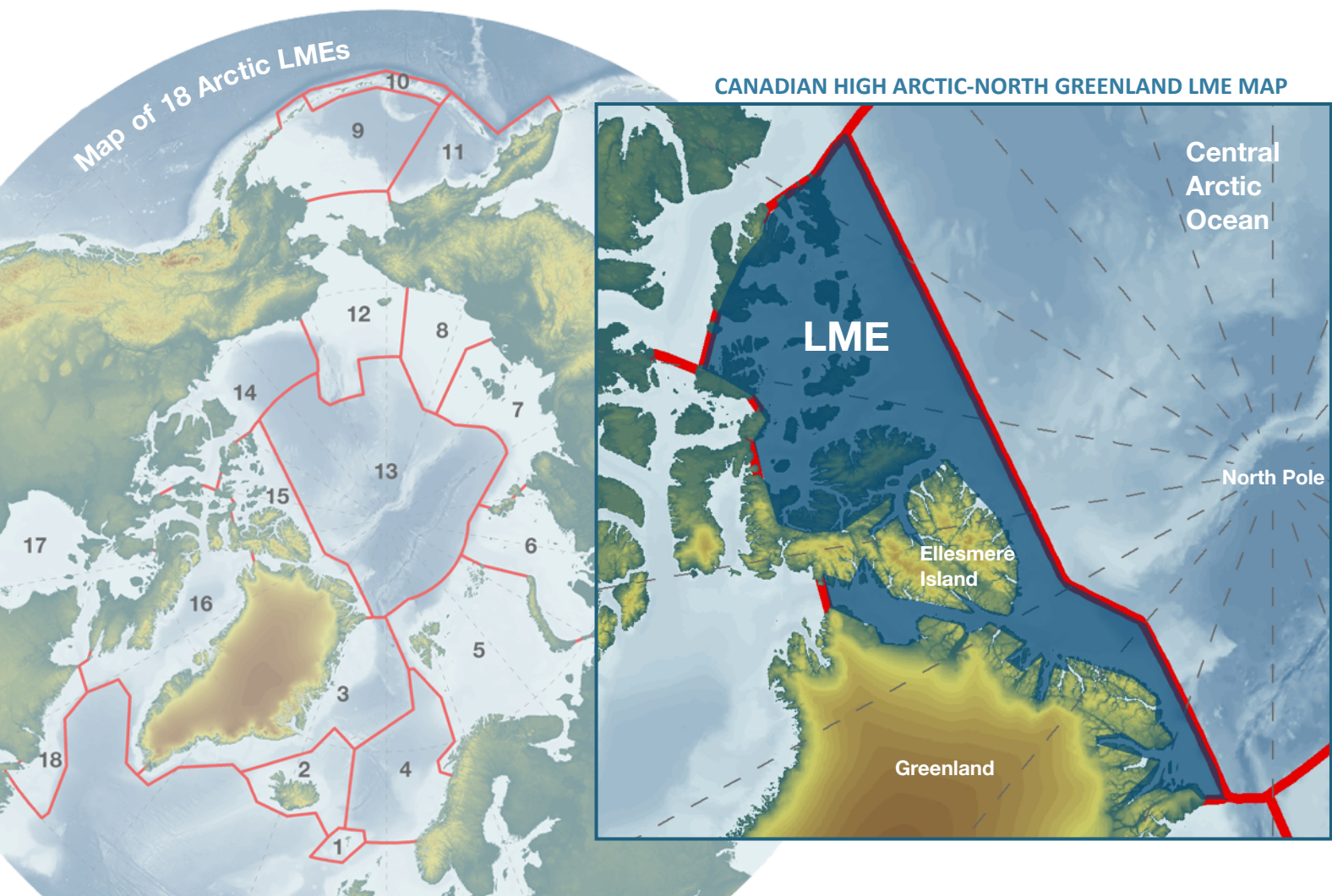


# CANADIAN HIGH ARCTIC-NORTH GREENLAND LME



# ARCTIC LMEs

Large Marine Ecosystems (LMEs) are defined as regions of ocean space of 200,000 km<sup>2</sup> or greater, that encompass coastal areas from river basins and estuaries to the outer margins of a continental shelf or the seaward extent of a predominant coastal current. LMEs are defined by ecological criteria, including bathymetry, hydrography, productivity, and tropically linked populations. PAME developed a map delineating 17 Arctic Large Marine Ecosystems (Arctic LME's) in the marine waters of the Arctic and adjacent seas in 2006. In a consultative process including agencies of Arctic Council member states and other Arctic Council working groups, the [Arctic LME map was revised in 2012](#) to include 18 Arctic LMEs. This is the current map of Arctic LMEs used in the

