CANADA'S ARCTIC MARINE ATLAS

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CANADA'S ARCTIC MARINE ATLAS

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FOREWORD

Inuit Nunangat, the Inuit homeland in Canada, embraces Canada's Arctic waters and coastline. From Davis Strait in the east to the Mackenzie Delta in the west, these waters are abundant with marine life that has sustained Inuit for millennia. Inuit, as humans, are a key part of a healthy Arctic and share the sea-ice, polynyas, estuaries, and passageways of Canada's northern seas with marine mammals, fish, and birds.

Canada's Arctic Marine Atlas is a compendium of maps and introductory descriptions that thoughtfully depict what we know about the animals that inhabit Canada's northern waters as well as their habitats. While recognizing what is known, it is important to understand that Canada's Arctic is experiencing unprecedented ecological change. At the same time, the region is facing a new generation of geo-political and industrial interests that will have a direct impact on the future of Inuit Nunangat and its 53 communities.

This compendium is about Arctic biological marine life. Even though it does not explicitly depict Traditional Knowledge, it does acknowledge the hard-fought political history and empowerment of Inuit in Canada. The atlas also includes maps of Inuit place names and trails, illustrating that Inuit Nunangat is the place of our people and all they do and know. Together with scientists and others, we can combine our knowledge and our vision to achieve what none of us can do alone.

I strongly encourage all who have an interest in the future of the Arctic and its people to use Canada's Arctic Marine Atlas as one starting point toward sound stewardship of our national Arctic heritage. Together with the continued involvement of Inuit in shaping their future on their terms, the information compiled here is an essential contribution to a vibrant, Canadian Arctic.

Mary Simon
Honourary Chair, Oceans North

CONTENTS

INTRODUCTION

Reflecting on Canada's storied history, the northern half of the country deserves more than a passing thought. From the search for the Northwest Passage to the recognition of land claims, the Arctic has loomed large in the imagination, geography, economy, law, and policy of Canada. It will continue to do so into the future, as Canada fulfills its role as a leader in Arctic affairs and as the Arctic shapes Canada's destiny and self-understanding.

The Canadian Arctic is a homeland and frontier, frigid and friendly, a source of riches and priceless just as it is. A place of competing visions and understanding—intimately known to Inuit, eagerly explored by adventurers, carefully studied by scientists, and yet filled with the unknown and the rapidly changing. It is deserving of respect, awe, wonder, and attention. The Canadian North is the largest area inhabited by a single Indigenous people and home to more Bowhead Whales, Beluga Whales, Polar Bears, and Narwhal than any other place on the planet.

In this atlas of Canadian Arctic waters, we celebrate what is known about the area and its inhabitants and ecosystems. We also acknowledge how much more is to be learned, if Canada is to serve as an able steward of all that its Arctic has and stands for. Inuit have thrived in the Arctic because they understand the fine details of land and sea in all their innumerable variations from day to day, year to year, generation to generation. Canada, too, can thrive as an Arctic nation only if it is guided by knowledge and care, created by hard work and by thoughtful listening to the land and its people.

The atlas, data, and beyond

We cannot know a region at a glance. We cannot capture a region in a map. Instead, we look back and forth from detail to panorama, from the remarkable properties of the Narwhal tusk to the great sweep of human history. In this atlas, we present a series of views of the Canadian Arctic marine environment, from physical geography, to biology and ecology, and on to human patterns and administration. The intent is to provide an introduction to what makes the region special, why it matters, and why it is worth the effort to govern it responsibly. This is especially true in a time of rapid climate and environmental change (see "The Changing Arctic" on page 6).

In each theme covered by the atlas, we provide several examples of key species, phenomena, or activities that help show the growth of our understanding of an ecosystem, as well as why that knowledge is important. While it is tempting to wait for better information, decisions will continue to be made based on what we know at the time. A dose of caution can help reduce the risk of mistakes, but neither the risk of unintended impact nor the risk of missed opportunity can be eliminated entirely.

If we are to act on the basis of the best available information, it is essential that existing information is in fact available. In compiling the data and creating the maps in this atlas, we have made use of extensive data in public archives and databases, for which we are very grateful. We have also had access to some data that are not, or not yet, publicly available, for which we are also grateful. Finally, we are aware of additional data that is not yet accessible, for a variety of reasons, and we encourage the holders of those data to make use of public archives as soon as possible. While the right to publish is important in research, good governance is a greater aim in the long run, and can be achieved only with access to all existing information.

Combining data from different sources and across different intellectual and ecosystem domains is essential to building a complete picture of the Canadian Arctic. It is, however, challenging to match data collected at different scales and times and for different purposes. Understanding an ecosystem requires thinking of it as a system, a set of interacting pieces that influence one another in different ways over time and space. Overlaying data on water currents, sea ice, plankton, fish, seabirds, and marine mammals can produce thought-provoking results, but does not by itself tell us why some areas stand out for abundance and richness.

A further step, beyond the scope of this atlas, is to conduct syntheses that aim to connect not just data but understanding of how an ecosystem works, how it will respond to change, and how human actions will affect it. The well-being of the Canadian Arctic and its people depends not on simply understanding the region one part at a time or one decision at a time, but on creating a shared vision for the region and developing together the knowledge needed to achieve that vision. Doing so is a social process rather than a scientific one, although science and Inuit knowledge can contribute. Simply put, if we do not know where we want to go, we will never get there. But if we know what we want, we will know what we need to learn in order to realize our goals.

We present this atlas in recognition of all those who have contributed to the understanding the atlas reflects, and in the hope of a future of abundance and well-being in the Canadian Arctic and beyond.

Photo facing page: Subsistence hunters at the polyna edge. (photo: Jennifer Provencher)

Canada's Arctic Marine Atlas by Topic

HUMANS AND THE ENVIRONMENT

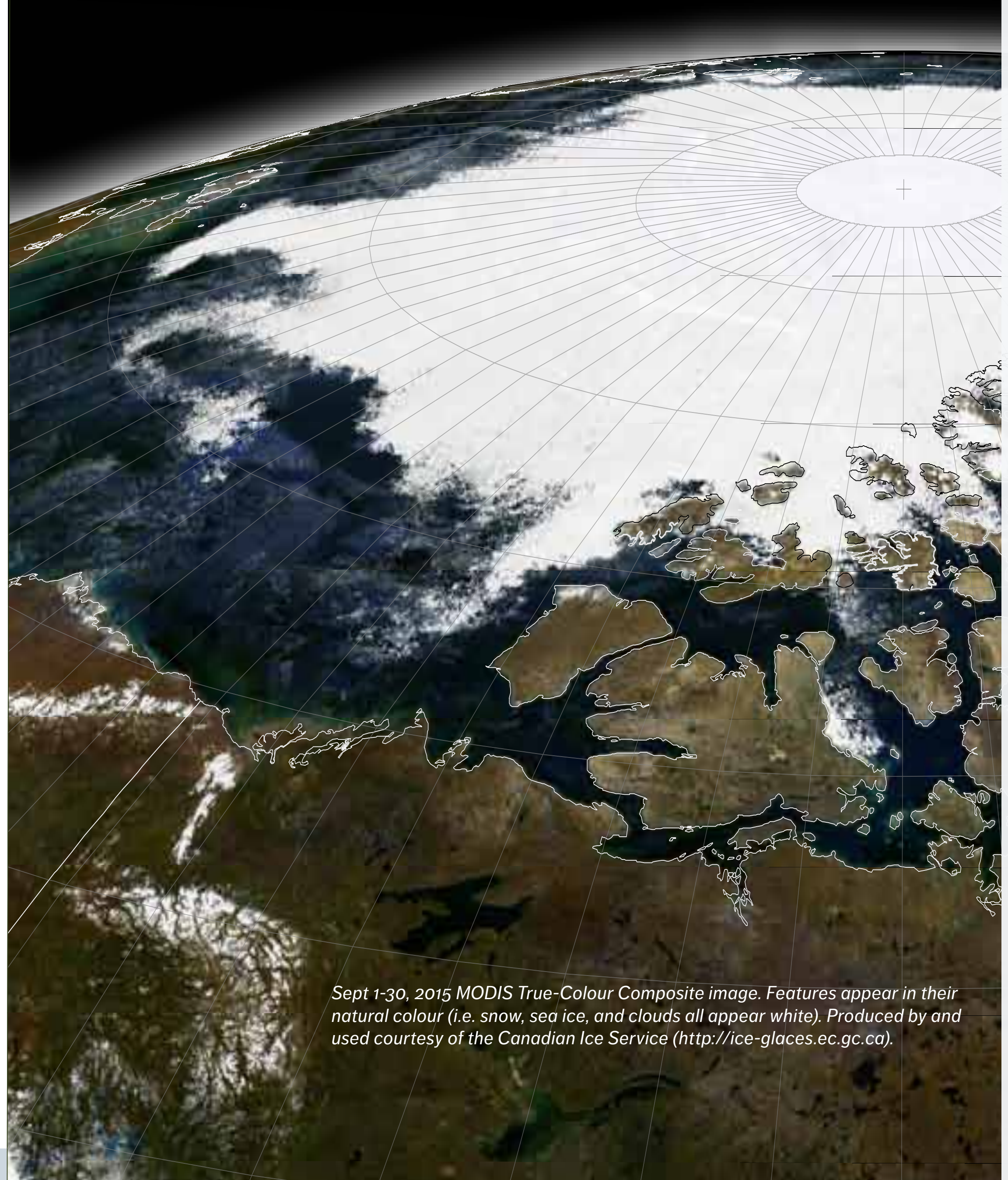
PHYSICAL OCEANOGRAPHY

BOTTOM OF THE FOOD WEB

FISHES

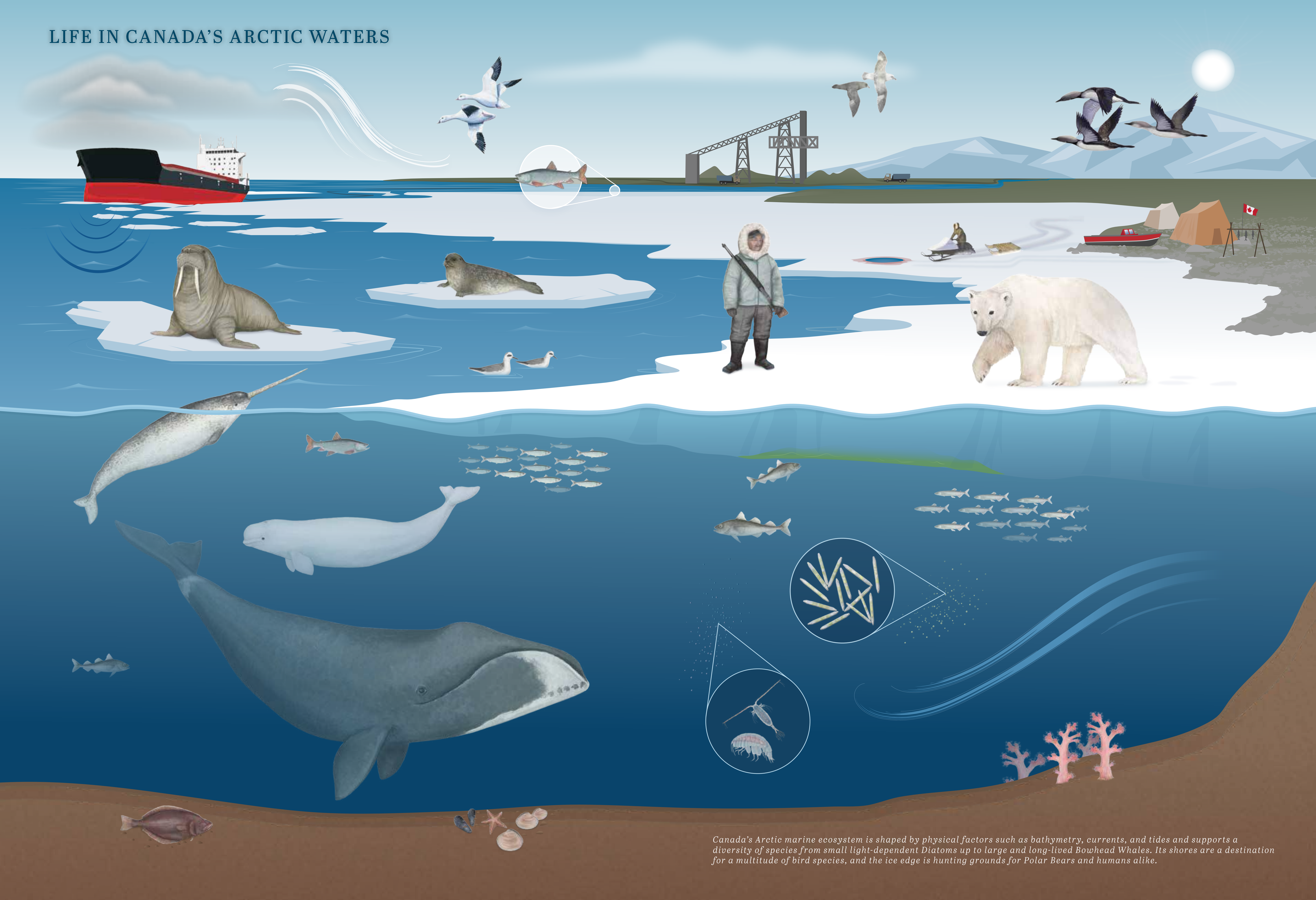
WATERBIRDS

MARINE MAMMALS



Sept 1-30, 2015 MODIS True-Colour Composite image. Features appear in their natural colour (i.e. snow, sea ice, and clouds all appear white). Produced by and used courtesy of the Canadian Ice Service (http://ice-glaces.ec.gc.ca).

The Canadian Arctic



Canada's Arctic marine ecosystem is shaped by physical factors such as bathymetry, currents, and tides and supports a diversity of species from small light-dependent Diatoms up to large and long-lived Bowhead Whales. Its shores are a destination for a multitude of bird species, and the ice edge is hunting grounds for Polar Bears and humans alike.

THE CHANGING ARCTIC

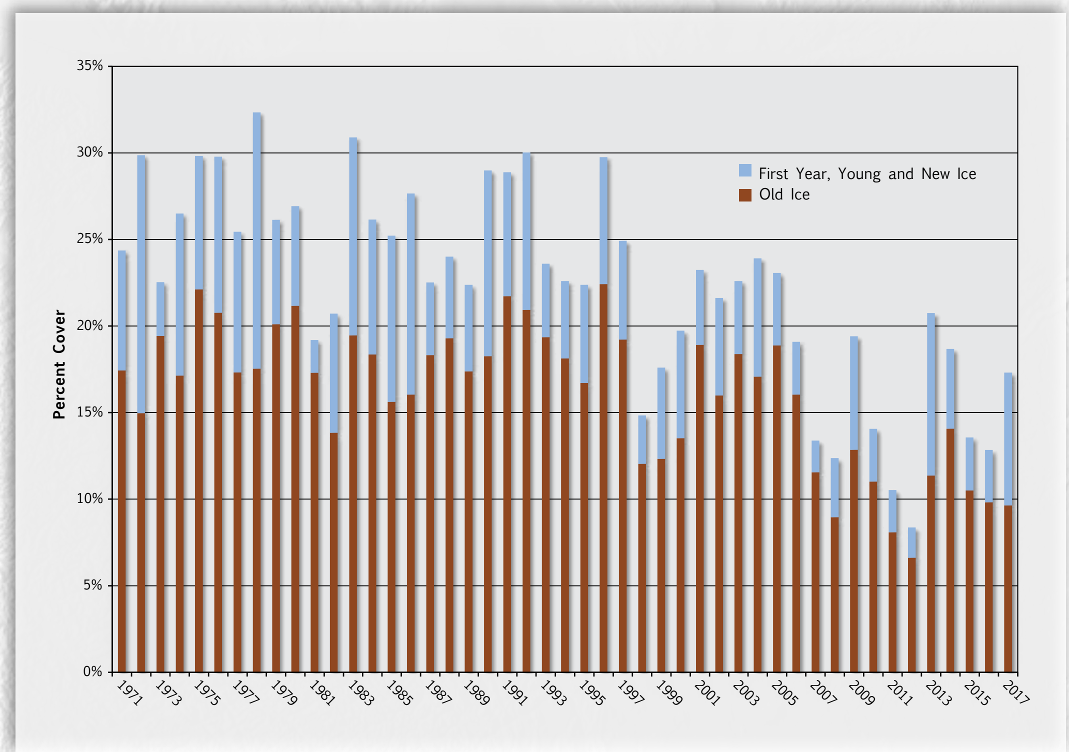
The loss of summer sea ice in the Arctic is one of the most visible signs of climate change on the globe. And it is only one symptom of how quickly the region's ecosystems are changing. Sea ice covers less area than it used to, in all months of the year. It is thinner and more vulnerable to rapid retreat. Sea surface temperatures are rising, too, partly because sunlight falls now on open water instead of reflecting off ice and snow.

For species adapted to cold and to ice, these changes are a threat. Sea ice algae, Arctic plankton, and Polar Bears must all adapt. Other species may move into the warmer Arctic. Killer Whales, for example, arrive in northern waters earlier, in greater numbers than before, and stay later. This is not good news for the marine mammals Killer Whales like to eat.

Less obvious but potentially more significant, warmer waters and less ice are restructuring the Arctic food web from the bottom up. Arctic plankton species face competition from subarctic plankton. Atlantic Cod, Atlantic Pollock, Capelin, and Haddock are moving northward. Seabirds find it harder to fill their bellies and feed their young. The ice is a less reliable platform for Walrus to haul out and rest in summer, for seals to build birthing lairs in deep snow, or for humans to travel across as they hunt.

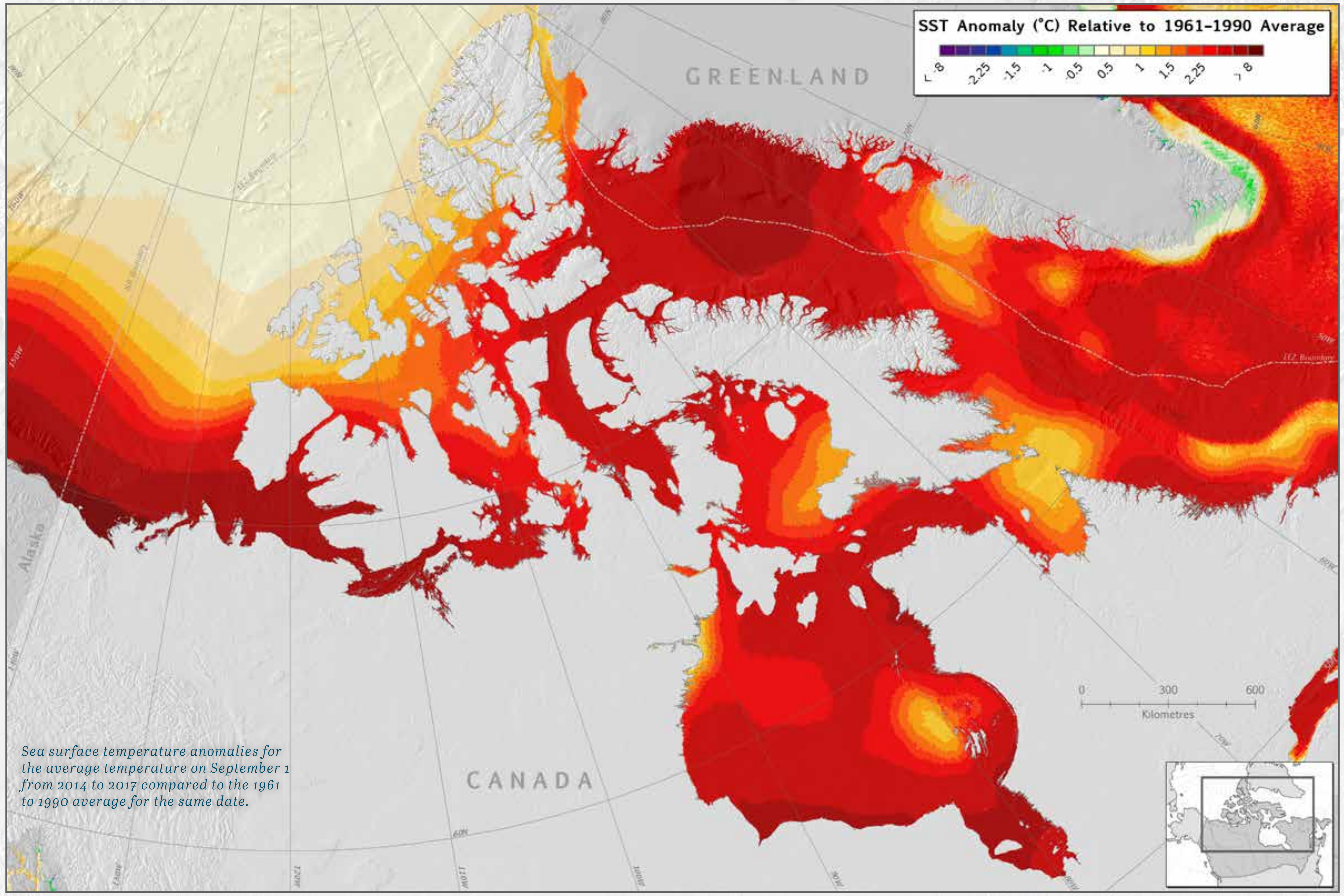
Amid these changes, the data in this atlas must be viewed with some caution. Field studies from decades ago provide valuable information, but may no longer reflect current conditions. We can expect broad patterns of ocean currents and marine productivity within the Arctic to remain intact. We can use the available information to manage human activities in ways to minimize further stress on Arctic ecosystems, species, and Indigenous peoples. We can continue to monitor the Arctic marine environment to detect and understand further change. And we can cherish what we have today and do our best to give our children and grandchildren the opportunity to do the same.

Historical Ice Coverage by Ice Age for the Canadian Arctic for the Week of September 10, 1971–2017.



DATA SOURCES
– *Canadian Ice Service. 2018. Ice Graph. http://iceweb1.cis.ec.gc.ca/CISWebApps/*
– *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

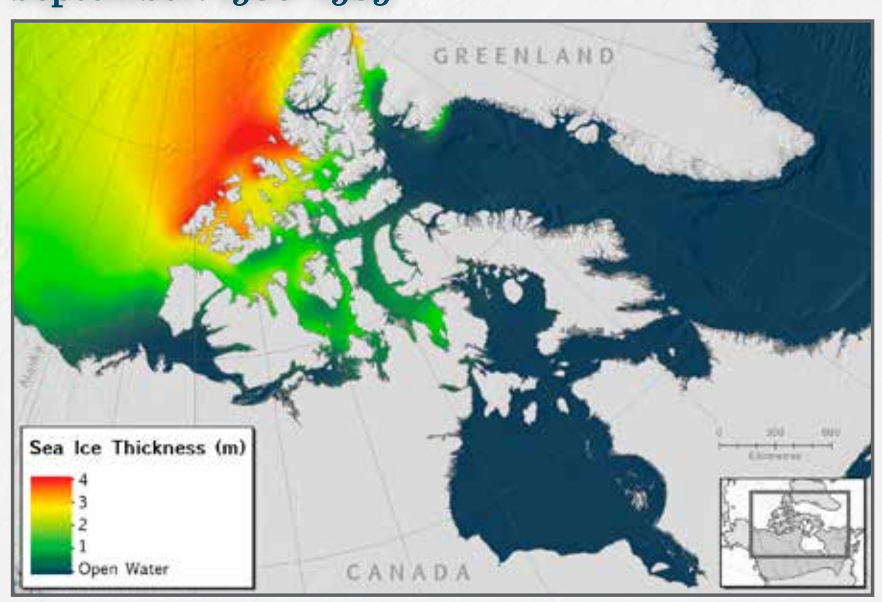
Mean Sea Surface Temperature Anomaly for Sept 1, 2014–2017



Sea surface temperature anomalies for the average temperature on September 1 from 2014 to 2017 compared to the 1961 to 1990 average for the same date.

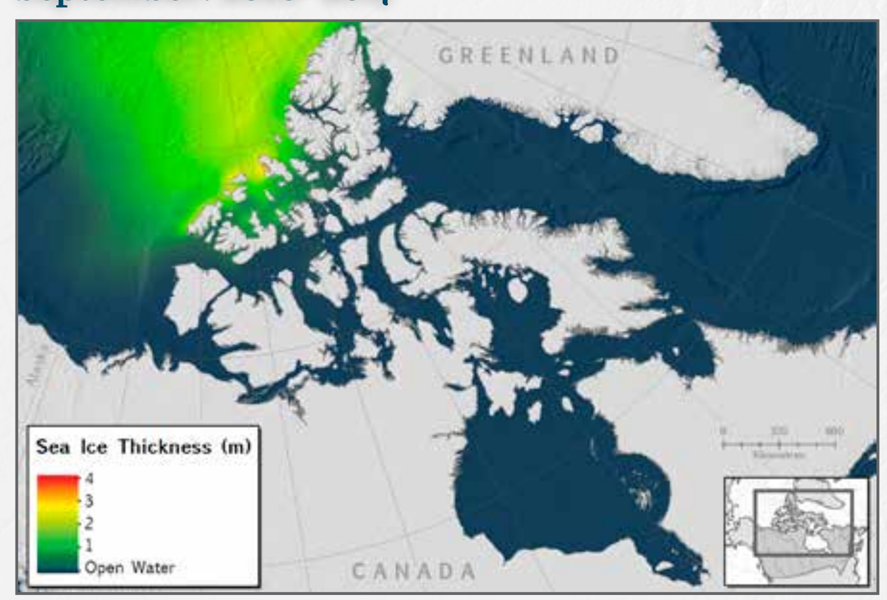
DATA SOURCES
– *SST anomaly data: Gemmill, W., Katz, B., and X. Li. 2007. DAILY REAL-TIME, GLOBAL SEA SURFACE TEMPERATURE - High-Resolution Analysis: RTG_SST_HR. NOAA/NWS/NCEP/EMC/MMAB, Science Application International Corporation, and Joint Center for Satellite Data Assimilation Technical Note Nr. 260. http://polar.ncep.noaa.gov/mmab/papers/tn260/*
– *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Mean Sea Ice Thickness in September: 1980–1989



DATA SOURCES
– *Sea Ice Thickness: Averages were derived from data downloaded from PIOMAS model grid data, downloaded from http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/data/model_grid. See Zhang, Jinlun and D.A. Rothrock. 2003. Modeling global sea ice with a thickness and enthalpy distribution model in generalized curvilinear coordinates, Mon. Wea. Rev. 131(5): 681-697.*
– *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Mean Sea Ice Thickness in September: 2010–2017



Decadal average sea ice thickness for the month of September: 1980–1989 compared to 2010–2017.

DATA SOURCES
– *Sea Ice Thickness: Averages were derived from data downloaded from PIOMAS model grid data, downloaded from http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/data/model_grid. See Zhang, Jinlun and D.A. Rothrock. 2003. Modeling global sea ice with a thickness and enthalpy distribution model in generalized curvilinear coordinates. Mon. Wea. Rev. 131(5): 681-697*
– *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

HUMANS AND THE ENVIRONMENT

About 60,000 people live year-round in Inuit Nunangat, with some 85% identifying as Indigenous. Canada's Arctic peoples hunt, fish, and gather from the land and sea; they govern their communities, their activities, and their environment; they develop natural resources and sustain their way of life.

Canada's Arctic Ocean encompasses the Northwest Passage, a waterway that has shaped the exploration and heritage of North America and embodies our differing perceptions of the Arctic.

Once hailed as a mythical transportation route by European geographers and adventurers, and seeing increasing shipping activity today, the passage has for far longer been home to people and wildlife. Accommodating the cultural, ecological, economic, and other assets of the Arctic will continue to require care and understanding from all concerned.

Facing Page: Northern Lights (aurora borealis), *Wapusk National Park, Manitoba. (photo: André Gilden)*

Netsilik Inuit at Pelly Bay, Nunavut breaking holes in the sea ice to hunt seals. The Netsilik caught seal to get blubber for their lamps, but also used the meat, skin, and bones. (Photo from the 5th Thule expedition, 1921–4, Nationalmuseet—National Museum of Denmark)

Politics and governance

Canada's northern waters fall predominantly within the jurisdiction of Canada's federal government and modern Inuit treaties, known as land claims. There are four Inuit land claim regions: the Inuvialuit Settlement Region, Nunavut, Nunavik, and Nunatsiavut. Land claim agreements establish constitutionally based co-management arrangements between the Inuit, the federal government, and applicable provincial and territorial government agencies. These arrangements relate to land and water management, resource development, environmental assessment, social services, education, and wildlife. The territorial governments of Yukon, Northwest Territories, and Nunavut all seek to take a greater role in the administration of northern waters by reaching agreements with the federal government and Inuit land claim organizations.

Conservation and management

For millennia, Inuit and other Indigenous peoples have worked to ensure the long-term health of the Arctic marine environment and wildlife through natural law and traditional forms of management and sustainable use. Today, Inuit actively promote marine planning initiatives, marine mammal and fishing plans, harvest management strategies, and conservation measures to ensure that the bounty of the ocean can support future generations. In addition, Inuit are key partners in guiding the advancement of federal mechanisms to protect Canada's Arctic Ocean.

Natural resource development

Modern industrial development in Canada's Arctic waters began with the advent of commercial whaling in the 19th century, in Baffin Bay, Hudson Strait, and the Beaufort Sea. Over the past century, a commonly held expectation among Inuit and the federal and territorial governments was that the natural resources of the Arctic would be developed and create financial prosperity for northern Canada. This expectation has not come to fruition. Despite discrete periods of interest and activity, in fact, little or no marine natural resource development has occurred. At present, a handful of commercial activities are scattered across all four Inuit land claim regions. These include shipping, oil and gas development, mining, and commercial fishing.

Transportation and heritage

As a homeland, the Canadian Arctic has a rich cultural heritage of archaeological sites, place names, trails, and other aspects of long habitation. Inuit qaujimajatuqangit or traditional knowledge shows a deep understanding of the region acquired by observation and experience over many generations. While the full range of cultural heritage cannot be captured on maps or in words, a few examples can illustrate how thoroughly the Arctic environment is known and used, and how intimate the relationship is between Indigenous peoples and the ecosystems of which they are part. Recent efforts have mapped Inuit trails and recorded Inuit place names. Both illustrate how far people travel throughout the region, with place names also indicating a profound appreciation for the characteristics of the land and the environment.

For further reading, see p. 106.

INUIT LAND CLAIMS

INUIT MAKE UP THE VAST MAJORITY (85%) of the human population of Inuit Nunangat, the Inuit name for their homeland of land, water, and ice. Approximately 44,000 Inuit live across four main regions—the Inuvialuit Settlement Region in the Western Arctic, Nunavut in the central Arctic, Nunavik in Northern Quebec, and Nunatsiavut in Northern Labrador. Other Indigenous peoples in these regions include Gwich'in in Yukon and Northwest Territories, the Dene of the Northwest Territories, the Innu in Labrador, the Cree around Hudson Bay, and Métis peoples, who make up another 2% of the total population.

All but three of the 53 Inuit communities of Canadian Arctic are located on the ocean shoreline, reflecting the central importance of coastal and marine environments in Inuit culture and daily life. Inuit have traditionally relied on marine animals as sustenance (seals, whales, walrus, and fish.) Today, Inuit continue to harvest wildlife or "country foods" to feed their families and communities, as they have for thousands of years. Inuit are also employed in the modern wage economy across a wide range of sectors including public and private services, transport, and resource extraction such as mining.

Inuit land claims agreements

Inuit co-manage their homelands with the Canadian federal government and the relevant provincial and territorial governments through constitutionally protected land claim agreements that act as modern-day treaties. The entire Canadian Arctic is governed by such agreements that correspond to the four major regions of Inuit Nunangat. The agreements create rights-based Inuit organizations that own lands and include, in some areas, rights to surface and subsurface resource development. The agreements establish co-management boards and other natural resource management bodies, provide financial compensation, and create structures for future co-management relationships between the organizations and the Canadian government.

Inuit Tapiriit Kanatami (ITK)

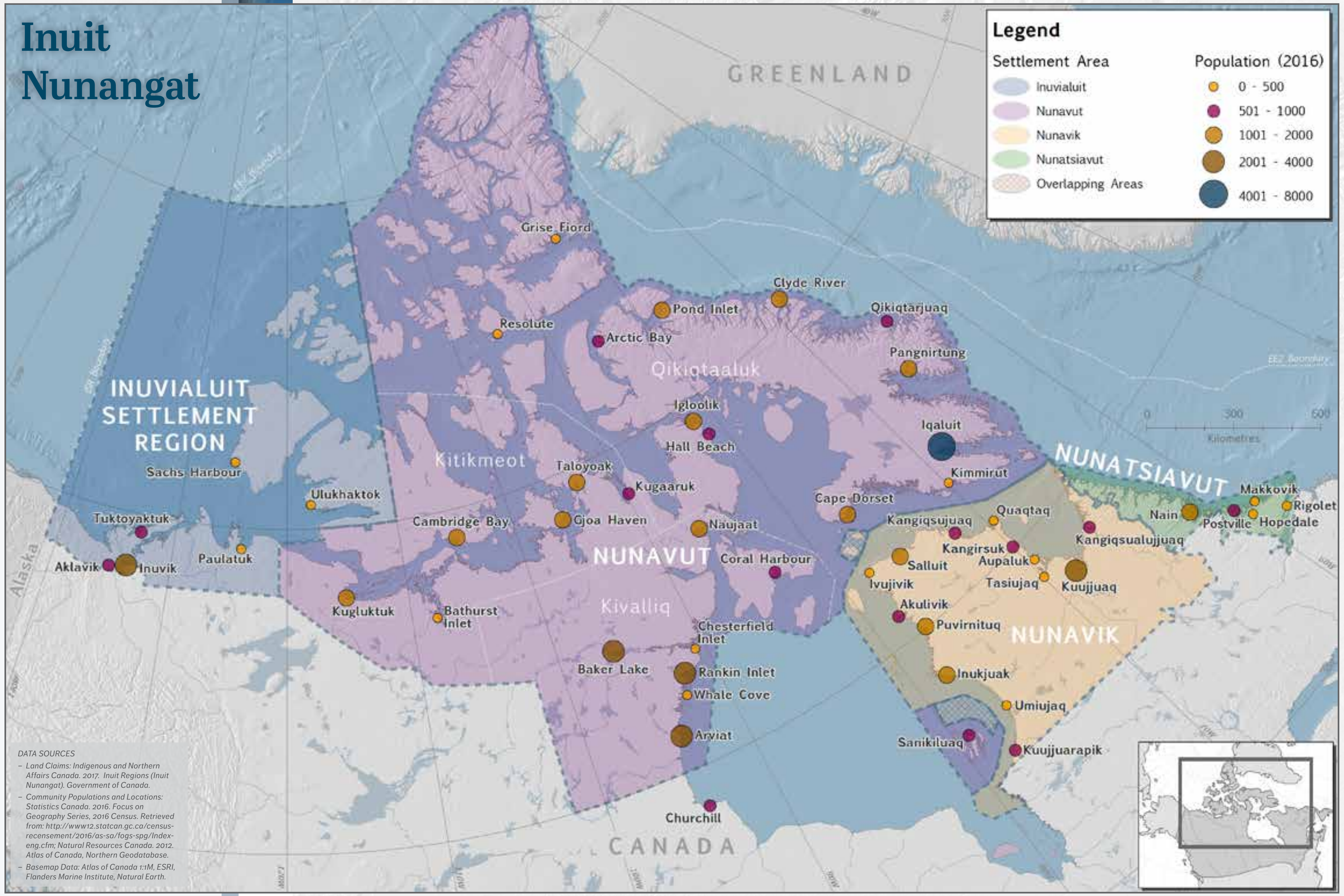
Inuit Tapiriit Kanatami, formerly the Inuit Tapirisat of Canada, was founded at a meeting in Toronto in February 1971 by seven Inuit community leaders. It is the national representational organization protecting and advancing the rights and interests of Inuit in Canada, including the approximately 16,000 Inuit who live outside Inuit Nunangat. The impetus to form a national Inuit organization evolved from shared concern among Inuit leaders about the status of land and resource ownership in Inuit Nunangat.

Inuvialuit Settlement Region (ISR)

In the Western Arctic, the Inuvialuit Settlement Region, spanning the northern Yukon and the northwestern Northwest Territories, is home to over 3,300 Inuit living in six communities. The communities of the ISR are located along the Mackenzie River Delta, the northern coast of the Northwest Territories, and on the westernmost islands of the Canadian Arctic Archipelago. In 1984, the Inuvialuit Final Agreement with Canada established the Inuvialuit Regional Corporation (IRC) to manage Inuit ownership of lands and the financial compensation for Inuit peoples in the region.

Nunavut

Nunavut, meaning "our land," is the largest land claim region, comprising 25 communities with a total Inuit population of 27,000 across 2 million km² and divided into three administrative regions: Kitikmeot, Kivalliq, and Qikiqtaaluq. The Nunavut Agreement was concluded in 1993, providing Inuit rights and ownership of a total of over 350,000 km², with the remainder to be co-managed with the federal government. Nunavut Tunngavik Inc. (NTI) represents Inuit under the agreement, manages financial compensation, coordinates regional land claims organizations, manages wildlife environmental protections, and works to ensure that the federal and territorial governments fulfill their agreement obligations. The agreement also resulted in the creation of the new territory of Nunavut and its public territorial government.



DATA SOURCES
- Land Claims: Indigenous and Northern Affairs Canada. 2017. Inuit Regions (Inuit Nunangat). Government of Canada.
- Community Populations and Locations: Statistics Canada. 2016. Focus on Geography Series, 2016 Census. Retrieved from: http://www12.statcan.gc.ca/census-recensement/2016/as-sa/fogs-spg/Index-eng.cfm; Natural Resources Canada. 2012. Atlas of Canada, Northern Geodatabase.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

Facing Page: Standing on snow pack wearing sealskin kamiks. (photo: Kristin Westdal)

Nunavik

The territory of Nunavik is populated by more than 10,700 Inuit living in 15 communities along Ungava Bay, Hudson Strait, and Hudson Bay. The Nunavik region is located within the province of Quebec and is one-third of that province's land mass. The Makivik Corporation was created to protect the rights, interests, and financial compensation provided by the 1975 James Bay and Northern Quebec Agreement, and the more recent offshore Nunavik Inuit Land Claims Agreement, which came into effect in 2008.

Nunatsiavut

Approximately 2,300 Inuit live in five communities along the northern coast of Labrador in the Inuit region of Nunatsiavut. In 2005, the Labrador Inuit Land Claim Agreement established the settlement area covering 72,500 km² and created the first Inuit regional government. The Nunatsiavut government remains part of the province of Newfoundland and Labrador but has authority over many central governance areas including health, education, culture and language, justice, and community matters, along with the power to pass laws.

INUIT TRAVEL ROUTES AND SEA ICE

HUMANS & THE ENVIRONMENT

- Inuit Land Claims
- ➡**Inuit Travel Routes & Sea Ice**
- Inuit Place Names
- Industrial & Commercial Activities
- Management & Conservation

BOTH HISTORICALLY AND TODAY, travel across the waters and seas of Inuit Nunangat is as important, if not more, than travel over land. For six to nine months of the year, the ocean is frozen and Inuit travel takes place over sea ice. Riding on dog sleds and now the snowmobile, Inuit consider sea ice a "highway" across their homeland, and use it daily for travel and hunting. Sea ice is a treasured symbol of Inuit freedom of movement and a bridge that connects people and places across time and space.

The Inuit view of the critical role of sea ice for travel and hunting stands in direct contrast with that of the 19th-century European explorers and today's operators of transport ships, to whom sea ice is an obstacle—something that stands in their way.

Before the existence of permanent settlements, Inuit travelled and lived seasonally in different locations throughout the Arctic. Their movements were shaped by the changing seasons, the availability of animals, and each community's preferred hunting and fishing camp sites and settlement locations. Travel routes on the sea ice acted as social and survival networks, connecting hunting and fishing grounds and camps and settlements.

Today, many Inuit travel routes continue to be used, year after year, generation after generation. Many of these routes maintain their important role in contemporary northern lifestyles and livelihoods. A map of all the Inuit travel routes would cover much of the Arctic in a dense network of trails.

During the winter months, sea ice facilitates access to hunting, harvesting, and fishing areas as well as the chance to socialize with people in other camps and settlements. Because travel on land can be difficult in areas of high topographic relief, wetlands, or areas with little snow, a route over sea ice is often the most efficient and direct way of reaching important destinations. Sea ice makes travel and hunting easier, especially for communities or camps located on islands.

