear denning, feeding,rearing, and summer refugia; walrus summer and winter feeding and haul outs												
			Breeding and feeding seabirds and seaducks												
3	Western Hudson Bay Coastline	3.1 (C-1.6)	Migration corridor and feeding area for Arctic Char			X	X			X		X		X	
			Fall migration area for Polar Bear, and aggregation area for Beluga												
4	Southwestern Hudson Bay Estuaries	4.1 (C-1.7)	Beluga summer aggregation and feeding; polar bear denning, feeding and rearing ; migrating and summering harbour seals		X	X	X			X	X	X		X	X
5	James Bay	5.1 (C-1.8)	Feeding area for marine and estuarine fish.		X	X	X		X	X	X	X		X	
			Walrus haul-out and feeding; Polar Bear denning and feeding ; beluga summering, feeding and overwintering												
			Critical staging, feeding, and moulting area by a variety of seaducks, shorebirds, and waterfowl												

6	Belcher Islands	6.1 (C-1.9)	Polar bear feeding; summering and overwintering beluga; aggregation of bearded seal; walrus haul outs		X	X	X		X	X	X	X		X	
			Aggregation of resident common eider subspecies												
			Eelgrass beds; aggregation of invertebrates												
	Eastern Hudson Bay Coastline	6.2 (C-1.10)	Beluga migration corridor			X	X				X	X		X	
7	Western Hudson Strait	7.1 (C-1.11)	Migratory corridor for beluga, bowhead, narwhal, killer whale and walrus; overwintering bowhead, narwhal and walrus		X	X	X		X	X	X	X		X	X
			Important seabird and seaduck colonies; feeding seabirds and seaducks												
			Aggregation of sponges												
	Eastern Hudson Strait	7.2 (C-1.12)	Migration corridor for beluga, bowhead and narwhal; overwintering bowhead and beluga; walrus haulouts		X	X	X		X	X	X	X		X	X
			Seabird nesting/feeding; aggregation of Ivory gull												

			Aggregation of coldwater corals												
8	Ungava Bay	8.1 (C-1.13)	Beluga summering; Polar bear denning, rearing and summer refugium			X	X			X	X	X		X	
			Seabird/seaduck breeding/feeding												
			Aggregation of coldwater corals												

Table 20. Ecologically important areas – Baffin Bay/Davis Strait LME

Area		ID.N°	Ecological function	season	PSSA criteria										
No.	Location				Uniq. rare	Crit. hab.	Dep-end.	Rep-res.	Div.	Prod.	Spawn breed	Natural	Integr	Fragil	Biogr.
1	North Water polynya	1.1 (C1)	Foraging area for mammals, mostly in the summer, but even some marine mammal populations winter here		X	X	X	X	X	X	X	X	X	X	X
	North Water Polynya	1.2 (D-2.14)	Summering and feeding beluga, bowhead and narwhal; wintering and feeding beluga; year-round use by walrus and ringed, bearded and harp seals; polar bear feeding; walrus haul out and migration		X	X	X		X	X	X	X		X	X
			Seabird breeding, staging and overwintering; Ivory gull												

			aggregation												
	Eastern Jones Sound	1.3. (D-2.15)	Summering and feeding walrus, beluga and ringed seals; polar bear denning and feeding			X	X			X	X	X		X	
			Seabird breeding, staging and feeding; molting seaducks												
			Foraging area for seabirds												
	Northern Baffin Bay	1.4 (D-2.13)	Aggregations of sea pens			X			X			X		X	
2	Baffin Island Coastline	2.1 (D-2.10)	Migration corridor for Arctic char		X	X	X			X	X	X		X	
			Migration corridor for bowhead and narwhal; bowhead nursery area; walrus haul-outs; polar bear feeding, denning and rearing												
			Seabird breeding and feeding												
	Baffin Bay Shelf Break	2.2 (D-2.11)	Aggregations of marine fish			X	X		X	X		X		X	X
			Migrating and feeding bowhead, narwhal, and ringed, bearded, harp and hooded seals.												
			Aggregations of corals and sponges												

3	Hatton Basin-Labrador Sea-Davis Strait	3.1 (D-2.8)	Migration corridor for bowhead, harp seals, narwhal, beluga and walrus; overwintering/feeding for beluga, bowhead and narwhal; summering and feeding polar bear, beluga, killer whale, harp and hooded seals; breeding hooded seals		X	X	X		X	X	X	X		X	X
			Seabirds feeding, staging and breeding; overwintering Ivory Gull												
			Diversity of deep-water corals and sponges												
	Cumberland Sound	3.2 (D-2.9)	Aggregation of Greenland halibut			X	X			X	X	X		X	
			Beluga summer feeding and rearing												
			Breeding/feeding seabirds; Iceland gull												
4	Southern Baffin Bay	4.1 (D-2.12)	Greenland halibut habitat		X	X	X			X	X	X		X	X
			Overwintering/feeding Narwhal and Bowhead												
			Aggregation of coldwater corals												
5	Melville Bay	5.1 (B4)	Critical summer habitat for narwhal, for polar bear winter and spring, and a migration corridor for whales			X	X				X	X		X	

6	Northwest Greenland Shelf	6.1 (B3)	Critical habitat for whales, migration corridor			X	X				X	X		X	X
			Important migration corridor and breeding and staging area for sea-birds.												
7	Central Baffin Bay (and mouth of Uummannaq Fjord)	7.1 (C2)	Wintering area for Narwhal, beluga and Polar bears. Bowhead whales migrate through the area in spring.			X	X			X	X	X		X	
8	Disko Bay and Store Hellefiske Banke	8.1 (B2)	Foraging and breeding areas for mammals.		X	X	X	X		X	X	X		X	X
9	Southwest Greenland Shelf.	9.1 (B1)	Migration corridor for marine mammals			X	X	X	X	X	X	X		X	X
			Migration corridor for seabirds in spring, and summer. Sea birds wintering												
			Foraging and breeding areas for seabirds												
10	Davis Strait marginal ice zone and Labrador Sea	10.1 (C3)	Whelping area for hooded seal			X	X				X	X		X	
			Wintering area and early spring migration corridor seabirds												

Overview of the identified areas of heightened ecological significance

The identified areas of heightened ecological significance are shown on a combined map for all the LMEs on Figure 16. There are 99 areas in total (note that this number is somewhat arbitrary as it reflects the way we have aggregated smaller areas or area components). The areas are listed in Table 21 which contains information on the size of the areas (km^2) and whether they are used by fish, birds and mammals as part of the rationale for why they are considered of heightened ecological significance.

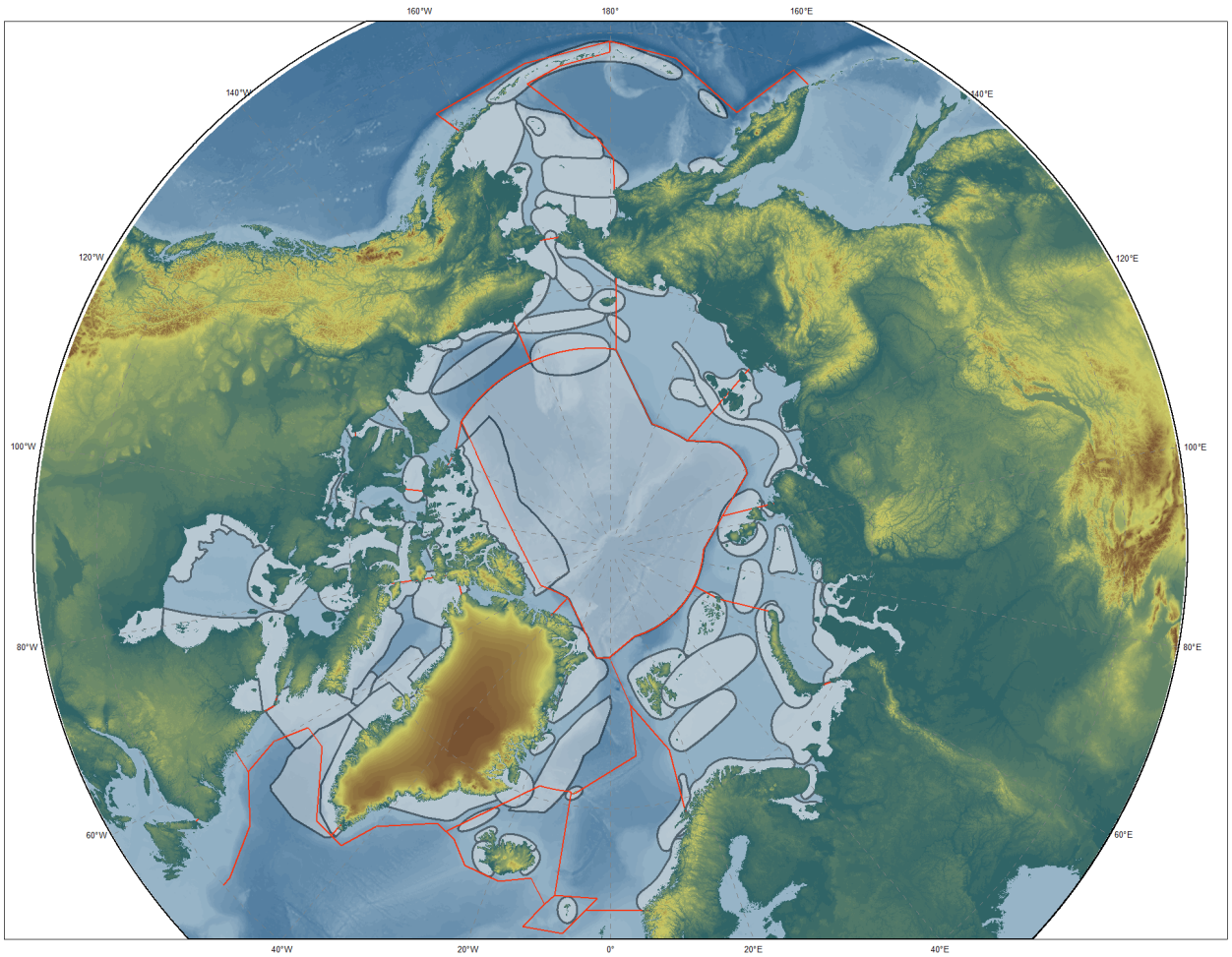

Figure 16. Map of all the identified Areas of Heightened Ecological Significance in the 16 Arctic LMEs