work of the Arctic Council in developing and promoting the Ecosystem Approach to management of the Arctic marine environment.

## Joint EA Expert group

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

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

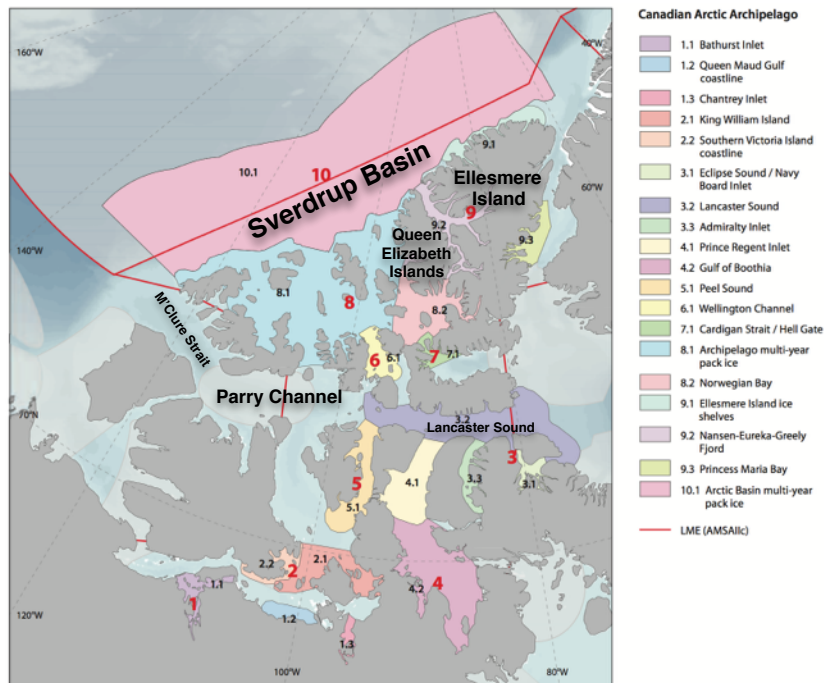
## OVERVIEW: CANADIAN HIGH ARCTIC-NORTH GREENLAND LME

The Canadian High Arctic-North Greenland LME (CAA) consists of the northernmost and high arctic part of Canada along with the adjacent part of North Greenland. The CAA is not a very clearly defined and coherent ecosystem but consists rather of three more or less separate parts, corresponding to three of Canada's Marine Biogeographic Regions: Western Arctic, Eastern Arctic, and Arctic Archipelago. The CAA was established as a new LME in the revised 2013 LME Report when the boundaries to the Canadian Arctic Archipelago changed to reflect Canada's Marine Biogeographic Regions.

The CAA is a large shelf region with more than 30.000 islands and passages as straits, sounds and channels between them. The sea area of the archipelago is about 1 million km<sup>2</sup>, with the land area constituting about the same.

This area is strongly influenced by heavy multi-year pack ice that is transported into the 'Sverdrup Basin' from the Arctic Ocean through the openings between the northern Queen Elisabeth Islands (east of Ellesmere Island). The main east-west connection through the archipelago is Parry Channel, a series of straits and sounds from M'Clure Strait in the west through Viscount Melville Sound and Barrow Strait to Lancaster Sound in the east.

Ice conditions vary considerably within the LME and on inter- and intra-annual time scales, with the heaviest ice conditions, featuring the predominance of multi-year ice, most prominent in more northern areas such as the Sverdrup Basin. Formidable concentrations of deformed ice with significant multi-year ice content are also common in more central and southern passages such as Viscount Melville Sound, M'Clure Strait, and M'Clintock Channel. Summer clearing usually occurs in the south-western and eastern portions of the archipelago.