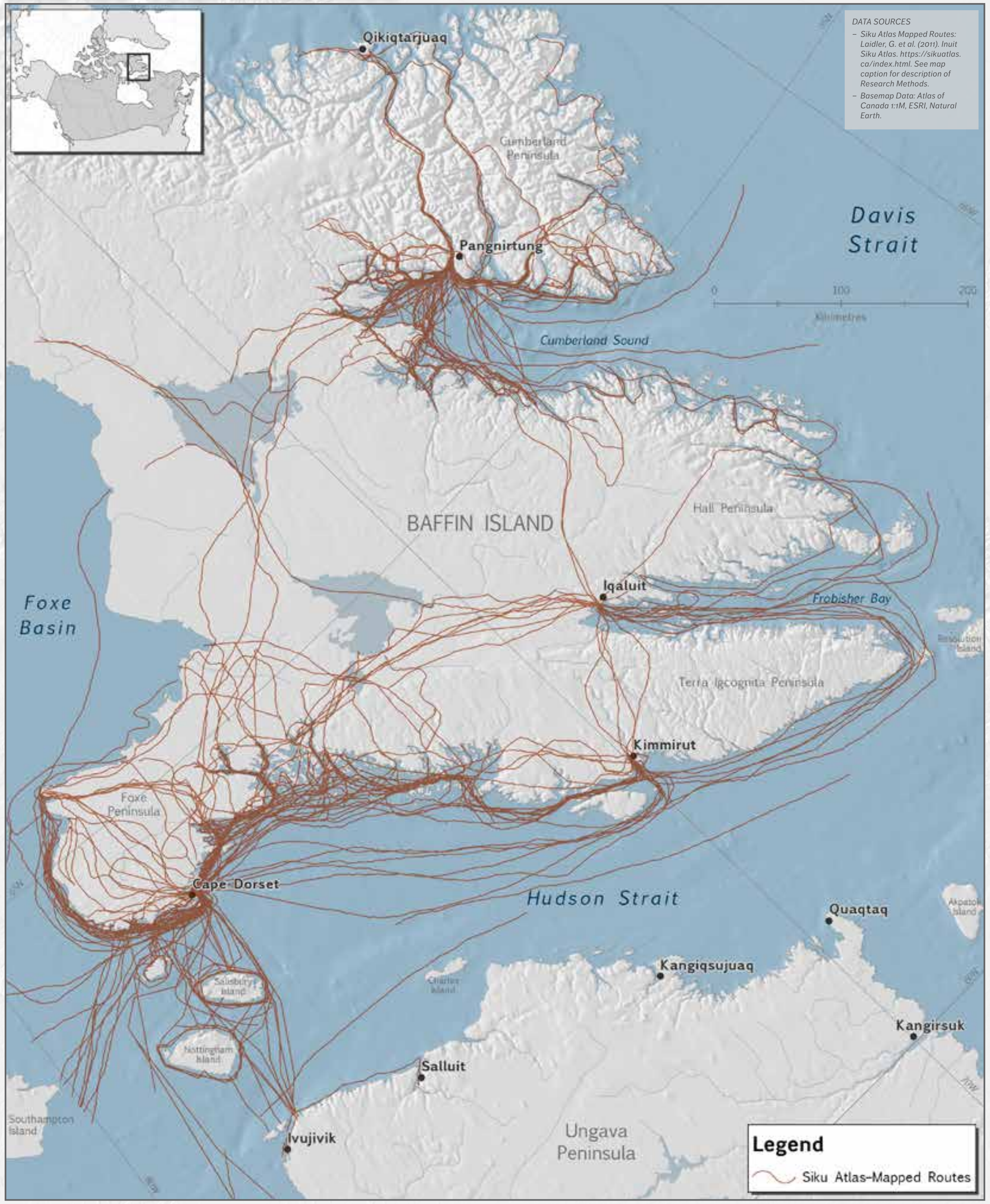
The knowledge Inuit have developed of sea ice, its nature, and its processes is embedded in their culture and identity. Sea ice plays an essential part in the daily life of northern Inuit communities for subsistence or commercial hunting, harvesting or fishing, and providing physical and spiritual nourishment.

Changes in sea ice conditions have a considerable effect on travel patterns, access to certain destinations, the ability to hunt, and knowledge of the physical geography. These changes can also make travel much riskier and threaten the safety of hunters and community members.

Top: On dog sled in Nunavik. (photo: Friedrich Stark)

Left: A qamutik used to transport people and goods, Pond Inlet, Lancaster Sound. (photo: Trevor Taylor)

Sea Ice Travel Routes



Inuit Travel Routes—Research Methods

The travel routes shown here were collected as part of research conducted with the communities of Cape Dorset, Igloolik, and Pangnirtung, Nunavut between 2003–2007 (Laidler, 2007). This work was then expanded through the creation of the Inuit Siku (sea ice) Atlas (www.sikuatlas.ca) as part of the Inuit Sea Ice Use and Occupancy Project (ISIUOP), an International Polar Year (IPY) project that ran from 2006–2011 (Aporta et al., 2011). These routes were recorded through participatory mapping sessions as part of interviews and small group meetings where Inuit Elders and active hunters were asked to discuss sea ice features, travel routes (land, sea, and ice travel), and indicators of change in each community. The lines on this map are not intended to be an exhaustive inventory of routes; they reflect the experiences that individual contributors were comfortable in sharing. In some cases, the full extent of travel was limited by the basemap used, and so this is only an indication of the extensive sea ice travel and use around Baffin Island.

INUIT PLACE NAMES

INUIT HAVE A LONG, INTIMATE RELATIONSHIP with their homeland over the vast area between Greenland and Alaska and south to Labrador and Hudson Bay. Over many generations and centuries, Inuit expressed this relationship, in part, through the naming of places and geographical features across the land. These names record Inuit's evolving understanding and deep local knowledge of their changing environment. And as Inuit share a common linguistic and cultural heritage, their place names constitute a uniquely Inuit geography of the Canadian Arctic.

However, many of the names still used and found on official maps of the Arctic today were given by European and Euro–North American explorers. They often named places they "discovered" after themselves, places in their home countries, European royalty, or the financial backers of their expeditions. The use of these names has obscured the naming traditions of the Arctic's Indigenous peoples.

The Inuit practice of naming places reflects their ongoing interaction with and observations of their environment. The names identify distinct geographic features; concentrations of game, fish, or edible plants; strategic sites for fishing or hunting; sources of raw materials; efficient and safe travel routes; landmarks for navigation; and superior or strategic campsites. They also mark sites of historical and legendary importance and areas of spiritual significance. As Inuit culture was until very recently strictly oral, place names were and continue to be an effective means of retaining and passing on knowledge about the landscape.

Today, Inuit are recording and mapping their Inuit place names throughout the Arctic, and even going through the process of having their names adopted as official names to be published on government maps. For this atlas, the Kitikmeot Heritage Society has provided the map shown here, which illustrates Inuit place naming in the Tariyunnuaq area of Nunavut.

Across Coronation Gulf from Victoria Island (Kiilliniq) one finds "the little ocean" or Tariyunnuaq, a fitting name for a long saltwater inlet separating the Kent Peninsula (Kiillinnguyaq) from the mainland (Ahiaq). Tariyunnuaq is almost completely cut off from the Coronation Gulf save for a narrow entrance and so is truly like a small ocean unto itself. Although the region is some distance from the nearest settlement of Cambridge Bay, and is now visited only occasionally, the names for the water and land features in the Tariyunnuaq area evolved over as many as seven centuries of continuous Inuit habitation. Over this long period Tariyunnuaq was an inhabited landscape named and discussed solely in an Inuit language expressing a distinctively Inuit way of seeing the world.

Several island names on the map indicate sites for marine hunting activities such as Nauyatuuq, Nauyaaraaryuit, and Hangutittivik, places to gather seagull eggs during the spring; Malirihiurvik, "a place to hunt Arctic loons"; and Uqhuutituuq, an island where seals were butchered and their oil stored. Important fishing locations are reflected in the names Iqalukpilik ("it has Arctic char") and Kapihiliktuuq ("place of many whitefish"). The lake Harvaqtuuq ("place of many rapids") has strong current and rapids at its outlet, making it a place of open water and thin ice in the winter, and therefore an easy place to fish. Inuit travel patterns by dog team are evident in the names for the routes Itipliryuaq and Itipliaryuk (the "big" and "little" portages) across the narrow isthmus connecting the Kent Peninsula to the mainland. Uivvarluk describes a peninsula that is simply in the way and annoying to have to go around when travelling on the sea ice. Inuit must have passed long evenings in the iglu villages on the sea ice of Tariyunnuaq, relaxing after a day of seal hunting and retelling the story of a group of muskox that turned into the islands of Hitamaiyarviit ("places like the four"), or describing encounters with the supernatural dwarves who live on the land and for whom the islands of Inuarulliit ("the little people") are named.

Editor's note: This section is intended as a representative example of Inuit place naming. The terms Inuit and Inuit language are used to describe a people and a language that span Arctic Canada. The contemporary people for whom the Tariyunnuaq area remains an ancestral homeland refer to themselves more specifically as Inuinnait and to their language as Inuinnaqtun.

Facing Page: Inukshuk on the banks of Hudson Bay, Manitoba. (photo: Oceans North)

DATA SOURCES
- *Inuit Place Names Data Collection Methods: These place names were recorded by the Kitikmeot Heritage Society as part of their Kitikmeot Place Names Atlas. For this map, the place names were collected through interviews with Elders in Cambridge Bay. This project was funded by the Department of Canadian Heritage and supported by the Geomatics and Cartographic Research Centre of Carleton University. For more information on the atlas, please see: https://atlas.kitikmeotheritage.ca/.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*

Kitikmeot Zoom Area

The Kitikmeot Heritage Society provided the map shown here, which illustrates Inuit place naming in the Tariyunnuaq area of Nunavut.

INDUSTRIAL AND COMMERCIAL ACTIVITIES

COMMERCIAL AND INDUSTRIAL ACTIVITIES IN THE CANADIAN ARCTIC started with commercial whaling in the 19th century, in Baffin Bay, Hudson Strait, and the Beaufort Sea. Since then, there have been several bursts of interest and activity amid periods of little or no development. At present, industrial and large-scale commercial activities in the region include shipping, oil and gas extraction, mining, and fishing. Industrial and commercial activities are regulated by various federal, provincial, and territorial laws, within the context of settled and unsettled Indigenous land claims.

Shipping

The vast majority of commercial vessel traffic in the Canadian Arctic is destination shipping, or voyages to and from Arctic locations. This includes the regular and largely predictable annual sea-lift to deliver supplies to Arctic communities during the ice-free summer months. It also includes support for mining and oil and gas operations, which increases or decreases depending on the level of activity in any given year. While much of the industrial support traffic comes in summer, some ice-capable ships arrive year-round in parts of the Canadian North to deliver supplies and take out ore and other products.

In recent years, there has been growing interest in the potential for transit shipping, using the Northwest Passage to shorten the distance between Asian, North American, and European markets. There has also been increasing cruise-ship tourism, including transits of the Northwest Passage. Transit shipping and tourism are so far confined to the ice-free season. In addition to risks to mariners and passengers, shipping creates noise, air and water pollution, and the threat of a fuel spill. These can all affect people and wildlife along the shipping route and where water currents may carry pollution.

Oil and gas

The earliest oil development in the Canadian North was at Norman Wells on the Mackenzie River, starting in the 1920s. In the Arctic, oil and gas exploration boomed in the 1970s and 1980s, particularly on the Mackenzie Delta region of the Beaufort Sea. The Bent Horn oil field on Cameron Island was developed in the 1980s and produced oil until the 1990s. In recent years, there has been continued interest in the Mackenzie Delta region and in exploring Baffin Bay. The challenges of operating in areas with seasonal sea ice and far from markets make oil and gas development expensive in the Arctic. For the marine environment, oil and gas activities typically require extensive vessel traffic to supply and support exploration and production, even on land. Offshore activities create noise and the risk of an oil spill, both of which can affect marine animals and those who hunt them.

Iron ore ship docked in Milne Inlet, Nunavut. (photo: Oceans North)

Mining

The Canadian Arctic is home to several major mines as well as extensive mineral prospects. While no offshore mining has occurred, Arctic mines require extensive sea-lift support to bring in supplies and equipment and to transport ore and other products to market. In some cases, the shipping activity is confined to the ice-free season, but for some mines, such as Voisey's Bay in Nunatsiavut, ice-capable ships are used through the winter. It is expected that more mines will do likewise in order to remain productive year-round, although this can pose a threat to marine mammals that make dens on sea ice and to hunters who use sea ice to travel.

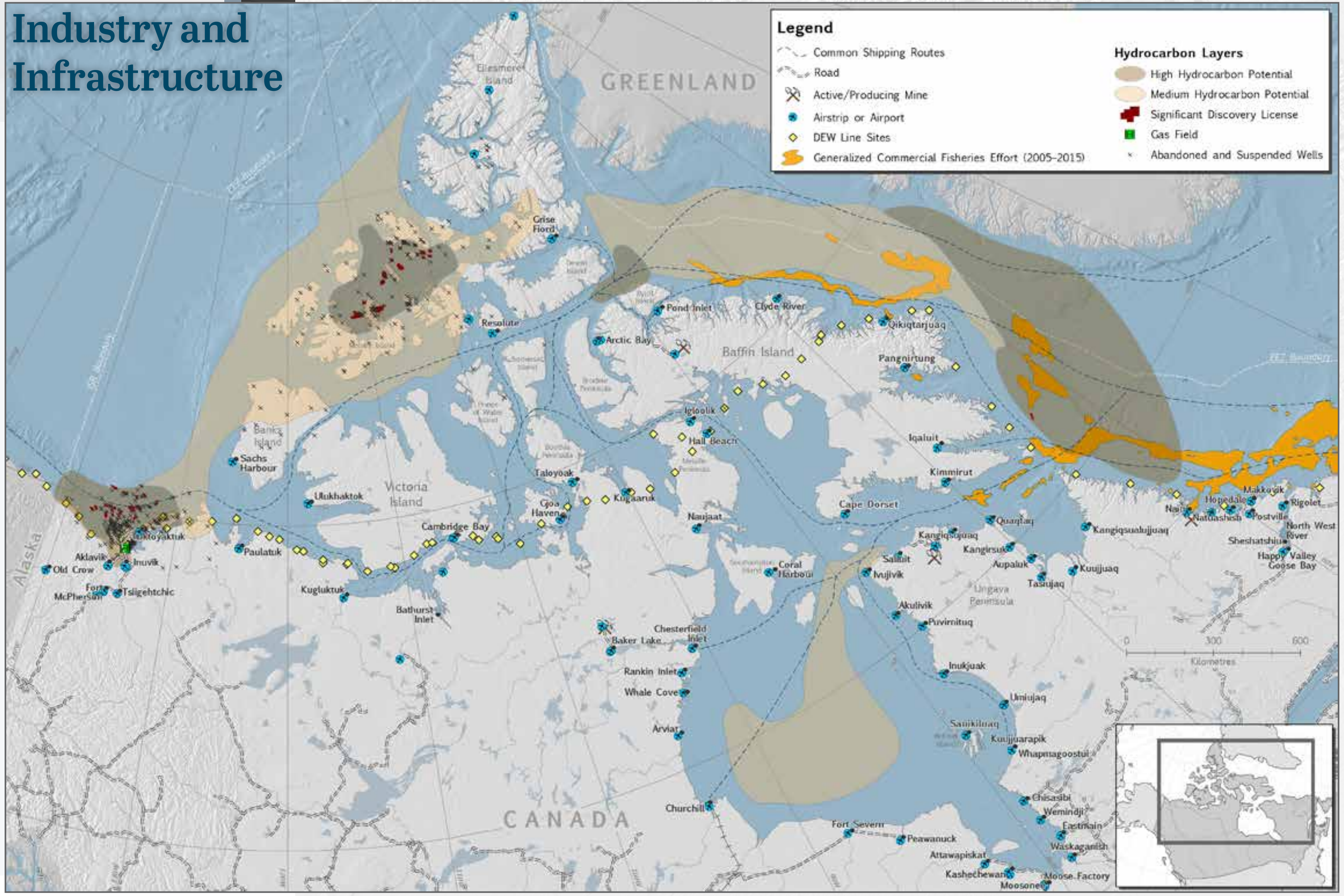
Fisheries

Commercial fisheries in the Canadian Arctic are at present confined to the Baffin Bay and Davis Strait area. In the 1960s, foreign vessels fished in the region for grenadier and redfish. By the time the 200-nautical-mile Exclusive Economic Zones (EEZs) were established in the 1970s, grenadier and redfish stocks had been overfished, and fishing operations targeted Greenland Halibut (Reinhardtius hippoglossoides). By the late 1980s, only Canadian vessels were involved. At around the same time, a shrimp fishery began in the Hudson Strait and Davis Strait area, gradually expanding northward. Today, the Greenland Halibut and shrimp fisheries continue in this area, with fishing activity in both winter and summer. There remain concerns about effects on Narwhal (Monodon monoceros) and other marine mammals through disruption of the food web, and also about damage to cold-water corals and other seafloor species and habitats. In the Beaufort Sea, the federal government in 2014 halted all commercial fishing, matching a similar policy in adjacent American waters.

Facing Page: Sea-lift bringing goods in Clyde River, Nunavut. (photo: Henry Huntington)

DATA SOURCES

- *Common Shipping Routes: Modified from Arctic Council. 2009. Arctic Marine Shipping Assessment Report and major routes identified with 2012–2014 exactEarth® satellite AIS data.*
- *DEW Line Sites: Arctic Institute North America. 2005. The Distant Early Warning (DEW) Line: A Bibliography and Documentary Resource List.*
- *Generalized Commercial Fisheries Effort: Derived from Fisheries and Oceans Canada. 2017. Delineation of Significant Areas of Cold-Water Corals and Sponge-Dominated Communities in Canada's Atlantic and Eastern Arctic Marine Waters and Their Overlap with Fishing Activity. CSAS 2017/007 and fishing activity identified with 2012–2015 exactEarth® satellite AIS data.*
- *Hydrocarbon Potential: Indigenous and Northern Affairs Canada, 2008.*
- *Significant Discovery Licenses: Indigenous and Northern Affairs Canada, 2016*
- *Gas Field: Natural Resources Canada, 2017*
- *Abandoned and Suspended Wells: Indigenous and Northern Affairs Canada, 2014*
- *Infrastructure (Road, Airport, Active Mines): Natural Resources Canada, 2017*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*



MANAGEMENT AND CONSERVATION

HUMANS & THE ENVIRONMENT
- Inuit Land Claims
- Inuit Travel Routes & Sea Ice
- Inuit Place Names
- Industrial & Commercial Activities
- ➡ **Management & Conservation**

THE CANADIAN ARCTIC HARBOURS one of the world's least disturbed marine ecosystems, plays a crucial role in moderating the planet's climate, and is home to spectacular wildlife, fish, and marine mammal populations. Inuit experts have identified over half of Arctic Ocean areas as important biological habitat needed to maintain a thriving marine ecosystem essential for continued use. Coastal areas, too, play important ecological roles for marine and terrestrial species. To date, however, few conservation measures have been legislated for Canada's Arctic waters.

The Government of Canada has pledged to create a network of marine conservation areas in at least 10% of its Arctic waters by 2020. It also pledged to exceed this target and develop policies to ensure abundant Arctic fish. Several mechanisms can be used to achieve these and other conservation goals.

Marine Protected Areas

At present Canada's federal marine protected area network comprises three legal instruments:

- The Oceans Act authorizes Fisheries and Oceans Canada to designate Marine Protected Areas (MPAs) to protect and conserve marine species, habitats, and/or ecosystems that are ecologically significant and/or distinct.
- National Marine Conservation Areas (NMCAs) established by Parks Canada protect and conserve representative samples of Canada's oceans and Great Lakes for public benefit and enjoyment.
- National Wildlife Areas (NWAs) are established by Environment and Climate Change Canada for wildlife conservation, research, and interpretation. Prohibited activities vary by site.

As of 2017, there are two MPAs and five NWAs in Canadian Arctic waters, and the final boundaries for Tallurutiup Imanga (Lancaster Sound), a proposed NMCA in the eastern Canadian Arctic, have been agreed upon.

As with industrial activities, the designation of protected areas requires concluding an Inuit Impact and Benefit Agreement (IIBA) to determine how the conservation action will both affect and help local residents. In addition, a new designation of Indigenous Protected Area (IPA) is under consideration, recognizing the special interests of Inuit and others in the long-term health and continued use of their lands and waters.

Shipping corridors

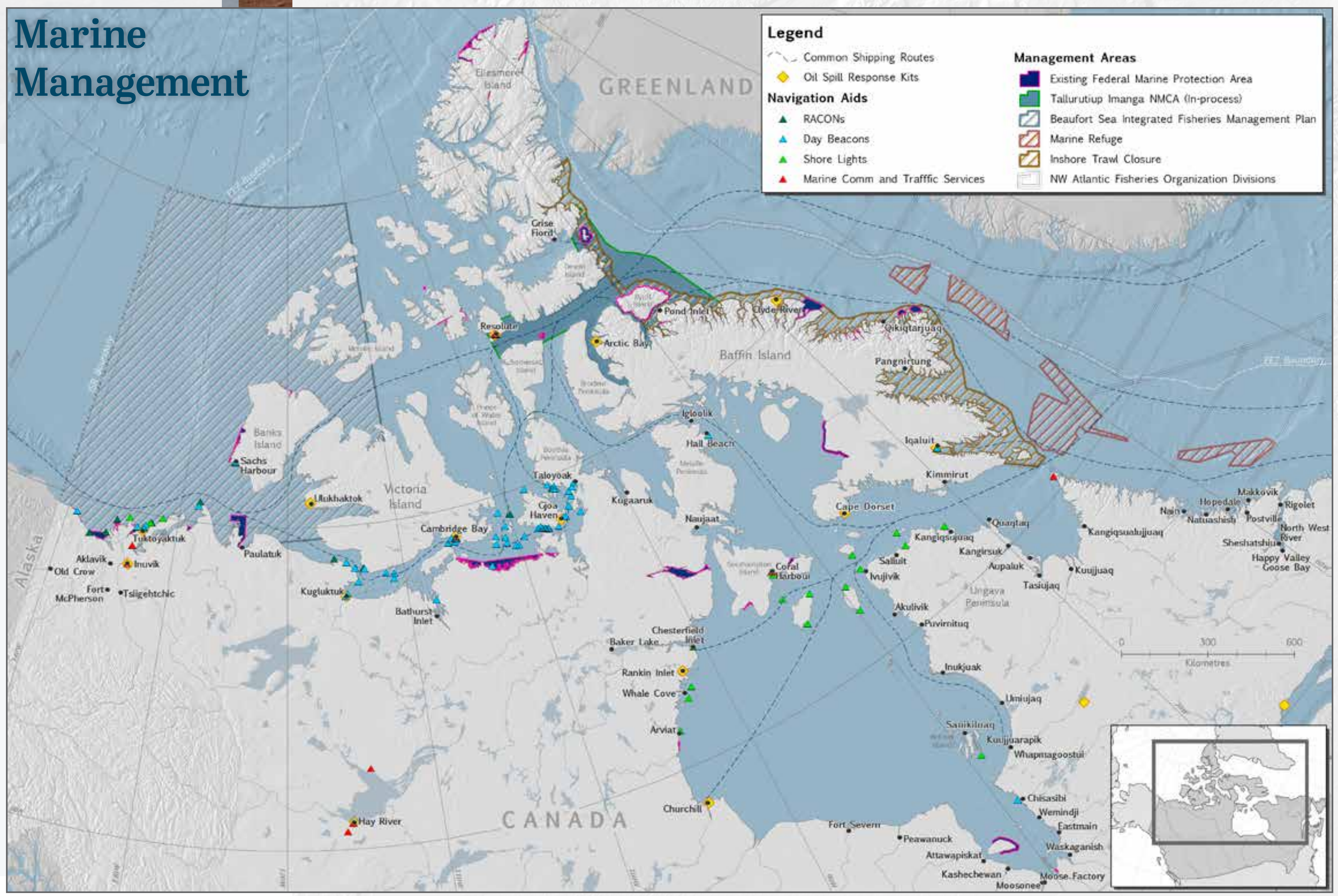
As commercial vessel traffic increases in the Canadian Arctic, establishing shipping corridors and other rules and guidelines for navigation can help reduce the risk of accidents, ship strikes of marine mammals, and conflicts with local hunters and fishers.

Fisheries closures

In 2014, the Beaufort Sea Integrated Fisheries Management Framework was completed by the Government of Canada and Inuvialuit institutions created under the Inuvialuit Final Agreement. The framework establishes that any commercial fisheries in the region should be orderly and sustainable, not just for the fish stock in question but also for the ecosystem as a whole. In light of the current state of scientific understanding of marine ecology in the region, no commercial fishing is authorized for the time being. This policy mirrors a similar one for adjacent American waters that was put in place in 2009. In eastern Canadian Arctic waters, where there are commercial fisheries for Northern Shrimp (Pandalus borealis) and Greenland Halibut, several areas are restricted to certain types of gear or vessels or closed to fishing altogether. In 2009, a large area of Baffin Bay was closed to Greenland Halibut fishing to protect the overwintering area of Narwhals and deep-water corals and sponges. In 2017, the closed area was adjusted and all bottom-fishing gear was prohibited. In 2013, the marine zone of the Nunavut Settlement Area, approximately equivalent to the 12-nautical-mile territorial waters off the coast, was closed to vessels longer than 100 feet (approx. 30 m) from the north end of Baffin Bay south into Hudson Strait. In 2017, a large area in Davis Strait was closed to bottom-contact fishing gear to protect corals and sponges; another large area in Hatton Basin, at the eastern approach to Hudson Strait, which had been closed voluntarily by the fishing industry, was expanded and closed by regulatory action to protect sponges, corals, fishes, and marine mammals.

Facing Page: Freighter canoe on the shores of Frobisher Bay, Nunavut. (photo: David Henry)

DATA SOURCES
- *Community Populations: Statistics Canada, 2016*
- *Beaufort Sea Fisheries Plan: INAC, 2017*
- *Inshore Trawl Closure: Department of Fisheries and Oceans.. 2014. Greenland Halibut (Reinhardtius hippoglossoides) - Northwest Atlantic Fisheries Organization Subarea 0 Integrated Fisheries Management Plan.*
- *Marine Refuge: DFO. 2017. Marine Refuges.*
- *NAFO Divisions: Northwest Atlantic Fisheries Organization. 2017. Divisions. https://www.nafo.int/Data/GIS*
- *Existing Marine Protections: UNEP-WCMC and IUCN. 2017. The World Database on Protected Areas (WDPA), April 2017. www.protectedplanet.net.*
- *Tallurutip Imanga NMCA: QIA, 2017*
- *Oil Spill Response Kits: L Ross Environmental Research Ltd., DF Dickins Associates LLC., Envision Planning Solutions Inc. 2010. Beaufort Sea Oil Spills State of Knowledge Review and Identification of Key Issues. Environmental Studies Research Funds Report No. 177. Calgary. 126p.*
- *Common Shipping Routes: Modified from Arctic Council. 2009. Arctic Marine Shipping Assessment Report and major routes identified with 2012–2014 exactEarth® satellite AIS data.*
- *Navigational Aids: DFO. 2010. Arctic Voyage Planning Guide.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*



PHYSICAL OCEANOGRAPHY OF THE ARCTIC

PHYSICAL OCEANOGRAPHY

Introduction

Ultimately, physical factors determine the characteristics of the marine environment. To start, the ocean is salt water bounded either by the coast or, in estuaries, by the interface between sea water and fresh water. Marine influences can extend inland as salt wedges (where salt water intrudes into fresh water) along river beds or as maritime air masses carried by wind. The marine environment forms habitat for marine life such as birds, mammals, fishes, invertebrates, algae, and micro-organisms at the bottom of the food web. Such life forms may spend their entire lives in the Arctic marine environment, live between fresh water and salt water, or migrate north for the short summer season and return south again as winter sets in. The Arctic marine environment is an important element of the Inuit world, providing food through the harvesting of many of the animals that live at sea, providing ease of travel over water and ice, and playing a critical role in Indigenous culture and well-being. The habitats of the ocean are constrained by physical factors such as water temperature, salinity, depth, currents, tides, the presence or absence of sea ice, seabed topography, seabed geology, and more. This section describes some of these influences and why they matter in the Arctic.

Ecological significance

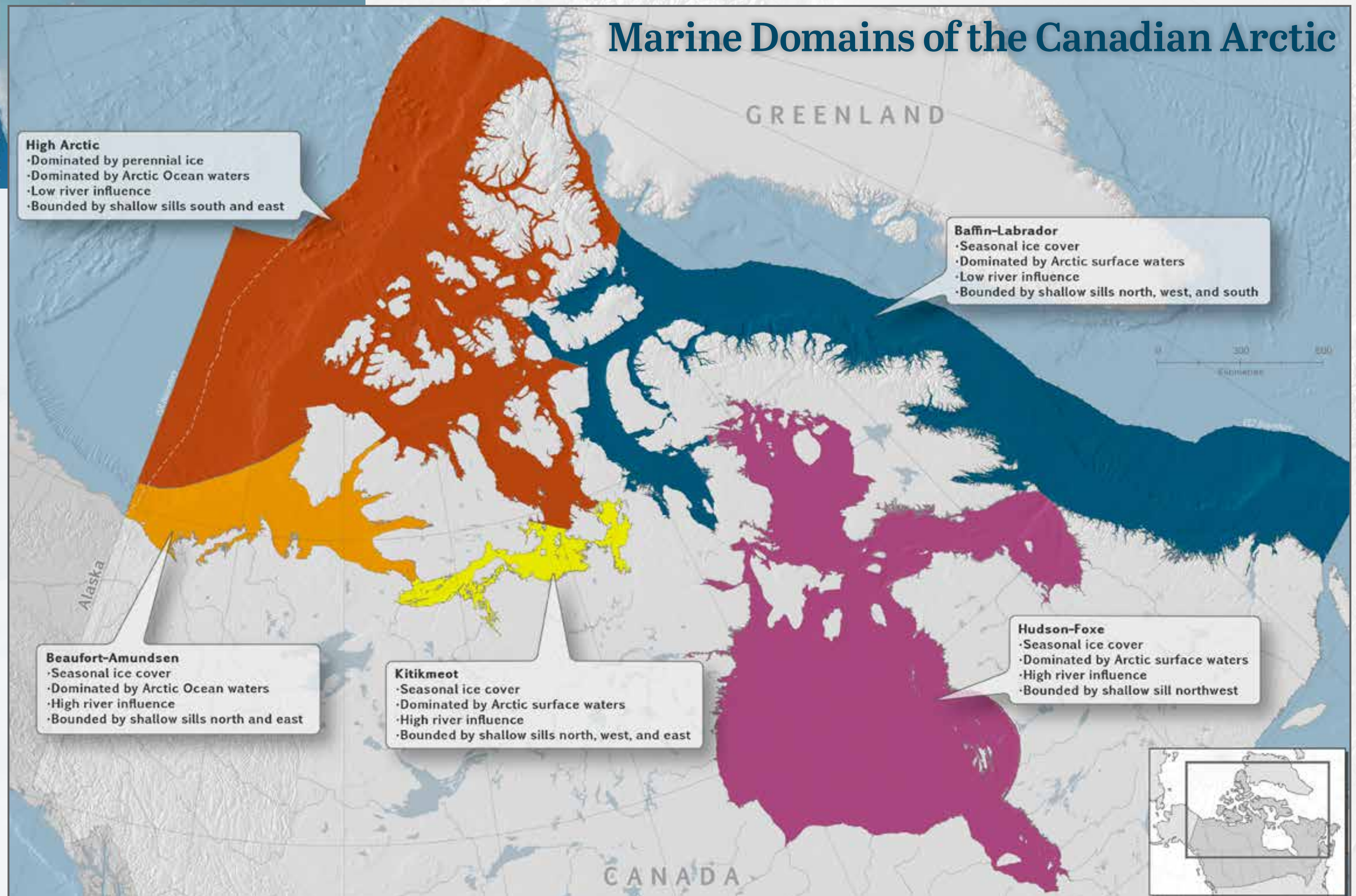
The Arctic marine environment can usefully be defined as waters affected by the presence of sea ice, either seasonally or year-round. A hard cap of ice on top of the water column has far-reaching effects on biology and climate in the Arctic. Marine mammals must get through the ice to breathe. Certain algae flourish on the underside of the ice, forming the bottom of the Arctic food web. Inuit use sea ice as a platform for travel and for hunting, relying on traditional knowledge to stay safe and to find and harvest seals and other animals. Sea ice reflects much more sunlight than does open water, helping keep the polar regions cool and thereby regulating Earth’s climate. As summer sea ice continues to retreat, Canada’s High Arctic is expected to be the last region where it is found.

The Canadian Arctic marine environment varies regionally, and local differences are important. Sea water that flows into, through, and out of the Canadian Arctic creates a range of conditions for living things. Rivers add fresh water, and in some places heat, to the seas into which they flow, creating specialized brackish habitat that varies with the seasons. Some fishes and marine mammals flourish in these mixed waters, whereas other organisms must avoid them to survive. Other factors such as ice cover and oceanic water masses allow the identification of five broad oceanic domains in the Canadian marine Arctic, as illustrated on this page.

Gaps in current knowledge

As outlined in this chapter, we have a general knowledge of the physical oceanography of the Canadian Arctic, but much remains to be discovered and understood. One challenge is the difficulty of reaching much of the area. Another is the current rate of environmental change, which may limit the application of past knowledge to the present and future. Constant factors are the region’s landforms and tides, which are driven by the moon and the sun, but factors that are changing, such as summer sea ice and river flow, affect sea water temperature and chemistry. This atlas provides a snapshot, but ocean monitoring and further research is essential to document how change is affecting marine life and those who depend upon it.

Facing page: Meltwater pool at base of iceberg with crack in the ocean sea ice in spring, Baffin Island, Nunavut. (photo: Louise Murray)



DATA SOURCES
- Domains: H. Melling pers. comm. 2017.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

Rationale for the features included

The sea is shaped by many influences small and large. For this atlas, we have chosen to present some of the most prominent of these influences and also ones for which we have relevant data. These include the landscape of the seabed, which shapes the ocean in extent and depth; sea ice, the defining characteristic of Arctic marine waters; the sources of sea water, which determine much of its chemical and physical properties; surface currents, which affect how water, ice, and planktonic organisms move; tides, which in some areas are important local energy sources; and storms, the dominant energy source driving ocean currents, ice drift, and mixing. We also consider how local and regional conditions create unique conditions on a small scale.

For further reading, see p. 106.

LANDSCAPE OF THE SEABED

TWO MAIN FACTORS MAKE SEAWATER more or less dense: temperature and the salinity. The seawater of greatest density at any place in the ocean eventually sinks to the seabed. There, ridges called sills tend to block the flow of the densest water, and valleys tend to channel it. For this reason, the shape and geography of the seabed determine where sea water can move and what path it takes. Knowledge of the seabed landscape is therefore critical to understanding the oceanography of any region.

Ecological significance

Because seabed landforms constrain the movement of ocean water, they also influence the characteristics of sea water and planktonic life that can reach any particular area of the ocean.

The main features of the seabed are the coastline, where water depth is zero; the relatively shallow continental shelves; banks, which are shallow shelf areas surrounded by deeper water; the shelf break, where the continental shelf ends and the seabed slopes steeply downward; basins, which are many times deeper than shelves or banks; and sills, which are the marine equivalent of mountain passes. Just as climbers find it easiest to cross mountains through passes, so deep ocean waters most easily cross between basins at sills.

The Canadian marine Arctic encompasses two deep basins—Canada Basin and Baffin Bay—separated by a broad, shallow continental shelf—the Canadian Polar Shelf. In the southeast, Baffin Bay is separated from a third basin—Labrador Basin—by a broad and relatively deep sill. Hudson Bay and James Bay, which are commonly overlooked as areas of the Canadian marine Arctic, actually occupy an appreciable fraction of the Canadian Polar Shelf. If we consider just the sills of the Canadian Arctic, it is clear that the Canadian Polar Shelf is a complicated place. Its glacial history has rendered it studded with both islands and sills. The most obvious seabed landforms are a necklace of sills along the northwestern edge of the Canadian Polar Shelf that rise to within 300 to 400 m of the sea surface and a cluster of sills near the centre of the shelf that rise even higher, within 15 to 220 m of the sea surface.

Major concerns

Changes in seabed landforms of the Canadian marine Arctic occur via geological processes that operate slowly by human standards. The principal factor in play is the slow uplift of the seabed that began when the huge burden of ice sheets vanished at the end of the most recent ice age. Continuing uplift causes water depth to decrease and relative sea level to drop by as much as 1 m per century in some areas.

Facing page: A shallow bay on the coastline of the Inuvialuit Settlement Region. (photo: Jennie Knopp)

Landscape of the Seabed

Gaps in current knowledge

Even preliminary seabed surveys are lacking over wide areas of the Canadian marine Arctic. This is particularly so in remote icebound northern areas and in coastal areas—nearshore regions, estuaries, bays, fjords—which are of great importance to people whose livelihood comes from the sea. Incomplete knowledge of seabed landforms restricts scientists' understanding of the functioning and vulnerability of Canadian Arctic marine ecosystems. Marine ecology is also influenced strongly by seabed sediments, but information on Arctic sediments is very sparse.

LANDSCAPE OF SEABED DATA SOURCES
- *Bathymetry: The GEBCO_2014 Grid, version 20150318, Retrieved from: www.gebco.net.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

PRINCIPAL SILLS OF THE CANADIAN ARCTIC DATA SOURCES
- *SIlls: H. Melling pers. comm. 2017.*
- *Bathymetry: The GEBCO_2014 Grid, version 20150318, Retrieved from: www.gebco.net.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

SEAWATER SOURCES AND SURFACE CURRENTS

THERE ARE THREE MAIN TYPES OF WATER within Canada's Arctic seas: (1) fresh water originating as snowfall, rainfall, or inflow from rivers; (2) sea water from the North Pacific Ocean; (3) sea water from the North Atlantic Ocean. These waters are identifiable by their salinity, temperature, and concentration of dissolved nutrients, all characteristics that are essential to the functioning of marine ecosystems. In places where all three types are present, as in Canada's Arctic seas, the fresh water floats on top, the Atlantic water sinks down deep, and the Pacific water slips in between.

The depths where each of these waters resides in the Arctic depend on how much of each type is present. In the Canadian Arctic, waters vary with depth from low salinity (0% to 2.8%) at the surface, warm (0°C to 10°C) in summer and cold (-1.8°C to 0°C) in winter; through a thick layer of increasing salinity (the halocline) which is warmer (-0.5°C) near the top (Pacific Summer Water) and colder (1.5°C) and nutrient rich lower down (Pacific Winter Water); and continuing into a thick, warm (0.3°C to 1°C) layer of high salinity (3.4% to 3.5%) that is relatively poor in nutrients (Atlantic Water).

There is a net flow from west to east through the islands of the Canadian Arctic, as Arctic and Pacific waters travel east toward the Atlantic, driven by the Pacific's higher sea level. In the west, the average pattern of wind maintains the Beaufort Gyre, which moves water and ice clockwise around the Beaufort Sea, forcing ice against the western islands of the archipelago in the north and dragging it westward in the south. Arctic and Pacific waters moving onto the Canadian Polar Shelf in this area flow through the narrow channels between islands and enter Baffin Bay through Smith, Jones, and Lancaster Sounds, or enter Hudson Bay through Foxe Basin. In Baffin Bay, as almost everywhere else on the Canadian Polar Shelf, shore-hugging currents flow in opposite directions on opposite sides. The north-flowing West Greenland Current meets Arctic Ocean and Pacific waters emerging through Smith, Jones, and Lancaster Sounds. The combined flow turns southward along the east coast of Baffin Island as the Baffin Current. Currents in Hudson Bay circulate counter-clockwise, with a net outflow of water through Hudson Strait into the Labrador Sea.

Ecological significance

Phytoplankton (single-celled marine plants) bloom under sea ice and in surface waters when the sun returns to the Arctic in spring, but quickly consume the nutrients available there. Later renewed blooms during summer and autumn require fresh deliveries of dissolved nutrients to the photic zone (waters that sunlight can reach) from the underlying Pacific Water layer. These can occur over wide areas by the mixing action of storms, in shallow narrow channels by the action of tides, and in areas of steep sloping seabed through the process of upwelling, caused by storm winds from certain directions.

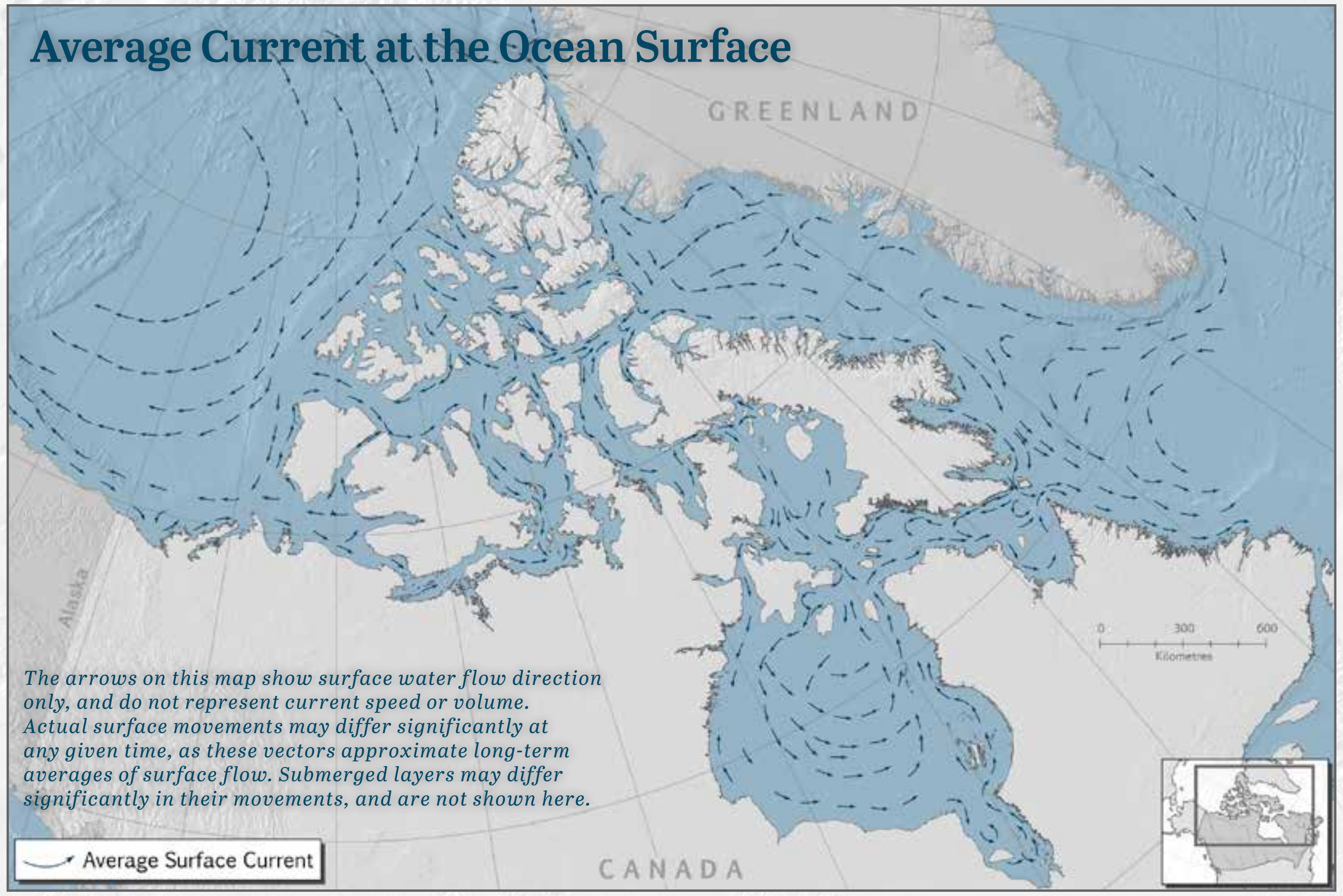
Sills on the seabed block the flow of water that resides below the depth of their crests. Water of a specific type can only flow to a given location if its entire path is at least as deep as the shallowest depth of that type. Because of the high nutrient concentrations of Pacific water, the areas isolated from its inflow are of particular interest. Where sills are shallower than the layer of Pacific Water, the seas behind those sills may never receive nutrient-rich inflowing water, as is the case for the Kitikmeot Sea (Coronation Gulf, Dease Strait, Queen Maud Gulf).