The number of areas ranges from one to 10 per LME (12 for the East and West Bering Sea LMEs combined), and the areas range in size from about 10 to 300 thousand km^2. An exception is the Central Arctic Ocean LME with an area of about 3.6 million km^2. Combined the identified areas of heightened ecological significance constitute more than half of the total area of the Arctic. While this is a high fraction there are two features that should be noted in this regard. One is that there is strong seasonality

in the use of the areas by the animals which make them ecologically important. Thus the sensitivity and heightened ecologically importance may occur in a relatively short period of time, such as spring migration by bowheads and belugas through lead systems for a period of 1-2 months early in the season, or molting and staging by waterfowl and shorebirds for a similar duration in the early autumn period. The other feature is that there is a wide span in the sensitivity to oil spills and disturbances from shipping across the areas. Some have very dense and concentrated animal life such as at large seabird breeding colonies, while others are characterized by more dispersed animal distributions and variable occurrences and locations. This is for instance the case for some of the wintering areas in the southern extent of ice and foraging areas for polar bears in the summer season.

The vast majority of the identified ecological areas are used by birds and mammals. Of the 99 areas, 87 are highlighted as used by birds and 79 as used by marine mammals. For only 3 areas are neither birds nor mammals included specifically in the justification for why the areas have been identified as important. In 69 of the 99 cases are the identified areas used by both birds and mammals, usually by several species and for different purposes such as breeding, feeding, migration, etc. (see Table 21). Thirty eight areas include use by fish, with spawning areas being part of the justification for 26 areas. Other uses by fish are as nursery and feeding areas and migration corridors for chars and whitefishes in estuaries and coastal waters.

The relatively high percentage of the total area identified as being of heightened ecological significance relate to the structuring effects of sea ice on the distribution of animals. The occurrence of ice results in concentration of birds and mammals along the edges and transition zones to open waters, such as in the marginal ice zone and in polynyas and flawleads. At any given time, these zones of concentration of animal life may cover relatively restricted areas. As the ice then undergoes its seasonal rhythm of retreat and advance, the zones of concentrated animal life sweep across the Arctic seas reflecting the migratory patterns of birds and mammals and also of fish. Cumulatively, over the annual cycle, large areas are therefore being identified as ecologically important because of the functions they serve for animals during their seasonal occurrence in the Arctic. Variability in ice conditions from year to year (‘heavy-ice years’ versus ‘light-ice years’ etc) contribute to the expansion of the identified areas. In any one particular year, a smaller fraction of the area may be considered of heightened importance dependent on the specific ice conditions that year.

The identified ecological areas can be broadly grouped into 4 classes based on their geographical locations: areas along mainland coasts, areas around Arctic archipelagos, areas on seasonally ice-covered Arctic shelves, and areas with drifting pack ice in the central Arctic.

Areas along mainland coasts are often important bird areas. This is the case for the open water coasts of Norway and also for open water coasts around Iceland, the Faroes, along southwestern Greenland, and around the Aleutians and Komandorsky islands. In all these cases there are large breeding colonies of seabirds on cliffs, rocks and islets on suitable locations along the coasts with the combined requirement of protected nesting sites and access to abundant food as zooplankton and juvenile fish. Several of these

coasts also serve as wintering areas for seabirds, notably the Aleutian Islands in the Pacific and southwest Greenland in the Northwest Atlantic. Along the mainland of Russia, Alaska and Canada there are extensive areas of low-lying coasts that provide important habitats for many birds of different types including seabirds, waterfowl and shorebirds. Many of these birds breed inland on adjacent tundras and wetlands and use coastal habitats for feeding, rearing and staging prior to the southward fall migration. All the major Arctic estuaries are important bird areas such as the Ob, Yenisey, Lena, Indirka and Kolyma river deltas and estuaries in Russia, the Yukon-Kuskokwim Delta in Alaska, and the Mackenzie and Churchill river deltas and estuaries in Canada. These and other estuaries are also important nursery, feeding and wintering habitats for anadromous fish such as whitefish, chars, and to some extent salmon. The estuaries also provide important summer habitat for belugas.

The archipelagos around the Arctic Ocean are important areas for birds and also for marine mammals, notably walrus and polar bear. Some of the islands and archipelagos hold large seabird colonies of various auks (thick-billed and common murres, litte auk, least auklet) and other seabirds. This is the case for islands in the Bering Strait region, in the Lancaster Sound and the Northwater region in the northern Baffin Bay, and around Svalbard in the northeastern Atlantic. Some of the high Arctic archipelagos such as Franz Josef Land, Severnaya Zemlya and the New Siberian Islands in Russia, the northernmost islands in Canada (Ellesmere, Queen Elisabeth Islands), and northern Greenland also hold important breeding and feeding habitats for seabirds (e.g. ivory gull) and other birds.

The seasonally ice-covered waters make up a number of important habitats at different times during the annual cycle. In winter, the southern extent of the sea ice constitutes winter habitats for marine mammals, notably for bowhead, beluga and narwhal. Important wintering habitats are found in the northern Bering Sea, the Davis Strait and Hudson Strait regions, and the southeastern Barents Sea. These areas and adjacent areas south of the winter ice are also important winter habitat for seabirds and seaducks. Polynyas, notably the Northwater, the Great Siberian polynya system, and polynyas at Franz Josef Land, are also ecologically important winter habitat for mammals and sometimes for birds (e.g. St. Lawrence Island Polynya). From the wintering areas, marine mammals migrate north into the Arctic through systems of recurrent shoreleads and leads in drifting pack ice. Polynyas (notably the Northwater and Cape Bathurst polynyas) are used by bowheads and belugas for feeding early in the season. Polynyas and leads are also used by migratory seabirds and seaducks for spring staging and feeding prior to breeding.

The fast ice environment is some places breeding habitat for polar cod that spawn in winter under the ice. This is the case in the Pechora Sea area and probably also in Franklin Bay in the Amundsen Gulf. Fast ice is important breeding habitat for ringed seal, such as in inlets along western Victoria Island. Such areas and adjacent leads may also constitute winter and foraging habitat for polar bears that feed on ringed seals. The retreating ice over the seasonally ice-covered seas provides many places concentrated zones of life that make them of heighten ecological importance. This is particularly the case early in the summer season when spring has arrived but substantial ice melt has not yet taken place, and late in the summer season when the ice edge has moved north towards its maximum retreat. Areas associated with

the retreating ice edge have been identified as ecologically important in the Greenland, Barents, Kara and Chukchi seas, and in Baffin Bay.

The drifting pack ice of the central Arctic Ocean is a special case. This LME, which includes the international waters (High Seas) but also parts of national Exclusive Economic Zones (EEZs) of Canada, Denmark/Greenland, Norway and Russia, is a large area of about 3.7 million km2. It contains areas with heavy multi-year pack ice as well as areas with more newly formed (annual) ice. It is well known and documented (e.g. the recent SWIPA 2011 report; AMAP 2012) that the summer ice has decreased in recent decades with open waters forming over a substantial part of the Canada Basin with minimum sea ice cover in 2007). The extent of the multi-year ice has also decreased substantially.

Canada identified the areas with multi-year pack ice within the northern part of the Canadian Arctic Archipelago and the adjacent part of the Arctic Ocean as EBSAs due to the unique habitats biological communities associated with the sea ice. The drifting pack ice of the Central Arctic Ocean is globally unique as an environment and it contains unique ice-associated biota. We have identified this whole area as an area of heightened ecological significance. The truly unique habitat is the multi-year pack ice with its associated biota of ice algae, amphipods and other animals. There is an export of multi-year ice out of the Arctic Ocean through the Fram Strait with the East Greenland Current. This loss is compensated by new formation of ice that accumulates over several seasons to become multi-year ice. The mechanisms that regulate the establishment and maintenance of the unique ice-biota communities are not well known. It is likely that old ice serves as core areas for colonization of new ice by ice biota, and also that younger ice play some role in the establishment and development of the ice-associated biological communities.

The drifting pack ice is a threatened habitat with global climate change. It is predicted that summer ice may be largely absent from the Arctic Ocean by the end of this century if not earlier. It is also predicted that the last area with multi-year ice will be the region north of Canada. It seems clear that this region is a core area of higher ecological significance than the other portion (toward the Eurasian side) of the Central Arctic Ocean. The area could be roughly divided by the 0-180 degree longitude through the North Pole, with the western (American) side being of higher significance than the eastern (Eurasian side). However, this distinction is uncertain and we consider that the whole area should be regarded as being of heightened significance.