Map: Canadian Arctic Archipelago LME, before the revised The Canadian High Arctic-North Greenland LME (CAA) was established in 2013. Source: AMSALIC Report

The average ice thickness in the Sverdrup Basin area has been found to be 3.4 m in late winter, reflecting a high proportion of multiyear ice (80-90 % in the northern portion). The outer coast of the archipelago faces the heaviest ice conditions of the whole Arctic Ocean with an average draft of 4-7 m. Modes of thick ice (6-9 m) exist in the Sverdrup Basin with ice thickness in pressure keels of up to 25 m or more (maximum observed keel draft 37 m).

The CAA LME is a transit zone for nutrient-rich Pacific waters. The Pacific water from the Arctic Ocean is richer in all nutrients compared to Atlantic water but is enriched especially in silicate and to some extent also phosphate. It has therefore a potential to support higher production (both new and regenerated) and in particular of diatoms due to its higher nutrient content.



## MARINE MAMMALS

Eight species of marine mammals occur regularly as year-round inhabitants of, or summer visitors to, the CAA. The Lancaster Sound area with adjacent inlets constitutes the major summer grounds for large migratory stocks of bowhead or Greenland whale, beluga whale, and narwhal. Ringed seal and bearded seal are year-round residents distributed widely over the archipelago. Atlantic walrus of the Baffin Bay (High Arctic) stock winter in northern Baffin Bay and migrate to summer feeding areas in Lancaster Sound, Barrow Strait, Jones Sound and adjacent passages to the Sverdrup Basin to the North. Some walrus may also spend the winter in polynyas north of Barrow Strait and Jones Sound. Harp seal of the large Northwest Atlantic stock migrate north in Baffin Bay and into Lancaster Sound as part of the summer feeding areas. Polar bear occurs over the whole archipelago with bears from 5 recognized subpopulations in specific geographic areas (Norwegian Bay, Lancaster Sound, M'Clintock Channel, Gulf of Boothia, and Kane Basin subpopulations). Additional to the 8 species mentioned above, killer whale may be a more or less regular visitor to the Lancaster Sound region in the summer period. Hooded seal can also occasionally occur in Lancaster Sound during the late summer season.

**Bowhead whale** (or Greenland whale) is a large, slow-moving arctic baleen whale that is well adapted for living in ice-covered waters. All stocks of this species were severely reduced in numbers by intensive commercial whaling during the 1800s and early 1900s. There are virtually no specific studies of the feeding of bowheads in the CAA, but it is assumed that calanoid copepods are the main prey sought by the bowheads. The Eastern Canada-West Greenland bowhead stock was until quite recently considered to number in the low hundreds for each of the two stock components in Baffin Bay and Hudson Bay. However, the situation has turned out to be much more positive for this bowhead stock. Large-scale aerial surveys in the eastern Arctic Canada in 2002-2004 resulted in best estimates ranging from 5,000 to 14,000 individuals. The Scientific Committee of the IWC considered several variants of methods and reanalysis of the survey data and arrived at an estimate of 6,340 animals to be used as the basis for IWC management advice.

**Beluga whale** has a northern circumpolar distribution, ranging south into the subarctic. It exists with around 25 recognized stocks; most of them are small and with restricted distributions, but a few are large and migratory to summering areas in the High Arctic. Belugas from two large migratory stocks occur in the CAA. Belugas typically do not occur in the central CAA, probably because belugas (and some other marine mammals) cannot penetrate the extensive areas of permanent pack ice that occur year-round in many of the central arctic channels. Thus belugas are not found in the Sverdrup Basin region in north or in the M'Clintock Channel east of Victoria Island. Events characterized as 'feeding frenzies' have been observed where belugas fed on schools of polar cod accompanied by large numbers of northern fulmars and black-legged kittiwakes and also by other mammals such as narwhals, harp seals, and ringed seals.