Major concerns

We lack the knowledge to predict how global change might affect a large range of factors related to water masses in the Arctic. These factors include future wind patterns across the Arctic that drive ice and ocean movements; inflow/outflow rates of the three principal water types and their "choice" of outflow pathways; stored volumes of each water type, which affect their depths of occurrence and therefore the influence of sills on their movements across the shelf; and ice cover, which influences mixing of waters, as well as others.

Facing page: Grinnell Glacier, Baffin Island. (photo: David Henry)

DATA SOURCES
- *Average Surface Current: Modified from Environment and Climate Change Canada 2015. Arctic average water currents. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/ice-forecasts-observations/latest-conditions/climatology/arctic-average-water-currents.html ; H. Melling, pers. comm. 2017.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*



Areas of Pacific Water Influence

Areas of Atlantic Water Influence

Areas of Arctic Water Influence

AREAS OF PACIFIC, ATLANTIC AND ARCTIC WATER INFLUENCE DATA SOURCES
- *Seawater Extents: H. Melling pers. comm., 2017, based on depth thresholds using GEBCO_2014 Grid, version 20150318, www.gebco.net.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*

SEA ICE AND ITS VARIATION

EXTENSIVE ICE COVER during at least part of the year is the defining characteristic of the Canadian Arctic seas. The ice forms as sea water freezes during cold winter temperatures. In Canada's extreme North it reaches more than 2 m thick between September and early June. Ice colliding with shorelines or other ice can break into fragments, which become stacked into thick meandering piles known as ridges. Ridges can attain a thickness of 10 m even very early in winter and may reach 30 m or more by winter's end. Along coastlines, ice that is thick and strong enough to resist the forces of winds and currents can stop drifting and become fast ice. The channels among islands on the Canadian Polar Shelf are unique in harbouring vast expanses of fast ice every winter. Broadly speaking, ice that remains adrift moves southwest on the Arctic side of the Canadian Polar Shelf and southeast on the Atlantic side. Around Hudson Bay, ice circulates counter-clockwise with some exiting via Hudson Strait, through which ice also enters intermittently. Sea ice that does not melt in summer thickens during subsequent winters and is known as multi-year ice. Most of the Arctic's multi-year ice is found in Canadian waters.

Ecological significance

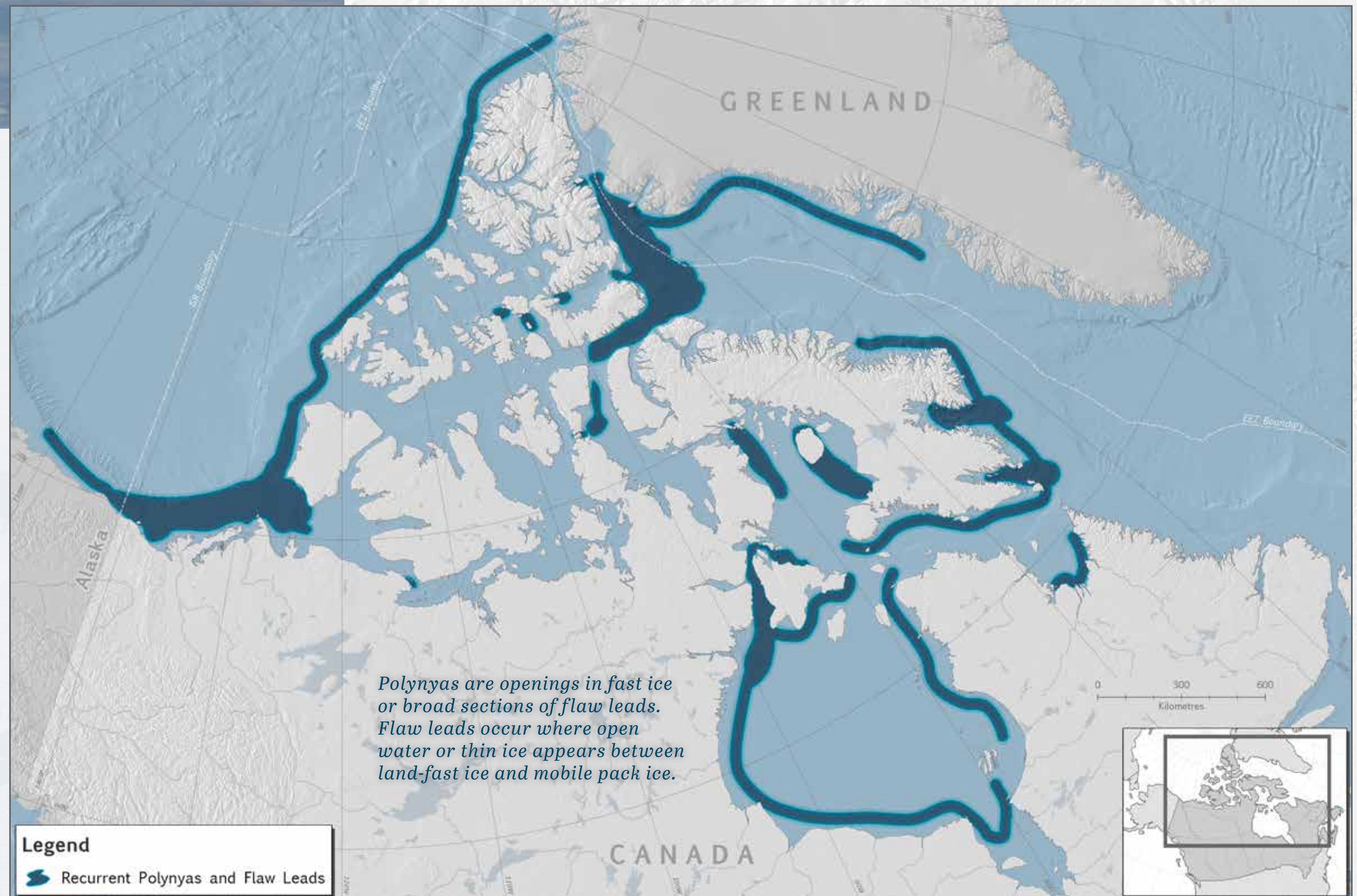
Sea ice has a dominant impact on all aspects of Arctic marine ecosystems. It is itself a habitat for life—bacteria, phytoplankton, zooplankton, fish, seals, walrus, birds, whales, foxes, polar bears, and Inuit. Its presence reduces the penetration of life-giving sunlight into ocean water. As it moves, its rough texture helps mix dissolved nutrients into the surface photic zone from deeper in the ocean. However, melting ice in summer impedes such mixing by forming a layer of brackish surface water. The solidity of ice provides support for mammals that walk (bears, foxes) and seabirds, but at the same time it impedes easy access to marine food sources. Its presence protects marine mammals from topside predators but may also isolate these same creatures from life-giving air. When winds are favourable in winter and spring, polynyas or flaw leads form along the edge of fast ice. These areas of thin ice or open water foster blooms of plankton early in spring and provide sanctuary for creatures needing both ocean and atmosphere to survive.

Major concerns

Because sea ice has such a controlling influence on Arctic marine ecosystems, it is safe to state that these ecosystems will be strongly influenced by observed and expected changes in sea ice conditions. However, statistically significant trends in ecosystem characteristics are elusive, and computer simulations of coupled ocean/ecology systems are only now under development.

Facing page: Seasonal sea ice in the Inuvialuit Settlement Region. (photo: Jennie Knopp)

Areas of Recurrent Polynyas and Flaw Leads of the Canadian Arctic

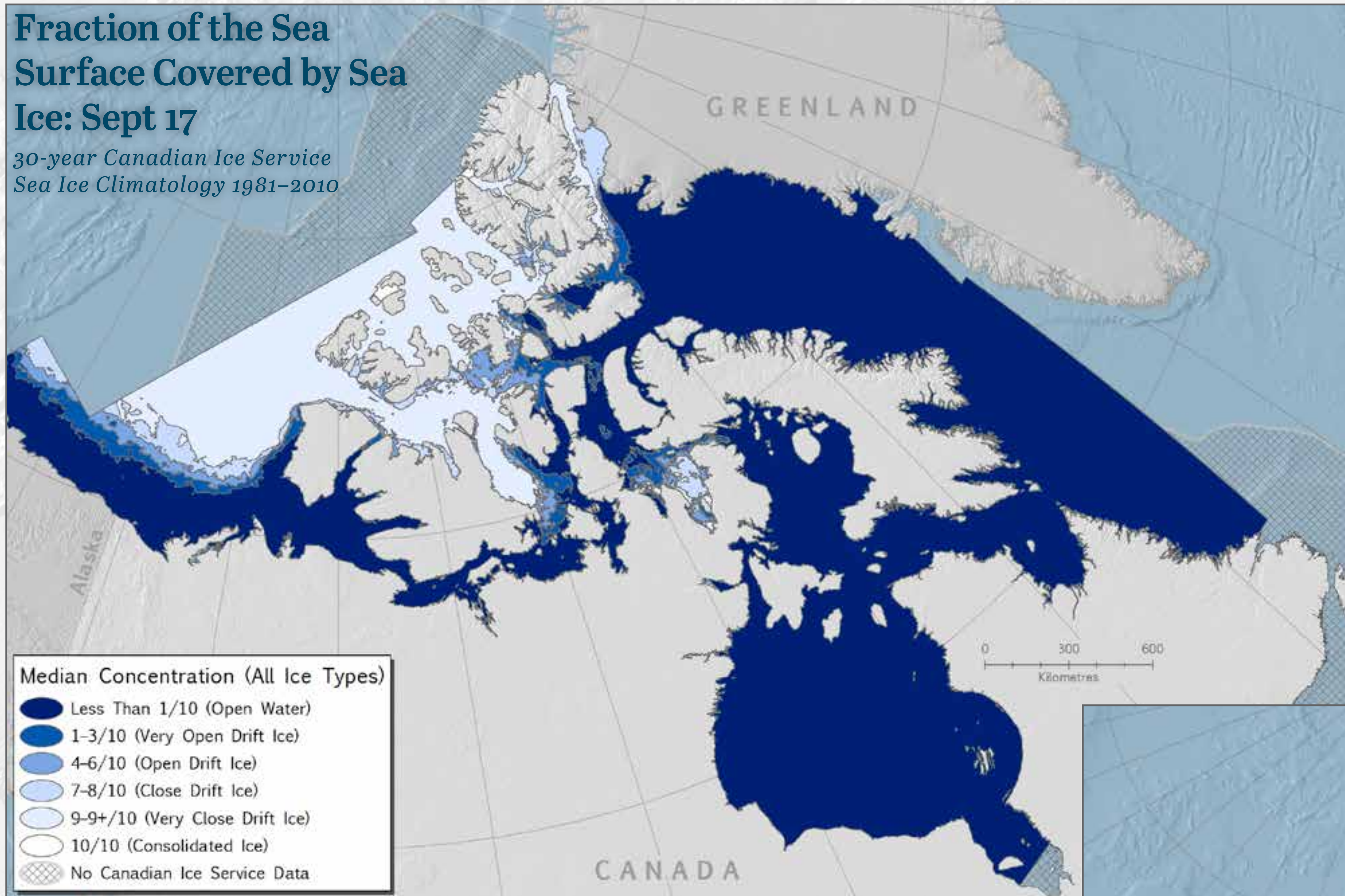


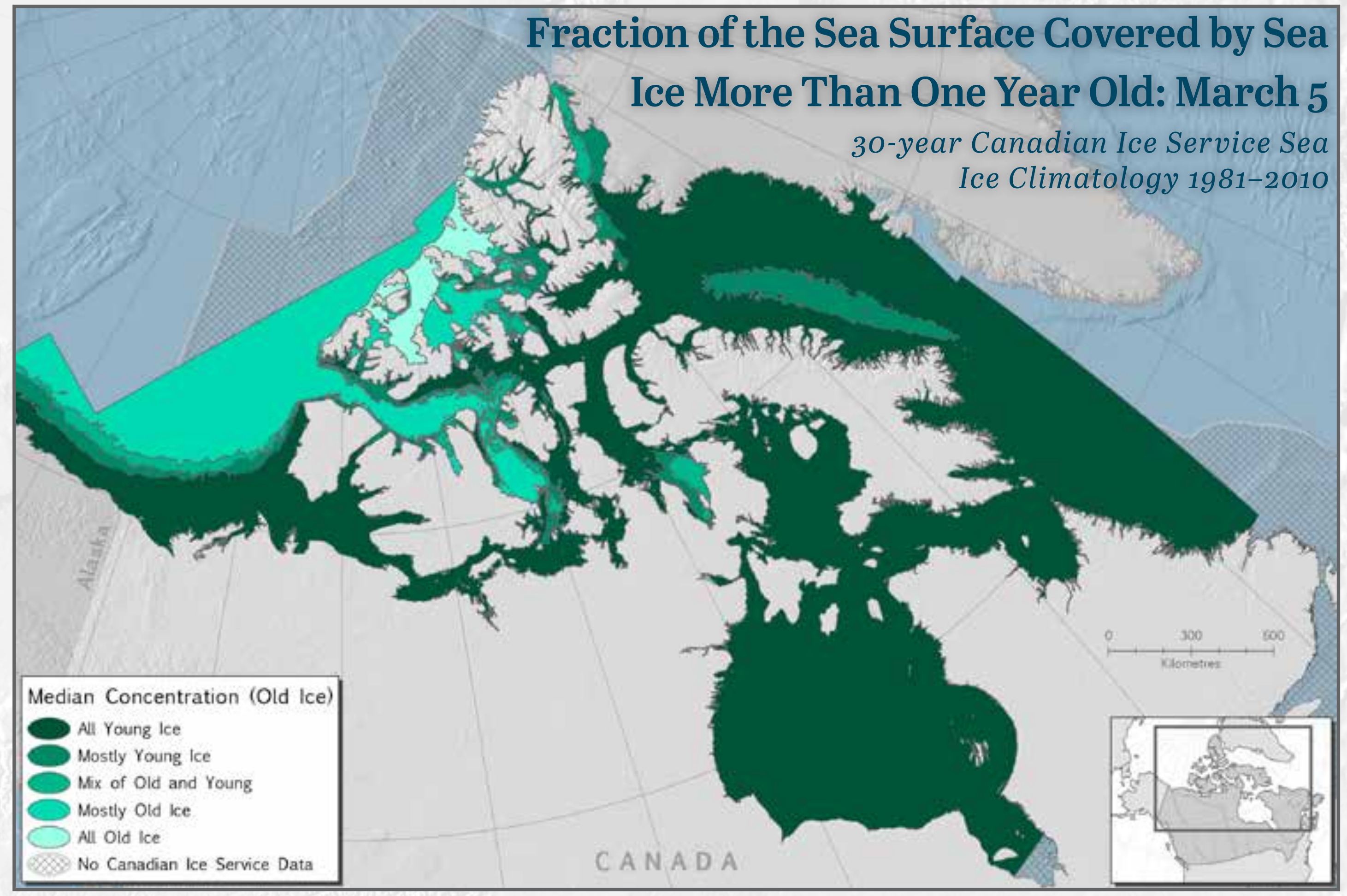
DATA SOURCES

- *Polynas and Flaw leads: Modified by Melling and Camack, 2017, based on maps from: Hannah, Charles G., et al. 2009. Polynyas and Tidal Currents in the Canadian Arctic Archipelago. Arctic 62(1): 83–95; Meltofte H. (ed.) 2013. Arctic Biodiversity Assessment. Status and trends in Arctic biodiversity. Conservation of Arctic Flora and Fauna, Akureyri.; Barber, D.G. and Massom, R.A. 2007. The Role of Sea Ice in Arctic and Antarctic Polynyas. In Smith, W. and Barber, D. (eds). Polynyas: Windows to the World. Elsevier Oceanography Series: The Netherlands; Melling and Camack 2017, pers. Comm.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Gaps in current knowledge

Accurate estimates of trends in sea ice conditions require accurate observations sustained over decades. Existing ice monitoring programs should be continued to provide the needed level of confidence. Knowledge of ice-linked trends in marine ecosystems lags far behind that of trends in the ice itself. There is a strong rationale for initiating strategic long-term monitoring of key ecosystem elements in the Canadian marine Arctic.



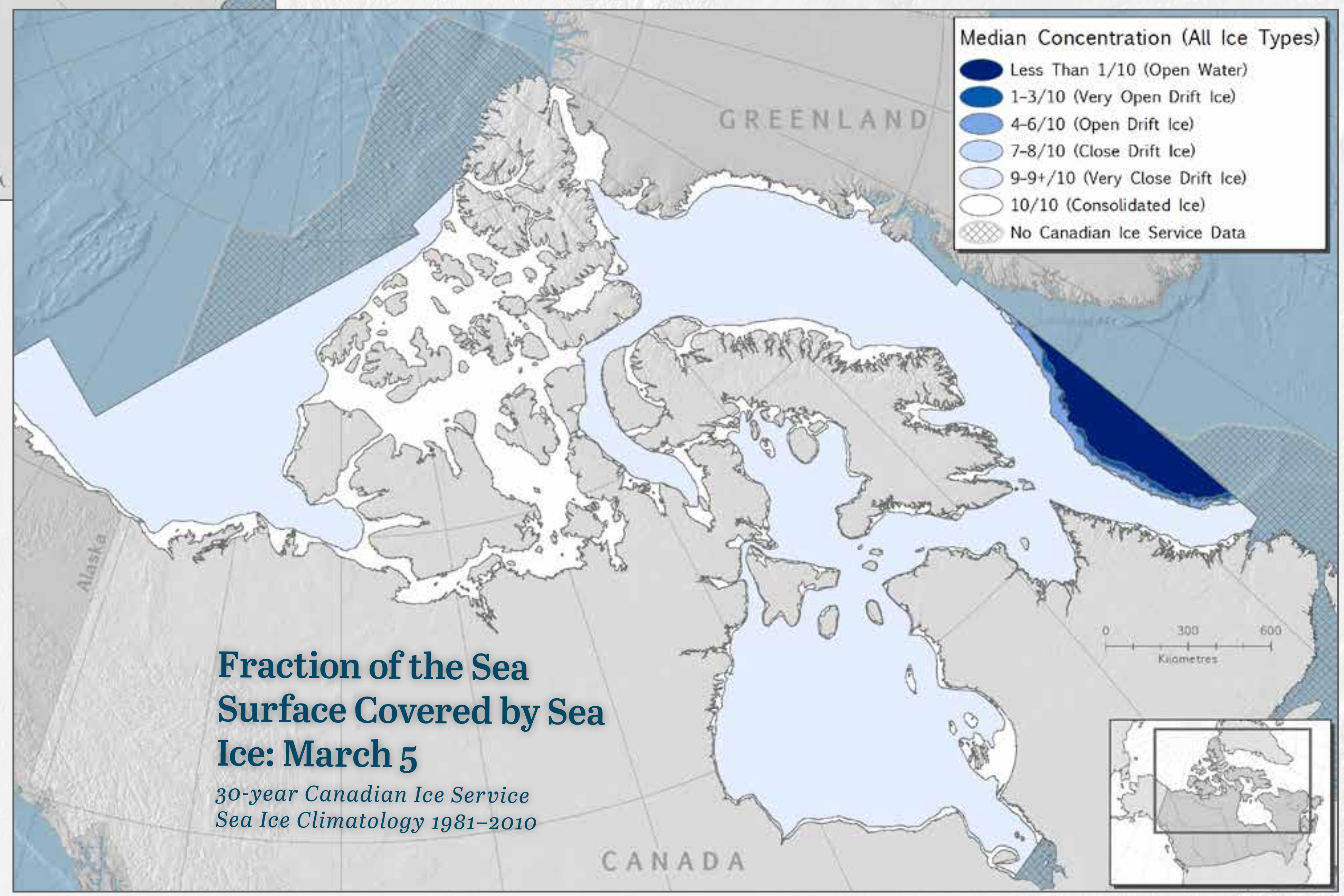


Fraction of the Sea Surface Covered by Sea Ice: Sept 17 (Above)
The date of least annual Arctic sea ice extent is typically mid-September but the minimum extent varies from year to year.

Fraction of the Sea Surface Covered by Sea Ice: March 5 (Right)
The date of greatest Arctic sea ice extent is typically late March, but that extent can vary from year to year. White areas denote fast ice that is immobile for much of the winter. Other areas are pack ice which remains mobile.

Fraction of the Sea Surface Covered by Sea Ice More Than One Year Old: March 5 (Facing Page, Above)
Some sea ice lasts through the summer melt and persists for years. This ice provides travel routes for some animals through the summer but is also very hazardous to ships travelling through Arctic waters because it is harder than younger ice.

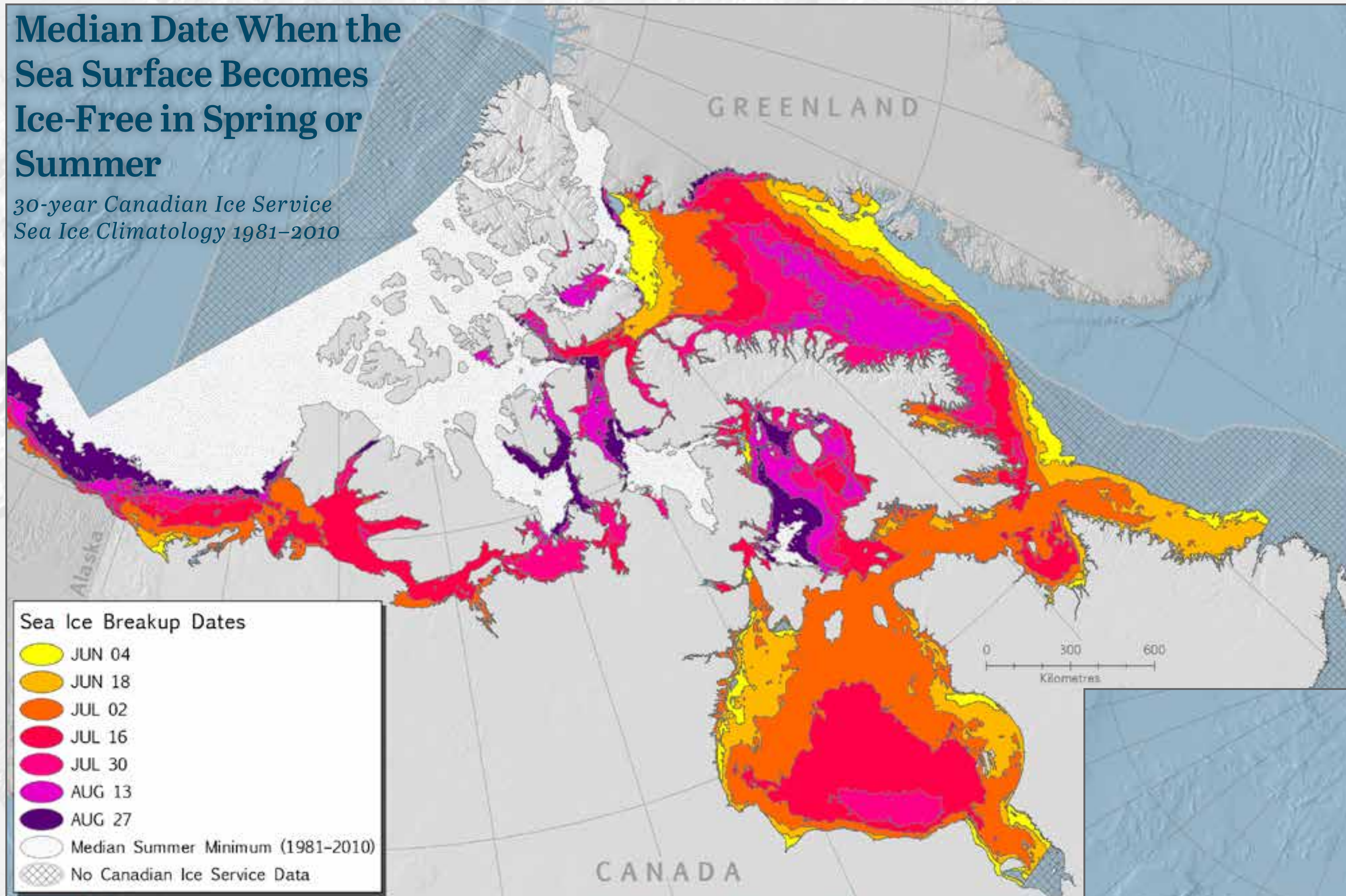
Note: Median summer ice minimum is the middle minimum extent, where the annual minimum ice coverage has been greater than this extent in half of past years and less than in the other half.



SEA ICE DATA SOURCES
- *Sea Ice: Canadian Ice Service (CIS). 2011. Climatic Ice Atlas (1981-2010). http://iceweb1.cis.ec.gc.ca/30Atlas/*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

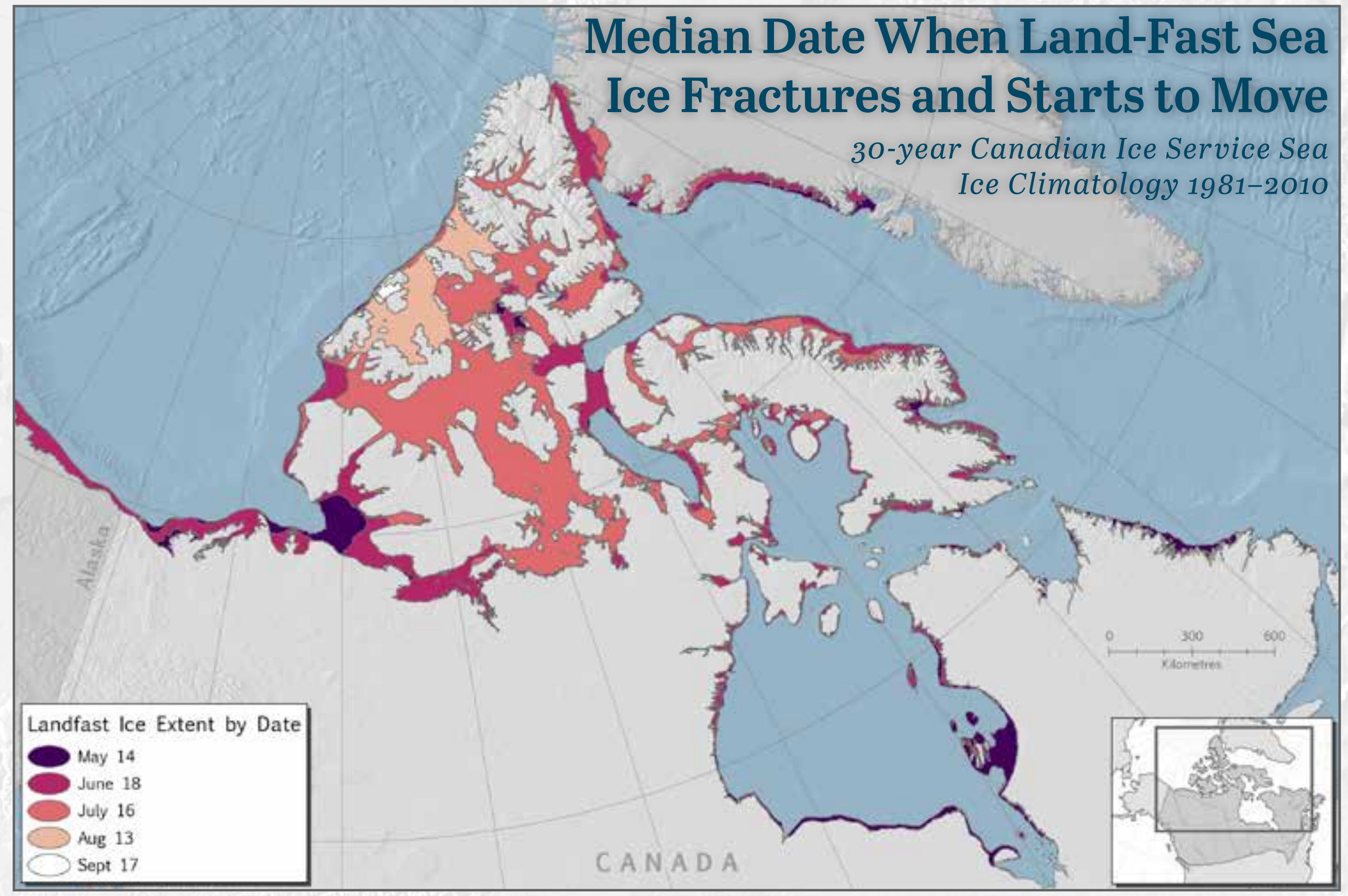
Median Date When the Sea Surface Becomes Ice-Free in Spring or Summer

30-year Canadian Ice Service Sea Ice Climatology 1981–2010



Median Date When Land-Fast Sea Ice Fractures and Starts to Move

30-year Canadian Ice Service Sea Ice Climatology 1981–2010



Date When the Sea Surface Becomes Ice-Free in Spring or Summer (Above)
The clearance of ice in the spring and summer is an event of significance for seabirds and large marine mammals since these organisms need open seas to feed or to breathe.

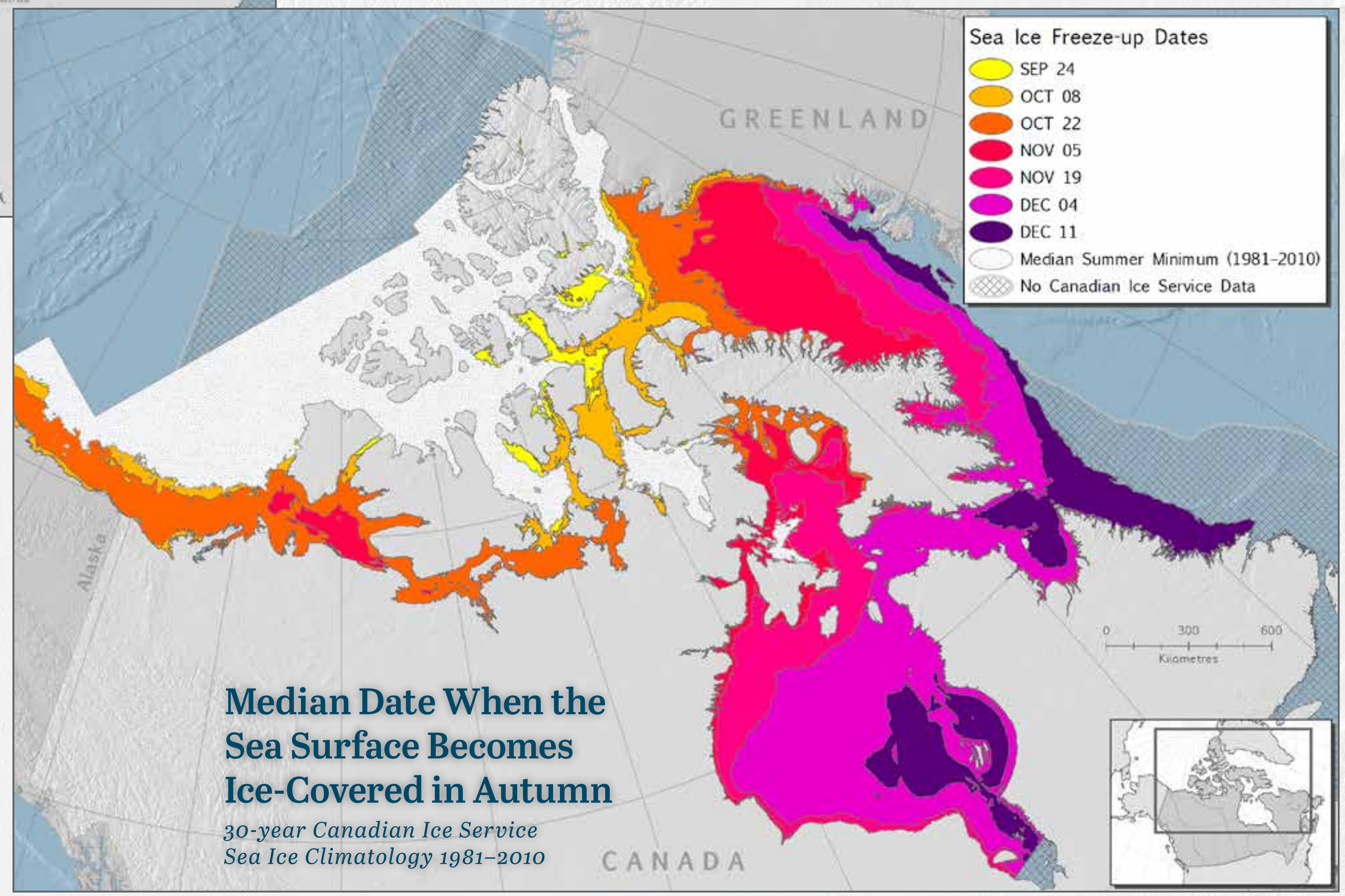
Date When the Sea Surface Becomes Ice-Covered in Autumn (Right)
As the sea surface progressively freezes after the sea ice minimum in September, areas accessible to large marine mammals shrink and less sunlight reaches the ocean water.

Date When Land-Fast Sea Ice Fractures and Starts to Move (Facing Page, Above)
The fracture and renewed movement of fast ice in the spring re-opens marine areas that were inaccessible to some creatures during winter months. On the other hand, it reduces opportunities for travel over sea ice and releases heavy ice into Arctic shipping lanes.

Note: Dates of these events have been earlier than the median in half of all past years and later in the other half.

Median Date When the Sea Surface Becomes Ice-Covered in Autumn

30-year Canadian Ice Service Sea Ice Climatology 1981–2010



SEA ICE DATA SOURCES
- *Sea Ice: Canadian Ice Service (CIS). 2011. Climatic Ice Atlas (1981-2010). http://iceweb1.cis.ec.gc.ca/30Atlas/*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Aerial view of iceberg grounded in shallow rapids during tidal rip in Wager Bay, Ukkusiksalik National Park. (photo: Paul Souders)

TIDES AND THEIR EFFECTS

TIDES ARE THE REGULAR VARIATIONS OF SEA LEVEL related to the positions of the sun and the moon, their gravitational pulls, and the rotation of the Earth. The gravity of the sun and the moon pulls Earth's sea water toward them, creating bulges that move around the Earth as the planet rotates beneath them. In a tidal cycle, sea level varies from low to high and back again. Cycles with the largest tidal range occur over approximate intervals of either 12 or 24 hours. Other, more subtle astronomical influences create weaker tides at longer periods—half-monthly, monthly, every six months, or every 12 months.

Irregularities in the depth and shape of ocean basins modify the bulges, so that tidal ranges (differences between high and low tides) are larger in some areas than in others. In the Arctic, changes in the ice cover between winter and summer cause changes in the tidal range and arrival time.

The rapid movement of the tidal bulges of sea water around the Earth creates tidal currents. These flow back and forth over the same intervals as the sea level changes that drive them.

Ecological significance

Tides are responsible for the intertidal zone, one of the marine habitats of the coastal ocean, alternately exposed and flooded by changing sea level twice each day. The width of the intertidal zone depends upon the tidal range and upon the slope of the seabed. It is narrow on steep shores and wide on gentle ones.

Tidal variation raises and lowers sea ice near shorelines, maintaining cracks between ground ice (nearshore) and floating ice (on deeper water). These cracks provide breathing opportunities for seals and hunting opportunities for polar bears.

The flow of tidal currents over the seabed and under the ice generates swirls and eddies in the water that mix possibly warmer and more nutrient-rich water from deep down into the surface layer, where life-giving sunlight can reach it. An upward mixing of nutrients can restore the productive capacity of surface waters in summer and sustain biological hotspots nearby. An upward mixing of heat can reduce the thickness of winter ice and create small polynyas providing better winter habitat for walrus and seals and facilitating earlier break-up in spring. This can occur even under fast ice because wind action is not required.

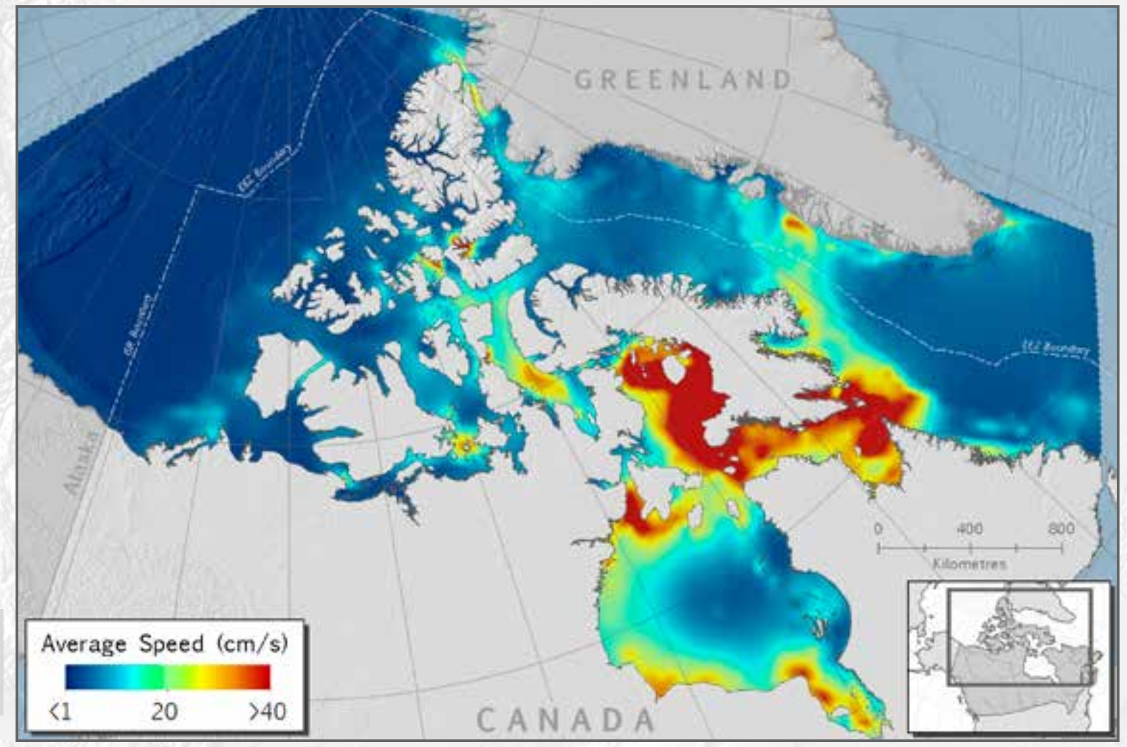
Major concerns

Because tides are driven by astronomy, not climate or human activity, there is no concern about change in tides. However, the ecological effects of tides are focused in small polynyas in fast ice and on biological hotspots; thus the impact of tides could possibly change as sea ice thins (polynyas could become larger and open earlier) or as the locally stored heat and dissolved nutrients in the water column change in amount or depth. It is difficult to predict how such things might change.