The drifting pack ice of the Central Arctic Ocean is a very low productive area. This is due to the combination of low incoming light (both low angle and short season), strong shading effect of ice, and low nutrient supply due to strong stratification of the water. In fact, this low productivity contributes to the unique characteristics of this habitat. On the other hand it means that there is limited food for predators and the area does not attract concentrations of animals. Some belugas, narwhals, ringed seals, and polar bears may venture into this area as do some ivory and glaucous gulls. However, their densities would generally be low. The sensitivity of this area to shipping would also generally be low. Oil spills that could remain in this habitat for a long time would be the main concern in this LME, while disturbances

from ships would be a an issue of little concern due to the low density of animals and the very wide distribution of the ice communities.

Table 21. List of all the identified areas of heightened ecological significance in each of the Arctic LMEs, with information on the area (thousand km^2) and use by fish, birds and marine mammals. B – breeding; F – feeding; Mi – migration; Mo – molting; Sp – spawning; St – staging; W – wintering.

LME	No	Area	Area (10^3 km^2)	Fish	Birds	Mammals
1 - Iceland	1	Southwest/West Iceland	30	Sp	B F Mo St W	
	2	Northwest Iceland	11		B F	
	3	Denmark Strait	33		W	F
	4	North Iceland	20		B F	
	5	East Iceland	12		B F St	
2 - Greenland Sea	1	Northeast Water polynya area and Peary Land	161		B F St	F B W
	2	Scoresby Sound fjord and adjacent fjord areas on Blosseville coast	70		B F Mo St	F B
	3	Sirius Water/ Young Sund Polynya	24		B F St Mi	F B
	4	Sea ice in the Western Greenland Sea	262		M	B F
	5	South East Greenland & Denmark Strait	130		B F Mo Mi St W	F B Mo W
3 - Faroe Plateau	1	Faroe Plateu	28	Sp	B F W	
4 - Norwegian Sea	1	Norwegian coast and shelf - Møre-Helgeland	67	Sp	B F Mo W	F B
	2	Lofoten area	73	Sp	B F	F
	3	Jan Mayen Island	12		B F	
5 - Barents Sea	1	Pechora Sea	263	Sp F	F St Mo	B F W
	2	Norwegian and Murman coasts	130	Sp	B F W	
	3	Entrance and northern White Sea	20		Mo W	B Mo Mi W
	4	White Sea (Kandalaksha, Onega and Dvina bays)	32	Sp	B F Mo St W	F W
	5	Bear Island	10		B F St	
	6	Svalbard Archipelago	150		B F Mo	B F W
	7	Franz Josef Land	117		B F St	B F W
	8	Western and central Barents Sea	139		F Mi W	F
	9	Northern Barents Sea - marginal ice zone	228			F

	10	Western Novaya Zemlya	101		F B Mi	Mi
6 - Kara Sea	1	Baydaratskaya Inlet - Western Yamal	124	Sp	Mi St	B Mi F
	2	Northeastern Novaya Zemlya	18		St B F	
	3	Western Severnaya Zemlya	52		St B F	F
	4	Northern Kara Sea - marginal ice zone	86		F	Mi F
	5	Northern Kara Sea islands	73		B F	F
	6	Ob Estuary and Fjord	52	F	F Mo St	F
	7	Yenisey Estuary and Bay	34	F	F Mo St	F
	8	Pyasina Estuary	12		F Mo St	
	9	Vilitskij Strait	9		B F	
7 - Laptev Sea	1	NW Laptev Sea	91		B F St	Mi F W
	2	Northeast Taimyr and Preobrazheniya Island	19		B F	F
	3	Great Siberian Polynya System	135		St Mi	F W
	4	New Siberian Islands	84		B F Mo	F
	5	Estuaries and deltas along the southern Laptev Sea	22	Sp F	F Mo St	
8 - East Siberian Sea	1	New Siberian Islands	84		F Mo	F W
	2	Great Siberian Polynya System	136		St F	F
	3	De Long Islands	51		B F	
	4	Ice zone on the northern shelf	27		F	F
	5	Indigirka and Kolyma deltas and estuaries	13	F	F Mo St	
	6	Chaun Bay	33		B F	
9/10 - E and W Bering Sea	1	Aleutian Islands	243	Sp	B F W	B F
	2	Komandorsky Islands	30		B F W	B F
	3	Continental SE Shelf and Shelf Break	179	Sp W	F	
	4	Continental NE Shelf and Shelf Break	205	Sp W	W	B F Mo Mi W
	5	Pribilof Islands	17		B F St	B F
	6	St. Matthew/Hall Islands	6		B F St	
	7	Bristol Bay and Southeast Bering Shelf	251	Sp F Mi	F Mo St	B F
	8	East Coast (Yukon-Kuskokwim to Norton Sound)	65	Sp F W	B F Mo St	W

	9	St. Lawrence Island/ St. Lawrence Polynya	43		B F W Mi	W F St
	10	Bering Strait and Chirikov Basin	68	Sp	B F	F Mi
	11	Gulf of Anadyr	86	Sp	F St	B F Mi W
	12	Northeast Coast of Kamchatka and offshore areas	29	Sp W		
11 - Chukchi Sea	1	Chukchi Rise (Plateau, Borderland)	196	Sp		
	2	Northeast Coastal (Alaska)	41	Sp F Mi	B F St Mo Mi	Mi F Mo
	3	Southeastern Chukchi Sea (Chukchi Bight, Kotzebue Sound)	60	Sp F Mi W	B F St Mi	B F Mi
	4	Northern Chukchi Peninsula	44		B F St	F Mi
	5	South-Central Chukchi Sea (including Bering Strait)	79		B F Mi	Mi F
	6	Wrangel/Herald Islands Area	42		B F Mo St	F
	7	Chukchi Shelf (Northern and Central parts)	103		F Mo	F
12 - Beaufort Sea	1	Amundsen Gulf area	94	Sp F Mi	B F St	B F Mi W
	2	Western Victoria Island inlets	34	Sp F Mi	B F St	B F Mi W
	3	Mackenzie Estuary and Shelf	82	Sp F W	B F Mo St	F Mo Mi
	4	Viscount Melville Sound	59			B F
	5	Northeast Alaska and Yukon coasts and shelves	19	Sp F Mi	B F Mo St	F
	6	North Alaskan coast and shelf	33	F Mi W	B F Mo Mi St	F
	7	Offshore pack ice	131			Mi F
13 - Central Arctic Ocean	1	Drifting pack ice	3659			
14 - Canadian Arctic Archipelago	1	Coronation/Queen Maud gulfs - coasts and inlets	21	F Mi	F St	F
	2	King William/S Victoria islands	35	F Mi		F
	3	Lancaster Sound and inlets	84		St B F	B F Mi
	4	Prince Regent Inlet/Gulf of Boothia	94	F Mi	B F	B F Mi
	5	Peel Sound	24			F
	6	Wellington Channel	13		B F	F W
	7	Cardigan Strait-Hell Gate	6		B F	F W

	8	Northern Archipelago/Norwegian Bay	197		B F	B F W
	9	Ellesmere	44			F
	10	Arctic Basin pack ice	530			F
15 - Hudson Bay Complex	1	Northern Foxe Basin (1.1-1.3)	61	F Mi	B F	B F Mi
	2	Northern Hudson Bay (1.4, 1.5)	128	F	B F	B F Mi W
	3	Western Hudson Bay (1.6)	35	F Mi		B F Mi
	4	Southwestern Hudson Bay (1.7)	101		F Mi St	B F Mi W
	5	James Bay (1.8)	70	F Mi	F St Mo	F Mi W
	6	Eastern Hudson Bay (1.9, 1.10)	142		B F Mo W	F Mi W
	7	Hudson Strait (1.11-1.12)	142		B F	B F Mi W
	8	Ungava Bay (1.13)	56		B F	B F
16 - Baffin Bay-Davis Strait	1	North Water-Northern Baffin Bay (D-2.13-2.15+C1)	127		B F St Mo W	F Mi W
	2	Eastern Baffin Island coast and shelf (D-2.10, D-2.11)	137		B F	B F Mi
	3	Hatton Basin-Labrador Sea-Davis Strait (D-2.8, D-2.9)	234		B F St	B F W
	4	Southern Baffin Bay (D-2.12)	30	F		F W
	5	Melville Bay (B4)	15		Mi	B F Mi W
	6	Northwest Greenland Shelf (B3)	43		B F Mi Mo	Mi F W
	7	Central Baffin Bay (C2)	89			F Mi W
	8	Disko Bay and Store Hellefiske Banke (B2)	101	Sp F	B F St Mo W	B F Mi W
	9	Southwest Greenland Shelf (B1)	108	Sp F	B F St Mi Mo W	F Mi
	10	Davis Strait marginal ice zone and Labrador Sea (C3)	310		Mi W	B

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Appendix 1

Fish species and communities

Overview of types and species of fish (Figure 17)

More than 500 species of fish inhabit arctic and subarctic marine ecosystems. It is common to distinguish between pelagic species that live in the water column and benthic species that live at the sea floor. This distinction is not always that clear since many fish show both modes, spending part of the time at the bottom while at other times being in the water column. Sandeel or sand lance (*Ammodytes* spp.) is a good example, burrowing into sand where they remain hidden much of the time, to emerge on occasions to feed on plankton in the water column. Polar cod (*Boreogadus saida*) is another example. This key species in Arctic ecosystems can be found in large aggregations close to the bottom in some areas but it is also found as a schooling plankton-feeder in the water column as well as on the underside of sea ice.