**Narwhal** inhabits deep marine waters of the eastern CAA. Traditionally, it does not occur in the western Canadian Arctic. These narwhals belong to the Baffin Bay population and use areas of the CAA as their summering grounds. The total numbers of narwhals of the Baffin Bay population is estimated to be (probably) more than 70,000 animals.

**Killer whale** is known to occur in the Lancaster Sound region in the open water summer season. Killer whales may occur in waters with sea ice but apparently avoid areas with heavy ice. Groups of killer whales have been observed (or inferred) to attack and eat narwhals in Eclipse Sound and Admiralty Inlet. The groups of killer whales in these cases have consisted of 10-15 animals. Interviews with Inuit hunters and elders have provided additional information on cases of killer whales attacking and killing narwhals and also bowheads and belugas in the Lancaster Sound region. There are also reports of killer whales taking seals, principally ringed seals but also bearded and harp seals, including observations by Inuits of killer whales hunting seals on ice floes. Narwhals are known to seek shallow waters where they remain quiet in order not to be detected and attacked by killer whales. This behaviour is well-known among Inuits, who has a special name for it ('aarlirijuk', meaning 'fear of killer whales') and exploit such situations to harvest narwhals.





**Walrus** is widespread in the eastern Canadian Arctic, but largely absent in Canadian waters west of there. The Atlantic subspecies, the only population that occurs regularly in the Canadian Arctic, is widely distributed in the eastern part of the CAA LME, from approximately Barrow Strait, Bathurst Island, and Devon Island east to Baffin Bay. The walrus in the CAA have been considered to be of the North Water stock (or Baffin Bay (High Arctic) stock). Walrus feed mainly on benthic bivalves. They suck out the soft parts of the bivalves leaving the empty shells on the seafloor, and siphons and feet are commonly the only parts found in walrus stomachs. Although widely distributed in the eastern Arctic, walrus tend to be abundant only in a few areas that provide suitable habitat. They prefer shallow waters (usually <100 m), where they can most easily reach their preferred benthic food sources, and where they have access to ice pans on which to haul out. If sea ice is unavailable during summer, walrus use traditional terrestrial haul-out sites. They are gregarious, foraging and migrating in herds and hauling out in densely-packed groups on the ice or shore.

**Bearded seal** has a northern circumpolar distribution, and are distributed throughout the CAA in relatively low densities, primarily in coastal areas. During winter, bearded seals are primarily restricted to areas of moving, broken pack ice. Because they have only a limited capability to maintain breathing holes in ice, most bearded seals are excluded from areas of fast ice during winter (e.g., many of the channels in the Arctic Archipelago). Bearded seals, therefore, undertake seasonal migrations in response to the advance and retreat of fast ice. The pupping and breeding period of bearded seals is in April and May. The bearded seal is a benthic feeder

that is most abundant in areas where it can reach the bottom to feed, usually in waters <200 m deep. Its preferred habitat is areas with thin, broken or rotten ice, or the floe edge, and it also prefers less stable ice during break-up and tends to avoid areas heavily used by walrus. Shrimps, crabs, whelks, and bivalves are often common benthic food but bearded seals also take various demersal and pelagic fish such as polar cod, sculpins, eelpouts and pricklebacks. There are no good estimates of the number of bearded seals in the CAA. It has been suggested that a minimum of 190 thousand animals inhabited the Canadian Arctic waters. The majority of these would occur in the Hudson Bay Complex, with a smaller fraction inhabiting the CAA.