Gaps in current knowledge

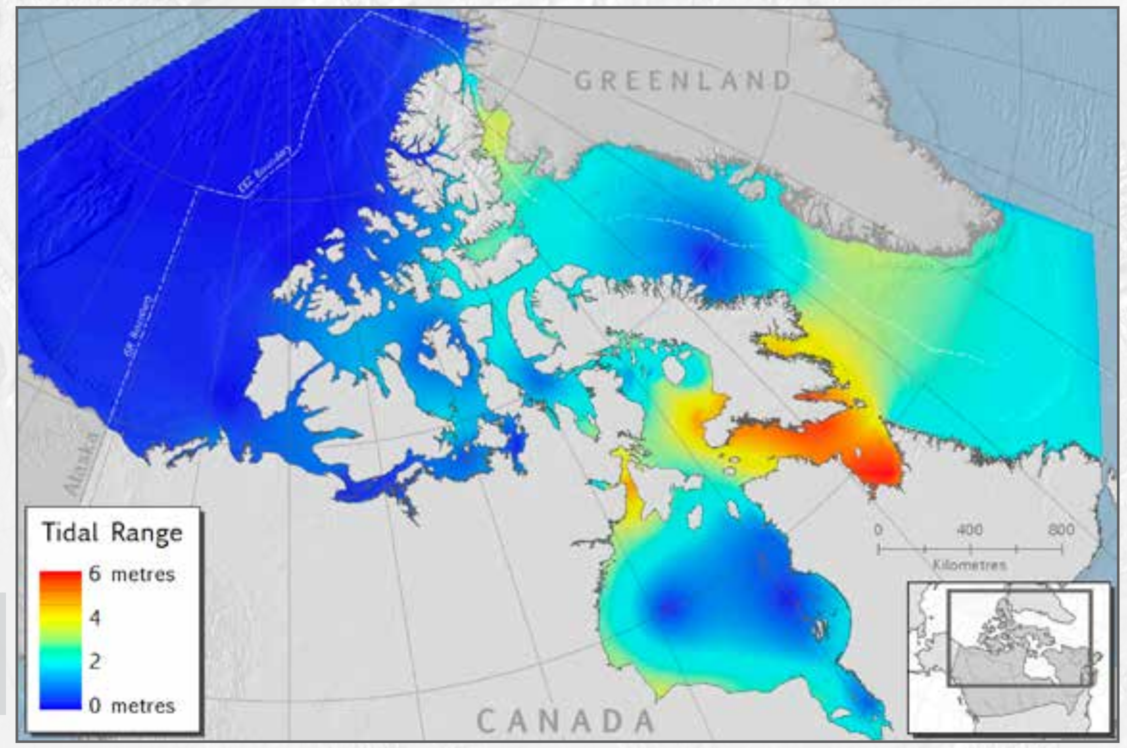
The principal missing element in current knowledge is the detailed landscape of the seafloor, namely its depth and topography. Existing survey coverage is spotty and sparse in navigable waters and generally missing where tides are strongest—nearshore areas and in bays, inlets, fjords, and narrow channels.

Energy in the Tidal Current, Averaged over a Lunar Cycle



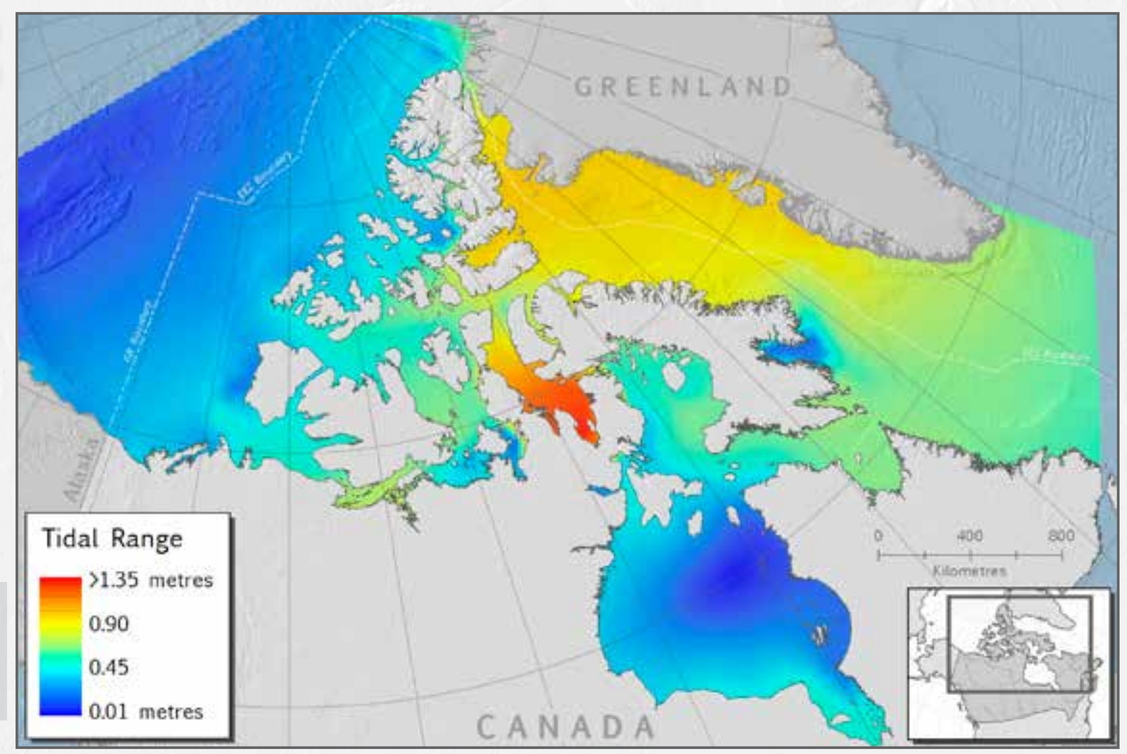
DATA SOURCES
- Average Tidal Current Speed: Derived from WebTide Tidal Prediction Model (v0.7.1).
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

Change in Sea Level with the Dominant Half-Daily Tide



DATA SOURCES
- Tidal Range: Derived from WebTide Tidal Prediction Model (v0.7.1).
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

Change in Sea Level with the Dominant Daily Tide



DATA SOURCES
- Tidal Range: Derived from WebTide Tidal Prediction Model (v0.7.1).
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

STORMS AND THEIR EFFECTS

VARIABILITY AND CHANGE IN THE OCEAN are driven by inputs and losses of energy. Arctic waters receive heat energy from the sun when available, kinetic (motion-associated) energy from tides and winds. The fact that the Arctic is distinctively cold and ice covered is primarily a consequence of inequalities between equatorial and polar regions in the inputs and losses of heat energy. Whereas the equator is generously provided with solar energy year-round, the poles receive modest solar input only during summer and radiate appreciable heat to space under clear skies during winter. The ocean's uptake of wind energy is almost entirely from strong winds. For this reason, information on storm winds is more useful to oceanographers than information on average wind.

Ecological significance

The ecological impacts of episodes of strong wind in Arctic marine areas are wide ranging. Such events in succession drive the movements of sea water and sea ice into, around, and out of the Arctic, which in turn maintain the conditions to which Arctic organisms have adapted. Strong wind events facilitate the annual cycle of freeze-up, icescape development, breakup, and decay. Their impact on the recurrent opening and closing of leads and polynyas and on the formation of ice ridges creates the unique ice habitat which is the most obvious feature of Arctic marine ecosystems. Strong winds generate rapid ice drift, powerful currents, and storm waves, all of which accelerate the mixing of surface waters with those beneath, thereby bringing dissolved nutrients from deeper layers into the photic zone. A nutrient-rich photic zone supports the primary production that is the basis of a diverse, productive ocean food web.

Major concerns

Possible changes over time in the Arctic-wide distribution of strong winds, their strength, and their prevalent directions are likely to bring change to the characteristics of ocean and sea ice habitats and to the productivity of the ecosystems that they support. Our understanding of the future storm climate of the Canadian marine Arctic is in its infancy.

Gaps in current knowledge

Scientific knowledge of atmospheric storm systems and the winds that they generate is well-established. Moreover, a worldwide atmospheric monitoring system already exists for forecasting weather. However, the geographic coverage of this system is poorer over oceans than over land, and the Arctic has been monitored for far fewer years than other regions. Knowledge of the attributes of strong winds across the Arctic could therefore be improved.

Rubbled Sea Ice *Storm winds can jam ice floes together, creating bands of rubble ice that can be many kilometres wide.*

An eye-level view of grounded rubble, Beaufort Sea, Spring 2006.

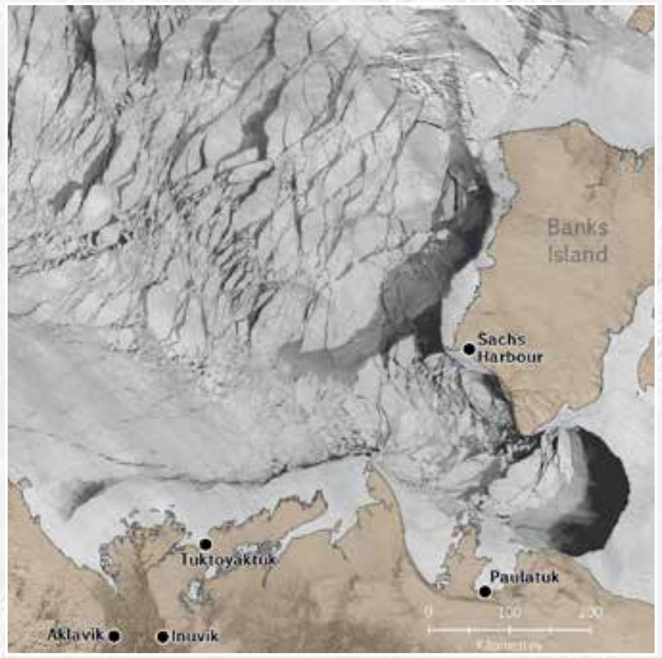
Summertime remnant of the network of ice rubble that stabilized a wide band of fast ice along the Beaufort coast during the preceding winter. (photos: H. Melling)

Facing page: A storm event, Churchill, Manitoba. (photo: All Canada Photos)

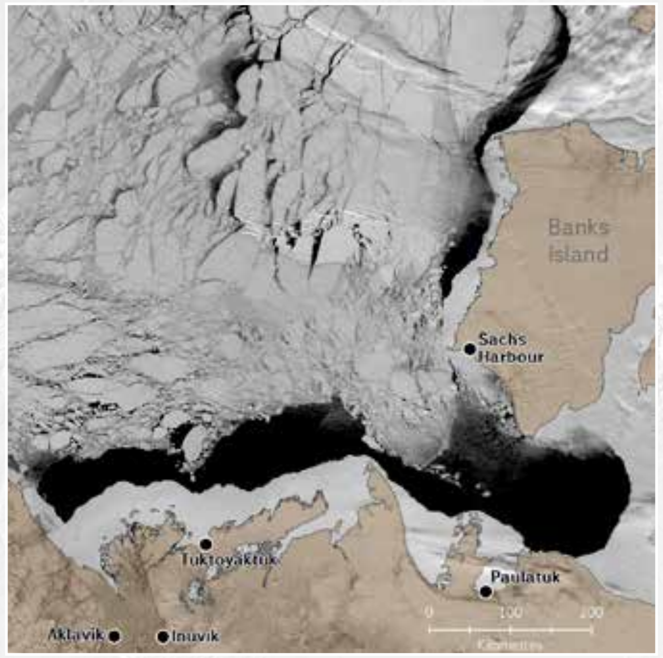
Storm Effects on Sea Ice Cover

Winds blowing seaward during a four-day storm event in April 2015 (seen in graphic at bottom of the page) opened a vast polynya in the eastern Beaufort Sea as seen by satellite imagery from that time (top of the page).

Before Storm Event: 4/19/2015

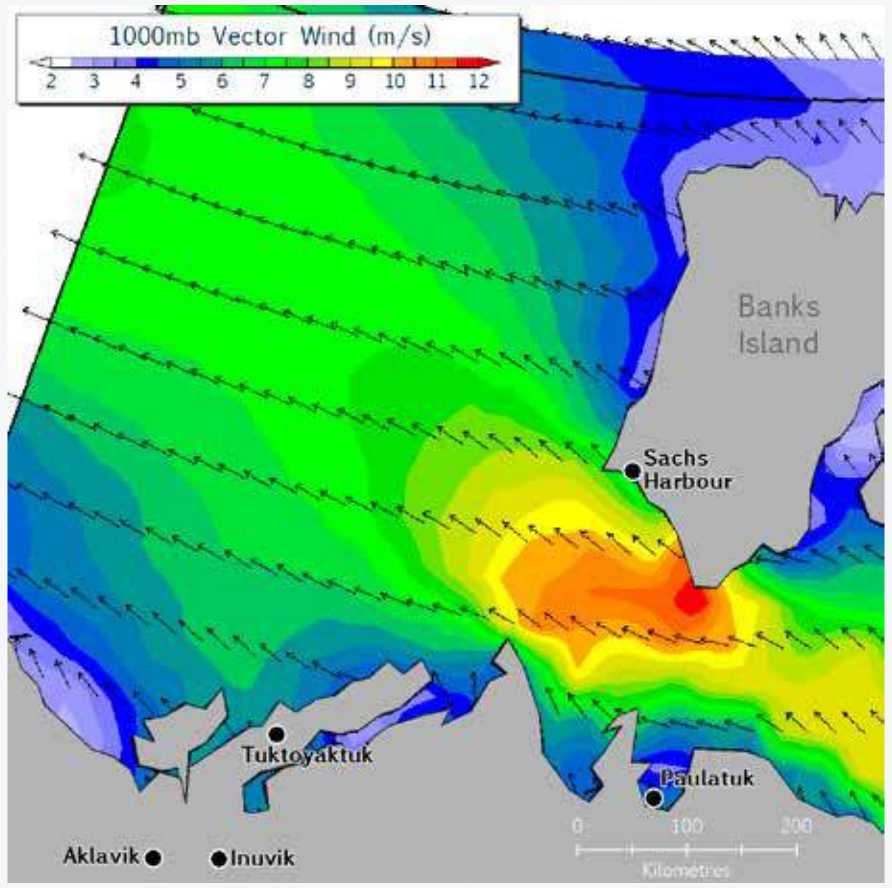


After Storm Event: 4/27/2015



Black areas are open water or ice free.

NCEP North American Regional Reanalysis 1000mb Vector Wind (m/s) Composite Mean



WIND DIRECTION AND SPEED DURING STORM EVENT, APRIL 19–22, 2015

Strongest winds in red.

DATA SOURCES
- *Satellite Images: Enhanced imagery from NASA Worldview.*
- *Graphic provided by the NOAA-ESRL Physical Sciences Division, Boulder Colorado from their website at https://www.esrl.noaa.gov/psd/; Kalnay et al.,The NCEP/NCAR 40-year reanalysis project, Bull. Amer. Meteor. Soc., 77, 437-470, 1996.*

BIG ARCTIC, LITTLE ARCTIC

THE PREVIOUS MAPS have illustrated the physical factors that influence the Canadian marine Arctic environment on a scale of hundreds to thousands of kilometres, including seabed landforms, ice conditions, currents, water masses, tides, and storms. The interaction of these factors has allowed the delineation of the five broad oceanic domains shown on the map at the beginning of this chapter. However, local intensification of these influences creates unique ocean conditions and marine habitat on scales too small to be seen on the maps presented so far in this chapter. Three of many possible examples are provided here.

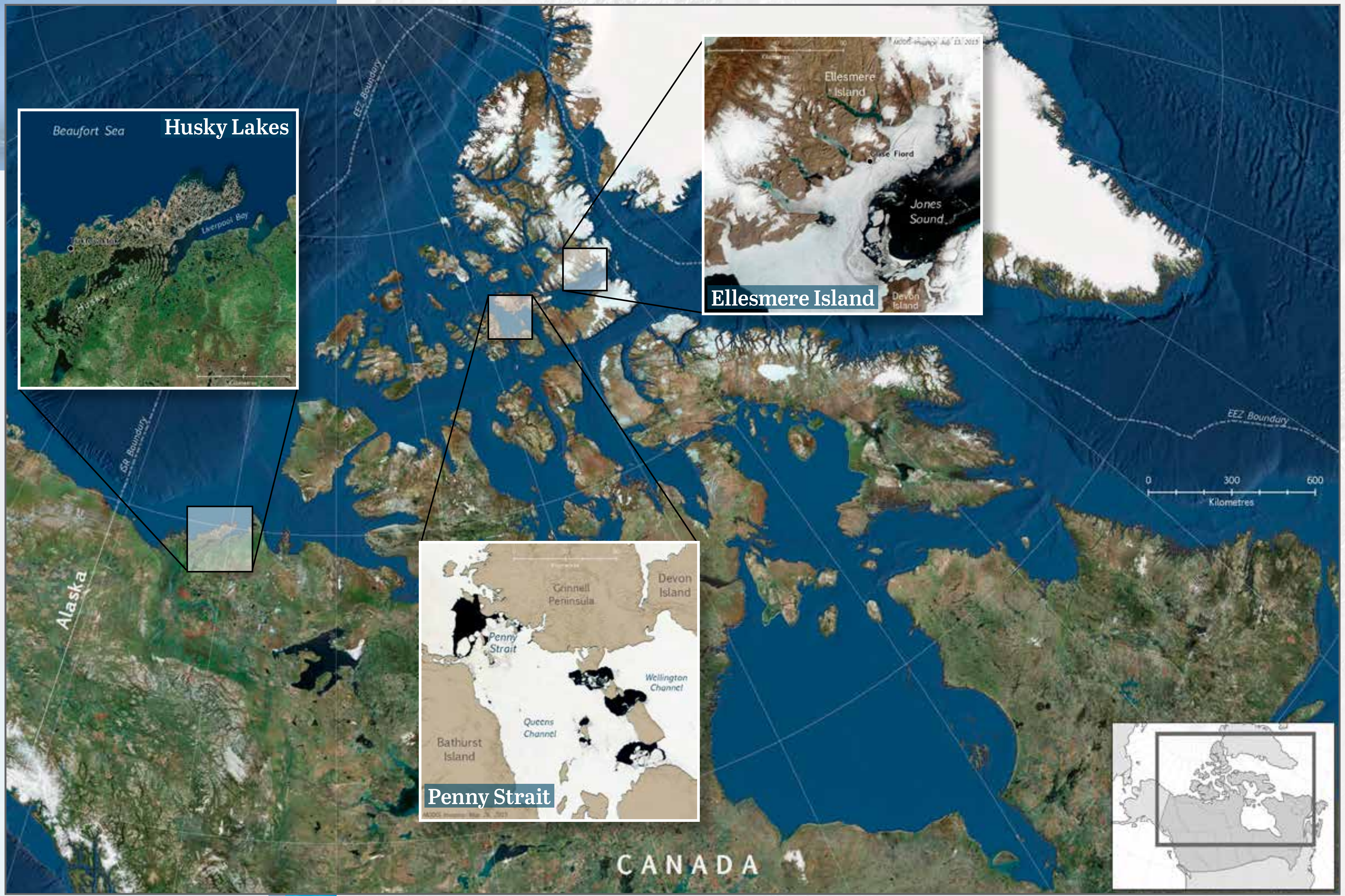
Penny Strait

Penny Strait is a 30-km-wide channel northwest of the central sills of the Canadian Polar Shelf. Currents generated by the tide here and in shallower straits to its southwest are strong (1 to 2 m/s). Whereas Atlantic water that reaches the slopes of the sills from the southeast and the northwest is too deep to flow over the sills, the energy of the tidal current forces it to mix with overlying Pacific and Arctic waters which are shallow enough to cross the sills. The mixing effectively lifts some of the warmth in Atlantic water to the surface, heating the underside of sea ice. The ocean heat reduces ice growth during cold months and accelerates the ice's disappearance months before surrounding ice breaks up. Light ice conditions allow walrus to overwinter here—small patches are almost always ice free—and make living easier for seals, bears, and seabirds. The area of strong tides near Penny Strait is less than 1,000 km2, tiny on the scale of the Canadian marine Arctic, yet ecologically important far beyond its size. Similar conditions occur in a handful of other straits on the eastern Canadian Polar Shelf.

Fjords of southern Ellesmere Island

The fjords of southern Ellesmere Island mark the paths of glaciers that formerly flowed into Jones Sound. The Inuit of Grise Fjord regard one of these, South Cape Fjord, to be an excellent place to hunt seals. Narwhal and seabirds are reportedly common here too. Locally enhanced productivity—the base of the food web—is the usual reason for such aggregations, and the reason for enhanced productivity is frequently an increased supply of ocean nutrients to surface waters. The likely source of nutrients is deeper waters because algae rapidly consume near-surface supplies. Scientists use ice as convenient indicator of nutrient upwelling because deeper water in the Arctic is generally warmer and richer in nutrients than surface water. Surveys have revealed warm water pushed up to the surface within South Cape Fjord, producing anomalously thin ice in winter here and in two other fjords. Research suggests that the interaction of tidal current with a shoal (sill) across the fjord's mouth is the cause of the upwelling, but that not all fjords will be affected in this way.

Facing page: The high hills and glaciers of Ellesmere Island flow into the sea. (photo: David Noton Photography)



DATA SOURCES
- Basemap Data and Husky Lake Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Penny Strait, Ellesmere Island
- NASA Worldview

Husky Lakes

The Husky Lakes estuary is a series of five linked basins that drain into Liverpool Bay in the Beaufort Sea, near the communities of Tuktoyaktuk and Inuvik. The Husky Lakes are separated from the Beaufort Sea by a shallow sill just 4 m deep, and they are ice covered about eight months of the year. The lakes are a unique ecosystem, defined by the mixing of freshwater runoff and the intrusions of salt water from the sea. Due to their varied salinity conditions, the lakes are home to a diverse fish population, including marine, anadromous, and even some freshwater species. Fish use the lakes for spawning, overwintering, and foraging. Beluga whales feed there during the summer. At times, beluga perish in the lakes during autumn when growing ice in connecting waterways blocks their escape to the open sea. The region is economically and culturally important to the Inuvialuit, who use it extensively for hunting, fishing, trapping, and travel.

BOTTOM OF THE FOOD WEB

Introduction

The species that make up the base of the marine food web and those that create important seafloor habitat structure include phytoplankton, zooplankton, sponges, hard corals, soft corals, and sea pens. Phytoplankton live in the upper levels of the water column and under Arctic sea ice. In the Arctic marine environment, zooplankton include crustaceans, such as amphipods and copepods, and floating molluscs, known as pteropods. All these species groups live in the water column, with amphipods forming high concentrations beneath the ice surface. Sea pens can form large fields with dense distribution, while some species of coral are more concentrated along the shelf edges. Corals and sponges are found throughout the Arctic, settling on both hard and soft substrates.

Ecological significance

Phytoplankton get their energy from the sun and from nutrients and form the base that feeds all other marine animals. Seasonal blooms trigger a cascade of feeding, reproduction, and growth in other species, and changes in these blooms in time and size have ramifications throughout the food web. Amphipods beneath the sea ice, while tiny in size, are a significant food source for marine fish and bird species as well as baleen whales, which filter the water to capture the nutrient-rich zooplankton.

Copepods play an important role in transferring energy and lipids from phytoplankton up through the food web. Dead zooplankton also carry carbon and nutrients to the sea floor, creating a food source for bottom-dwelling and bottom-feeding organisms. Large corals and sponges provide structure on the sea floor, giving shelter and habitat complexity to commercially harvested fish (both juveniles and adults) and invertebrates including Greenland Halibut and Northern Shrimp. They are also hosts to many other marine invertebrates and serve as oases, particularly in soft-sediment areas where there is little geological structure. The bamboo coral thickets found in Baffin Bay are globally unique. Sea pens have been found to be used for the deposition of fish larvae, potentially playing an important role in the early life stages of commercially harvested fish.

Cultural significance

Seasonal blooms of phytoplankton serve to concentrate birds, fishes, and marine mammals in key areas, such as polynyas, which are often important hunting areas. Most invertebrate species have little direct cultural significance, except as habitat providers for traditionally and commercially harvested fish and marine mammals. Some clams and mussels are harvested in some Arctic communities, and other invertebrates may be eaten when they are found on the beach after storms and at other times. Most deep-sea corals and sea pens are not used by Inuit, as traditional methods of harvest for other species would not typically have caught corals or sea pens.

Major concerns

Phytoplankton are vulnerable to changing temperature and nutrient runoff from land, and ocean acidification poses a significant threat. Zooplankton are vulnerable to climate change, and major populations can shift with changing sea ice distribution as well as the timing of the annual phytoplankton blooms. There is also some concern that toxins can be taken up by zooplankton and then become further concentrated up the marine food chain, culminating in top predators such as marine mammals. As marine waters become more acidic due to climate change, the shells of crustaceans and pteropods become weaker and easily damaged. The most immediate threat to corals, sponges, and sea pens is bottom-fishing activity through gillnets and bottom trawls, which can destroy hundreds or even thousands of years of growth in a single pass over the sea floor. Some progress is being made in restricting these fishing methods in areas with high concentrations of these benthic (deep-sea) species, and recovery is possible following fishing closures.

Rationale for selected species

The species groups selected for inclusion make up the bulk of the known biomass for lower trophic levels in Arctic waters. The corals described in this chapter are those that have most frequently been collected in research trawl surveys.

Background Image: Phytoplankton—The foundation of the oceanic food chain. (photo: NOAA MESA Project)

The diatom, Nitzschia frigida, *is a common type of phytoplankton that lives in Arctic sea ice.*

PHYTOPLANKTON

Natural history

Marine phytoplankton are single-celled organisms that grow and develop in the upper water column of oceans and in polar sea ice. Phytoplankton are responsible for primary productivity—using the energy of the sun and transforming it via photosynthesis. The dominant species of phytoplankton are of two main types: diatoms and dinoflagellates. Diatoms have a silica-based cell wall that differs in shape from species to species. Dinoflagellates have distinct flagella—whip-like structures that allow the cells to move through the water column. Phytoplankton life cycles have four distinct major phases: growth, reproduction, inactivity, and cell death. These phases are influenced by the ecology of the species as well as environmental conditions. Sympagic algae live beneath the sea ice and within brine channels inside the ice. They provide food for a diverse community of other organisms. The first comprehensive baseline study of Arctic phytoplankton, completed in 2010, found more than 4,000 species of phytoplankton.

Distribution

Arctic phytoplankton are found throughout the surface of the water column as well as beneath the sea ice. They are most abundant between April and August, during the spring bloom period and summer, when sunlight is available.

Ecological significance

Phytoplankton are the basis of the Arctic marine food web. Spring blooms starting in April and continuing to August trigger zooplankton growth and activate key feeding areas for zooplankton, fishes, seabirds, and marine mammals. Changes in phytoplankton community structure and growth have ramifications throughout the Arctic food web. As phytoplankton die, they fall to the sea floor, becoming a nutrient source for sea floor ecosystems and transferring carbon from the ocean into sediments.

Conservation concerns

Environmental changes are already evident in the Canadian Arctic, most notably a decline in the volume and extent of sea ice cover and an increase in river discharge to the Arctic Ocean. These changes together lead to both an increase in the annual spring phytoplankton bloom and a new fall bloom, which is a shift from the characteristic Arctic production cycle to that seen in mid-latitude seas. In addition, new species of phytoplankton have been found in the Arctic, including a species previously known only in the Pacific Ocean, suggesting that the community structure is also changing as a result of climate change and changing ocean circulation. With increasing ocean acidification, the calcium-based skeletons of some diatoms may not form properly. Primary productivity in the Arctic has increased 30% over the last 10 years, indicating significant shifts in the base of the food web.

Gaps in current knowledge

As sea ice cover changes and more light is available for longer periods of time, the impact of increased phytoplankton and a second fall bloom on Arctic food webs is not well understood. The effects of ocean acidification, especially in areas of upwelling water, are unknown across Arctic ecosystems.

See Chlorophyll-a map series, pages 40–41.

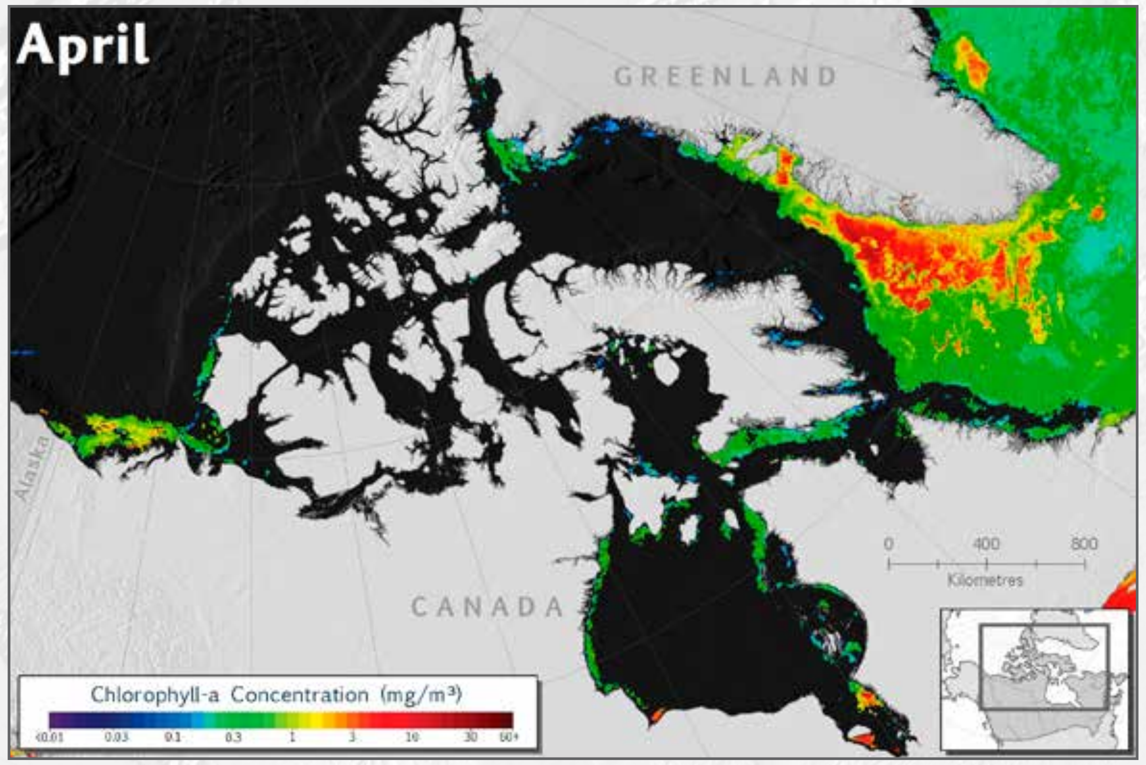
Gaps in knowledge

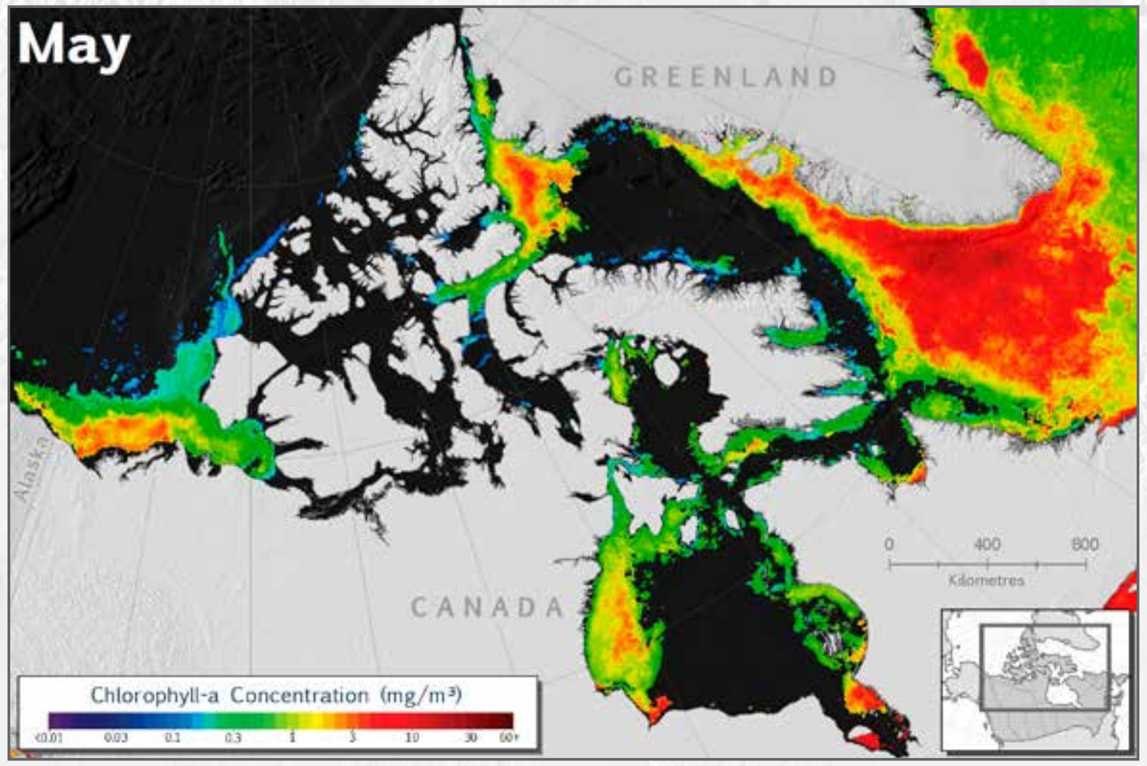
Given the importance of phytoplankton and its vulnerability to changing sea ice cover and land-based nutrients, more information is needed on year-to-year variability. Accumulation of contaminants in zooplankton is an important area of research in order to understand the impacts of consuming fish and marine mammals on human health. Continued research and monitoring of the abundance of zooplankton will be important to understanding how climate change impacts these important species groups. Increased in situ research is needed on corals and sponges; however, their ecological function is relatively well understood and mirrors the function of corals in more southern areas. There is a lack of understanding of the life history and reproduction of many coral and sponge species, but research on samples collected in trawl surveys is beginning to shed light on this subject.

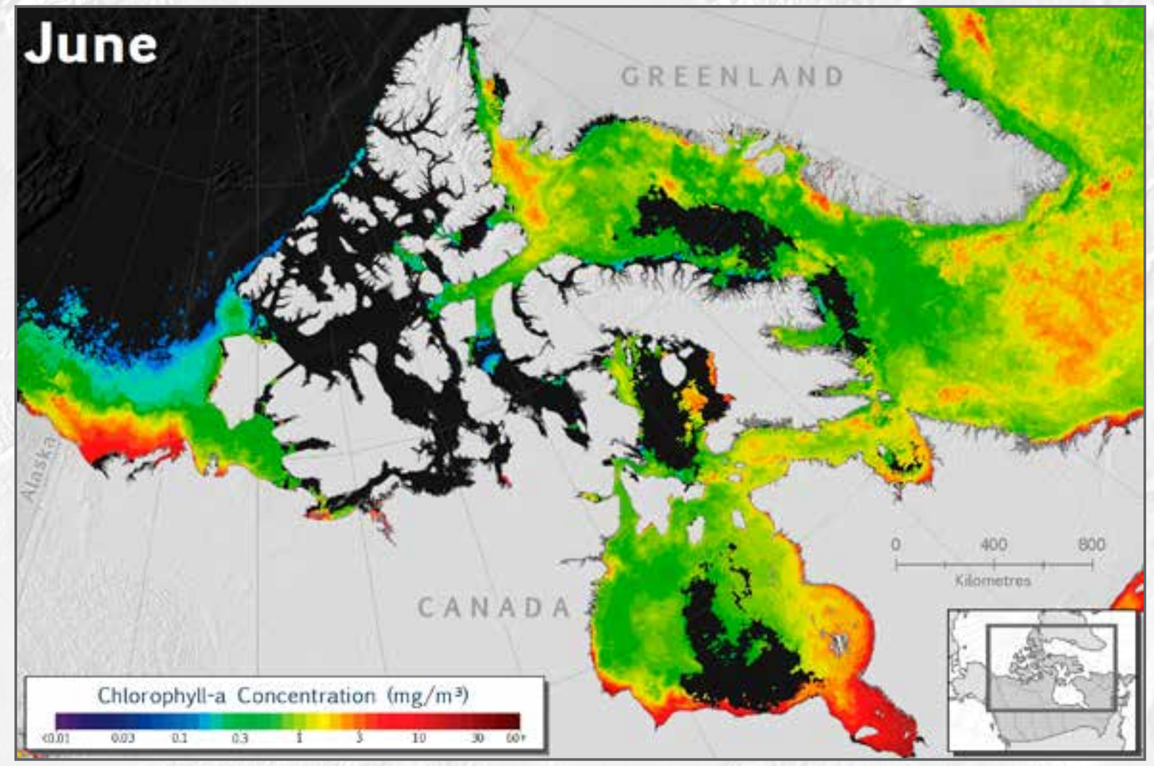
For further reading, see p. 106.

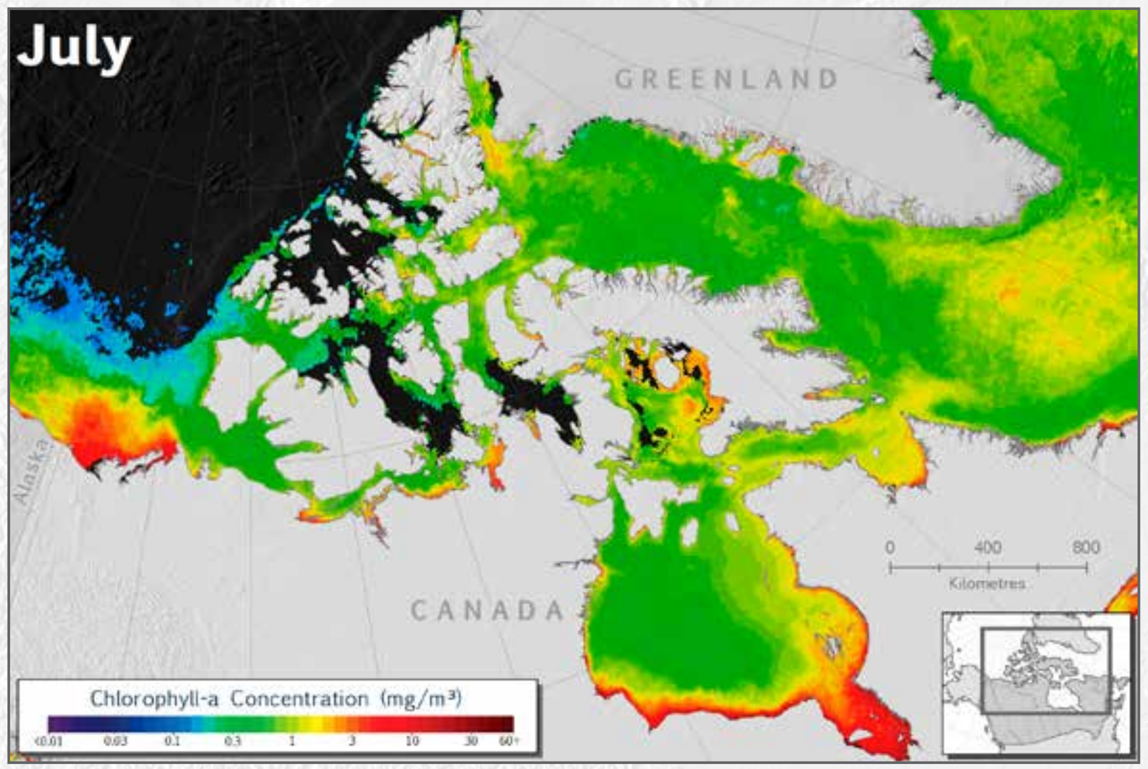
Monthly Chlorophyll-a Climatologies

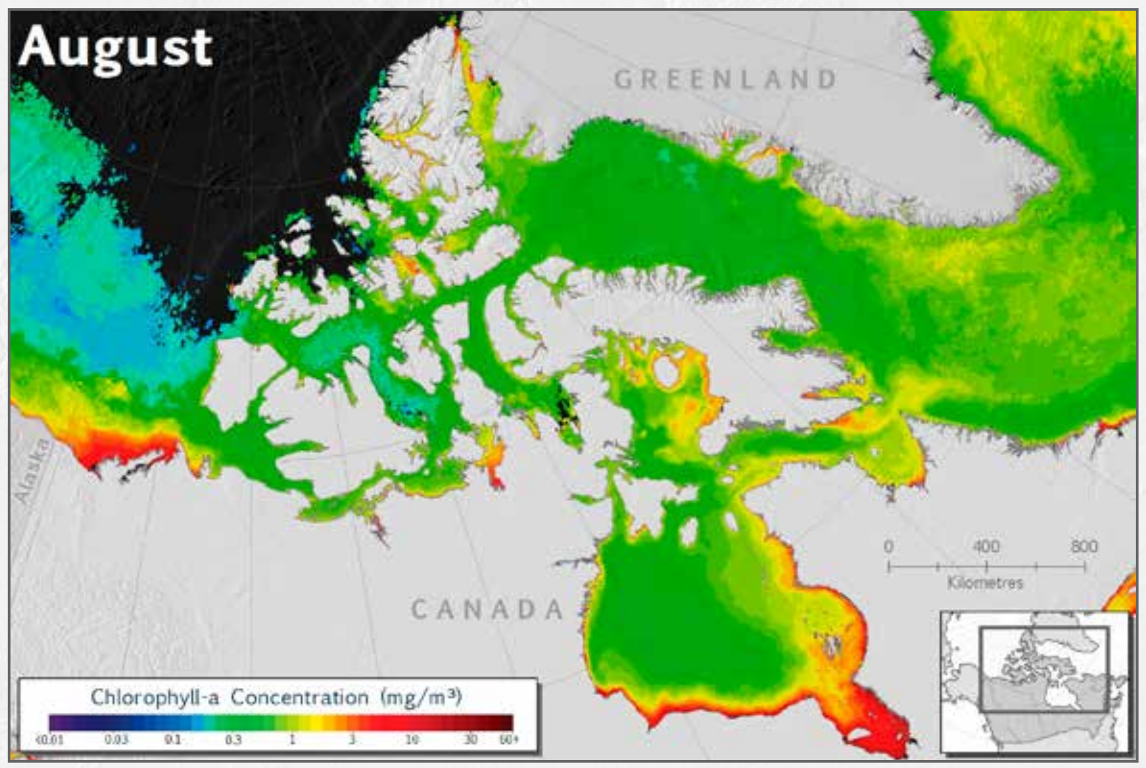
The series of maps below shows the monthly average chlorophyll-a concentration in the Canadian Arctic based on satellite imagery. Chlorophyll is the green pigment in phytoplankton, so areas with high chlorophyll concentrations are places where phytoplankton are growing. Phytoplankton can be seen blooming in select locations in April, which expand across the Canadian Arctic through the spring and summer months. The blooms provide food for zooplankton and the rest of the food web, including fishes, seabirds, and marine mammals, which gather at these feeding sites.