Another type of fish are anadromous or amphidromous species that live both in the sea and in fresh water. Atlantic and Pacific salmon belong to the group of anadromous fish, feeding and growing in the sea and returning to their natal rivers to spawn. Whitefishes (*Coregonus* spp.), Arctic charr (*Salvelinus alpinus*) and Dolly varden (*Salvelinus malma*) show great flexibility and variability in their life cycles, where many fish move to estuaries and coastal waters to feed during summer while returning to spend the winter in rivers and lakes.

Fish feed on zooplankton, bottom-dwelling invertebrates (benthos), and other fish. The plankton-feeders are usually relatively small species. They play very important roles in arctic marine ecosystems as links between lower and higher trophic levels, such as marine mammals and seabirds, and are for that reason often called forage fishes. Many other fish species also feed on the forage fishes. These include cod, pollock, halibut and others. Many demersal fish such as flounders and sculpins feed on benthic polychaetes, bivalve mollusks, amphipods, shrimps and other benthic prey.

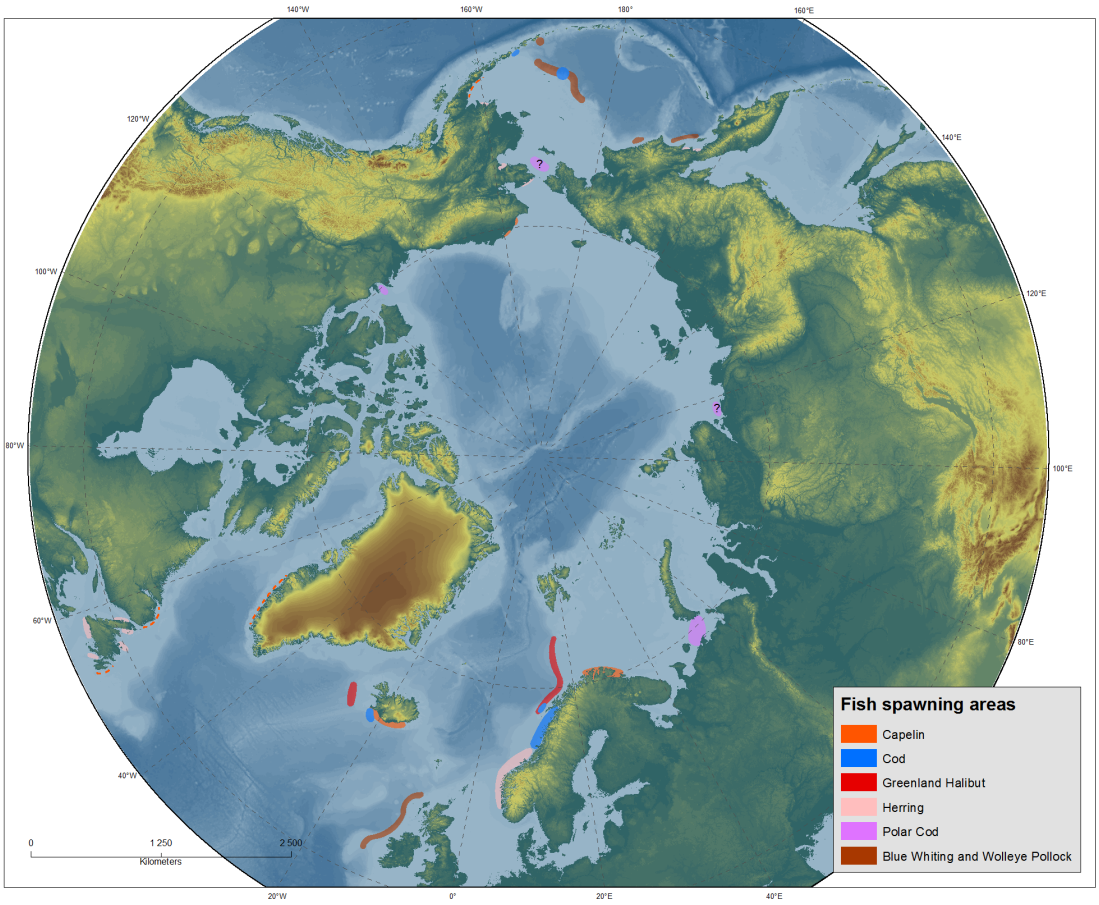

Figure 17. Fish spawning areas in the Arctic

There is a large gradient in productivity going from the high productive subarctic seas to the very low productive, ice-covered waters of the high Arctic. The subarctic seas such as the waters around Iceland, the Norwegian Sea and the Bering Sea, support some of the largest and most productive fish stocks in the world. On a gradient from south to north, there are large stocks of plankton-feeders in the basins and shelf areas of the subarctic seas. These include blue whiting (*Micromesistius poutassou*) and walleye pollock (*Theragra chalcogramma*) which are relatively small codfishes that live in the basins of the Bering Sea and the Nordic Seas, and Atlantic herring (*Clupea harengus*) and Pacific herring (*Clupea pallasii*) that live over shelves and basins in the subarctic seas. Capelin (*Mallotus villosus*) forms populations over sub-arctic and low arctic shelf regions, whereas polar cod (*Boreogadus saida*) is a true arctic species found in low and high arctic areas. The northernmost species is the little-known Arctic cod (*Arctogadus glacialis*) which is assumed to live with a large population (or more) in the Canada Basin of the Arctic Ocean.

Atlantic halibut (*Hippoglossus hippoglossus*) and Pacific halibut (*Hippoglossus stenolepis*) are large species of piscivorous flatfish (up to 2 m in length) that live along the continental slopes and shelf areas of the subarctic seas. Greenland halibut (*Reinhardtius hippoglossoides*) has similar life style but is a

somewhat more northern species, extending its range well into low arctic waters in the northern Bering Sea, Baffin Bay, and Greenland Sea. Along the subarctic slopes there are a number of redfish species (*Sebastes* spp.) that are mainly plankton-feeders and give birth to juveniles (viviparous). Atlantic cod (*Gadus morhua*) and Pacific cod (*Gadus macrocephalus*) are important commercial species on the boreal and subarctic shelves as are a number of other species of codfish and flatfishes. The latter group is particularly important on the wide eastern shelf of the Bering Sea where yellow-fin sole (*Pleuronectes asper*) is the major species in the fisheries. Navaga (*Eleginus navaga*) and saffron cod (*Eleginus gracilis*) are two medium-sized codfishes (40-50 cm in length) that are important in low arctic shelf areas where they spawn in winter under the ice. On the low and high arctic shelf regions surrounding the Arctic Ocean there is special demersal arctic fish communitiesy with several and mostly small species in the groups of sculpins, eelpouts, sea snails, lumpsuckers and others. Species in these groups also dominate in the fish communities down along the low productive arctic slopes to the Arctic Ocean basins.

In the group of anadromous or amphidromous fishes, Atlantic salmon (*Salmo salar*) and the 5 species of Pacific salmon (*Oncorhynchus* spp.) are large species that feeds in the subarctic basins before returning to their rivers in the boreal and subarctic zones. The most northern of the species is chum salmon (*Oncorhynchus keta*) that is found as far north as in the Mackenzie and Lena rivers. Smelts are smaller fish related to capelin. There are several species that move to feed in coastal and shelf waters of subarctic seas, such as eulachon (*Thaleichthys pacificus*) on the eastern Bering shelf. Arctic rainbow smelt (*Osmerus mordax dentex*) is widely distributed in the Arctic were it feeds in coastal waters in summer. Arctic charr (Salvelinus alpinus) and whitefishes (*Coregonus* spp.) have complex taxonomy and life histories and move in great numbers out from arctic rivers to feed in estuaries and coastal (mostly brackish) waters in summer.

Migrations, spawning and wintering habitats

Migrations are a key feature of all large fish stocks that move between spawning, feeding and wintering areas. These seasonal migrations are illustrated below for some of the key species of fish in the Arctic area. Plankton-feeders such as herring, capelin and polar cod have large-scale feeding migrations where they spread out and feed on the zooplankton that grow and develop in the upper water layer of subarctic and low-arctic waters during the short summer season. Demersal species such as Atlantic and Pacific cod and Greenland halibut also have large-scale seasonal migrations.

Migratory fish typically have defined spawning grounds from where the spawned eggs and/or larvae drift with the currents to suitable nursery areas. As the juveniles grow and develop swimming capacity they will join older fish on seasonal feeding migrations and when mature will return to the spawning grounds in a spawning migration. The spawning behavior and spawning areas can be broadly grouped into three types:

i) spawning demersal eggs at the bottom,

ii) spawning pelagic eggs in the water column, and

iii) spawning eggs under the ice in winter.

Demersal and pelagic spawning can occur either in shallow water or in the upper part of the water column, or in deeper water. Spawning under the ice and demersal spawning in shallow water were considered the most sensitive situations to oil spills in the OGA.