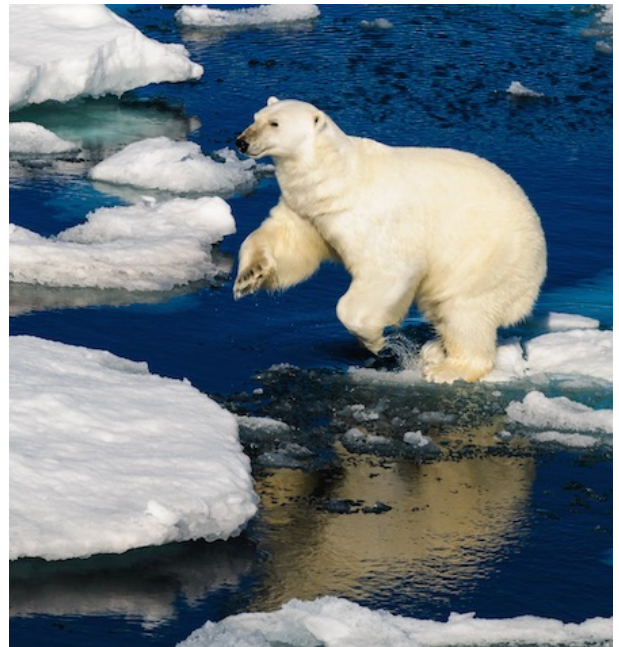
**Ringed seal** has a continuous northern circumpolar distribution with the Arctic ringed seal subspecies (*hispidus*; two more marine subspecies occur in the Baltic Sea (*botnica*) and Sea of Okhotsk (*ochotensis*), while two subspecies occur in freshwater lakes in Russia (*ladogensis*) and Finland (*saimensis*). In Canada, their distribution is centered in the Arctic Archipelago, but they range from Newfoundland to the Beaufort Sea. Ringed seals are the most abundant marine mammals in the Canadian Arctic, but accurate population estimates are difficult to obtain. Their preferred breeding habitat is land-fast seasonal ice which they occupy as ice starts to form in autumn. Ringed seals apparently establish and defend territories leading to exclusion of subadults which are found mainly in unstable ice and leads in the shear zone outside the fast ice. The quality of the breeding habitat depends on sufficient snow cover to construct birth lairs, and ice with some deformation with ridges and cracks that favour snow-drifts are prime habitat sought by female ringed seals.

**Harp seal** occurs with three distinct populations or stocks: Northwest Atlantic, Greenland Sea/West Ice, and Barents Sea/East Ice. Studies of genetics, morphology and vocalizations have shown significant differences between the Northwest Atlantic and the two stocks in the Northeast Atlantic. Polar cod appears to be the main prey sought by harp seals in the Lancaster Sound and Jones Sound regions. Harp seals have been observed to move into coastal waters in bays and inlets to feed intensively on schools of polar cod, often together with beluga, narwhal and seabirds in what has been described as ‘feeding frenzies’. The total Northwest Atlantic stock of harp seals that was estimated to be around 1.8 million individuals in the 1970s, increasing to about 5-6 million in the 1990s and 2000s.

**Hooded seal** is a North Atlantic species with two recognized populations, one in the northwestern Atlantic and the other in the Greenland Sea. Seals of the Northwest Atlantic population may occur in low numbers in the eastern part of the CAA. Hooded seal is a deep diver and its food includes deepwater fish like Greenland halibut.

**Polar bear** is distributed throughout the circumpolar Arctic in a total of 19 relatively discrete subpopulations. Fourteen of the subpopulations are found fully or shared in Canada, nine of them in the CAA. The local distribution and abundance of polar bears vary through the year, and are strongly influenced by those of their principal prey, the ringed seal, and by the presence or absence, distribution, and quality of sea ice. During winter and spring, most polar bears are found on the sea ice, where they tend to concentrate along pressure ice that parallels the coasts and in the vicinity of floe edges. In those areas of thinner ice, they are able to hunt seals most effectively. In summer, when the pack ice retreats offshore, polar bears are found along the edge of the pack ice. During years with little or no pack ice near the coast, polar bears are often found along the coastline and on barrier islands.

The populations of polar bears within the CAA range in numbers by about an order of magnitude, from about 200 individuals or less for the Norwegian Bay and Kane Basin subpopulations to about 2,500 individuals for the Lancaster Sound subpopulation. Roughly 20-25% of the global population of polar bears occur in subpopulations in the CAA, about half of them in the Lancaster Sound area. The Gulf of Boothia is the second largest polar bear subpopulation in the CAA, the subpopulation was recently estimated to be about 1,600 bears.