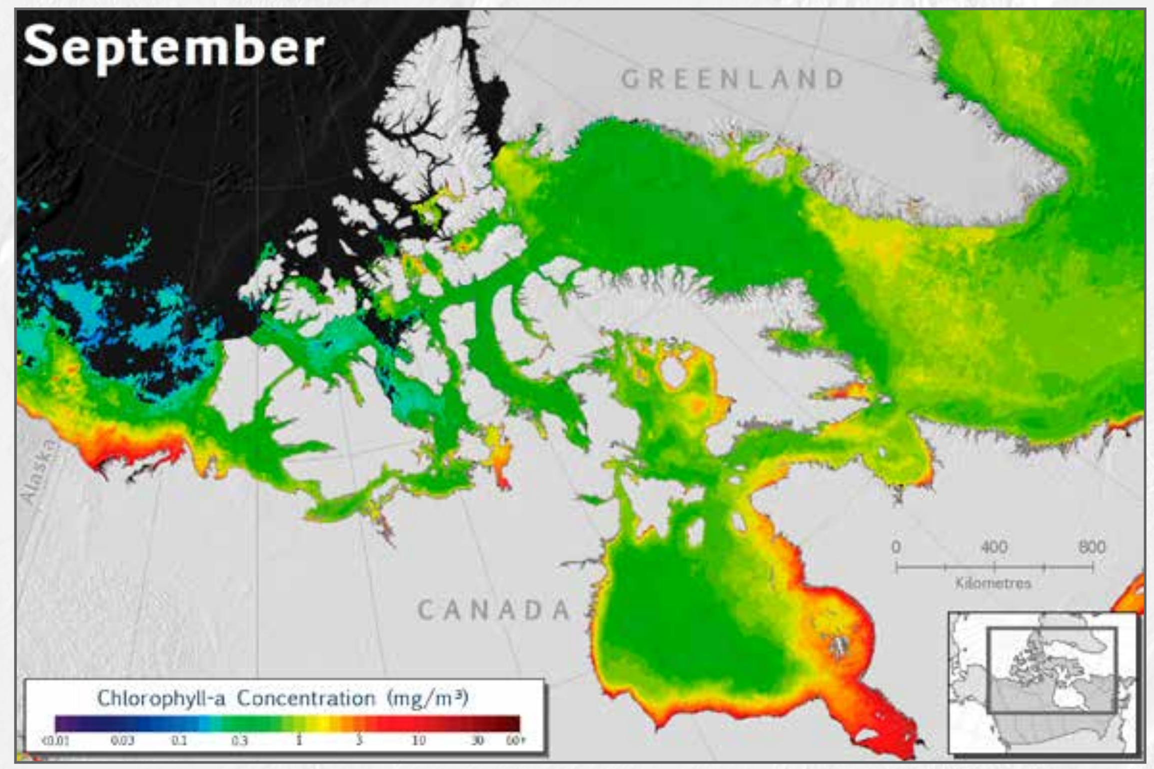








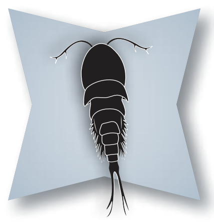


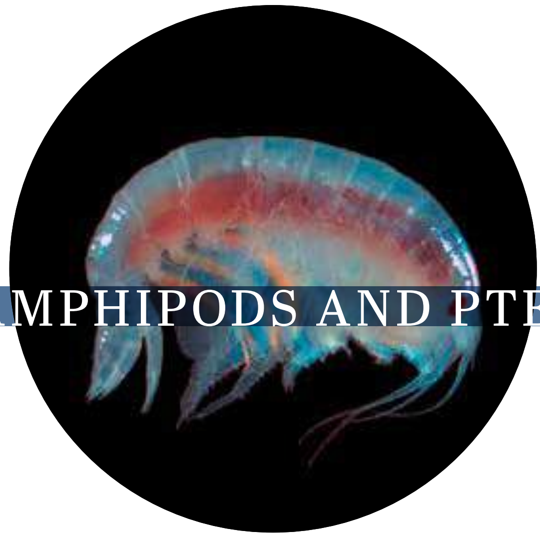


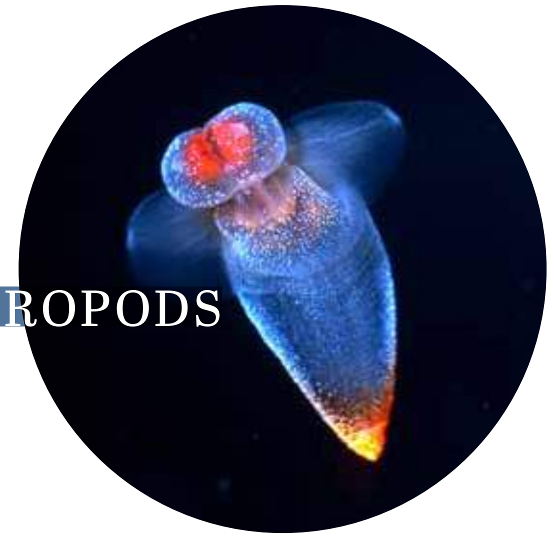
Black Shading = no data

DATA SOURCES

- *Chlorophyll-a: NASA Goddard Space Flight Center, Ocean Biology Processing Group; (2016): Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Ocean Color Data, NASA OB.DAAC, Greenbelt, MD, USA. http://doi.org/10.5067/ORBVIEW-2/SEAWIFS_OC.2014.0. Maintained by NASA Ocean Biology Distributed Active Archive Center (OB.DAAC), Goddard Space Flight Center, Greenbelt MD.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*







AMPHIPODS AND PTEROPODS

BOTTOM OF THE FOOD WEB

- Phytoplankton
- ➡ **Amphipods & Pteropods**
- Copepods, Cold Water Corals & Sponges

Top left: Onisimus glacialis
(photo: B. Bluhm UAF/CoML)

Top right: Clione limacina
(photo: D. Kent, Ocean Wise, Vancouver Aquarium)

Amphipods

Natural history

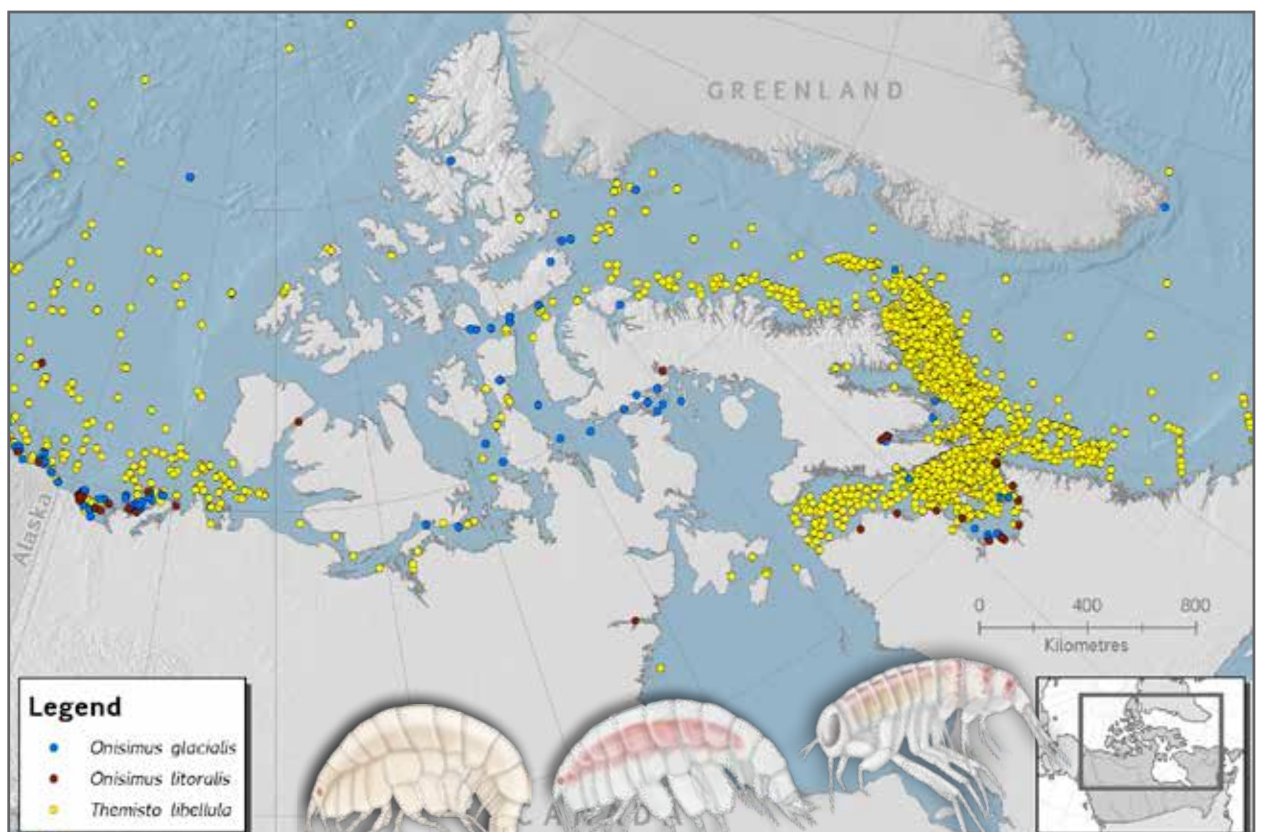
Amphipods form a diverse group of crustacean zooplankton that inhabit all types of Arctic marine habitats. Hundreds of amphipod species have been recorded in the Canadian Arctic seas alone, and many of them are endemic (found only in the Arctic). They are composed of two main families, the Gammaridae and the Hyperiidae. Gammaridae are primarily found beneath the sea ice and on the sea bottom, while Hyperiidae are most common in open waters.

Amphipods typically measure between 12 and 25 mm, but some species can be as large as 6 cm. The species *Onisimus litoralis* and *Onisimus glacialis* are among the most abundant Gammaridae in sea ice and sea-bottom habitats of the Canadian Arctic. *Onisimus* species have distinctive shiny, red eyes. *O. litoralis* is adaptable and feeds opportunistically beneath the sea ice, on the sea floor, and sometimes in surface waters. It eats sea ice algae, zooplankton, and even dead organisms and detritus when food is scarce. In contrast, *O. glacialis* is strictly found under sea ice, where it feeds on ice-associated food resources such as sea ice algae and other sympagic or ice-associated crustaceans.

The surface-dwelling Hyperiidae species can be carnivorous or omnivorous, and sometimes are scavengers. One of the most abundant species in the Canadian Arctic is *Themisto libellula. T. libellula* is primarily carnivorous and preys on zooplankton in surface waters, including large amounts of calanoid copepods.

Distribution

Arctic amphipods can be found across Arctic seas. Their distribution is dictated by the types of habitats and food resources available. *Onisimus litoralis* and *Onisimus glacialis* are endemic to the Arctic. *O. glacialis* follows the sea ice cover and is particularly abundant below multi-year ice. *O. litoralis* can adjust to the dynamic seasons of the Arctic, living on the underside of the ice during the winter and migrating to the sea floor or sea surface in summer months. They are commonly found in nearshore waters and under first-year ice. *Themisto libellula* has a circumpolar distribution but can also be found in subarctic ecosystems such as the North Atlantic.



Amphipods *Onisimus glacialis, Onisimus litoralis, Themisto libellula*

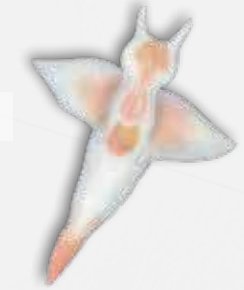
Ecological significance

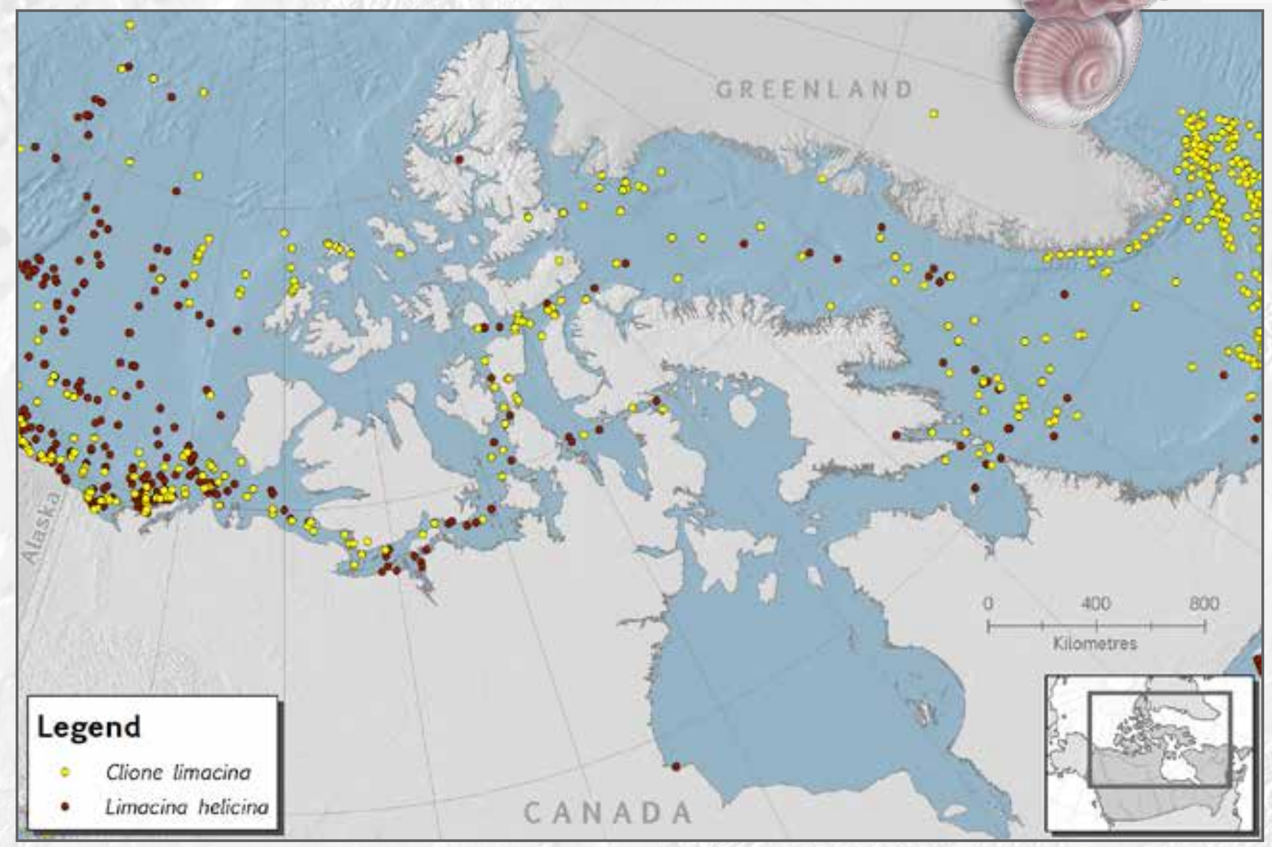
Arctic amphipods are major food source for fishes, seabirds, and marine mammals in the Canadian Arctic. They live in a variety of habitats and are thus preyed upon by diverse larger animals such as Arctic Char, Gray Whales, Bowhead Whales, and ice-associated species such as Arctic Cod and seals.

Conservation concerns

There is currently no conservation concern for amphipods. The availability of sea ice habitats is diminishing due to the shrinking ice cover, which may threaten sympagic amphipods that rely on sea ice algae and other sympagic organisms for food.

Pteropods *Limacina helicina, Clione limacina*





DATA SOURCES

Amphipods

- *Documented Occurrences: GBIF. 2016. Onisimus litoralis. GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.nollg5; GBIF. 2016. Onisimus glacialis. GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.kmyuso; GBIF. 2016. Themisto libellula . GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.mrbcsr; OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 13/09/2017. http://www.iobis.org*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Pteropods

- *Documented Occurrences: GBIF. 2016. Clione limacina. GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.sfhh8r; GBIF. 2016. Limacina helicina. GBIF Occurrence Download. Accessed 04/08/2017. https://doi:10.15468/dl.ldumdm; OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 13/09/2017. http://www.iobis.org*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*

Gaps in current knowledge

In general, information on the ecology and life cycles of most amphipod species in the Arctic is very scarce. Data on the diversity and distribution of Arctic amphipods is also lacking. A better understanding of their ecology would be useful due to their pivotal role in Arctic marine food webs, particularly regarding the possible responses of ice-associated species to disappearing sea ice.

Pteropods

Natural history

Pteropods are a zooplankton group of free-swimming molluscs. Their name means “wing footed” because their foot is modified to form a pair of swimming wings. Three species are found in the Arctic. The two most abundant in the Canadian Arctic are *Limacina helicina*, a shelled species also named the “sea butterfly,” and the naked species *Clione limacina*, or “sea angel.”

The sea butterfly, *L. helicina*, can measure up to 8 mm in its adult form, while the sea angel *C. limacina* can measure up to 4 cm. *L. helicina* is an omnivorous filter feeder that captures prey using large mucous webs in which phytoplankton and smaller zooplankton (such as calanoid copepods) get entangled. This unique feeding technique allows *L. helicina* to feed on prey larger than itself, including other *L. helicina. C. limacina* feeds on phytoplankton at the larval stage, but the adult form is carnivorous and feeds almost exclusively on *L. helicina. C. limacina* has developed specific adaptations to feed on the shelled pteropod *L. helicina*, including a synchronized predator–prey life cycle and the production of specialized lipid reserves, which allow it to survive long periods when its prey is unavailable.

Distribution

Limacina helicina and *Clione limacina* are two pan-Arctic species widely distributed in the surface waters of Arctic seas. Because *C. limacina* feeds primarily on *L. helicina*, the two species almost always co-occur. They were considered for a long time to inhabit both polar regions, but further investigations revealed that the species found in Antarctica are distinct (*Clione antarctica* and *Limacina antarctica*).

Ecological significance

Limacina helicina and *Clione limacina* are important zooplankton prey in Arctic marine food webs, eaten by fishes, seabirds, and whales. Furthermore, *L. helicina* influences the ocean carbon pump. The mucous webs they produce contribute to the “marine snow,” the constant rain of detritus and decaying material falling from the surface waters to the ocean bottom. As well, their shells sink to the bottom after they die, thus contributing to the transport of the carbon from the atmosphere and surface layers of the ocean to the sea floor.

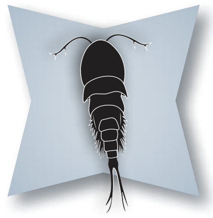
Conservation concerns

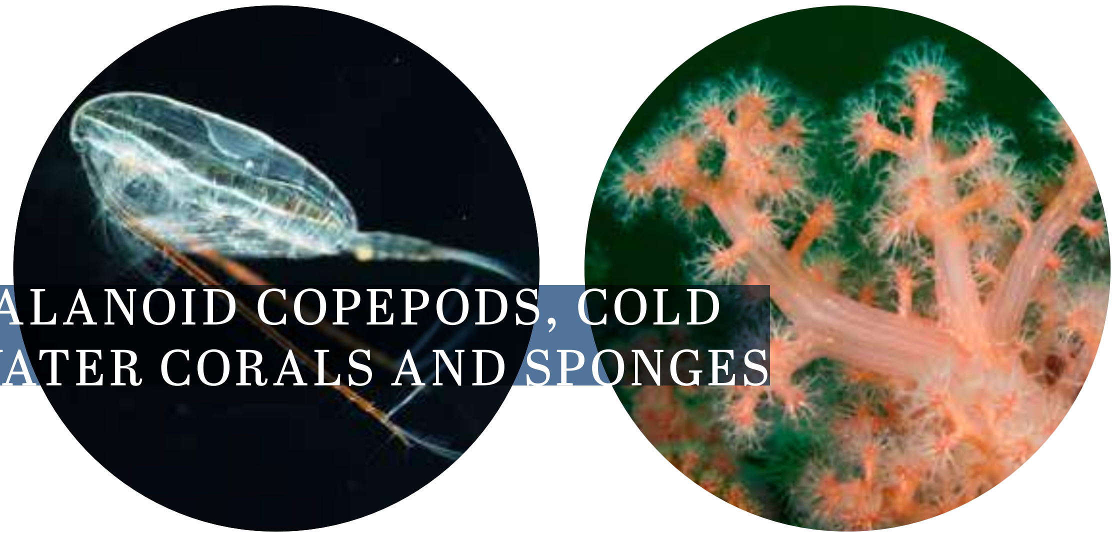
Climate change is of great concern for Arctic pteropods: ocean acidification driven by the rise in CO_2 emissions will make it more difficult for pteropods, *L. helicina* in particular, to produce their shells. Moreover, among Arctic zooplankton, pteropods were shown to have the highest levels of mercury, a harmful contaminant that biomagnifies in aquatic food webs. Thus, they transfer considerable amounts of mercury to Arctic fishes, seabirds, and whales, and in turn to Inuit that eat these larger animals.

Gaps in current knowledge

Contaminants are a big concern for Inuit health; improved knowledge is needed about the interplay between pteropods' ecology and accumulation of contaminants, as well as their role in transferring toxic elements to top predators. Furthermore, laboratory experiments on the effects of acidification on *L. helicina* should be extended over long periods of time to assess for potential acclimation to future conditions.

Inset: The Sea Butterfly, Limacina helicina.
(photo: D. Kent, Ocean Wise, Vancouver Aquarium)





CALANOID COPEPODS, COLD WATER CORALS AND SPONGES

BOTTOM OF THE FOOD WEB

- Phytoplankton
- Amphipods & Pteropods
- ➨ **Copepods, Cold Water Corals & Sponges**

Calanoid Copepods

Natural history

Calanoid copepods are the most abundant type of zooplankton, and they are major prey for fishes, birds, and whales. The zooplankton biomass of all Arctic seas is dominated by the calanoid copepods *Calanus glacialis* and *Calanus hyperboreus*, but several other calanoid species are present including *Calanus finmarchicus*, *Calanus marshallae*, *Pseudocalanus* spp., *Metridia longa*, *Triconia borealis*, and *Microcalanus* spp.

C. glacialis and *C. hyperboreus* are endemic to Arctic waters. They have developed specific adaptations to this extreme environment such as a resting stage, called diapause, which allows them to overwinter in the cold Arctic waters. *C. glacialis* and *C. hyperboreus* range between 3 to 8 mm in length, depending on the life stage, with *C. hyperboreus* being slightly larger. Calanoid copepods increase in size by moulting. After hatching, they have several stages of development, including the nauplius stage, followed by six copepodite stages, with the last one being the adult stage.

Distribution

C. glacialis and *C. hyperboreus* can account for as much as 70% of the zooplankton biomass in some areas of the Canadian Arctic. Both species are distributed across the Arctic seas, with *C. glacialis* being most abundant on shelf areas and *C. hyperboreus* associated with central basins and deeper shelves. The two species migrate down to deep waters during the winter: *C. glacialis* between 200 and 500 m and *C. hyperboreus* between 500 and 2,000 m. Their vertical distribution can also vary daily in response to changing light patterns, a process called nycthemeral migrations.

Ecological significance

C. glacialis and *C. hyperboreus* are the most important herbivores in Arctic waters, grazing on large amounts of phytoplankton and ice algae, especially during the brief but intense spring bloom. They convert the carbohydrates and protein found in these primary producers into energy-rich and specialized lipids, which they store in large reserves. As such, they are key components of Arctic marine food webs, transferring high-energy lipids to Arctic fishes, birds, and marine mammals. Furthermore, calanoid copepods play a role in the carbon pump of the Arctic because they actively transport carbon to deeper waters through their respiration at depth during the winter.

Conservation concerns

There is no conservation concern for Arctic calanoid copepods at this time. However, climate change could eventually affect these species through, for example, their peak abundances not coinciding with the phytoplankton blooms. Invasions of boreal zooplankton species as a result of climate change are also a concern. Despite their stable status, the key role of calanoid copepods in Arctic marine food webs calls for careful monitoring of their response to climate change.

Gaps in current knowledge

Data on the diet of Arctic calanoid copepods and their interactions with other zooplankton species is limited. Some aspects of their vertical migrations remain poorly understood, such as the effect of nycthemeral migrations on the ocean carbon pump, and a year-round portrait of their seasonal migrations is lacking. Furthermore, research about the role of calanoid copepods in the carbon pump is scarce and should be extended to more Arctic areas.

Corals

Natural history

Corals are invertebrates that can anchor in soft sediments and on hard surfaces. While corals are most often viewed as tropical species, their existence and ecosystem function in deep-water and cold-water environments has been an important area of research for the past three decades.

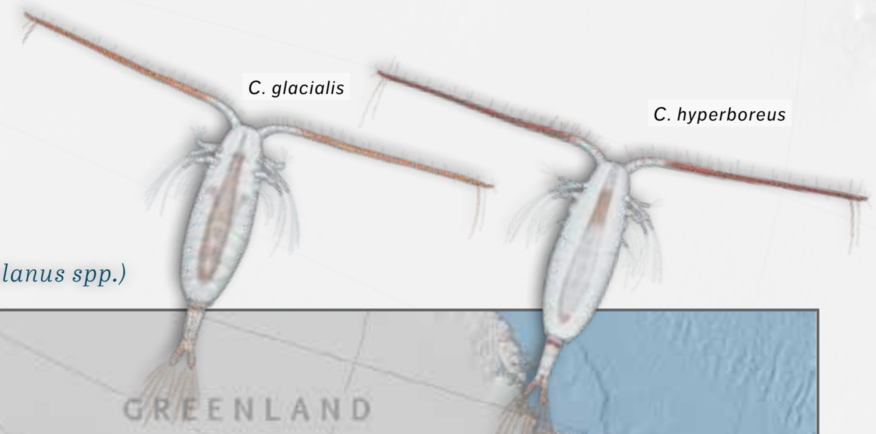
Hard corals have a solid skeletal structure; soft corals have minute internal skeletal structures called sclerites that provide support and are also used to identify the species. Cold-water hard corals include several species groups, including black corals or antipatharians, gorgonians of which there are large and small species, and scleractinians, all of which are small. The most abundant soft corals include *Anthomastus grandiflorus*, *Gersemia rubiformis*, and *Duva florida*, with several species of nephtheids also found.

Corals form colonies made up of polyps that feed by filtering plankton from the water. Corals have a variety of reproductive strategies, from broadcast spawning to asexual reproduction, where new polyps bud from the parent coral and begin a new coral structure.

Corals are thought to be slow growing, with larger species and thickets of bamboo coral hundreds to thousands of years old. Soft corals have been observed to reach 3–4 mm within three to four months. Deep-water coral colonies range in size from small and solitary to large, branching tree-like structures—with records of the gorgonian *Paragorgia arborea* as high as 3 m.

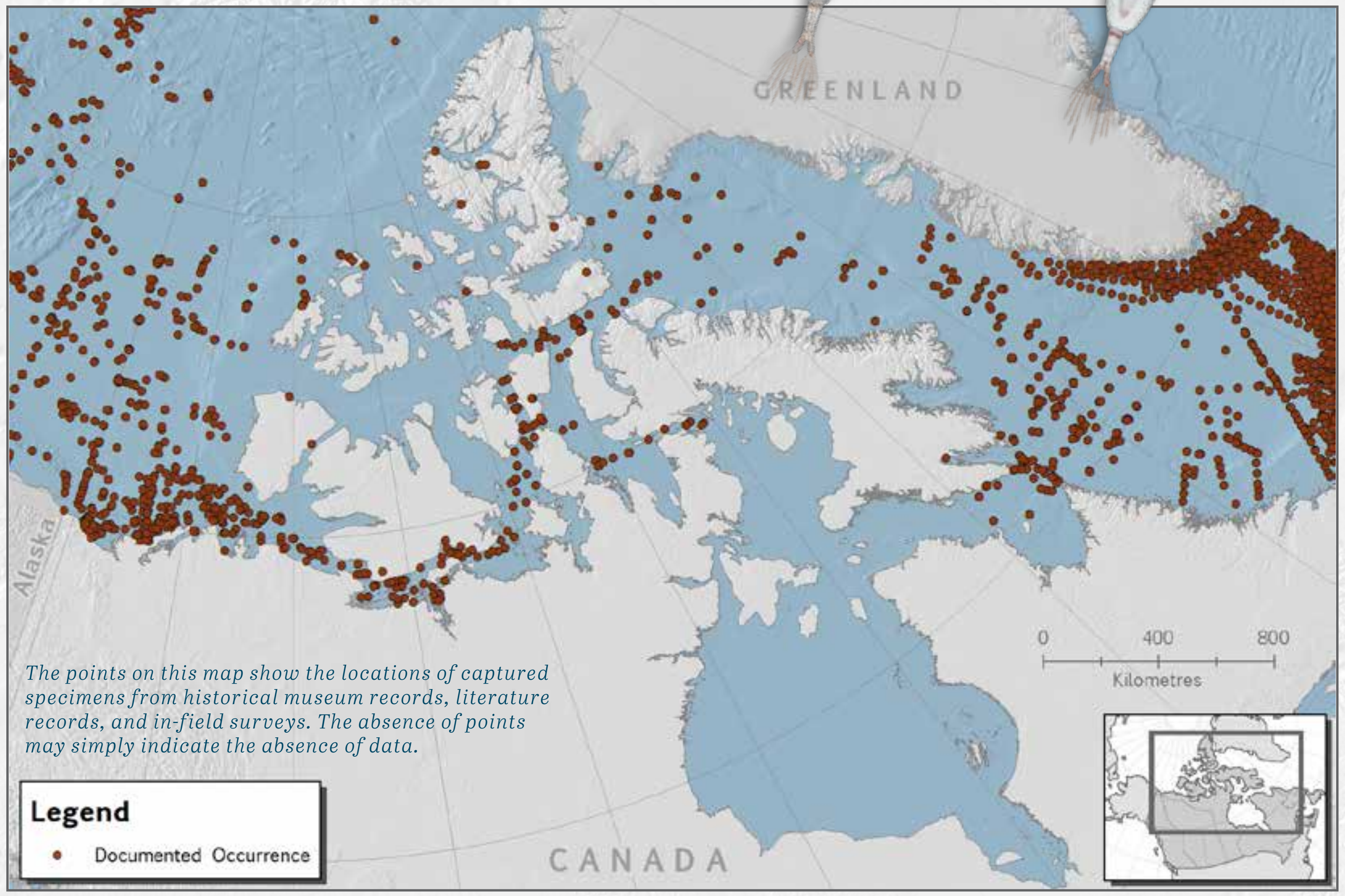
Top left: Calanus glacialis (photo: Allison Bailey/Norsk Polarinstitutt)

Top right: Gersemia rubiformis (photo: Robert La Salle/Aqua-Photo)



Calanoid Copepods *Calanus species*

(C. glacialis, C. hyperboreus, C. finmarchicus, and unidentified Calanus spp.)



DATA SOURCES

- Documented Occurrences: GBIF. 2016. Calanus hyperboreus. GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.cp9fuc; GBIF. 2016. Calanus glacialis. GBIF Occurrence Download. Accessed 13/09/2017. https://doi.org/10.15468/dl.oiieg7; OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 04/08/2016. http://www.iobis.org
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

In Baffin Bay, unique forests of bamboo coral, *Keratoisis* spp., were filmed in 2013. These forests were estimated to reach up to 1 m in height, and are anchored in soft sediments in the sea floor through a complex root structure. These corals formed an unusual habitat structure in this otherwise muddy environment.

Finally, sea pens, or Pennatulacea, are important sea floor species, with some growing more than 2 m high. Sea pen fields can be dense, providing both shelter and food for other marine species.

Distribution

Hard corals are found along the shelf edge from eastern Labrador and continue into Baffin Bay, with records in areas that have been surveyed and distribution likely into the high Arctic. There is an apparent shift in coral diversity and abundance between Davis Strait and Baffin Bay, but this may be also due to sampling intensity. Hard corals reach peak abundance between 300 m and 1,000 m. Soft corals and sea pens are found on the continental shelf and shelf edge.

Ecological significance

Corals provide structural habitat for many species, including commercial fish species. The relative importance of corals as habitat depends on their overall size and body structure, as well as their geographical environment. Corals anchored in soft sediment can help to ensure sediment stability.

Conservation concerns

Corals are impacted by fishing activity, with the first pass of a trawl, or bottom-fishing gear, the most damaging. Continued fishing pressure can hamper recovery of corals through disturbance of the sediment and newly settled recruits. Corals are also vulnerable to climate change, particularly those with calcareous skeletons, which are affected by ocean acidification.

Inset: Sea pen, Pennatulacea. (photo: Bedford Institute of Oceanography)

Cold Water Corals and Sponges (cont'd on pages 46–47)

COLD WATER CORALS AND SPONGES

BOTTOM OF THE FOOD WEB
- Phytoplankton
- Amphipods & Pteropods
- ➡ **Copepods, Cold Water Corals & Sponges**

Sponges

Natural history

Sponges are an ancient type of animal, with a fossil record longer than 800 million years. They feed by filtering water to trap and digest bacteria and other particulate materials. Most sponges are supported by skeletal components called spicules. Other sponges contain a fibrous material that provides skeletal support. Sponges grow in myriad forms: some encrusted on rock faces, some in branching forms, and some in globular forms of various sizes. They are often found in areas with soft and hard corals and other invertebrates, all of which together can form complex sea floor habitats. These habitats can be oases for a wide variety of other marine species, including commercially fished species.

Recent efforts have been made to collect sponges through research trawl surveys. In the eastern Canadian Arctic, about 100 different species have been recorded. Samples identified through research surveys show dominance by the Glass Sponge, *Asconema foliata* and the Demosponge, *Mycale lingua*. Data collected through observer records and fishing activity has revealed large biomass of Geodid sponges, which are also found further south along the Labrador coast, the Grand Banks, and in North Atlantic waters surrounding Iceland and the Faroe Islands. Other commonly found sponges in the Arctic include those in the genus *Polymastia*. Several species of carnivorous sponges from the genus *Chondrocladia* have also been found in Canadian Arctic waters.

Distribution

Sponges are distributed throughout Arctic waters, in both hard-bottom areas and soft sediments. In recent years, samples have been collected from research trawl surveys and in situ videos, providing an increased understanding of species richness and distribution.

Ecological significance

Sponges diversify the types of habitats found on the sea floor, and they harbour other marine invertebrate species. Sponge spicules provide structure, particularly in soft-sediment environments. High concentrations of sponges have been identified as "sensitive benthic areas" and "vulnerable marine ecosystems" and are protected from fishing in some areas. Egg deposition by cuttlefish has been discovered in *Mycale* on the Labrador shelf, suggesting that some sponges provide important habitat for life stages of other marine invertebrates.

Conservation concerns

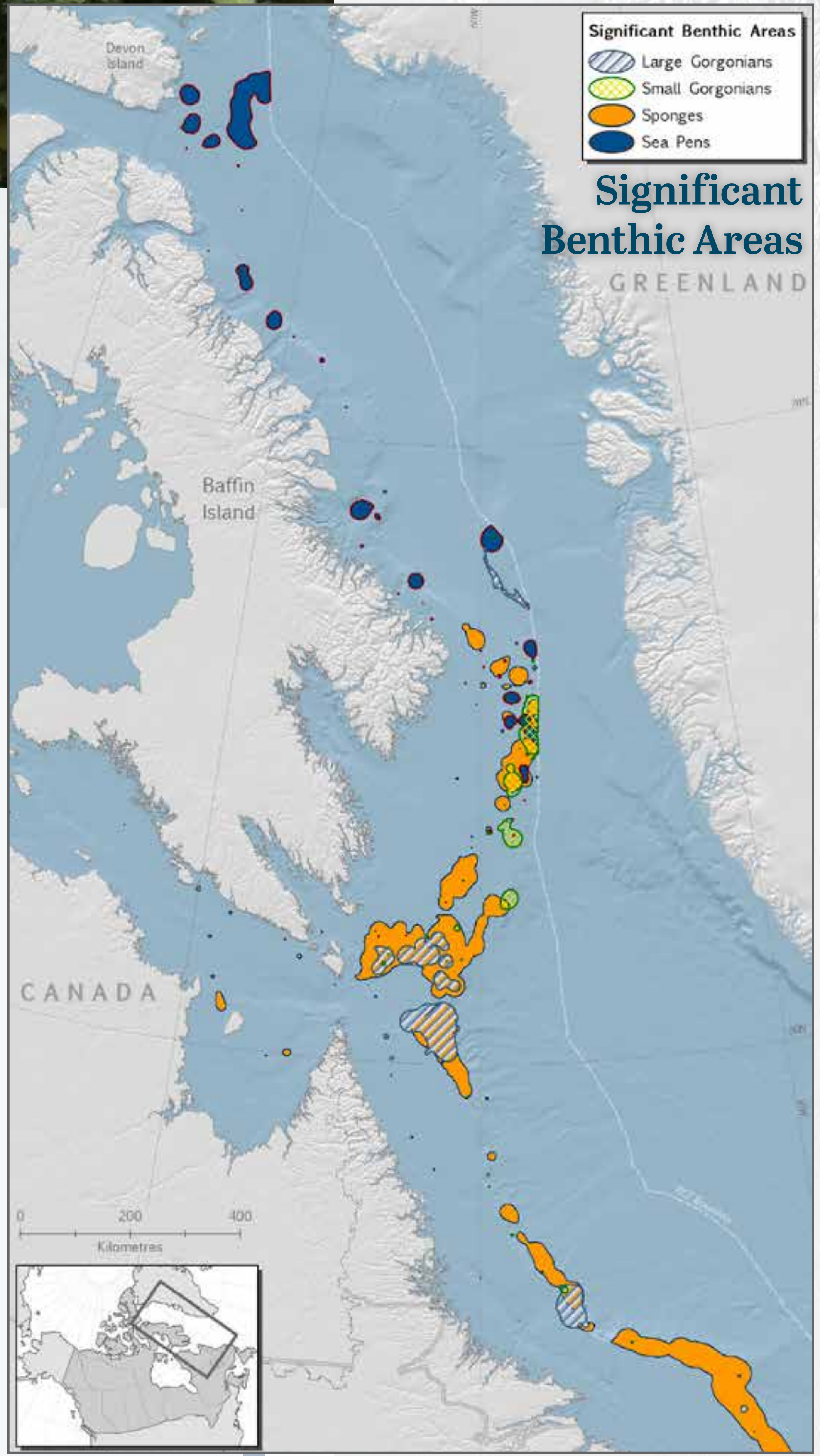
Sponges can be damaged by bottom trawling, and recovery rates for Arctic species are unknown. Fishing trawls have caught up to 8,000 kg of sponges at a time in the Davis Strait / Saglek Bank area, primarily those in the Geodid family. Encrusting species and those that are low growing or round are less susceptible to harm by fishing gear.

Gaps in current knowledge

Sponges in the Canadian Arctic are only just starting to be recorded and identified. While their ecological significance can be inferred from knowledge gathered in other areas, relatively little is known about their reproduction and growth rates, nor about their significance for other species in the ecosystem.