Polar cod, Arctic cod, navaga and saffron cod spawn under the ice in winter. For navaga and saffron cod this takes place under fast ice in relatively shallow water (check). Polar cod also appears to spawn in relatively shallow water such as in the Pechora Sea area for the East Barents Sea stock.

Herring and capelin spawn demersal eggs. Pacific herring and capelin may in some areas (e.g. Bering Sea and Labrador) spawn on beaches or in shallow water just below beaches. Other places they spawn on coastal banks in deeper water (50-200 m), such as the stock of Atlantic herring off the west coast of Norway and capelin in the southern Barents Sea.

Many demersal fish species (codfishes, flatfishes) spawn pelagic eggs in the upper layer. Spawning usually takes place during spring so that the fish larvae can be nourished by the spring growth of phyto- and zooplankton. This is the case for Atlantic cod (but not Pacific cod that spawns demersal eggs), yellow-fin sole in the Bering Sea, and many others. Other species spawn in deeper water, often in late winter so that the larvae that hatch can ascend to feed in the upper layers during spring and summer. Atlantic and Pacific halibut and Greenland halibut are species with deep spawning along the continental slopes in boreal and subarctic waters where they aggregate in winter.

During spawning migration and on the spawning grounds, the fish may occur concentrated and be potentially sensitive to disturbances such as from seismic surveys. Some species may also concentrate during wintering. This is the case for herring as illustrated by the large stock of Norwegian spring-spawning herring that occurred in one huge aggregation (5 million tons or more) in a fjord area (Ofoten-Tysfjord) in the inner Vestfjord in the Lofoten area. Pacific herring may also occur concentrated on the outer Bering shelf in the area between the Pribilofs and St. Matthews islands in Alaska.

Amphidromous fishes return from the sea to spend the winter in estuaries, rivers and lakes. This is related to the lack of physiological adaptation to cope with the low temperature (-1.8^{o}C) at freezing in water with full marine salinity. Herring also presumably survives in Arctic areas by seeking lower-salinity waters in estuaries during winter. These estuaries may be winter habitats of limited spatial extent for herring and other fish species and may therefore constitute area that are sensitive areas to pollution and disturbances during the winter period.

Marine mammals

Overview of species (Figure 18)

There are 35 species of marine mammals that occur within the Arctic area. Most of them are found in the southern sub-arctic parts where many occur as seasonal visitors from lower latitudes. The marine

mammals can be broadly grouped into four main categories: baleen whales, toothed whales, seals and walrus, and other carnivores. There are 9 species of baleen whales, 13 species of toothed whales, and 11 species of seals plus walrus. The 'others' are two species: polar bear and sea otter. Polar bear is considered to be a marine mammal although it is not in a strict taxonomic sense since it belongs to a mainly terrestrial group of carnivores. This is also the case for sea otter.

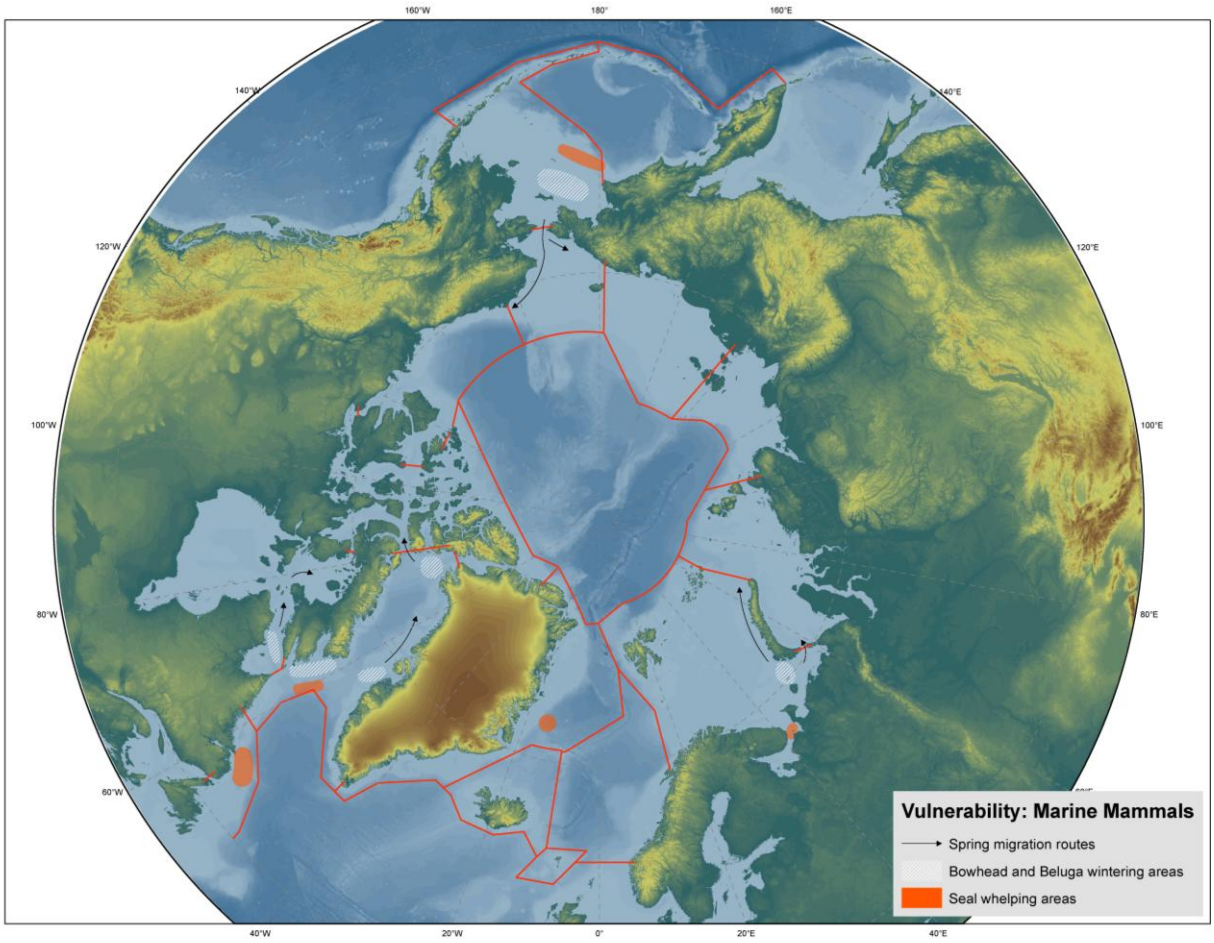

Figure 18. Marine mammals in the Arctic

Eleven of the species are true Arctic residents, living in the Arctic year-round and in association with sea ice to large extent. These are polar bear (*Ursus maritimus*), three whale species, 6 seals, and the walrus (*Odobenus rosmarus*). The whales are beluga or white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), and bowhead (*Balaena mysticetus*), while the seals are ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), spotted seal (*Phoca largha*), ribbon seal (*Histriophoca faciata*), harp seal (*Phoca groenlandica*) and hooded seal (*Cystophora cristata*). Other species are mainly confined to the sub-arctic and boreal areas. This group includes northern fur seal (*Callorhinus ursinus*), harbour seal (*Phoca vitulina*), gray seal (*Halichoerus grypus*), killer whale (*Orcinus orca*), northern bottlenose whale (*Hyperoodon ampullatus*), minke whale (*Balaenoptera acutorostrata*), and sea otter (*Enhydris lutra*).

Several species have large-scale migrations between warmer waters where they spend the winter and reproduce, and the Arctic where they feed during the summer. This group includes the large baleen whales: blue whale (*Balaneoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale (*Megaptera novaeangliae*), and grey whale (*Esrichtius robustus*).

Fifteen of the marine mammal species have circumpolar or amphi-boreal distributions and occur around the Arctic and/or in both the North Atlantic and North Pacific Oceans. Six of the ice-associated species have circumpolar distributions (polar bear, bowhead, beluga, walrus, and ringed and bearded seals), while 3 are found only in the Atlantic sector (narwhal, harp and hooded seal) and 3 only in the Pacific sector (gray whale and ribbon and spotted seals). Five large baleen whales (blue, fin, sei, humpback and minke) are found both in the Atlantic and Pacific, as are also sperm and killer whales, harbour porpoise, and harbour seal. Five of the subarctic and boreal species are Atlantic species (northern bottlenose and pilot whales, white-beaked and Atlantic white-sided dolphins, and gray seal), while 6 are Pacific species (Baird's beaked whale, Pacific white-sided dolphin, Dall's porpoise, Steller's sea lion, and sea otter).

Migration, feeding and reproduction

Migration is a key feature for most marine mammals. The ice-associated species move seasonally with the ice. Bowhead and beluga winter in the southern part of the winter pack ice or in persistent polynyas. In spring they move north using lead systems to summer feeding grounds in the Arctic that become available as the ice open up and recedes. In autumn they move south again as the sea freezes over and winter approaches. Large migratory populations of both species winter in the northern Bering Sea and migrate seasonally to summer feeding areas in the Beaufort Sea. Similarly, populations in the Baffin Bay area migrate from wintering areas into the Canadian Arctic Archipelago to feeding areas in Prince Regent Inlet and other adjacent inlets (Figure 13). Narwhal has similar migration between Baffin Bay and the Canadian Arctic.