## SHOREBIRDS

There are 19 (or 20 species) of shorebirds that regularly breed within the Canadian Arctic Archipelago area. These are 4 species of plovers (American golden, grey, common ringed, and semipalmated), 11 sandpipers of subfamily Calidrinae (red knot, sanderling, semipalmated, least, white-rumped, Baird’s, pectoral, purple, dunlin, stilt, buff-breasted), 2 phalaropes (red and red-necked), ruddy turnstone, and spotted sandpiper. In addition is Eskimo curlew that used to breed adjacent to the southwestern most part of the area but which is now possibly extinct.

About half of the species (10) have wide circumpolar or near circumpolar distributions. Many of the shorebirds that breed in the northeastern part of the CAA (Ellesmere and adjacent parts of the Queen Elisabeth Islands) belong to migratory populations that fly east to winter in western Europe or Africa. The rest of the species (or subspecies) migrate south to winter in the Americas. Some are long-range migrants to wintering areas in southern South America, others winter mainly at lower latitudes or have wide latitudinal distribution along coasts. Many of the long-range migrants show an elliptical pattern, migrating south over the western Atlantic to South America while returning north via the Caribbean and interior across North America.





The CAA LME supports a large fraction of the total circumpolar seabird population during the summer breeding season. Small areas of recurring open water (polynyas) in this LME also support large numbers of pre-breeding seabirds during late winter and early spring. In winter, much of this LME is ice-covered, and few birds over-winter, with the possible exception of the black guillemot at some polynyas.

The most abundant seabird species nesting in this region are thick-billed murre (~600,000 pairs), northern fulmar (~250,000 pairs), black-legged kittiwake (~200,000 pairs), common eider (~150,000 pairs), and black guillemot (>100,000 pairs). Population size in this LME for some other species, e.g., long-tailed duck are unknown, but are considered very large (~104–106). Other less abundant nesting species, but of global importance, include the Iceland gull (>50,000 pairs), glaucous gull (~15,000 pairs), Thayer's gull (<5000 pairs), Sabine's gull, arctic tern and several species of shorebirds (ruddy turnstone, red knot, and purple sandpiper) and geese (brant, lesser snow goose, and greater snow goose).

As with several of the other circumpolar LMEs, the majority of seabird species within the CAA are colonial breeders, often nesting in large colonies on steep cliffs along coasts, and sometimes in mixed-species assemblages, e.g. thick-billed murres, black-

legged kittiwakes, and northern fulmars nesting together. Their reproductive success is often linked to sea ice conditions near the colony in spring and early summer, which in large part govern access to open-water feeding areas. The major colonies are located in the Lancaster Sound area (Prince Leopold Island, Bylot Island, and southern Devon Island) and at the mouth of Jones Sound (Coburg Island).

Polynyas, or areas of recurring open water during winter and often with high productivity, are especially important feeding and resting areas for early spring migrant seabirds before they disperse to breeding habitats. Almost all major seabird colonies in Arctic Canada are located near recurring polynyas.

Marine birds breeding in the CAA LME migrate northward in spring primarily through the Baffin Bay-Davis Strait LME. In contrast, many sea ducks and some marine-associated waterfowl (e.g., black brant) migrate eastward through the Beaufort Sea LME via Russia and Alaska. Timing and routes of migration vary by species. A few migrations are notable—all individuals of a discrete population of the light-bellied brant goose (~20,000) migrate from wintering grounds in Ireland via Iceland, over the Greenland ice cap, to reach their high arctic breeding grounds in the CAA LME.

Similarly, some shorebirds of the families Charadriidae and Scolopacidae reach their high arctic breeding grounds in this LME via migrations through Iceland and Greenland and through eastern North America and the Baffin Bay-Davis Strait LME. The Arctic tern, an archetypical long-distance migrant, travels over 10,000 km during its one-way migration from Antarctic wintering grounds to High Arctic nesting grounds in this LME.





## WATERFOWL

The CAA is home to a large number of waterfowl, particularly in the southern part and on the mainland south of the archipelago. Fifteen species are common or regular breeders in the archipelago or on the mainland adjacent to the CAA LME. These are 6 species of geese (brent, cackling, Canada, snow, Ross's and greater white-fronted), one swan (tundra), four sea ducks (common eider, king eider, long-tailed duck and red-breasted merganser), one dabbling duck (northern pintail), and three species of divers (red-throated, black-throated and white-billed) (Table Waterfowl Canadian LMEs).