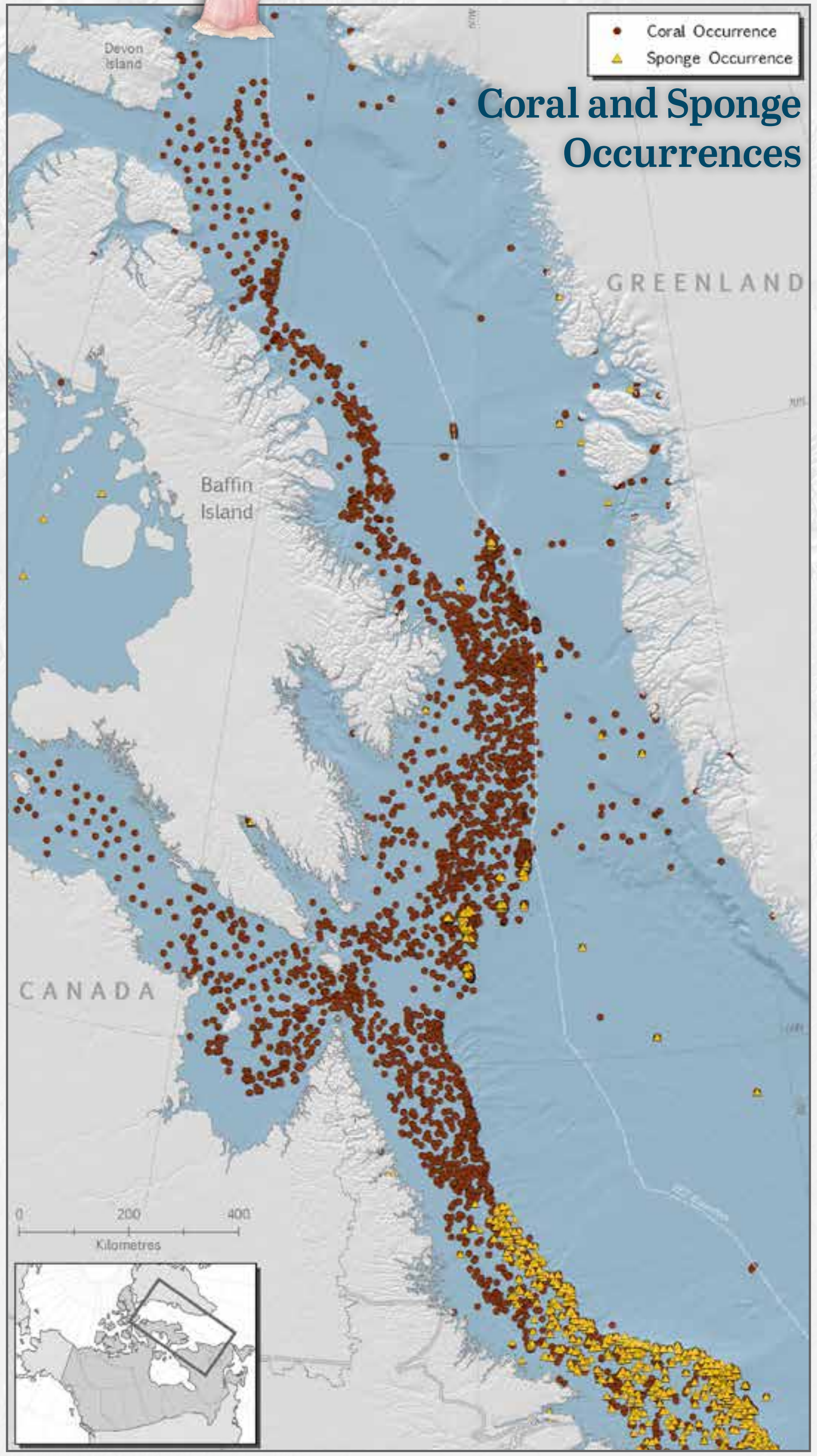
Facing page: Sponges, soft corals, crinoids, bryozoans and hydroids cover the seafloor of Davis Strait in the eastern Canadian Arctic. (photo: Fisheries and Oceans Canada)

DATA SOURCES
- *Significant Benthic Areas: Kenchington, E., L. Beazley, C. Lirette, F.J. Murillo, J. Guijarro, V. Wareham, K. Gilkinson, M. Koen Alonso, H. Benoît, H. Bourdages, B. Sainte-Marie, M. Treble, and T. Siferd. 2016. Delineation of Coral and Sponge Significant Benthic Areas in Eastern Canada Using Kernel Density Analyses and Species Distribution Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/093. vi + 178 p*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*



Gersemia rubiformis is among the most abundant cold-water soft corals.

DATA SOURCES
- *Coral and Sponge Occurrences: DFO (2017). Sponge and Coral Data. Retrieved from Vulnerable Marine Ecosystems Portal, International Council for the Exploration of the Sea (ICES). http://vme.ices.dk/*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Natural Earth.*



MARINE AND ANADROMOUS FISHES OF THE ARCTIC

MARINE & ANADROMOUS FISHES
- Anadromous Fishes
- Pelagic Fishes
- Bottom Fishes
- Forage Fishes

Introduction

We know of at least 1,439 freshwater and marine fish species native to Canada. Of these, 222 fish species occur in Canadian Arctic marine waters. Within the Arctic marine environment, approximately 20 species are anadromous, meaning they move between fresh water and salt water for feeding, spawning, and overwintering. About 55 fish species are found in fresh water north of 60° latitude, mostly in the Northwest Territories, and some in Nunavut. This number includes anadromous species that occur in both habitats. The Canadian portion of the Beaufort Sea is home to approximately 52 marine and 20 anadromous and freshwater species. The Canadian Archipelago area of the Arctic Ocean (north of the mainland to the 200–nautical mile Exclusive Economic Zone boundary) is home to approximately 68 marine and 13 anadromous and freshwater species. The Baffin Bay and Davis Strait area is home to approximately 104 marine and 5 anadromous species of fish.

Ecological significance

Arctic marine fishes are key players in the ocean ecosystem as they transfer energy from lower levels of the food web to other fishes, seabirds, and marine mammals. In other words, fishes eat plankton, and in turn become food for birds and mammals. An overview of marine fishes must also consider anadromous fishes (those such as Arctic Char that migrate from the sea into fresh water to lay their eggs) that occur in both nearshore and offshore marine locations in the summer months and therefore play an important role in the Arctic marine ecosystem. The migration of anadromous fishes from the sea to rivers and lakes also carries energy and nutrients to freshwater and terrestrial ecosystems.

Cultural significance

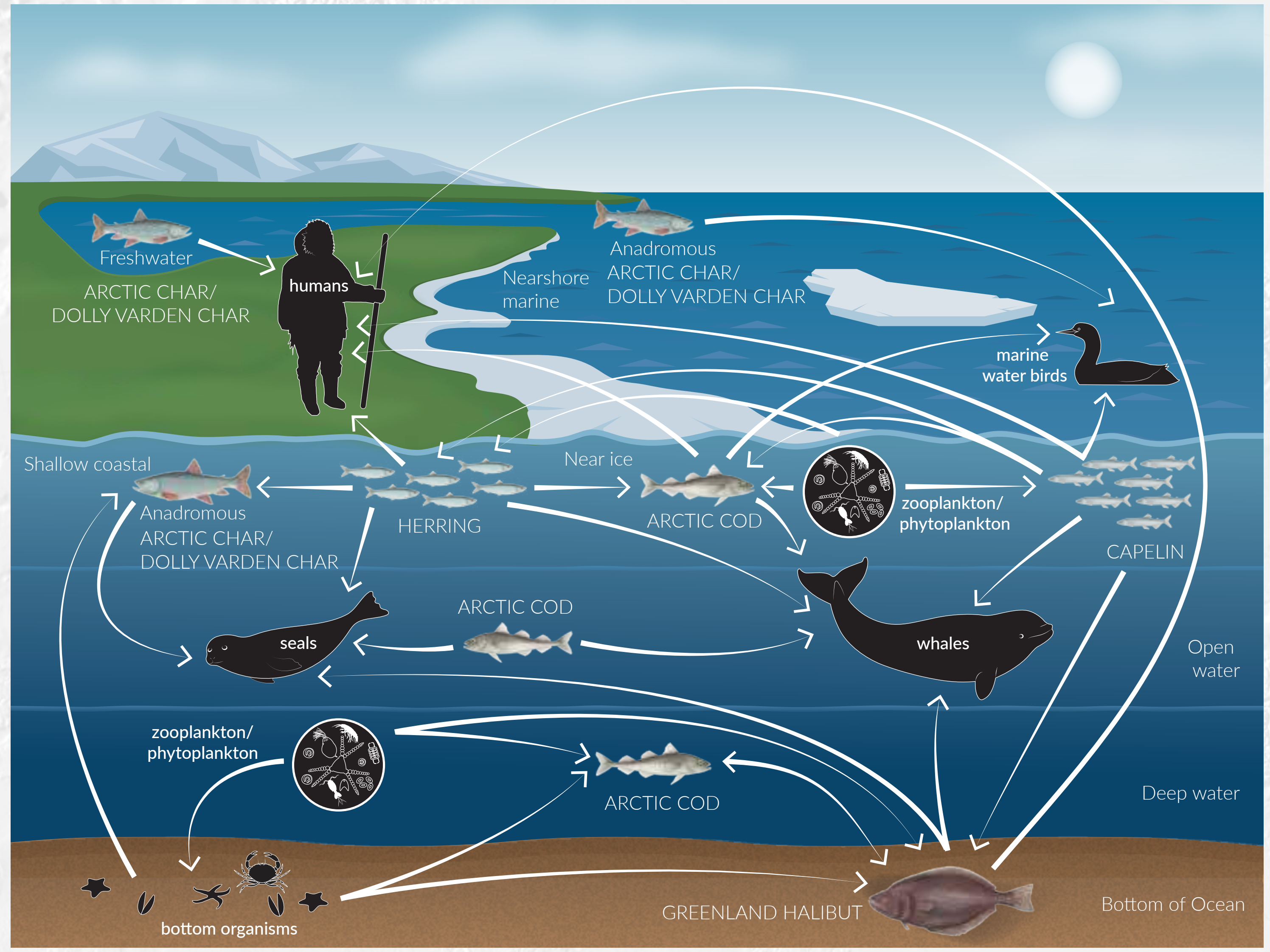
Fishing has long been an important part of Inuit culture and lifestyle. Freshwater, anadromous, and ocean fishes were captured year-round, with major fishing efforts occurring in the spring and fall when the fish were migrating back to their spawning and overwintering grounds in large numbers. Today, fish are still an important part of the culture, diet, and economy of the Inuit. In addition to subsistence fisheries, small-scale commercial fisheries also play an important role in the economy of several communities in Inuit Nunangat, including Arctic Char fisheries from the Mackenzie Delta to Baffin Bay that serve southern as well as northern markets.

Major concerns

Climate change is resulting in changes to marine productivity, decreased sea ice coverage, and increased water temperature. All these changes can lead to the expansion of southern fish species ranges into the Arctic marine regions. Decreased sea ice coverage could allow increased Arctic marine shipping that may interfere with the migratory routes of fish or result in pollution and introduced species. The decrease in sea ice also brings increased interest in large-scale commercial fisheries exploitation. Currently there are no such fisheries in Canadian Arctic waters. In 2011, an agreement was signed between the Canadian government and the Inuvialuit people of the western Arctic placing a hold on large-scale fisheries in the Beaufort Sea, matching a similar action on the US side of the border, until further data and information can provide a better understanding of this ecosystem. Canada is currently engaged in international discussions to extend this policy to the international waters of the central Arctic Ocean. In Baffin Bay, Greenland Halibut (Turbot) and shrimp fisheries occur in Canadian as well as Greenlandic waters. A fisheries ecosystem management plan is in development for the Canadian side of the bay.

Subsistence fishing in Gjoa Haven, a western Nunavut community. Fish are an important part of a country food diet for Inuit across the Canadian Arctic. (photo: Ton Koene)

ARCTIC FISHES SIMPLIFIED FOOD WEB



This simplified food web shows the movement of energy through key Arctic marine and anadromous fish species. The overlapping network of food chains shows how each species is interconnected.

Rationale for selected species

Seven fish species are highlighted in this section, chosen because of their value to northern culture and economy and/or the important role they play in the Canadian Arctic marine ecosystem. There are other fish species that are important to the Arctic marine environment. For example, sand lances (*Ammodytes* species) are a very important food for many of the larger marine animals in the Arctic Ocean. They have been found in the stomachs of many of the animals eaten by the Inuit, including Beluga Whales, seals, and seabirds including Thick-Billed Murres, whose eggs Inuit eat. The Northern Sand Lance (*Ammodytes dubius*) is an important food for commercially important fish species, including Atlantic Salmon (*Salmo salar*) and cod. However, there is a lack of available data documenting its known locations.

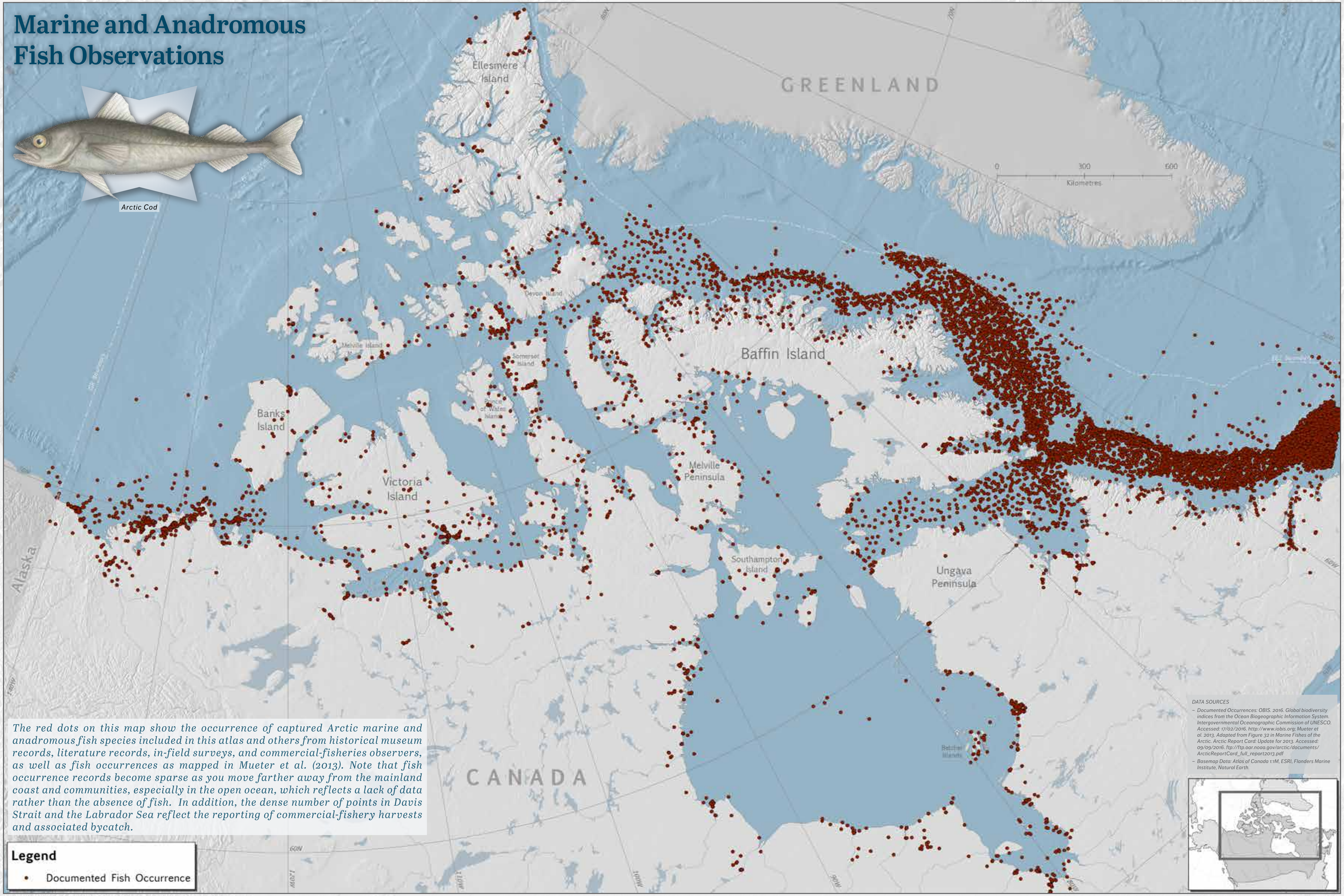
Gaps in knowledge

While there are some data from specific sampling locations within Canadian Arctic waters, many areas remain to be sampled, and basic data are lacking. Surveys in the Arctic marine environment are limited by remoteness, cost, and sea ice. However, with new surveys, new species are being discovered. While it is possible to predict the general effects of a changing climate on Arctic marine fishes, population trend, distributions, and ecological interactions of most species are poorly understood, leaving a great deal yet to be learned.

For further reading, see p. 107.

An Arctic Tern (Sterna paradisaea) holding a Capelin flies above Hubbart Point along Hudson Bay. (photo: WorldFoto)

Marine and Anadromous Fish Observations



The red dots on this map show the occurrence of captured Arctic marine and anadromous fish species included in this atlas and others from historical museum records, literature records, in-field surveys, and commercial-fisheries observers, as well as fish occurrences as mapped in Mueter et al. (2013). Note that fish occurrence records become sparse as you move farther away from the mainland coast and communities, especially in the open ocean, which reflects a lack of data rather than the absence of fish. In addition, the dense number of points in Davis Strait and the Labrador Sea reflect the reporting of commercial-fishery harvests and associated bycatch.

DATA SOURCES

- *Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; Mueter et al. 2013. Adapted from Figure 32 in Marine Fishes of the Arctic. Arctic Report Card: Update for 2013. Accessed: 09/09/2016. ftp://ftp.oar.noaa.gov/arctic/documents/ArcticReportCard_full_report2013.pdf*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

MARINE & ANADROMOUS FISHES

- ➨ **Anadromous Fishes**
- Pelagic Fishes
- Bottom Fishes
- Forage Fishes

Arctic Char and Dolly Varden Char

Natural history

Arctic Char (*Salvelinus alpinus*) and Dolly Varden Char (*Salveninus malma*) belong to the trout and salmon family (Salmonidae). Both species can be anadromous (moving between fresh water and sea water during their life history) or freshwater-restricted, living their entire lives in lakes or rivers. Both species can also be polymorphic, meaning their shape can differ depending on their diet and where they live. For example, there can be anadromous and freshwater-restricted morphs (shape variations), and within some deep lakes, several small and large morphs can be found. Arctic Char and Dolly Varden Char eat fish, insects, and crustaceans.

Arctic Char are very abundant throughout the Canadian Arctic, whereas Dolly Varden Char are considered uncommon. Dolly Varden Char were long confused with Arctic Char in the western Canadian Arctic, and therefore under-reported. The Dolly Varden Char subspecies present in the Canadian Arctic is *Salvelinus malma malma*. It is a subspecies as it is taxonomically distinct from other Dolly Varden Char that occur within Pacific watersheds and drainages.

Distribution

Arctic Char is the northernmost freshwater or anadromous fish species, with a circumpolar distribution north of 75°N. Because of their behaviour, anadromous fishes are often found feeding in coastal marine waters during spring, summer, and fall. Arctic Char and Dolly Varden Char inhabit shallow coastal waters over the continental shelf.

An Arctic midnight sun illuminates men fishing for Arctic Char on Lake Hazen, Ellesmere Island. (photo: National Geographic Creative)

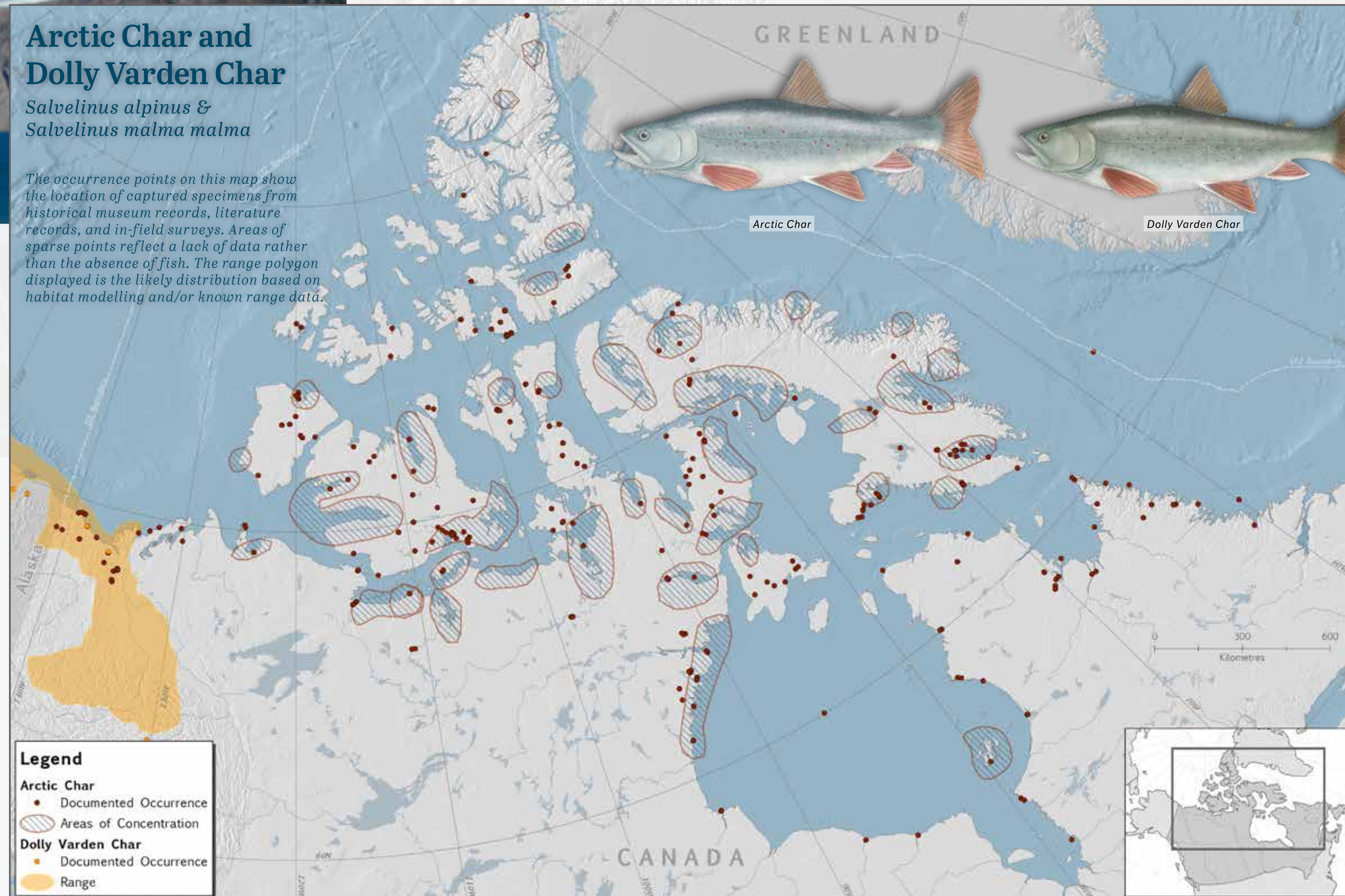
Importance to Inuit

Arctic Char and Dolly Varden Char are an extremely important subsistence resource and a nutritious food for Inuit. In Nunavut, Arctic Char is the second-most widely consumed country food after caribou and in the Inuvialuit Settlement Region it is the third-most widely consumed food after caribou and berries. There are also commercial Arctic Char fisheries in Nunavut and Nunatsiavut that employ Inuit. Commercial landings were 57 tonnes valued at $186,000 in 2012.

Conservation concern

The western Arctic population of Dolly Varden Char was listed as a "species of concern" under the Species at Risk Act in 2010. Some Inuit communities report that populations on which they rely are in decline. Climate change affecting both freshwater and marine environments is likely the biggest threat to both these species. These stressors will lead to environmental influences that will result in a suite of biological, physical, and chemical impacts on aquatic ecosystems.

Facing page: Drying Arctic Char in Clyde River, Nunavut. (photo: Henry Huntington)



Gaps in current knowledge

Data are limited regarding the exact geographic range of Arctic Char, and it is also unknown how far both species travel away from coastal areas and into the deeper marine environment. Canadian researchers are currently conducting studies to determine how far anadromous Arctic Char travel along coastlines once they enter the marine environment, as well as to identify different populations of Arctic Char.

DATA SOURCES

- *Dolly Varden Char Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org*
- *Dolly Varden Char Range: NatureServe, IUCN (International Union for Conservation of Nature). 2008. Salvelinus alpinus. The IUCN Red List of Threatened Species. [Version 2016-3]. Accessed:15/07/2016. http://maps.iucnredlist.org/map.html?id=19877*
- *Arctic Char Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org*
- *Arctic Char Areas of Concentrations: Stephenson, S.A., and L. Hartwig. 2010. The Arctic Marine Workshop: Freshwater Institute Winnipeg, Manitoba, February 16-17, 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934:vi+67p. http://www.dfo-mpo.gc.ca/Library/341178.pdf*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

PELAGIC FISHES

MARINE & ANADROMOUS FISHES
- Anadromous Fishes
- ➡**Pelagic Fishes**
- Bottom Fishes
- Forage Fishes

Arctic Cod

Natural history

Cod belong to the family Gadidae. There are eight species currently known in the Canadian Arctic. In addition to Arctic Cod (*Boreogadus saida*), there are four other marine species present: Atlantic Cod (*Gadus morhua*), Greenland Cod (*Gadus ogac*), Polar Cod (*Arctogadus glacialis*), and Saffron Cod (*Eleginus gracilis*).

Arctic Cod are found in shallow or deep cold ocean waters to maximum depths over 1,300 m. Being hyper-adapted to life in ice-covered seas, this species can also be found near the bottom of the sea ice. They eat crustaceans such as small copepods and smaller fish or fish eggs, as well as plankton. Arctic Cod reach an average maximum body length of 40 cm in Canadian Arctic waters. They are generally brownish with many black dots on their backs and a silvery underbelly. Arctic Cod have very small scales.

Distribution

Globally, Arctic Cod have a circumpolar distribution. In the Canadian Arctic, they are found across the Arctic Ocean in abundance. Optimal temperatures for Arctic Cod growth are believed to be between 0°C and 4°C.

Ecological significance and importance to Inuit

Arctic Cod is a key component of the Arctic marine ecosystem, responsible for up to 75% of the energy transfer between plankton and vertebrates (fish, seals, whales, and marine birds). Narhwal are believed to feed predominantly on Arctic Cod. Due to this role, as well as their abundance, Arctic Cod are a critically important food source for the animals which are eaten by Inuit. Arctic Cod are also harvested by many Inuit communities.

Conservation concern

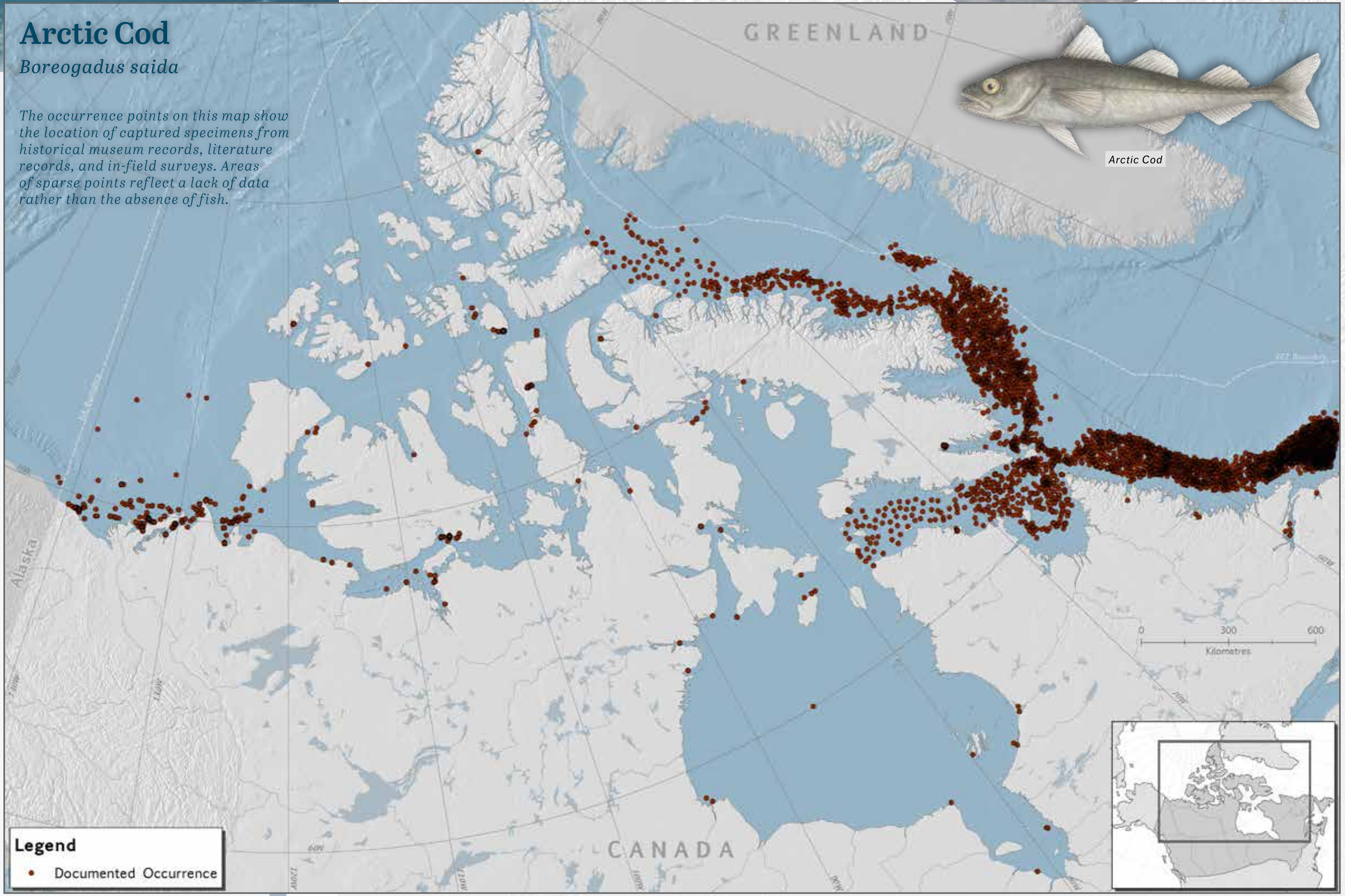
Currently there is no conservation concern for the Arctic Cod. Climate change effects resulting in reduced sea ice coverage seen in the Beaufort Sea appear to be leading to higher numbers of copepods, the major source of prey for Arctic Cod, which could result in an increase in cod size or numbers. However, significant numbers of Pacific Sand Lance (*Ammodytes pacificus*) juveniles were detected for the first time in 2010–2011 and may be displacing Arctic Cod as the sea ice retreats. A reduction in this single species could disrupt the Arctic marine food web, with far-reaching consequences.

Gaps in current knowledge

Arctic Cod are being monitored to better understand how climate changes such as sea ice reduction, warmer water at the ocean surface, increased nutrient upwelling caused by stronger winds (a process where wind blowing over water creates lower pressure at the water's surface, which then draws deeper water to the surface), and invasive species will affect their abundance. Despite the research that is being conducted on this species, much is yet to be learned about their life history and abundance, and other basic aspects of their biology and ecology.

Found in the icy waters of the Arctic Ocean, Arctic Cod feed on plankton and is an important source of food for seals, whales, seabirds, and humans. (photo: Bjorn Guliksen)

Facing page & right: Sea ice is an important habitat for juvenile Arctic Cod. It provides access to food (such as sea algae) and serves as a safe haven from predators. (photos: Peter Leopold)



DATA SOURCES
- Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

BOTTOM FISHES

MARINE & ANADROMOUS FISHES

- Anadromous Fishes
- Pelagic Fishes
- ➡**Bottom Fishes**
- Forage Fishes

Greenland Halibut (Turbot)

Natural history

Greenland Halibut (*Reinhardtius hippoglossoides*) is a deepwater flatfish abundant in icy waters and belonging to the family Pleuronectidae. This family of fish is known as "right-eye flounders" because they lie on the seafloor on their left side and both of their eyes are on or near the right side of the head. Common prey include crustaceans, cephalopods, and fish that live close to the ocean floor. In the northwest Atlantic Ocean, Greenland Halibut are highly migratory. In Canada, Greenland Halibut are also commonly referred to as Greenland Turbot or simply Turbot.

Distribution

Greenland Halibut are distributed throughout Arctic temperate waters in the northern hemisphere, including the northern Atlantic, Arctic, and Pacific Oceans, as well as the Bering and Chukchi Seas. They have a depth range of 1–2,200 m and are usually found at depths of 500–1000 m. In Canada, they are abundant in the northwest Atlantic from the Gulf of St. Lawrence to the deep Grand Banks of Newfoundland and north to Davis Strait and Baffin Bay along the northeastern coast of Nunavut. In the Arctic Ocean, they are abundant in Cumberland Sound, present in Hudson Strait and Ungava Bay, and known to exist as far north as Smith Sound. The first written record of Greenland Halibut in the Beaufort Sea, in Canada's western Arctic, was documented in 1995.

Importance to Inuit

Greenland Halibut is an important commercial fishery to eastern Canadian Arctic communities. Three of the four Inuit land claims in Canada have a quota for the commercial harvest of this species through private fleets and Indigenous-owned companies. The Baffin Bay fishery has quota reserved exclusively for Nunavut interests, as approved by the fisheries minister. In 2010, Nunavik Arctic Foods and the Labrador Inuit Development Corporation (Nunatsiavut) each had a quota of 70 tonnes/year within the Davis Strait fishery. The Torngat Fish Producers Co-op in Nunatsiavut has a total allowable take of 160 tonnes/year.

Conservation concern

Fisheries and Oceans Canada has an Integrated Fisheries Management Plan for Greenland Halibut in the western area of Baffin Bay and Davis Strait. A precautionary approach to stock management is used. A precautionary approach means being cautious about management decisions, such as determining the total allowable catch and setting quotas, when scientific information is uncertain. Major known spawning grounds of the Greenland Halibut are the deep slope off the coasts of Labrador and northeastern Newfoundland. Commercial fishing and oil and gas activity may occur in the same area at the same time; therefore protection of spawning grounds is important to ensure the continued replenishment of the stocks.

Ice fishing for Greenland Halibut (Turbot) near Clyde River, Nunavut. (photo: Henry Huntington)

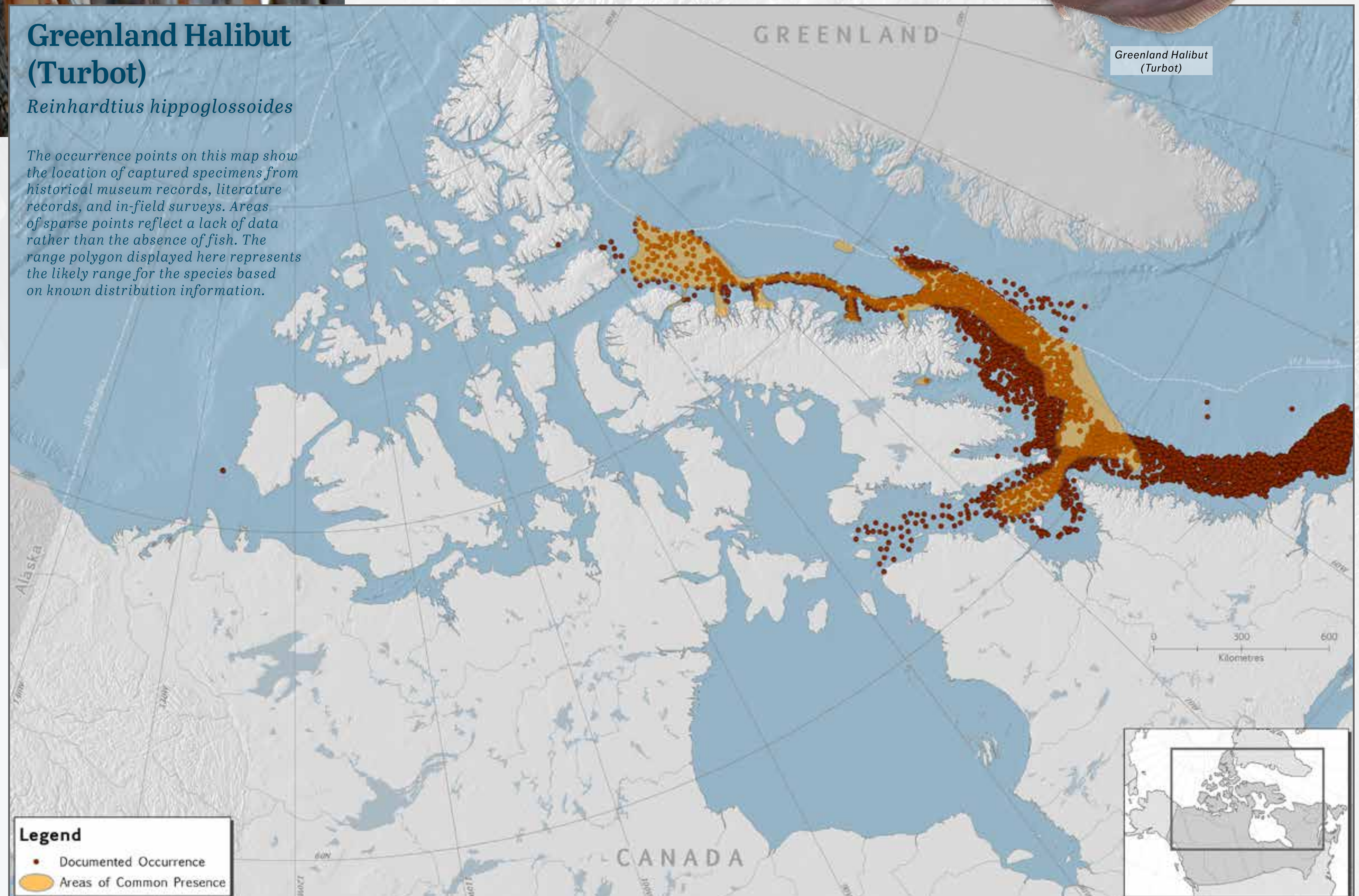
Facing page: Air-drying halibut and other fish is a traditional way of preserving an important food source. (photo: Mark Hannaford)

Greenland Halibut (Turbot)

Greenland Halibut (Turbot)

Reinhardtius hippoglossoides

The occurrence points on this map show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points reflect a lack of data rather than the absence of fish. The range polygon displayed here represents the likely range for the species based on known distribution information.



Gaps in current knowledge

The full range of Greenland Halibut in the Arctic Ocean within Canada is not known, and little is known about the habitat or behaviour of Greenland Halibut in the central and western Arctic Ocean.

DATA SOURCES

- *Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org.*
- *Areas of Common Presence: Stephenson, S.A., and L. Hartwig. 2010. The Arctic Marine Workshop: Freshwater Institute Winnipeg, Manitoba, February 16-17, 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934:vi+67p.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

FORAGE FISHES–1

Capelin

Natural history

Capelin (*Mallotus villosus*) is a short-lived species of fish belonging to the family Osmeridae, also known as the Northern Smelt family. They are a small fish that grow to a size of approximately 25 cm. Capelin are locally abundant in locations within their Canadian Arctic range, and occur in large numbers in coastal areas. They live in the open water areas of the ocean and can be found from shallow areas to 725 m in depth.

Capelin feed in the cold Arctic waters where they eat zooplankton such as Calanoid copepods, krill, worms, and small fish. They school in large numbers and represent abundant high-energy prey in the Arctic marine food web. Capelin have two different spawning behaviours, with beach spawning in the warmer water reaches of their range and deepwater spawning in the regions of colder water. They spawn around four years of age and usually do not survive the spawning event.

Distribution

Globally, Capelin have a circumpolar distribution, including oceans surrounding northern Canada, the United States (Alaska), Russia, Eurasia, Greenland, and Iceland. In North America, Capelin distribution spans from Glacier Bay, Alaska in the west and wrapping around the Arctic and Atlantic coasts to Sainte-Flavie, Québec on the St. Lawrence River. In the Canadian Arctic, they are found in nearshore and offshore areas in the Beaufort Sea, Amundsen Gulf, Queen Maude Gulf, Lancaster Sound, Foxe Basin, Hudson Bay and James Bay, Hudson Strait, Baffin Bay, and Davis Strait.

Ecological significance and importance to Inuit

Capelin are important part of the Arctic marine food web as they are the main forage species for many larger predatory fish such as cod (family Gadidae) and anadromous Arctic Char *(Salvelinus alpinus)*, sea birds such as Thick-Billed Murres and marine mammals such as Beluga Whales. They also represent a high amount of biomass available as prey to these species. Due to this role in the food web, as well as their abundance, Capelin are a critically important food source for the animals that are eaten by Inuit. In addition, Capelin are eaten by the Belcher Island Inuit (Nunavut) and the Labrador Inuit (Nunatsiavut). They are scooped out of the water in large numbers and eaten boiled, raw, or dried.

Capelin are a nutritious food source for many sea birds, including Atlantic Puffin (Fratercula arctica) *which can be found in Nunatsiavut. (photo: Barrett & MacKay)*

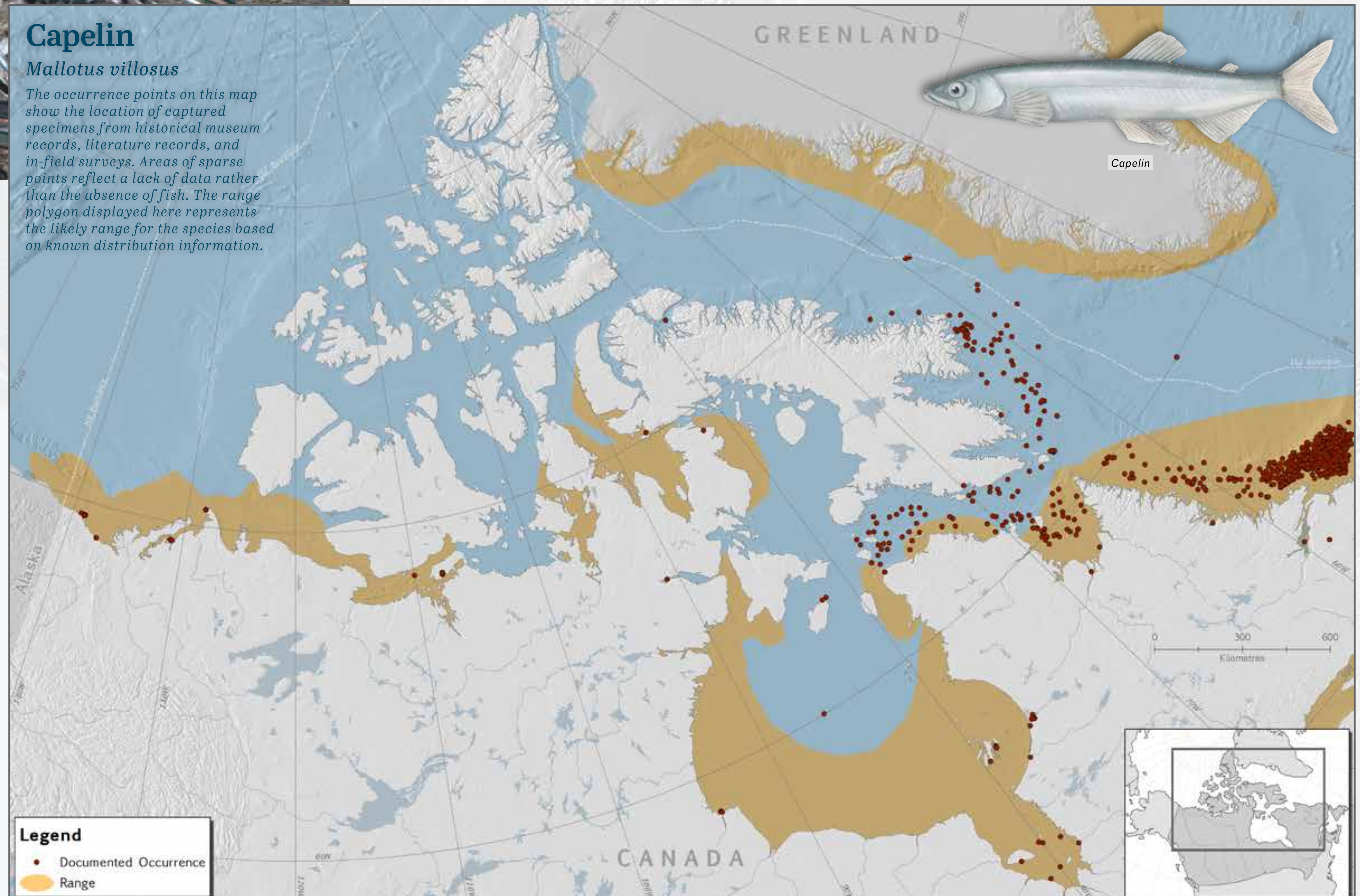
Conservation concern

Currently there is no conservation concern for Capelin. Capelin have been known to quickly and consistently change their ranges based on changing climate conditions, typically expanding their range north when water temperatures warm. Climate change resulting in warmer sea water temperatures may result in increased numbers of Capelin in areas where they were not in high abundance before. While this may be beneficial for the predators of Capelin mentioned above, it can be detrimental for species that may be displaced, such as Arctic Cod *(Boreogadus saida)*.