Ringed seal is an important species in Arctic marine ecosystems as the principal prey item for polar bears and also for subsistence hunting. Their fore-flippers are equipped with claws that it uses to maintain breathing holes in ice, which allows it to live in high arctic areas year round. Nevertheless, many ringed seals migrate seasonally as the ice and feeding conditions changes. Migrations are also characteristic for other seals such as harp seal in the Atlantic sector and spotted seal in the Pacific. Pacific walrus has a large scale migration (mainly of females and juveniles) from wintering areas in the pack ice of the northern Bering Sea to summer feeding areas in the Chukchi Sea and the eastern East Siberian Sea.

Many baleen and toothed whales migrate north to summer feeding grounds in the sub-arctic seas where they exploit the rich seasonal occurrence of zooplankton, fish and squid. The baleen whales use their baleen feeding apparatus to filter zooplankton and small schooling fish from the water. The right whales (family Balaenidae) including bowhead skim-feed by swimming with open mouth and feed to a large extent on zooplankton including large calanoid copepods. The rorquals (family Balaenopteridae) feed by engulfing a large mouthful of water with prey by distending the skin in the throat region and then forcing

the water out through the baleen. These whales feed largely on krill and schooling fish. Blue whale feeds mainly on krill, whereas humpback and minke whale are more versatile and often target fish schools such as capelin, herring and sandeel/sand lance.

Toothed whales feed mainly on fish and squid. Several of the whales are deep divers and target deepwater squid and fish such as Greenland halibut and redfish (*Sebastes* spp.). Narwhal can dive to 1,500 m or more. In winter they live in dense pack ice in the southern Baffin Bay and dive to feed on the squid Gonatus fabricii and Greenland halibut in deep water. Beluga is also capable of deep diving down to 1,000? m. Many of the smaller species of toothed whales including harbour porpoise and dolphins feed mostly on small epipelagic fish or demersal fish at shallower water over shelves. Killer whale is the largest of the dolphins and has as a species a broad range of prey items including fish and marine mammals. Within that broad range there is considerable specialization so that some populations eat fish while others eat marine mammals. For the mammal-eating ecotype, pinnipeds appear to be the predominant prey although killer whales may also attack and kill baleen whales, notably their calves.

The seal species feed to a large extent on fish and crustaceans. Polar cod (*Boreogadus saida*) and capelin are important prey for seals in Arctic waters as are ice-associated and pelagic amphipods such as Themisto libellula. This is the case for ringed seal and harp seal. Hooded seal is a deep diver (to 1,000 m) and eats in addition deep-water fish. Bearded seal is a benthic feeder on a variety of invertebrates but it also eats polar cod. Walrus feeds predominantly on bivalve shells in relatively shallow sediments. Northern fur seal and Steller sea lion in the Bering Sea feed on a variety of fish and invertebrates.

Most marine mammals produce one baby calf or pup at the time. They typically breed in winter or spring and give birth to the young after around one year. Many of the large whales migrate south to breeding and calving areas in warmer waters. Bowhead and beluga give birth to the calves commonly in ice-covered waters during the spring migration to their summer feeding grounds. Seals give birth to their whelps on land or on ice. Ringed and bearded seals live mainly solitarily and whelp widely dispersed. Ringed seal construct a lair in snow drift where the whelp is nursed. Harp, hooded, spotted and ribbon seals gather in specific whelping areas in the southern extent of winter ice where they give birth to the young.

Whale calves and seal pups are borne relatively large, with a length of around 1/3 the length of the mother. Thus a bowhead calf is about 4 m long and weighs a ton, a beluga calf is about 1.5 m, a walrus calf is 1.2 m (about 60 kg), and ringed seal whelp is about 0.5 m. The young are fed very rich milk and grow fast. Whale and walrus calves suckle their mothers for up to a year or longer. In contrast, the seal whelps of harp, hooded, spotted and ribbon seals that are equipped with rich wooly pelt to keep them warm, are nursed on the ice only for some weeks before they are abruptly weaned and left by their mothers. The most extreme case is with hooded seal where the “bluebacks” are nursed for only 4 days, when they drink 10 litre of milk (60 % fat) and put on 7 kg of weight per day.

An important feature in the biology and ecology of whales relate to their mode of reproduction. In the long nursing period, the young calves swim with their mother on the annual migration from wintering and calving grounds to the summer feeding grounds at higher latitudes. By this they learn a particular migration route from their mothers which is the basic mechanism for the matrilineal structure of whale populations. This is particularly well studied with humpback whales that can be individually recognized by the colour pattern on their flukes and bodies (photo id). By this it has been shown that individual whales show a high degree of site fidelity, returning each summer to the same summer feeding grounds in the even if they mix on a common wintering and breeding ground (in the West Indies region for North Atlantic populations).

Populations and conservation status

Marine mammals occur often with more or less well-defined and discrete populations. The separation between the Atlantic and Pacific sectors of the Arctic and adjacent boreal areas is often expressed in genetically distinct forms. Thus, separate subspecies are recognized for walrus, harbour porpoise, minke whale, and possibly also fin and blue whales. Harbor seal occurs with 4 subspecies within the Arctic area, two in the North Atlantic and two in the North Pacific. However, even within Atlantic or pacific sectors of the Arctic, there are often recognized several populations that are more or less separated by geographical distance and biological mechanisms such as the one referred to above for whales. These population units are often called stocks as practical management units for whales, or subpopulations in many cases such as with polar bear.

Bowhead occurs with 4 recognized populations (Okhotsk Sea, Bering Sea, Eastern Canada-West Greenland, and Spitsbergen stocks). The Bering and Eastern Canada-West Greenland stocks are relatively large (each of order 10,000 individuals), while Spitsbergen stock may number in the 10s of individuals and is considered to be ‘Critically’ endangered. Bowhead as a species is no longer considered a Threatened species by IUCN (assessed to be in the ‘Least concern’ category).

Beluga occurs with 20 or more subpopulations, each with their separate summering grounds even some may mix in the wintering areas. Many of the subpopulations are small (100s to few 1000s) and remain in ice-free sub-arctic waters in summer. Four of the stocks or subpopulations are large (number in the range of 20-50,000 individuals) and are migratory to summer feeding grounds in the low and high Arctic. These are the Bering-Chukchi-Beaufort, Western Hudson Bay, Eastern High Arctic-Baffin Bay, and Karskaya subpopulations. The total population of beluga numbers about 200,000 individuals and it is assessed by IUCN to the ‘Near threatened’. This is also the case for narwhal that occurs with at least two populations, the largest in Baffin Bay (total population >80,000 individuals).

Pacific walrus occurs with one large migratory population that winters in the northern Bering Sea and summers (females and juveniles) in the Chukchi and East Siberian seas. The size of the population is not well known but was previously estimated to be of order 200,000. Atlantic walrus occurs with 8 subpopulations, totalling only about 1/10 the numbers for the Pacific walrus. At the species level, walrus

is assessed to be 'Data deficient' due to the uncertainty about population size and the threat from climate change.

The large whales were severely depleted by former whaling. North Atlantic and North Pacific right whales are estimated to number about 400 and 500 individuals, respectively, and are assessed by IUCN to be 'Endangered' (they should possibly be considered critically endangered given their precariously low populations). Blue whale, fin whale and sei whale are also considered to be 'Endangered' although their global populations are much higher (10-100,000). Sperm whale is assessed to be 'Vulnerable'.

Sea otter and Steller sea lion in the Bering Sea are both assessed to be 'Endangered' due to previous strong decline for sea otter (near extinction) and more recent and ongoing decline. Northern fur seal is listed as 'Vulnerable' as is hooded seal in the Atlantic sector. The ice-associated spotted seal and ribbon seal in the Bering Sea are assessed to be 'Data deficient' due to uncertainty about their situation. Polar bear is listed as 'Vulnerable' by IUCN due to threat from climate change and overharvesting.

Marine and coastal birds

Types of birds

There is a great variety of birds that occur in marine and coastal areas in the Arctic, with a total of about 200 species (Table). Many terms are used to classify birds, such as seabirds, waterbirds, waterfowl, and shorebirds. 'Waterbird' is a term used by Wetlands International and the Ramsar Convention for birds that occur in wetlands. In this use, 'waterbirds' include traditional waterfowl such as ducks, geese and swans, divers, grebes, shorebirds, cranes, and some forms of seabirds such as gulls, terns and cormorants.

Table 22. Overview of types and number of species of Arctic marine and coastal birds

Type of birds	Families/Subfamilies/Tribes	No of species [1]			
		Arctic	Subarctic [2]	Total	
Seabirds	Albatrosses		3	3	
	Petrels and shearwaters	1	7	8	
	Storm-petrels		3	3	
	Cormorants	1	4	5	
	Gannets		1	1	
	Skuas	3	2	5	
	Gulls	8	12	20	
	Terns	2	4	6	
	Auks	7	13	20	
	Sum seabirds	*22*	*49*	*71*	
Waterfowl [3]	Swans	1	2	3	
	Geese	10	3	13	
	Seaducks	6	10	16	

	Diving ducks	2?	5	7	
	Dabbling ducks	1?	10	11	
	Divers	4	-	4	
	Grebes		3	3	
	Sum waterfowl	*24*	*33*	*57*	
Shorebirds	Lapwings		1	1	
	Plovers	7?	3	10	
	Woodcocks		1	1	
	Snipes and dowitchers	1	6	7	
	Godwits and curlews	5	6	11	
	Shanks	0?	13	13	
	Turnstones	1	1	2	
	Sandpipers (calidrine)	23?	1	24	
	Phalropes	2	1	3	
	Oystercatchers		2		
	Sum shorebirds	*39*	*35*	*74*	
	Total sum			**202**	

1) Including inland (or mainly inland) species

2) Number of bird species that are restricted to the sub-arctic part of the Arctic area, which are broadly the open water areas south of seasonal sea ice in the marine and forested areas south of tundra on land.