Of these the most widespread and high-Arctic are brent goose, snow goose, king eider, long-tailed duck, and red-throated diver. Other species such as tundra swan, greater white-fronted goose, Richardson's cackling goose, and black-throated diver are found in the southern half of the archipelago, on Victoria and other islands, as well as on the mainland side. Other species again, including Ross's goose, lesser Canada goose, red-breasted merganser and northern pintail, occur primarily on the mainland side but extend the breeding range onto the southernmost islands.

Common eider is the most marine of the waterfowl species, followed by brent goose among the geese, and red-throated diver among the divers. Most species of ducks and divers use leads and polynyas to feed and stage during spring migration and prior to breeding. Polynyas at the eastern entrances to Jones and Lancaster Sounds and in the western Lancaster Sound and adjacent areas in the central archipelago, as well as Lambert Channel polynya at the western entrance to Coronation Gulf, are important open water areas used by eiders, divers and other waterfowl in spring (refs.). Sea ducks and divers also use coastal marine waters for molting (sea ducks) and feeding by non-breeders in summer and post-breeders with their young later in summer and early autumn prior to fall migration. Snow and Ross's

geese breed to some extent in river deltas and on coastal islands and some cackling geese and tundra swans feed in coastal areas in shallow marine and brackish waters.

The tundra and wetlands on the mainland side, particularly south from Queen Maud Gulf where there is a large migratory bird sanctuary, are important breeding grounds for geese and ducks. This is also the case for tundra on Victoria, Banks and Bylot Islands.

All waterfowl species in the CAA are migratory except that some king and common eiders and long-tailed ducks may remain to winter in polynyas (1981 paper). Most of the geese species including snow, Ross's, greater white-fronted, Richardson's cackling, and lesser Canada geese migrate south to winter inland and on coasts in southern USA and northern Mexico. Most of the other species of waterfowl in the CAA migrate to winter along coasts on both sides of North America.

Generally, breeders from the western part of the CAA migrate west to the Pacific coast, while breeders from the eastern part migrate to the Atlantic coast. This is the case for common eider, king eider, long-tailed duck, red-breasted merganser, brent goose and red-throated diver. Common eider and brent goose occur with separate subspecies (Pacific eider *v-nigra* and northern eider *borealis*; light-bellied brent *hrota* and black brant *nigra*) that form distinct populations, while king eider is also recognized with western and eastern populations.

All tundra swans from the CAA (as well as from northern Alaska) migrate east to the Atlantic coast, while black-throated divers (Pacific loon, subspecies (or species) *pacifica*) and white-billed divers migrate west to the Pacific coast. The coast of southwestern Greenland is part of the wintering area for common and king eiders, while one population of light-bellied brent goose from the northeastern part of the CAA migrates east to winter in western Europe.







## FISH

Large schools of arctic cod occur in the CAA; they have a circumpolar distribution and are ubiquitous. Arctic cod are important prey for seabirds (e.g., Northern fulmars, black-legged kittiwakes) and marine mammals (e.g., ringed seals, beluga whales); and affect the distributions of these animals during the summer months.

The arctic char is circumpolar and is the most northerly distributed freshwater fish. Arctic char are either anadromous, migrating to the sea in spring and returning to freshwater in the fall, or resident, remaining permanently in fresh water. The arctic char has great subsistence, sport, and commercial value.

In the CAA, they spawn in September and October, usually over gravel areas in lakes, generally not more frequently than every other year. Eggs incubate over winter and hatch in the early spring, and young-of-the-year spend the first few years in fresh water. Arctic char occur in the CAA near any suitable freshwater habitat. When at sea, most char apparently remain within 30 or 40 km of their natal rivers, although long-distance movements (e.g., 400 km) have been documented.