Gaps in current knowledge

Currently the full range of Capelin in the Arctic Ocean within Canada is not known. Capelin are being monitored to better understand how climate changes will affect their range expansion.

Facing page: Male and female Capelin during spawning season. (photo: Rolf Hicker)



DATA SOURCES
- *Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org*
- *Range: Modified from Dodson et al. 2007. Trans-Arctic dispersals and the evolution of a circumpolar marine fish species complex, the capelin (Mallotus villosus). Molecular Ecology. 16:5030-5043. doi:10.111/j.1365-294X.2007.03559.x; Modified from Carscadden, J. E., and Vilhjalmsson, H. 2002. Figure 1-- Capelin – what are they good for? ICES Journal of Marine Science, 59: 863–869. doi:10.1006/jmsc.2002.1283)*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

FORAGE FISHES–2

Pacific Herring and Atlantic Herring

Natural history

Herring are small, silvery, laterally compressed fish that live in the open water of the ocean. Pacific Herring (*Clupea pallasi*) and Atlantic Herring (*Clupea harengus*) can inhabit shallow coastal waters over the continental shelf, and can be found as deep as 475 m and 364 m, respectively. Atlantic Herring grow to a maximum length of 45 cm, and the oldest reported age is 25 years. Pacific Herring grow to a maximum length of 46 cm, and the oldest reported age is 19 years. Atlantic Herring is one of the most abundant marine fish species on the planet. South of the Arctic Ocean, Atlantic and Pacific Herring adults and eggs are highly important in commercial fisheries.

Herring move in schools between spawning, wintering, and feeding grounds. They follow migration patterns learned from older fish. Adult herring spend the day in deeper water and rise to shallower water at night to feed, with light being an important factor controlling this movement. Both species swim with their mouths open, to feed by filtering phytoplankton and zooplankton including copepods, crustaceans, and small fish. One- and two-year-old herring prey heavily on the larval stage of Capelin (*Mallotus villosus*).

Distribution

Globally, herring are found in the northern Atlantic and Pacific Oceans as well as the Arctic Ocean. In the Canadian Arctic, Pacific Herring are found in the Queen Maud Gulf and the Beaufort Sea and Amundsen Gulf, Liverpool and Wood Bays, and along the south shores of Dolphin and Union Strait at the border of the Northwest Territories and Nunavut. Atlantic Herring are found in James Bay, Hudson Bay, Hudson Strait, and Lancaster Sound.

Ecological significance and importance to Inuit

Many species of fish, birds, and marine mammals rely on herring as a source of food. As such, herring play an important role in the Arctic marine food web. Pacific Herring has been identified as an important fish species by the community of Paulatuk, and are eaten by Mackenzie Delta Inuit in the Inuvialuit Settlement Region. Atlantic Herring have been reportedly eaten by the Makkovik Inuit in Nunatsiavut.

A juvenile Atlantic Herring (Clupea harengus). *(photo: Blickwinkel)*

Conservation concern

Currently there are no conservation concerns for herring in the Arctic Ocean. It has been shown that the sizes and numbers of herring increase rapidly with warming ocean water temperatures. Thus herring biomass may increase as a result of climate change effects in the Arctic Ocean.

Facing page: Pacific Herring swim in a school to avoid and confuse predators. (photo: Manfred Ruckszio)

Gaps in current knowledge

Currently the full range of Atlantic and Pacific Herring in the Arctic Ocean within Canada is not known. Much remains to be learned about their life history and abundance, and other basic aspects of their biology and ecology in Canadian Arctic marine waters. A lack of understanding of fish resources in the Arctic is a result of the vast geographic area and the presence of sea ice throughout much of the year, making sampling and research difficult and costly.

DATA SOURCES
- Documented Occurrences: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

COASTAL AND MARINE BIRDS OF THE ARCTIC

COASTAL & MARINE BIRDS

- Geese
- Sea Ducks
- Loons
- Seabirds
- Shorebirds

Ecological significance

Marine birds are found around the globe, from the poles to the tropics, where they live at the interface between air, land, sea, and ice. The harsh conditions that marine birds find in these environments have caused unique adaptations in their physiology and morphology and require enormous flexibility in life-history strategies. Despite the diversity of their diets, marine birds are generally top consumers in marine food webs. They are useful and effective indicators of Arctic marine ecosystem health—revealing shifts in marine food webs, changes in prey distributions, and the accumulation of contaminants—they play an increasingly important role in the assessments of marine health, habitat conservation, and marine spatial planning exercises.

Cultural significance

In general, birds have a broad cultural significance in the Arctic, often considered important harbingers of spring, and are heavily featured in Indigenous folklore and arts. Migratory birds also offer a fresh source of meat and eggs after a long, harsh northern winter, and the skins, bones, and down of marine birds are also used in clothing, as tools, and for ceremonial purposes. The subsistence harvest of marine birds and their eggs has deep roots in the Canadian Arctic, being a long-standing tradition by both Indigenous peoples and European settlers. These days, most marine bird species are protected from harvest by non-Indigenous hunters across Canada, except for a few waterfowl species (eiders, scoters) and murres specifically in Newfoundland and Labrador. Indigenous hunters harvest coastal and marine birds and their eggs wherever they are available, but most often in and around communities located close to large seabird colonies.

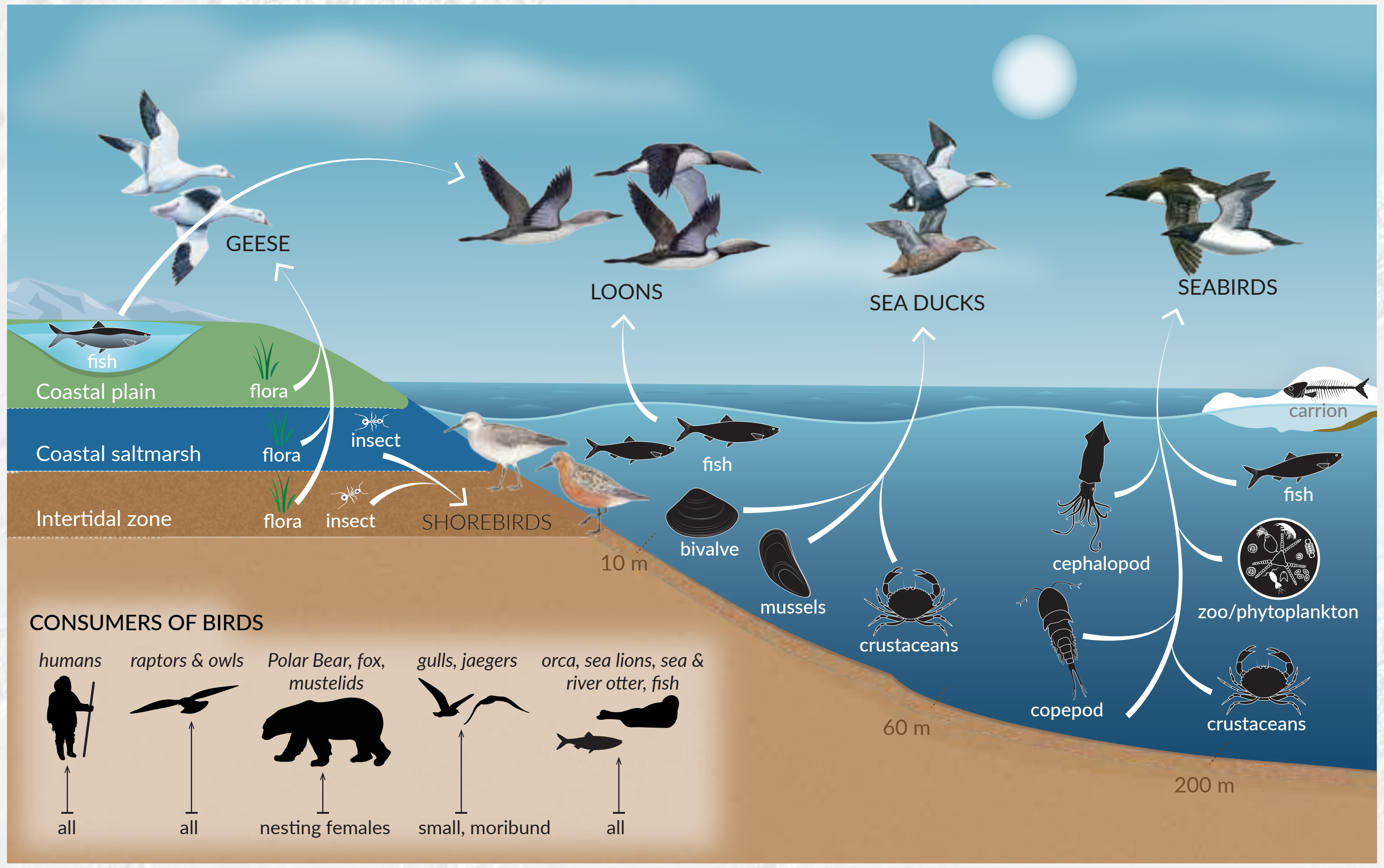
Conservation concerns

Many marine bird species are considered threatened or endangered at both global and continental scales. In fact, marine birds are more threatened globally than are other groups of birds, and their status has deteriorated faster over recent decades. Some of the evolutionary traits that make marine birds well suited to harsh environments also make them vulnerable to extinction.

Around the world, marine birds face multiple ecological and environmental stressors, including habitat loss and alteration, disturbance, hunting, interactions with commercial fisheries, oil spills, persistent pollutants, ocean acidification, and other issues associated with climate change. Many of these pressures are currently evident across the Arctic region.

Ivory Gull on an ice floe edge. (photo: Roberta Olenick)

ARCTIC BIRDS SIMPLIFIED FOOD WEB



This simplified food web shows the movement of energy through key Arctic coastal and marine bird species. The overlapping network of food chains shows how each species is interconnected.

Major concerns

With climate change influencing the Arctic faster than any other region of the globe, rapid changes are affecting Arctic-breeding birds in a number of ways, including the degradation or loss of specific habitats, mismatches in breeding or staging with the timing and availability of ephemeral food resources, and increased occurrence of extreme weather conditions. The associated drastic long-term decline in the extent of annual sea ice may allow year-round shipping and an increase in industrial development for natural resource extraction. Developments of this kind can exacerbate the direct impact of climate change on marine birds, by increasing environmental disturbance, habitat loss, pollution, and other problems.

Gaps in current knowledge

Evaluating the conservation status and trends of bird populations is difficult at the best of times, but gathering reliable data on the abundance and distribution of marine birds at sea is an enormously challenging exercise, especially across an area as vast and remote as the Canadian Arctic. More studies using remote tracking methods, including drones, to follow local foraging movements as well as annual migrations of marine birds around or to and from the Arctic are essential to filling this critical information gap and in identifying important breeding, foraging, and stopover areas, as well as migration corridors and flyways.

Rationale for selected species

Seven distinct marine bird species or species groups are highlighted in this section. These species/groups were specifically selected based on a number of important factors, including their cultural, ecological, and conservation significance, as well as the availability of recent and reliable spatial data for the Arctic region. These species also span a broad range of trophic levels, including herbivores (geese), invertivores (shorebirds), benthivores (eiders, scoters), planktivores (Long-Tailed Duck, Northern Fulmar), piscivores (loons, murres), and scavengers (Ivory Gull).

For further reading, see p. 108.

Left to right: Eider ducklings hatching; Common Eider ducks diving for food. (photos: Joel Heath)

Designated Sites

Coastal and marine Key Habitat Sites and Important Bird Areas in Canada's Arctic

These designated sites are Key Habitat Sites and Important Bird Areas that host important aggregations of birds or which support at least 1% of the Canadian population of the species. They may be sites used for colonies, nesting, feeding, brood rearing, molting, staging, migration, or wintering.

Legend

Designated Sites: Key Habitat Sites and Important Bird Areas

DATA SOURCES

- *Key Habitat Sites: Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service. http://publications.gc.ca/collections/collection_2009/ec/CW69-1-114-1E.pdf; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service. http://publications.gc.ca/collections/collection_2011/ec/CW69-1-109-eng.pdf*
- *Important Bird Areas: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

ARCTIC-BREEDING GEESE

Snow Goose, Ross's Goose, and Brant

COASTAL & MARINE BIRDS
- ➡ **Geese**
- Sea Ducks
- Loons
- Seabirds
- Shorebirds

Natural history

The three species included here all breed exclusively in the Arctic. Two subspecies of Snow Goose are recognized in North America—the mid-continent and western populations, known as the Lesser Snow Goose *(Chen caerulescens)*, and the eastern population, known as the Greater Snow Goose *(Chen atlantica)*. Both Snow Geese and Ross's Geese have two colour morphs: the more common white morph and the less common blue morph. Blue morph Ross's Geese are rare and thought to be the result of hybridization with blue morph Snow Geese. Two subspecies of Brant are also present in North America—the eastern population, known as the Atlantic Brant *(Branta hrota)*, and western population, known as the Black Brant *(Branta nigricans)*.

All three goose species have similar behavioural and ecological traits. All are rapidly maturing (two to four years), large-bodied birds with relatively high reproductive rates and low juvenile survival. In Canada, all three species nest in coastal tundra habitats. Brant are more coastal throughout the year compared to the other two species. Brant nest in saltmarshes and around coastal ponds, estuarine deltas, and braided river valleys, and they winter near intertidal mudflats with extensive eelgrass beds. Snow and Ross's Geese typically nest further from the coast in drier tundra areas and sedge meadows. Historically, Snow and Ross's Geese wintered in coastal marshes, but in the mid-1950s their winter distribution shifted to open agricultural habitats in the southern and central US in response to changing cultivation practices. All three species are all highly gregarious throughout the year. Snow and Ross's Geese nest together in extremely large, dense colonies, and form massive aggregations outside of the breeding season.

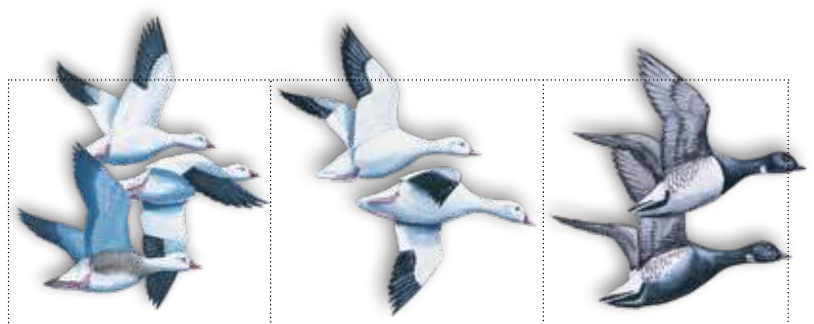
Distribution

All three species of geese are broadly distributed across the Canadian Arctic during the breeding season with the exception of Ross's Geese, which are concentrated in the Queen Maud Gulf region. Snow and Ross's Geese use all four continental flyways during migration and are broadly distributed across the US and Mexico during winter months. The winter distribution of Brant is divided between the Pacific and Atlantic coasts of North America. Prior to fall migration, all three species of geese use specific post-breeding sites to moult their wing and body feathers, during which individuals are flightless for several weeks. Snow Geese and Brant also use specific stopover sites during migration, with large numbers of individuals stopping in Hudson Bay and James Bay in spring and fall.

Importance to Inuit

Geese in general are an important part of Inuit subsistence harvesting across the Canadian Arctic, and

Table 1:
The global and national conservation status and continental conservation needs of selected geese.



	Snow Goose *(C. caerulecens)*	**Ross's Goose** *(C. rossii)*	**Brant** *(B. bernicla)*
Global Conservation Status[1]	LEAST CONCERN	LEAST CONCERN	LEAST CONCERN
Continental Conservation Needs[2]	ABOVE OBJECTIVE	ABOVE OBJECTIVE	HIGH (ATLANTIC – MODERATELY LOW)
Canada Conservation Status (wildspecies)[3]	SECURE	SECURE	SECURE

[1]IUCN 2015, [2]North American Waterfowl Management Plan 2004, [3]CESCC 2011.

Snow goose pair stand near chicks in the nest. (photo: Sergey Gorshkov)

Snow, Ross's, and Brant Geese are harvested where they are locally available. Adult birds are hunted for meat, eggs are collected for food in early summer, and goose down is used as insulation in winter clothing. All three goose species are also targeted by sport hunters across North America. Sport hunting harvest pressure varies by species and location, and has varied over time. Annual regulations are intended to maintain populations at target levels described in the North American Waterfowl Management Plan 2012.

Conservation concerns

None of these three goose species are considered to be of conservation concern at the global or continental level (see Table). Snow Goose and Ross's Goose numbers have increased dramatically since the 1960s in response to improved winter forage and reduced hunting pressure. Collectively, these "light" geese are now considered overabundant and a management concern because of the extensive and prolonged habitat degradation they can cause. An expanded harvest season and increased bag limits were recently introduced to reduce numbers of light geese, which have been effective for the eastern population, but the mid-continent population has continued to expand. Numbers of Brant have declined since broad-scale winter surveys were initiated in the 1960s. Currently, winter populations appear stable or gradually increasing, whereas some breeding populations have declined or fluctuate markedly perhaps, in part, because sport hunting appears to affect annual mortality.

There are numerous impacts to these geese on their Arctic breeding grounds, including degradation of Snow and Ross's Goose breeding habitats due to overpopulation, and a mismatch in breeding phenology (seasonal cycles) and high-quality forage due to the earlier arrival of breeders. Predation on tundra-breeding birds, including geese, can be extreme in years following lemming population crashes when predators, particularly Arctic Foxes, switch to alternative prey sources. Rates of Polar Bear nest predation have also increased in response to a longer ice-free summer and more time being spent on land. Lead poisoning can also be an issue for many waterbirds. Although lead shot was banned for waterfowl hunting in 1999, geese and other waterbirds can still ingest old, spent lead shot while foraging.

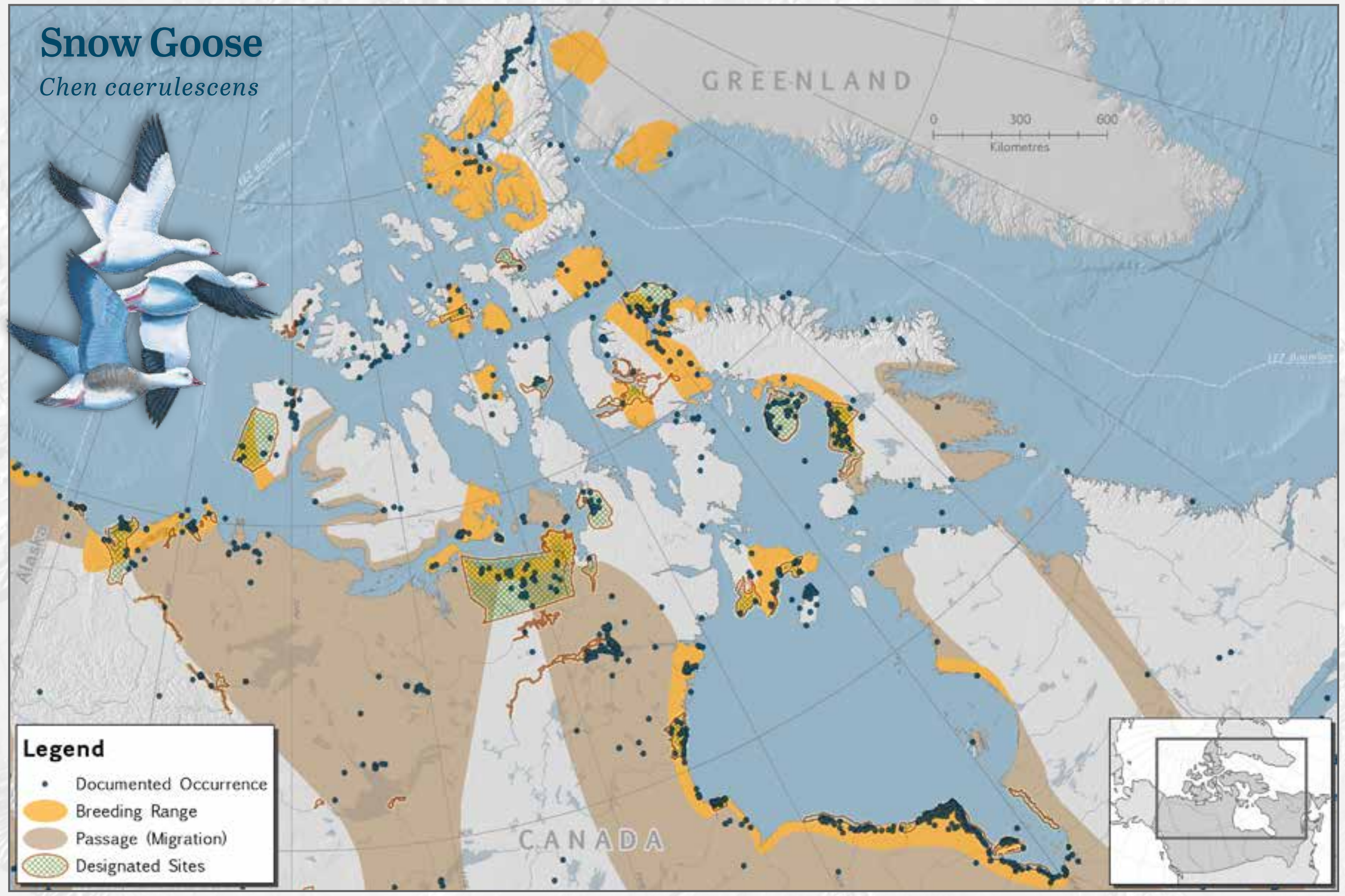
Gaps in current knowledge

Arctic geese, and Snow Geese in particular, are well studied compared to other Arctic-breeding birds. However, knowledge gaps important to conserving Arctic habitats do remain. Chief among these gaps are the long-term impacts of overabundant light geese on tundra ecosystems and whether vegetation recovery rates and trajectories will limit local habitat availability or suitability for geese and other species in the future. Factors supporting overpopulation, estimates of carrying capacity, and potential limiting factors also require further study. Because hunting regulations do not distinguish between Snow and Ross's Geese, continued on-the-ground monitoring is needed to ensure one species is not disproportionately impacted by the expanded harvest. For Brant, discrepancies between local breeding population trends and population estimates from annual mid-winter surveys need to be resolved to prevent local extirpations. Additional demographic and ecological information is also needed from a greater number of colonies across the breeding range. Additional information is also needed on threats to migration and wintering habitats, and on linkages between wintering and Arctic breeding areas and the potential for cross-seasonal effects on demography.

Harvesting goose and Brant eggs. (photo: Trevor Taylor)

Snow Goose

Chen caerulescens

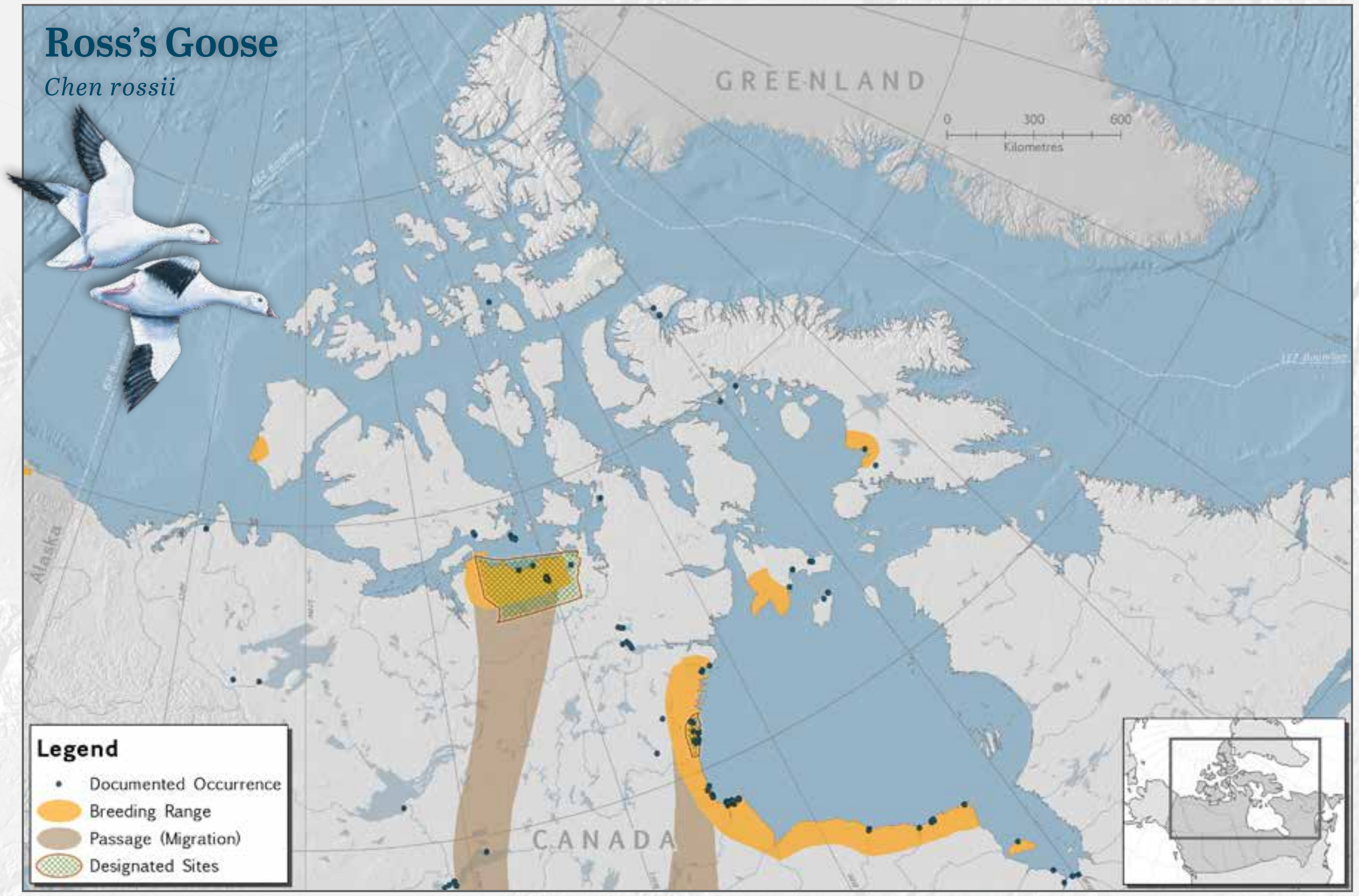


SNOW GOOSE DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility) (2016). Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Ross's Goose

Chen rossii

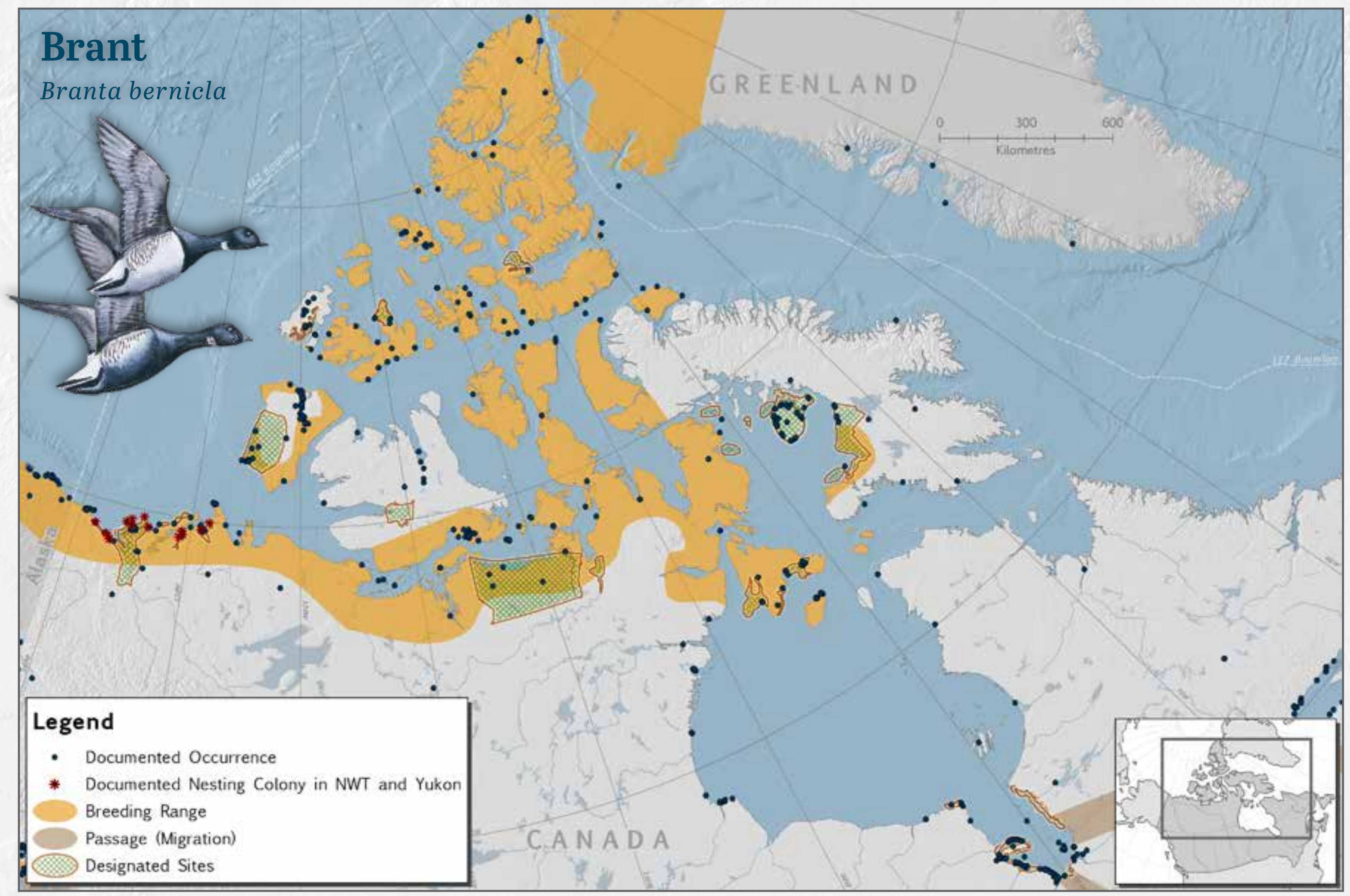


ROSS'S GOOSE DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility) (2016). Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Brant

Branta bernicla



The occurrence points on these maps show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect either a lack of data or an absence of birds. Designated Sites are important bird areas and key habitat sites; these are recognized areas that support larger numbers of individuals of one or more species during one or more periods of the year and can include aggregation areas, colonies, nesting, feeding, brood rearing, molting, staging, migration or wintering.

BRANT DATA SOURCES

- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al (2008). Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

ARCTIC-BREEDING SEA DUCKS—1

Common Eider, King Eider, and Long-tailed Duck

COASTAL & MARINE BIRDS
- Geese
- **Sea Ducks**
- Loons
- Seabirds
- Shorebirds

Natural history

There are 15 species of sea ducks in North America. This includes three Arctic-breeding subspecies of Common Eider *(Somateria mollissima)*—the Northern race *(Somateria borealis)*, the Hudson Bay race *(Somateria sedentaria)*, and the Pacific race *(Somateria v-nigra)*. The Common Eider is the largest duck in North America, more than twice the size of the Long-tailed Duck *(Clangula hyemalis)*. The King Eider *(S. spectabilis)* is approximately halfway between the other two species in body size. This range of body sizes corresponds to their range of life-history strategies. On average, Common Eiders live approximate twice as long as Long-tailed Ducks (7.4 years vs. 3.1 years), take longer to achieve sexual maturity (three vs. two years of age), and lay fewer eggs per clutch (three to five vs. seven to eight). Information on juvenile survival is limited, but is generally assumed to be low for all three species.

These three species have relatively similar behavioural and ecological traits. All have circumpolar breeding distributions and are widespread across Arctic and sub-Arctic coastal and marine habitats in Canada during the breeding period. Each is highly gregarious in winter, often forming mixed flocks, but they vary in their degree of sociality during the breeding season. Common Eiders nest in dense colonies, mostly on small marine islands, and form large aggregations in inshore bays or polynyas (open water enclosed by sea ice) outside of the breeding season. This colonial habit means Common Eiders are relatively easy to monitor during the breeding season. King Eiders are loosely colonial and may nest among Common Eiders, in small groups of themselves on islands, or widely dispersed across coastal tundra. Long-tailed Ducks occasionally nest in small loose clusters, but more often they are widely dispersed or solitary nesters among small ponds in coastal wetland areas. Because King Eiders and Long-tailed Ducks are more dispersed and, subsequently, more difficult to locate and to monitor during the breeding season, population sizes are estimated from wintering surveys.

Distribution

All three species divide between Pacific and Atlantic coastal waters during winter months. On the west coast, Common Eiders winter in southern Alaska and around the Aleutian Islands. On the east coast, they winter in coastal areas of Atlantic Canada and the northeastern United States as far south as Chesapeake Bay, and along the southern coast of Greenland. The Hudson Bay population *(sedentaria)* winters in marine waters around the Belcher Islands in southeastern Hudson Bay. King Eiders and Long-tailed Ducks have a winter range similar to Common Eiders. King Eiders are more likely to use areas further offshore, and Long-tailed Ducks extend considerably further south on the Pacific coast, as far as northern Oregon. Long-tailed Ducks also regularly winter in all five Great Lakes, and are often found in large concentrations (tens to hundreds of thousands) in coastal waters of the mid-Atlantic region of the US.



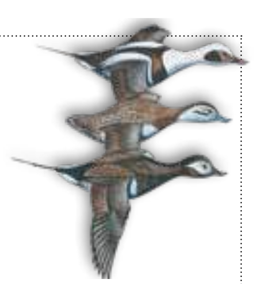


Table 1: The global and national conservation status and continental conservation priority of selected sea ducks.

	Common Eider *(S. mollissima)*	King Eider *(S. spectabilis)*	Long-tailed Duck *(C. hyemalis)*
Global Conservation Status[1]	NEAR THREATENED	LEAST THREATENED	VULNERABLE
Continental Conservation Needs[2]	HIGH	MODERATELY HIGH	MODERATELY HIGH
Canada Conservation Status (wildspecies)[3]	SECURE	SENSITIVE	SECURE

[1]IUCN 2015, [2]North American Waterfowl Management Plan 2004, [3]CESCC 2011.

A female Common Eider feeding on urchins and bivalves beneath sea ice. (photo: Joel Heath)

Common and King Eiders feed largely on benthic (bottom-dwelling) invertebrates year-round, such as mussels and urchins, but may also take other aquatic invertebrates. King Eiders will also forage on plant material in breeding areas. Long-tailed Ducks have a more varied diet, including larval and adult insects and crustaceans. In all three, incubating females rely on internal resources during incubation, only leaving their nest occasionally to drink.

Importance to Inuit

Sea ducks, particularly eiders, are heavily harvested for subsistence purposes across the Canadian Arctic; their eggs are collected for food in early summer, and their nest down is collected commercially in some areas. Common Eiders are the most commonly hunted marine bird in Nunavut, with some Inuit communities relying heavily on this species for much of the year (e.g., Sanikiluaq, in the Belcher Islands). Eider harvests are assessed annually in harvest survey questionnaires. These either are mailed to recreational hunters with their permits (although this method captures only a portion of the harvest because Indigenous residents are not required to purchase a permit) or are voluntary community-based efforts. Eiders are also hunted for sport in Atlantic Canada and New England, and Canadian Arctic breeders are also heavily hunted for subsistence in Greenland.

Conservation concerns

Of these three species, the Common Eider is listed as the highest conservation concern globally ("near threatened"; see Table) and is the highest conservation priority continentally ("high"). In Canada, King Eiders are considered "*sensitive*" whereas Common Eiders and Long-tailed Ducks are considered Secure.

Threats to sea ducks on their Arctic breeding grounds are many, including high levels of predation on eggs and young, subsistence harvest, and degradation of breeding habitat from mining and oil and gas exploration and development. Contaminants are a major issue for sea ducks globally, with these species generally having elevated levels of heavy metals that are likely picked up on their wintering grounds. Outbreaks of infectious diseases have been observed in the southern ranges of these sea ducks, which lead to major, episodic winter die-offs. Avian cholera has also recently affected Common Eiders breeding in the Arctic, where it has had a devastating effect in some colonies. In their wintering areas, the major issues likely vary for each species, but include exposure to contaminants, marine pollution (oil spills), and offshore development. Traditional knowledge has also identified declines in the resident Common Eider population in Hudson Bay, which was later verified by surveys during the breeding period. Causes for the decline are unknown but are suspected to be driven by changes in wintering sea ice conditions, linked, in part, to hydroelectric development on the coast.

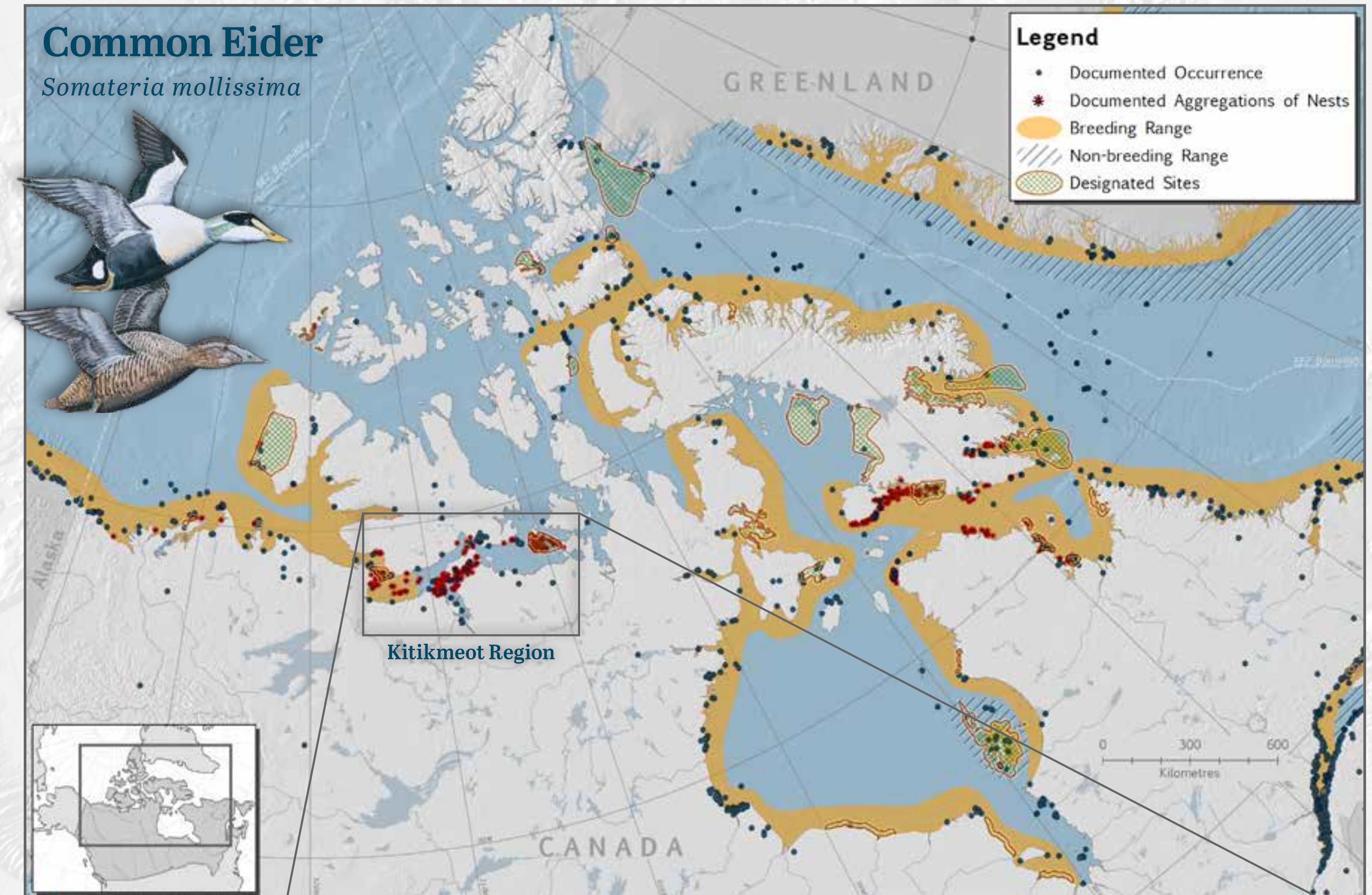
Gaps in current knowledge

In general, the largest unknowns for these three sea ducks are the potential impacts of climate change, which may exacerbate existing threats. There are still considerable gaps in knowledge of demographics and aspects of habitat use, such as brood-rearing areas.