3) Including divers and grebes which are usually not considered to be in this group.

Seabirds contain a variety of types or families of birds including auks, gulls, terns, skuas, cormorants, storm-petrels, petrels and shearwaters, and albatrosses. A total of about 70 species of seabirds may be found within the Arctic area, most of them (about 50 species) restricted to the sub-arctic region. Auks and gulls are the two most dominant families in terms of number of species (about 20 each), with 7-8 species breeding in the true Arctic. Among the auks, thick-billed and common murres are abundant species that breed in seabird colonies on cliffs around the circumpolar Arctic. The smaller dovekie is very numerous in the high arctic of the Atlantic sector, while black guillemot is widely distributed around the coasts and islands of the Arctic. Among the gulls, glaucous gull is a large species with an Arctic circumpolar distribution. Herring gull has also a wide distribution, extending into the low arctic. Black-legged kittiwake is the most numerous of the gull species, extending the breeding range into the low arctic both in the Atlantic and Pacific sectors. The Iceland gull breed in the Arctic in northeastern Canada. The Ivory gull is a high Arctic species that are among the few birds that remain in the Arctic during winter.

Other seabirds include northern fulmar which is a petrel with a wide distribution in low Arctic and boreal areas of both the Atlantic and Pacific sectors. Other petrels and shearwaters, storm-petrels, and three North Pacific species of albatrosses are found north into the sub-arctic zone. This is the case also for cormorants, where pelagic cormorant in the Bering Sea region and great cormorant in the NW Atlantic extend their breeding ranges into the low arctic.

Waterfowl (used in a narrow sense) is a segment of waterbirds that include the family of swans, geese and. *Seaducks* are a group of ducks (tribe Mergini) that contain 4 species of eiders that are prominent and conspicuous members of the Arctic fauna. Common and king eiders have wide circumpolar breeding distributions, while spectacled eider is found in the Pacific sector of the Arctic. Steller's eider breeds in northern Russia with a western (Atlantic) and an eastern (Pacific) population. Long-tailed duck is another abundant and wide-spread seaduck in the Arctic.

Geese are to a large extent an Arctic group of birds with about 10 species breeding in the true Arctic. These are found mainly inland and away from the coasts. The most arctic and marine of the species are brent goose that occurs (with different subspecies) with a circumpolar distribution. Snow goose and Ross's goose breed in Arctic Canada (and on Wrangel Island for snow goose) and they occur to some extent in coastal habitats. Emperor goose occurs in the Bering Sea and is very much a coastal species with breeding distribution north to the Bering Strait region. *Dabbling ducks* tend to be largely associated with freshwater wetlands, and about 10 species are found in sub-arctic areas. Northern pintail is a numerous species with a circumpolar breeding distribution north in the low arctic zone, and the mallard in Greenland constitute a true low arctic subspecies.

Divers or loons occur with four (or 5) species which all breed in the true Arctic. Red-throated, black-throated and white-billed divers have wide circumpolar or holarctic distributions, while great northern diver is largely a North American species.Divers utilize the marine environment during post-breeding andmigration, e.g. staging in coastal polynyas before the lakes in the inland becomes free of ice.

Shorebirds or waders are generally smaller and more slender birds with long legs and beaks which allow them to wade and feed along shorelines. A total of about 70 species occur within the Arctic area, with almost 40 of them breeding in the true Arctic. There are two families of birds that comprise the majority of shorebirds. The *plover* family includes the Eurasian, Pacific and American golden plovers which are conspicuous species on Arctic tundra but with limited use of Arctic coastlines. The family of snipes, sandpipers and phalaropes is more diverse. *Shanks* and *snipes* are medium-sized birds that are found mainly in the boreal zone with breeding range extending north in the sub-arctic zone for several species.

Godwits and curlews are relatively large shorebirds. Whimbrel is a common curlew species with a circumpolar breeding distribution in the low arctic. Bar-tailed godwit breeds on tundra and wetlands across northern Eurasia. Eskimo curlew was once a numerous species breeding in northern Canada but this species may now be extinct.

Sandpipers are a subfamily of mostly small shorebirds where the majority breeds in the true Arctic. Red knot and dunlin are diverse species (many subspecies recognized) with circumpolar breeding distributions. Purple and rock sandpipers occur in the Atlantic and Pacific sectors, respectively, and are species with strong association with Arctic coasts. Spoon-billed sandpiper is a species with restricted breeding range along the coasts of the Chukchi Peninsula. This is probably the most threatened bird species in the Arctic, now believed to exist with fewer than 1,000 individuals and declining. Phalaropes

are small swimming birds which mainly breeds at freshwater habitats, but outside the breeding season they are strictly associated to the marine environment usually far off-shore. Red and red-necked phalaropes are abundant species with Arctic circumpolar breeding distributions.

Arctic breeding birds

The great majority of birds in the Arctic stays there only during the summer season and migrates south to spend the winter at lower latitudes or even at the southern hemisphere. Many of the birds, such as geese and shorebirds, use the Arctic primarily as a breeding ground and are more appropriately considered to be Arctic breeding birds. Among the group of seabirds, however, there are several species that are true Arctic birds although most of them move south to spend the winter in the sub-arctic zone or beyond in the adjacent boreal zone. This is the case for many auks (e.g. common and thick-billed murres, black guillemot, little auk, least auklet) and some gulls such as glaucous, ivory and Ross's gulls. However, the low arctic shelf waters off West Greenland are very important winter habitats for thousands of seabirds: auks, gulls, cormorants and seaducks.

There are two broad patterns or strategies for reproduction used by the arctic or arctic breeding birds. Some species breed on cliffs or remote islands or islets that are free from and/or inaccessible for terrestrial predators such as arctic fox. Many auks, notably common and thick-billed murres and little auk, kittiwakes and northern fulmar breed typically in large colonies on cliffs. Murres and northern fulmar lay single eggs on narrow cliff ledges where they are incubated in shifts by both parents. Other species that breed in colonies place their eggs in crevices, cracks or among rocks in scree slopes and boulder fields (e.g. many auklets), or in excavated burrows in the turf on talus slopes (e.g. puffins). Large colonies of seabirds depend on the coincidence of two factors: availability of suitable breeding habitats and access to a sufficient food supply that allows the parents to feed and raise their chicks. The feeding range out from the colonies may be from 10 to 200 km or more dependent on the species. Zooplankton (copepods, krill, amphipods) is the main food for several species of auks such as little auk, and auklets, while small fish (e.g. herring, capelin, polar cod, sand lance/sandeels), or a combination of small fish and zooplankton, comprise the diet for many seabirds such as common and thick-billed murres, kittiwakes, terns, and some gulls. Large gulls, such as glaucous, are partly top-predatory and take eggs and chicks of seabirds and other birds, as well as adults of small species that they are able to catch.

The other breeding pattern is to use the vast space of arctic tundra and wetlands as the breeding ground and to spread out in a highly dispersed manner which makes it more difficult for predators to locate many of the nests. This is a pattern used by most of the shorebird species, divers, and many ducks and geese. Even among the seaducks, most of the species breed dispersed inland and away from the coasts. This is the case for king, spectacled and Steller's eiders, long-tailed duck, and the species of scoters and mergansers. Common eider is the exception and breeds in colonies on coastal habitats on inaccessible islands or islets. Seaducks, and many species of shorebirds, other ducks, geese and divers move to coastal habitats after breeding where they feed and prepare for the autumn migration. Eiders and other seaducks molt their flight feathers and are flightless for a period of about 3 weeks. During this period

they usually aggregate in specific molt areas where they have access to food and are relatively safe from predators. Geese also have a flightless period during molt when they aggregate near water. Brent, barnacle and emperor geese are species that molt and spend the non-breeding season in the marine coastal zone. Many species of auks have a similar molt period after breeding when they occur flightless at sea.

The broad patterns of feeding ecology are that shorebirds generally feed on insects at their breeding grounds while they change to feed more on various invertebrates in coastal habitats during the post-breeding period. Seaducks (except mergansers which are fish-eaters) feed on insects and aquatic invertebrates at the inland breeding areas and feed on bivalves, crustaceans and other invertebrates in the coastal and marine habitats after breeding. Geese are largely plant-eaters and feed variously on terrestrial and aquatic vegetation. Divers eat mainly fish both in freshwater and marine habitats.

The life history characteristics vary across the different types and species of arctic or arctic breeding birds. The number of eggs produced is a good reflection of the mortality experienced by the different types. Most species of auks and some other seabirds such as northern fulmar lay only one egg. They are long-lived species and typically reproduce over many years. Gulls and terns usually lay 2-3 eggs, while most shorebirds lay 4 eggs. Geese lay around 5 eggs which is also the typical clutch size for eiders. Many ducks lay around 10 eggs, with the largest clutch sizes found among the dabbling and diving ducks. This pattern reflect the high predation on ducks and geese; on eggs and chicks by a range of terrestrial (e.g. Arctic fox) and bird predators (notably large gulls), and also on adults, particularly for ducks, by birds of prey.