Capelin has a circumpolar distribution, occurring more commonly west of Barrow, Alaska, and of Hudson Bay in cold deep waters. In the CAA, it has been recorded in Coronation Gulf and in Bathurst and Chantrey inlets and also occurs in Queen Maud Gulf and the Lancaster Sound region. Capelin is a major food item throughout its range for other fish, birds, and marine mammals.

Pacific herring are distributed throughout the North Pacific, in the Beaufort Sea, and in the CAA only in Coronation Gulf as far east as the Kent Peninsula. It has been recorded in Coronation Gulf, Bathurst Inlet, and Melville Sound.

The fourhorn sculpin is one of the most common marine species found in coastal waters. It is a demersal species that has a circumpolar nearshore distribution and is most abundant in shallow (15–20 m) water. This species migrates onshore into brackish coastal habitats during summer to feed, and may travel considerable distances up rivers. Sculpin have no commercial or subsistence use, but they serve as forage for fish and birds.

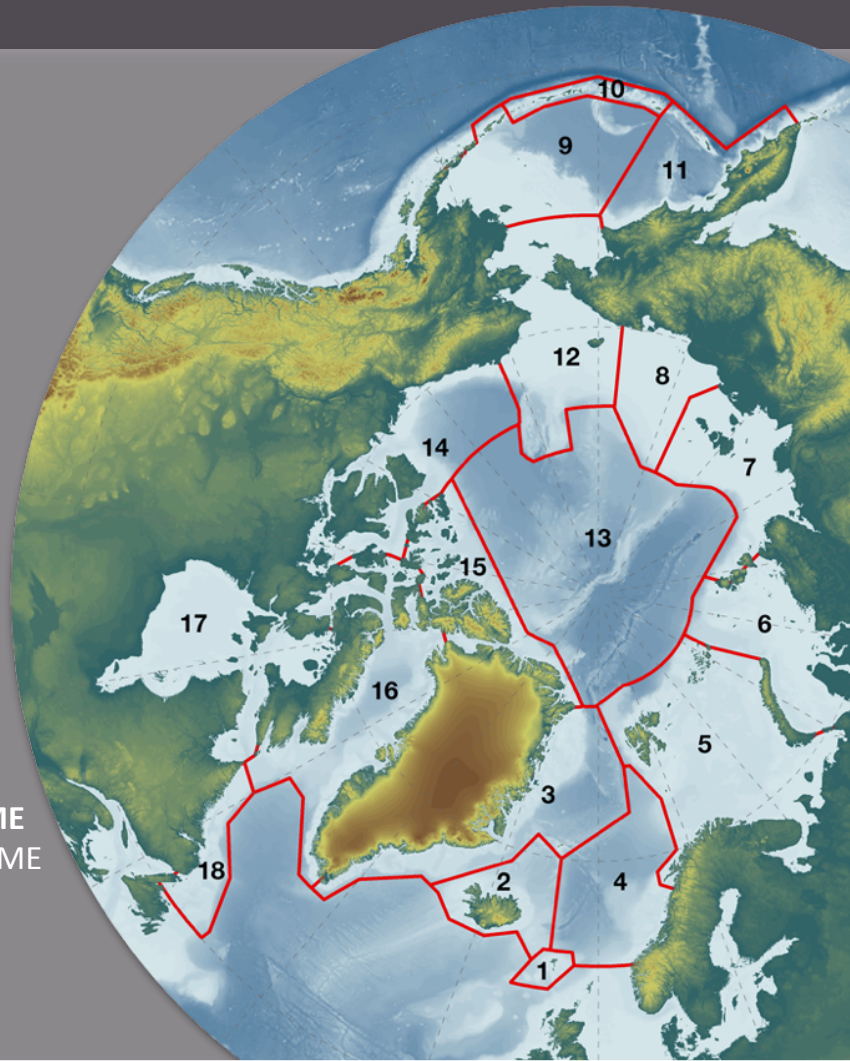
The distributions of a number of species that are common in the Beaufort Sea extend to varying degrees into the CAA. Other species that occur in the CAA include polar cod, three species of the snailfish, leatherfin lump sucker, smooth lumpfish and Atlantic spiny lump sucker, saddled eelpout, and polar eelpout, and Bering wolffish.





## ARCTIC LMEs

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



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