A special adaptation among arctic breeding birds is a shortening of the incubation period and the time from hatching to fledging by the chicks. The incubation period may be as short as 3 weeks (22-24 days for king eider) and the time from hatching to fledging may be shorter than 3 weeks for some of the small sandpipers. The shortening of the breeding period to 2 months or less allows these species to breed during the short arctic summer and be ready to fly out in time before the onset of harsh conditions in fall. Many of the migratory birds also arrive early in the season to be able to start breeding as soon as the local conditions allow access to the breeding grounds and feeding areas.

Migrations and flyways

Each spring large numbers of birds arrive on the arctic breeding grounds and leave with a new generation of chicks at the end of the season. Many of these migrations are long. Arctic tern migrates to spend the winter in the Antarctic. Many species of shorebirds have similar long migrations to wintering areas in the southern hemisphere as far south as to the pampas of Argentina and Tierra del Fuego for some species. Skuas and phalaropes migrate south to upwelling regions off South America and Africa. Geese, ducks and gulls typically have shorter migrations to warmer latitudes on the northern hemisphere. Auks tend to be the most Arctic and northern of the birds, and several species migrate south to winter in the sub-arctic zone, as do also some of the sea ducks such as eiders.

There are some broad patterns in the geography of the migrations along what has been termed flyways. Birds from the Barents Sea region migrate south to winter in western Europe and western Africa. However, millions of auks and some gulls from Svalbard move across the North Atlantic to the waters off SW Greenland and Newfoundland. Birds from western and central Siberia migrate south to winter in eastern Africa, the Middle East and South Asia. Birds from eastern Siberia migrate south on the pacific side to wintering areas in East and Southeast Asia and Australasia. Birds from Alaska tend to migrate south along the Pacific coast to winter in the western Americas. Birds from northwestern and central Arctic Canada and also partly from northern Alaska migrate south via inland routes east of the Rocky Mountains to wintering areas from the southern USA to South America. Birds from eastern Canada and western Greenland migrate south on the Atlantic side to the Caribbean area and eastern and southern South America.

The migrations are energetically costly. The fuel consumption of brent geese is about 1 g of fat per 10 km and they burn about 0.5 kg fat (about 1/3 of the body weight) to fly 5,000 km from Alaska to California. Smaller shorebirds are highly adapted physiologically to long migrations and they put on a fat reserve of 50% or more of the body weight for the flight. Bar-tailed godwits have been logged to fly non-stop more than 10,000 km over the ocean between northern breeding grounds and wintering areas in the southern hemisphere . The long-range migratory birds depend very much on favorable feeding and staging areas to put on the necessary 'fuel' for the flight and also for reproduction when they return north in spring. Many of these staging areas are in the temperate zone south of the Arctic, such as Copper River Delta in southern Alaska, Delaware Bay in eastern USA, Bay of Fundy in maritime Canada, the Wadden Sea in western Europe, and the Yellow Sea area in China. Important staging areas within the Arctic include lagoons on the north side of the Alaska Peninsula and the Yukon-Kuskokwim Delta in the eastern Bering Sea, the Anadyr Gulf region in the northwestern Bering Sea, western Hudson Bay and James Bay in Canada, estuaries and intertidal areas in Iceland, and coastal wetlands, in particular river deltas and estuaries and coastal shallows, along the Siberian coast and the Pechora and White Sea region in Russia.

Species diversity and conservation status

The migrations and migratory behavior have driven a diversification of species related to the site fidelity of the birds. This is expressed as a high degree of use of the same breeding, staging and wintering grounds along specific migratory routes by individual birds. The routes are learned by young birds that follow their parents during the flights, or are evidently 'learned' evolutionary in the genes of birds where the juveniles are left behind by the parents to find their own way south from the breeding grounds. A result of this site fidelity and use of fixed migratory routes is the differentiation into different forms or subspecies, usually with distinct morphological and genetic characteristics. For species with wide circumpolar (or amphi-boreal) distributions, a common pattern is that they are represented with different subspecies in North America and in Eurasia, or in the Atlantic and Pacific sectors. Several species occur with more than 2 subspecies recognized. Thus common eider has about 6 subspecies, dunlin (a small shorebird species) is recognized with 8-10 subspecies, while cackling goose occurs with 4 species (after it's 'divorce' from Canada goose with has 7 subspecies).

The subspecies level is important from a conservation and management point of view since they are distinct units with geographical connection through the site fidelity associated with migrations. At the species level, 14 of the about 200 species of seabirds, waterfowl and shorebirds that occur in the Arctic area, are listed as 'Threatened' by IUCN, with another 8 species listed as 'Near threatened'. Two of the species are listed as 'Critically Endangered': Kittlitz's murrelet and spoon-billed sandpiper, both of them occurring in the Bering Sea region. In addition, Eskimo curlew is listed as 'Critically Endangered/Possibly Extinct'. Three of the species are listed as 'Endangered': marbled murrelet and black-footed albatross, which both are North Pacific species, and red-breasted goose. Among the 9 species that are listed as 'Vulnerable' (which is the least serious category of Threatened) are Steller's eider, red-legged kittiwake and bristle-thighed curlew.

At the subspecies level, some are red-listed nationally although the species are not listed as 'Threatened' by IUCN. This is the case for subspecies rufa of red knot which is listed as 'Endangered' in Canada. Rock sandpiper occurs with 4 or 5 subspecies with restricted range in the Bering Sea area. Subspecies ptilocnemis which breeds on the Pribilof Islands is listed as being of 'high conservation concern' in the US, while subspecies kurilensis (provisional) which breeds on the tip of Kamchatka, is included in the Red data book of Russia.

Appendix 2: IMO criteria for identification of a Particularly Sensitive Sea Area (PSSA)

Ecological Criteria

4.4.1 Uniqueness or rarity – An area or ecosystem is unique if it is "the only one of its kind". Habitats of rare, threatened, or endangered species that occur only in one area are an example. An area or ecosystem is rare if it only occurs in a few locations or has been seriously depleted across its range. An ecosystem may extend beyond country borders, assuming regional or international significance. Nurseries or certain feeding, breeding, or spawning areas may also be rare or unique.

4.4.2 Critical habitat – A sea area that may be essential for the survival, function, or recovery of fish stocks or rare or endangered marine species, or for the support of large marine ecosystems.

4.4.3 Dependency – An area where ecological processes are highly dependent on biotically structured systems (e.g. coral reefs, kelp forests, mangrove forests, seagrass beds). Such ecosystems often have high diversity, which is dependent on the structuring organisms. Dependency also embraces the migratory routes of fish, reptiles, birds, mammals, and invertebrates.

4.4.4 Representativeness – An area that is an outstanding and illustrative example of specific biodiversity, ecosystems, ecological or physiographic processes, or community or habitat types or other natural characteristics.

4.4.5 Diversity – An area that may have an exceptional variety of species or genetic diversity or includes highly varied ecosystems, habitats, and communities.

4.4.6 Productivity – An area that has a particularly high rate of natural biological production. Such productivity is the net result of biological and physical processes which result in an increase in biomass in areas such as oceanic fronts, upwelling areas and some gyres.

4.4.7 Spawning or breeding grounds – An area that may be a critical spawning or breeding ground or nursery area for marine species which may spend the rest of their life-cycle elsewhere, or is recognized as migratory routes for fish, reptiles, birds, mammals, or invertebrates.

4.4.8 Naturalness – An area that has experienced a relative lack of human-induced disturbance or degradation.

4.4.9 Integrity – An area that is a biologically functional unit, an effective, self-sustaining ecological entity.

4.4.10 Fragility **–** An area that is highly susceptible to degradation by natural events or by the activities of people. Biotic communities associated with coastal habitats may have a low tolerance to changes in environmental conditions, or they may exist close to the limits of their tolerance (e.g., water temperature, salinity, turbidity or depth). Such communities may suffer natural stresses such as storms or other natural conditions (e.g., circulation patterns) that concentrate harmful substances in water or sediments, low flushing rates, and/or oxygen depletion. Additional stress may be caused by human influences such as pollution and changes in salinity. Thus, an area already subject to stress from natural and/or human factors may be in need of special protection from further stress, including that arising from international shipping activities.

4.4.11 Bio-geographic importance – An area that either contains rare biogeographic qualities or is representative of a biogeographic "type" or types, or contains unique or unusual biological, chemical, physical, or geological features.

Social, cultural and economic criteria

4.4.12 Social or economic dependency – An area where the environmental quality and the use of living marine resources are of particular social or economic importance, including fishing, recreation, tourism, and the livelihoods of people who depend on access to the area.

4.4.13 Human dependency – An area that is of particular importance for the support of traditional subsistence or food production activities or for the protection of the cultural resources of the local human populations.

4.4.14 Cultural heritage – An area that is of particular importance because of the presence of significant historical and archaeological sites.

Scientific and educational criteria

4.4.15 Research – An area that has high scientific interest.

4.4.16 Baseline for monitoring studies – An area that provides suitable baseline conditions with regard to biota or environmental characteristics, because it has not had substantial perturbations or has been in such a state for a long period of time such that it is considered to be in a natural or near-natural condition.

4.4.17 Education – An area that offers an exceptional opportunity to demonstrate particular natural phenomena.

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