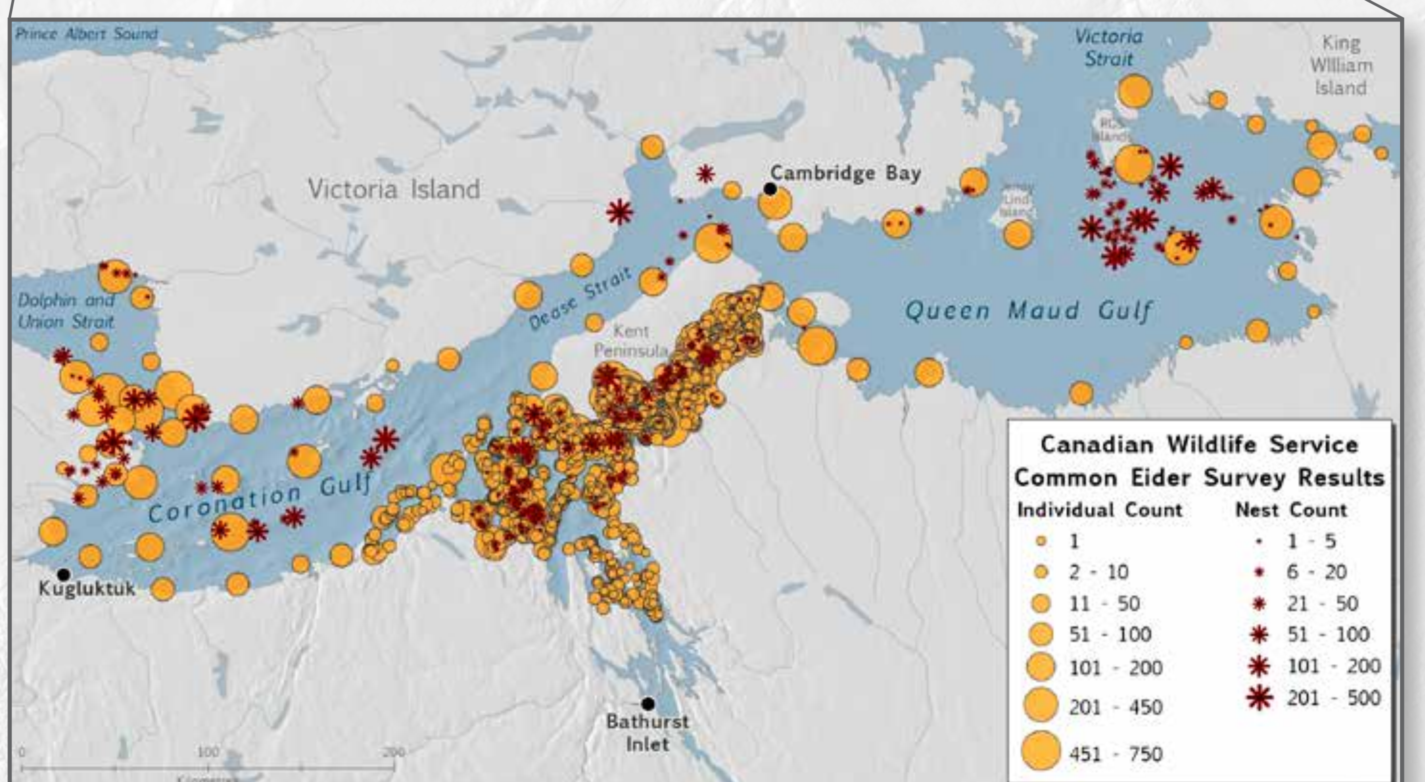
Common Eider eggs in a down nest. (photo: Sheila Enfield)

Common Eider

Somateria mollissima



The occurrence points on these maps show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect either a lack of data or an absence of birds. Designated Sites are important bird areas and key habitat sites; these are recognized areas that support larger numbers of individuals of one or more species during one or more periods of the year and can include aggregation areas, colonies, nesting, feeding, brood rearing, molting, staging, migration or wintering.



COMMON EIDER DATA SOURCES - KITIKMEOT

- *Environment and Climate Change Canada – Canadian Wildlife Service. 2008. Common Eider Survey Data: 1995, 2006, 2007, 2008.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

COMMON EIDER DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/*
- *Colony Data: Alexander et al. 1988; Alexander and Hawkings, 1988; Cornish and Dickson, 1997; Environment and Climate Change Canada. 2016. Common Eider Surveys, 1965-2016; Falardeau, FG., Rail, J.-F., Savard, J.-P.L. 2003. Breeding survey of Common Eiders along the west coast of Ungava Bay, in summer 2000, and a supplement on other nesting aquatic birds. Canadian Wildlife Service, Quebec Region; Johnson and Ward, 1985; Kay et al., 2006; Ward, 1979.*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

KING EIDER DATA SOURCES

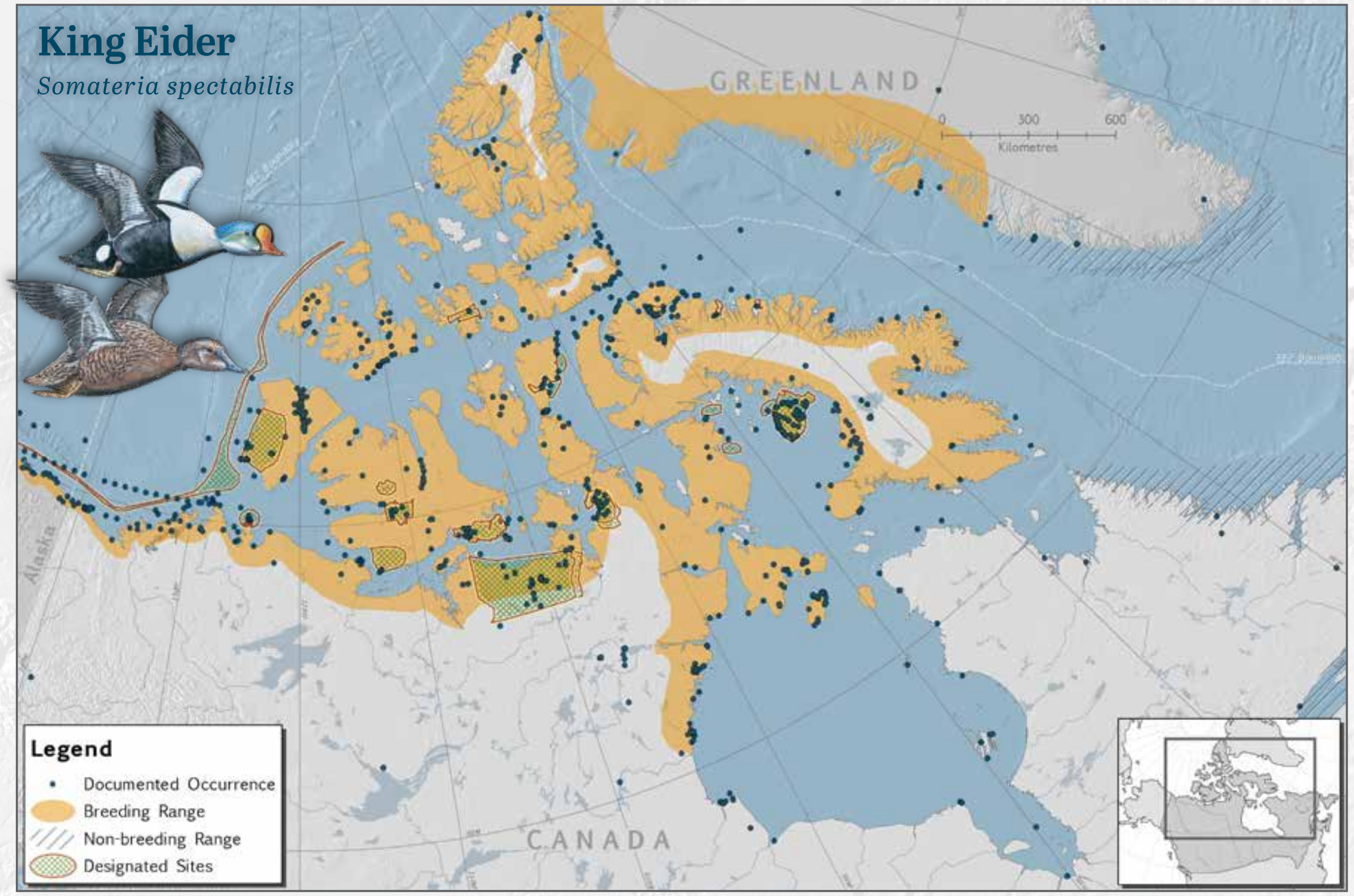
- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

LONG-TAILED DUCK DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility) 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al (2008). Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

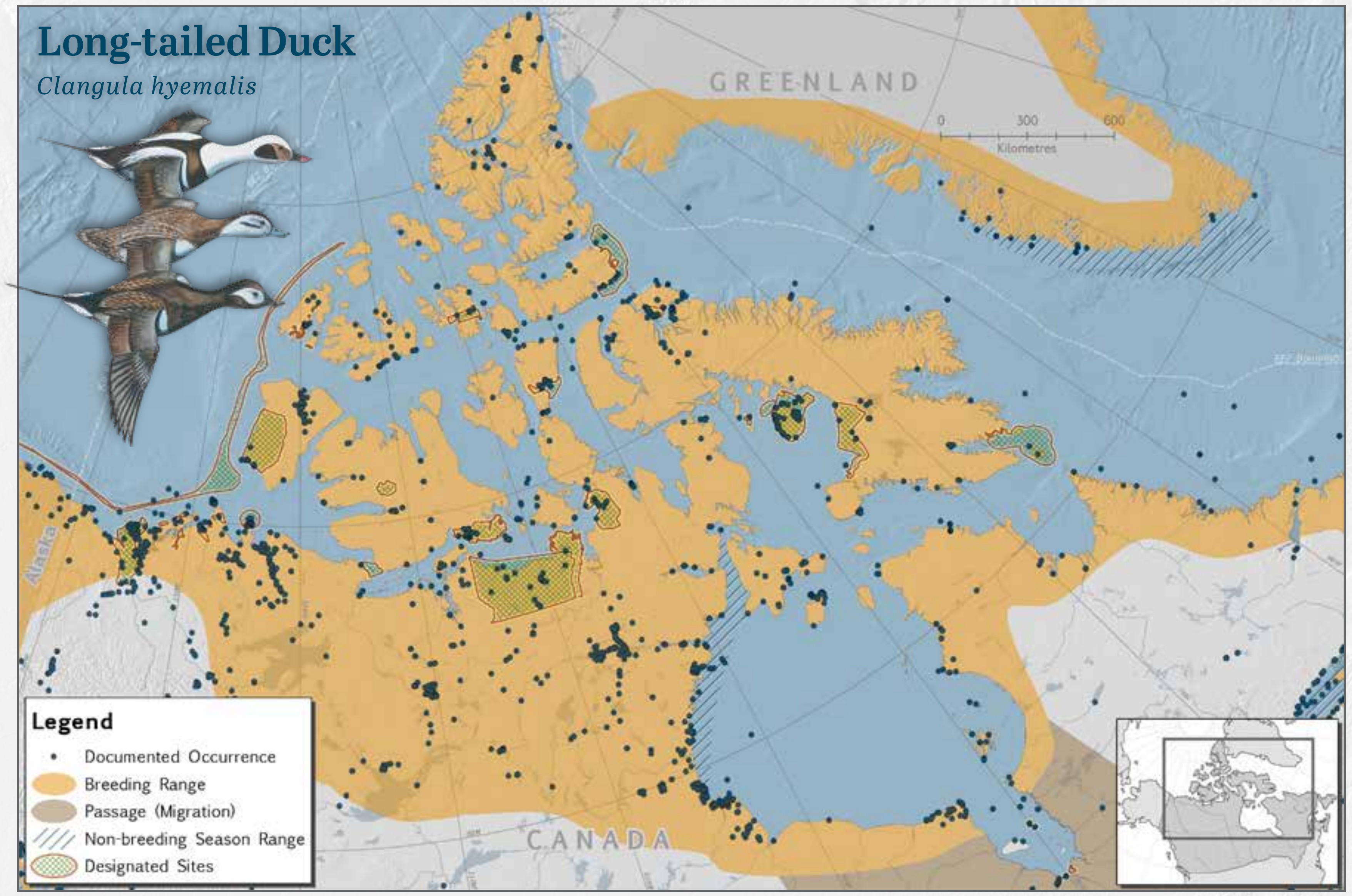
King Eider

Somateria spectabilis



Long-tailed Duck

Clangula hyemalis



ARCTIC-BREEDING SEA DUCKS—2

White-winged Scoter, Surf Scoter, and Black Scoter

Natural history

There are four species of scoter in the world, three of which breed in Canada's sub-Arctic and Arctic regions. Scoters are distinctive, heavy-bodied sea ducks. White-winged Scoters *(Melanitta fusca)* are the largest, with males weighing up to 2 kg. Black Scoters *(M. americana)* are approximately half the size of White-winged Scoters, and Surf Scoters *(M. perspicillata)* are intermediate in size. Scoters begin breeding at two years of age, and lay eight to nine eggs per clutch. Information on adult survival is limited, but is generally assumed to be relatively high (10 or more years) for all three species.

Scoters have similar behavioural and ecological traits, and all are relatively widespread across sub-Arctic and lower Arctic Canada during the breeding period. White-winged Scoters have a circumpolar breeding distribution and, in North America, breed in prairie regions of central Canada and interior British Columbia. Surf Scoters are confined to North America during breeding, although stray birds are fairly common in northwest Europe. The Black Scoter has recently been split form the Common Scoter (*M. nigra*) in Europe; its breeding range is also largely confined to North America with a small population in eastern Russia. Black Scoters are commonly thought to breed in two distinct populations. The eastern population extends from western Hudson Bay to Labrador with the majority of the population concentrated in northern Quebec. The western population extends west from the Mackenzie Delta in the Northwest Territories, through coastal and parts of central Alaska. More recent telemetry and survey data indicate the breeding range of Black Scoters also includes tundra habitats west of Hudson Bay, suggesting eastern and western breeding populations may not be disjunct. Scoters are highly gregarious in winter, often forming large mixed flocks, but they vary in their degree of sociality during the breeding season. White-winged Scoters can nest in relatively high densities, mostly on small islands, and sometimes among nesting gulls and terns. Surf and Black Scoters are more dispersed during breeding and nest solitarily close to ponds and wetlands.

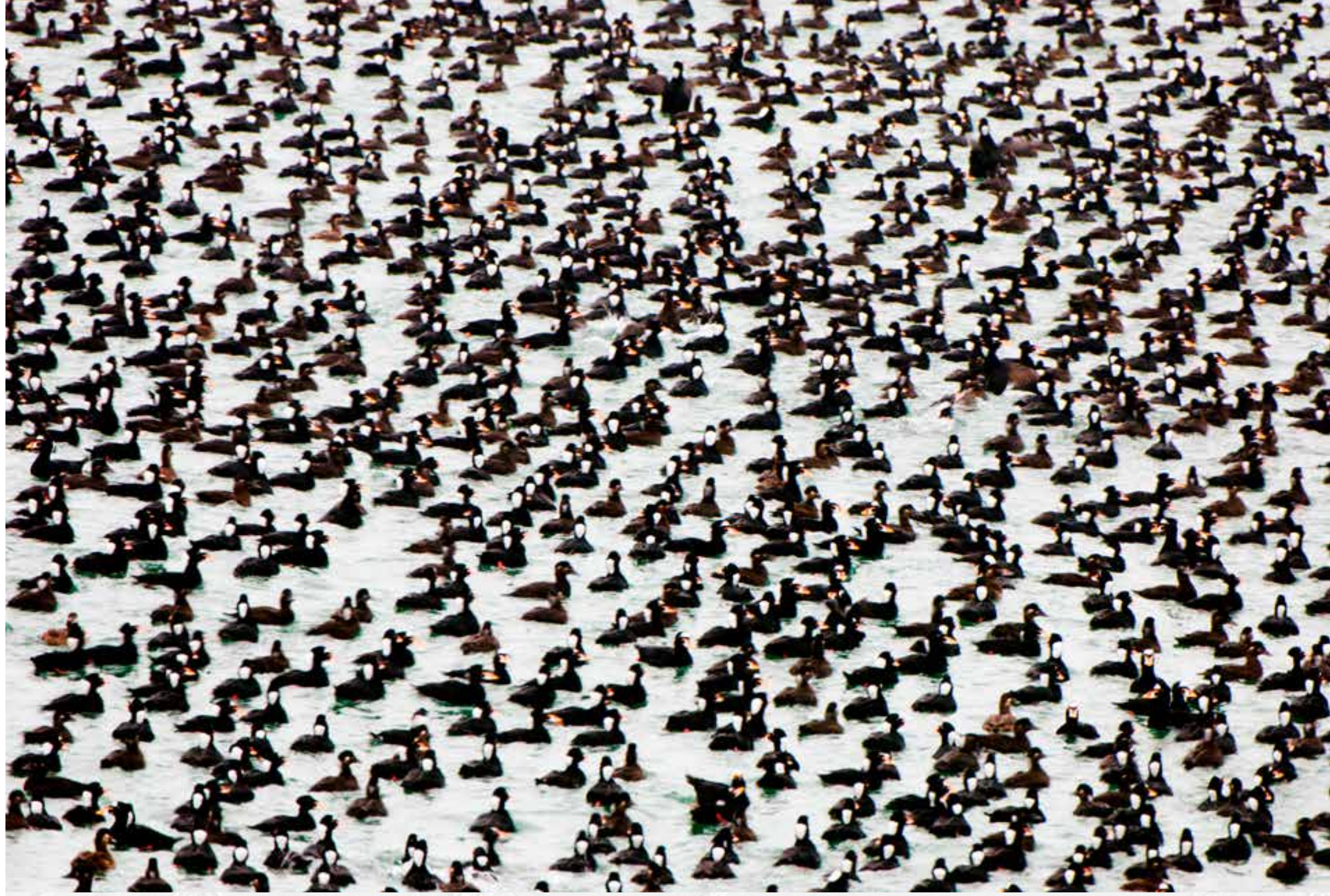
Distribution

All three scoter species divide between east and west coastal waters of North America during winter months, with eastern breeders migrating to the Atlantic coast and western breeders migrating to the Pacific coast. On the Pacific coast, all three species range from the Aleutian Islands to as far south as the Baja California peninsula. On the Atlantic coast, all three species of scoters range from Atlantic Canada south to the Gulf of Mexico, with small numbers remaining on the Great Lakes each year. Scoters often winter in large concentrations, sometimes in mixed-species flocks. In coastal waters of the mid-Atlantic region of the US, for example, they often form flocks of tens of thousands of birds, particularly in and around Chesapeake Bay. The largest aggregations tend to be found in areas with the highest density and biomass of benthic prey (macroinvertebrates).

Table 1: The global and national conservation status and continental conservation priority of scoters.

	White-winged Scoter *(M. fusca)*	Surf Scoter *(M. perspicillata)*	Black Scoter *(M. americana)*
Global Conservation Status[1]	LEAST CONCERN	LEAST CONCERN	NEAR THREATENED
Continental Conservation Needs[2]	MODERATELY HIGH	MODERATELY HIGH	MODERATELY HIGH
Canada Conservation Status (wildspecies)[3]	SECURE	SECURE	SECURE

[1]IUCN 2015, [2]North American Waterfowl Management Plan 2004, [3]CESCC 2011.



A large raft of Surf Scoters. (photo: Paul Colangelo)

Importance to Inuit

Like other sea ducks, scoters are harvested for subsistence purposes across the Canadian Arctic, and their eggs are occasionally collected for food in early summer. The non-breeding sport harvest is much larger and, in recent years, 40,000–50,000 scoters have been harvested annually in the eastern US alone.

Conservation concerns

Globally, the Black Scoter is listed as the highest conservation concern ("near threatened"), while the White-winged and Surf Scoter are listed as "least concern." All three, however, have the same conservation priority continentally ("moderately high"), and are considered "secure" in Canada (see Table).

Potential threats to scoters on their Arctic breeding grounds are many, including predation on eggs and young, subsistence harvest, and degradation of breeding habitat from mining and oil and gas exploration and development. Scoters generally exhibit elevated levels of contaminants that are likely accumulated from invertebrate prey on their wintering grounds. White-winged and Surf Scoters are attracted to aquaculture sites, where they may affect the commercial harvest of cultured mussels, opening the potential for conflicts in some areas. Since they have similar wintering distributions, threats during non-breeding are also likely similar for each species, including exposure to contaminants, marine pollution (oil spills), disturbance by vessels, and offshore development. In Europe, scoters were found to be displaced by offshore wind farms for a number of years after construction, but eventually returning to the area. The cumulative impact of multiple offshore wind developments is unknown, however.

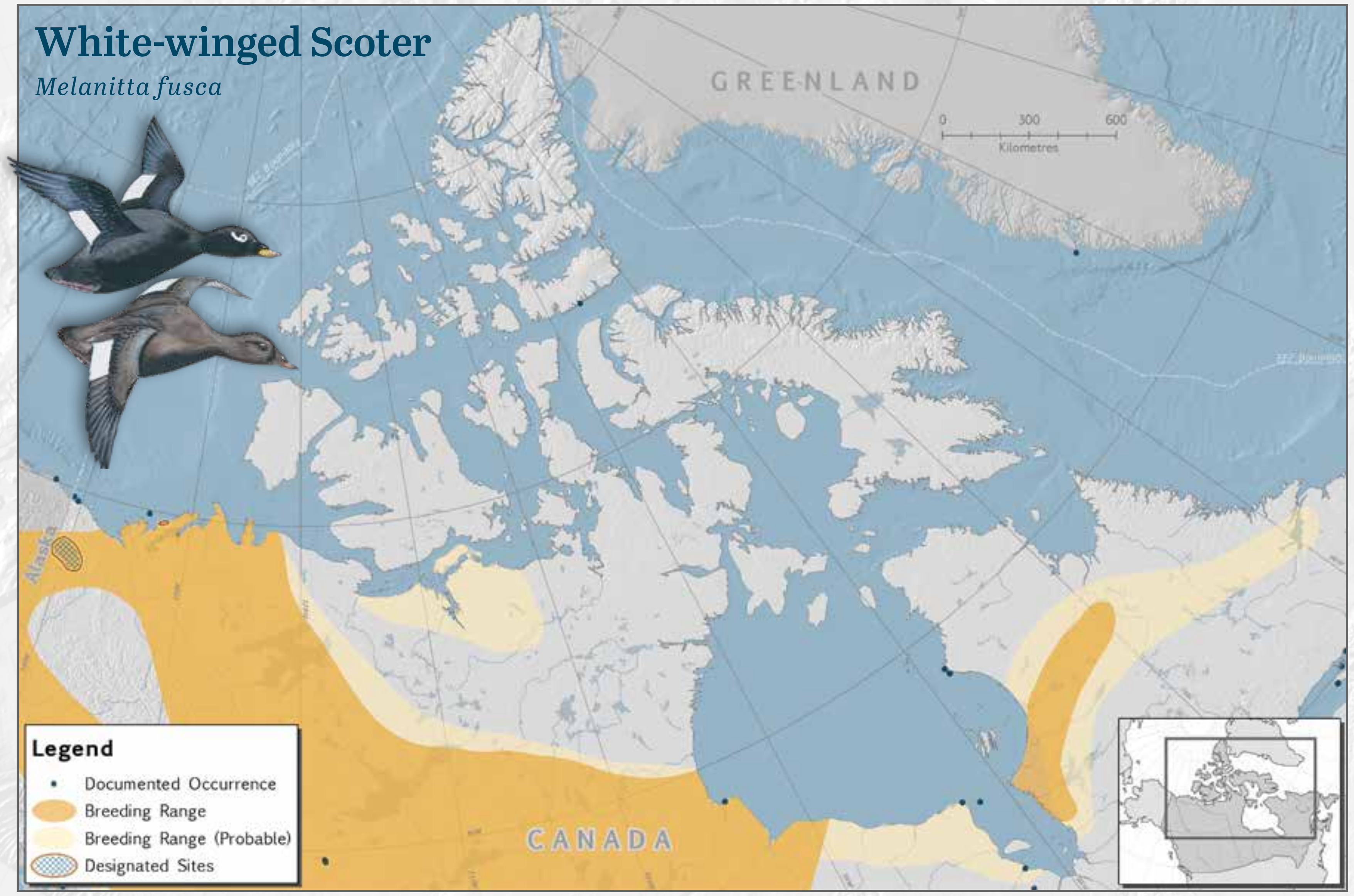
Gaps in current knowledge

There are many unknowns for scoters in the Canadian Arctic, including population size and trend, population dynamics, population ecology, and the effects of human harvests. In addition, little is known about the potential effects of climate change, such as drying of wetland tundra breeding habitat, which may exacerbate existing threats. Gaining an improved understanding of population sizes and trends is a primary conservation and management priority for sea duck species, including all three scoters.

Male Surf Scoter eating bivalves. (photo: Nigel Tate)

White-winged Scoter

Melanitta fusca

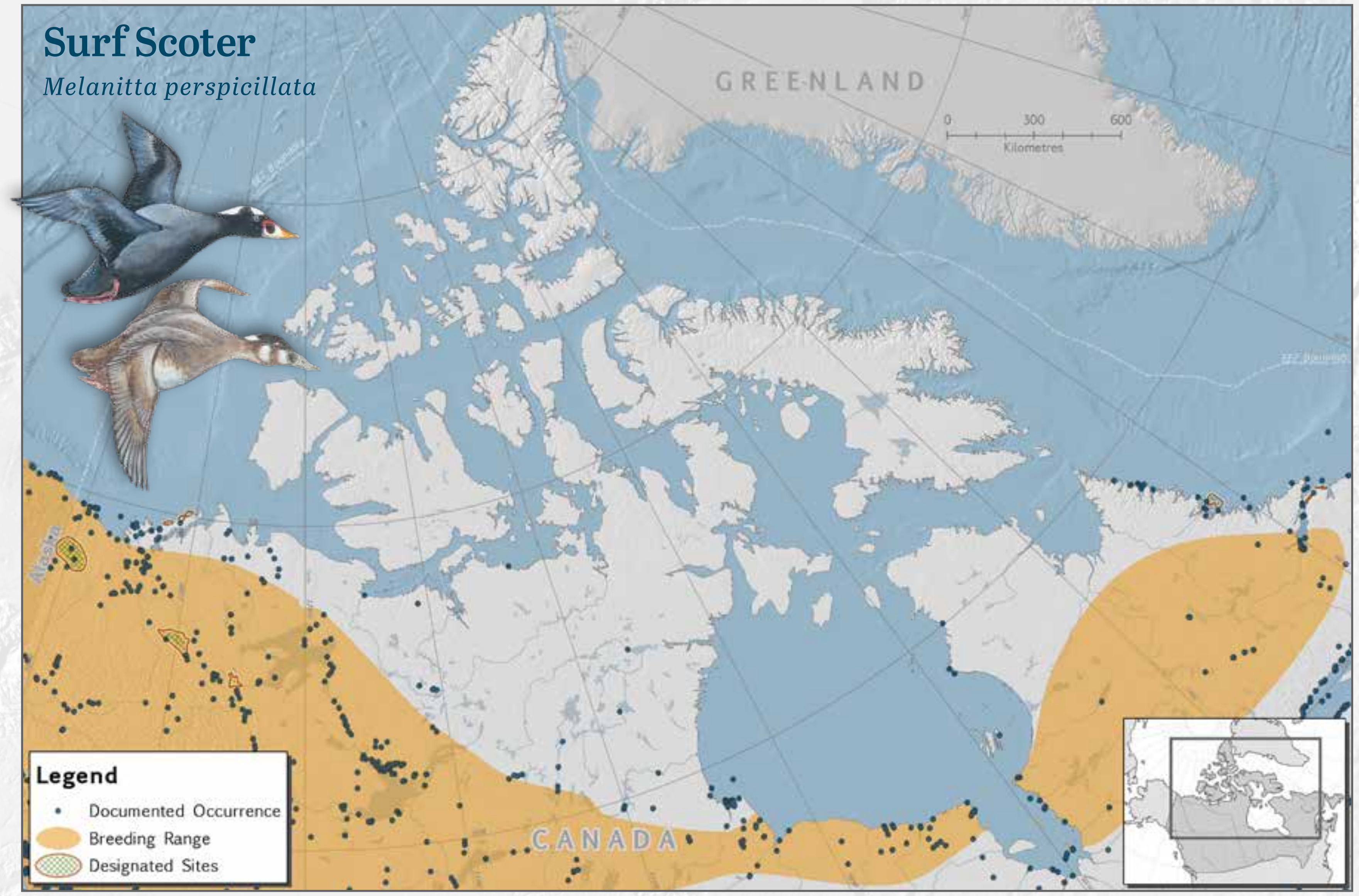


WHITE-WINGED SCOTER DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility) 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: Consortium Gauthier & Guillemette – G.R.E.B.E. 1990. Complexe Grande-Baleine. Avant-projet Phase II. Étude de l'avifaune et du castor : écologie des Macreuses à bec jaune (Melanitta nigra) et à front blanc (M. perspicillata) en période de reproduction sur le territoire du complexe Grande-Baleine. Rapport final présenté à Hydro-Québec, vice-présidence Environnement, Saint-Romuald, Québec, 58 p.; Consortium Gauthier & Guillemette – G.R.E.B.E. 1992. Complexe Grande-Baleine. Avant-projet Phase II. Étude de l'avifaune et du castor : aire de reproduction des macreuses dans la péninsule Québec-Labrador. Rapport présenté à Hydro-Québec, vice-présidence Environnement, Montréal, Québec, 35 p.; Consortium Gauthier & Guillemette – G.R.E.B.E. 1993. Complexe Grande-Baleine. Avant-projet Phase II. Étude de l'avifaune et du castor : description et utilisation de l'habitat d'élevage des macreuses à l'été 1990. Rapport présenté à Hydro-Québec, vice-présidence Environnement, Saint-Romuald, Québec, 54 p.; Benoit, R., A. Reed, R. Lalumière et G. Morissette. 1991. Utilisation par la sauvagine des habitats côtiers de la baie of Many Islands, baie James. Rapport présenté au Service écologique, Direction Ingénierie et Environnement, Société d'énergie de la Baie James, 62 p.; Benoit, R., A. Reed et R. Lalumière. 1992. Utilisation par la sauvagine des habitats côtiers de la côte nord-est de la baie James, été 1991. Rapport présenté au Service écologie, Direction Ingénierie et Environnement, Société d'énergie de la Baie James, 62 p.; Benoit, R., R. Lalumière et A. Reed. 1993. Étude de la sauvagine sur la côte-est de la baie James – 1992. Société d'énergie de la Baie James, 91 p. ;Benoit, R., A. Reed et R. Lalumière. 1994. Étude de la sauvagine sur la côte nord-est de la baie James – 1993. Rapport présenté au Service écologie, Direction Ingénierie et Environnement, Société d'énergie de la Baie James, 113 p.; Benoit, R., R. Lalumière et A. Reed. 1996. Étude sur la Bernache cravant et la Macreuse à ailes blanches (côte nord-est de la baie James – 1995). Rapport présenté au Service écologie, Société d'énergie de la Baie James, 55 p.; Savard, J.-P.L. 1977. Étude de la faune avienne dans les bassins de la Grande rivière de la Baleine et de la Petite rivière de la Baleine (été 1976). Rapport pour Hydro-Québec, Direction de l'Environnement. GB-BIOP-ECO-77-3. Éco-Recherches Ltée, Pointe-Claire, Québec, 132 p. Environment and Climate Change Canada - Quebec Region. 2014. Breeding Scoter Survey. Unpublished data; Environment and Climate Change Canada - Quebec Region. 2010. Satellite telemetry work. Unpublished data. Environment and Climate Change Canada - Quebec Region. 2012. Satellite telemetry work. Unpublished data.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Surf Scoter

Melanitta perspicillata

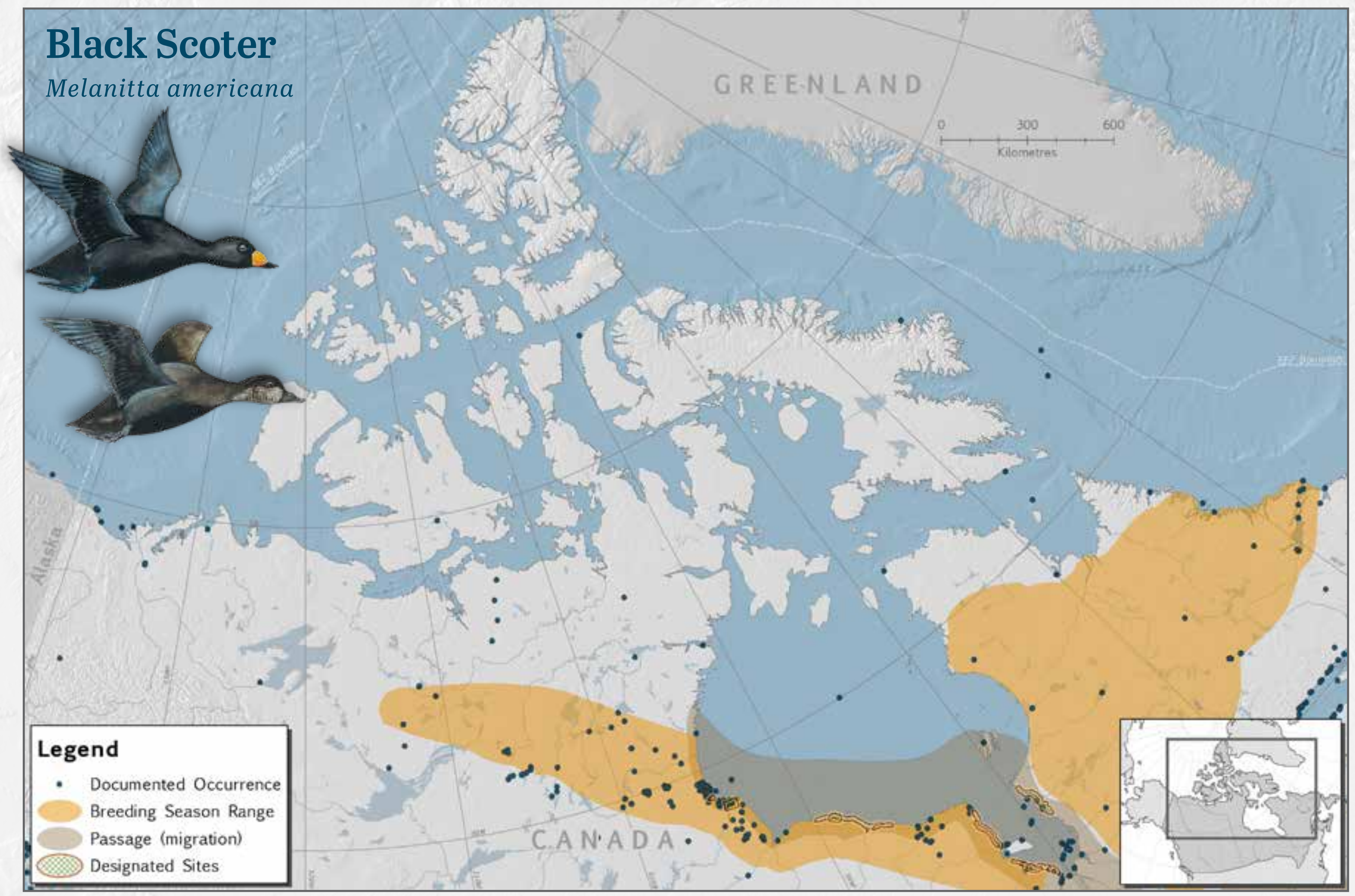


SURF SCOTER DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

Black Scoter

Melanitta americana



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BLACK SCOTER DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.; Sea Duck Joint Venture. 2017. Black Scoter Range Map. https://seaduckjv.org/meet-the-sea-ducks/black-scoter/*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

ARCTIC-BREEDING LOONS

Red-throated Loon, Yellow-billed Loon, and Pacific Loon

COASTAL & MARINE BIRDS

- Geese
- Sea Ducks
- ➡Loons
- Seabirds
- Shorebirds

Natural history

Loons are slow-maturing, relatively large-bodied birds with high adult survival and low reproductive rates. All five loon species (family Gaviidae) are present in North America, and all breed within the Arctic region. Three of these species, however, are primarily dependent on the Canadian Arctic to provide the majority of their continental breeding grounds—the Red-throated Loon *(Gavia stellata)*, Yellow-billed Loon *(Gavia adamsii)*, and Pacific Loon *(Gavia pacifica)*. All three species nest on freshwater or brackish ponds in low-lying coastal and inland tundra areas. Red-throated Loons forage almost exclusively in marine waters, while the other loon species forage in their breeding territory, if large enough to sustain suitably sized fish for both adults and young, or on surrounding lakes.

Distribution

During the breeding period, Red-throated and Yellow-billed Loons are broadly distributed across much of the circumpolar North, whereas Pacific Loons are found primarily in the Canadian Arctic, Alaska, and northern Siberia. Because loon breeding territories are widely distributed across this vast landscape, they are relatively difficult to count and to monitor, compared to highly colonial species. During the non-breeding period, all three species of loons that rely on the Canadian Arctic are found in coastal marine waters. Red-throated Loons divide between the Pacific and Atlantic Oceans in winter. On migration, birds wintering on the Atlantic coast stage in Hudson Bay before passing through James Bay and the Great Lakes on their way south. Yellow-billed Loons breeding in the central and western Canadian Arctic and Alaska winter along both northern Pacific coasts as far south as northern California in the eastern Pacific and the Yellow Sea in the western Pacific. Pacific Loons winter along the eastern Pacific coast from Alaska to Mexico.

Importance to Inuit

Across the Canadian Arctic, all loon species are occasionally harvested for subsistence purposes, and their eggs may be collected for food in early summer, although they are not a major focus of hunting. Historically, at least in some Arctic regions, loon feathers, bones, and skins were used for ceremonial purposes (e.g. Yellow-billed Loons in Alaska), and loons also commonly appear in carvings, other crafts, and traditional stories, suggesting a strong spiritual connection with Indigenous peoples.

Conservation concerns

The Yellow-billed Loon is listed as high conservation concern globally ("near threatened"), whereas the Red-throated and the Pacific Loon are considered secure ("least concern"; see Table 1). In Canada, the Yellow-billed Loon is considered "secure" or data deficient. The Red-throated and the Yellow-billed Loon are listed as "birds of conservation concern" by the US Fish and Wildlife Service.

Loons are vulnerable to coastal oil spills in both their breeding and wintering areas, and this could worsen with a potential increase in shipping traffic in the Arctic. Other threats to these species on their Arctic breeding grounds include subsistence harvest, bycatch in subsistence fisheries, breeding habitat degradation and disturbance from mining and oil and gas exploration and development, contaminants, and other effects of climate change. In their wintering areas, the major issues likely vary for each species, but include bycatch in commercial fisheries, contaminants, and offshore wind energy development. Some or all of these threats to loons could be exacerbated by the impacts of climate change, such as changes in prey availability.

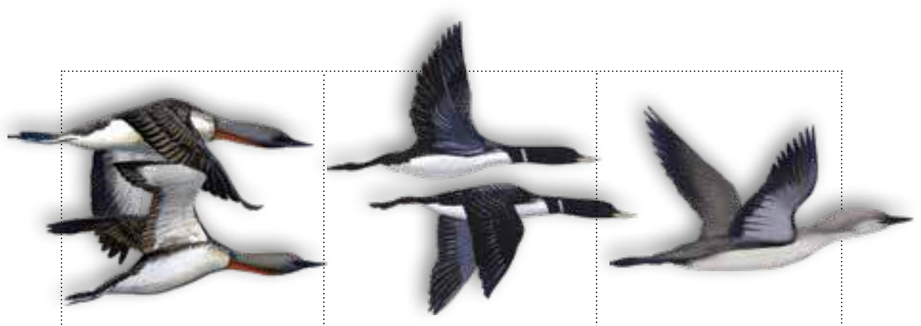


Table 1:
The global and continental conservation status of loons.

	Red-throated Loon (*G. stellata*)	Yellow-billed Loon (*G. adamsii*)	Pacific Loon (*G. pacifica*)
Global Conservation Status[1]	LEAST CONCERN	NEAR THREATENED	LEAST CONCERN
Continental Conservation Needs[2]	HIGH CONCERN	HIGH CONCERN	MODERATE CONCERN
Canada (Wings Over Water)[4]	LOW CONCERN	INFO. LACKING	INFO. LACKING
Canada Conservation Status (wildspecies)[3]	SECURE	SECURE	SECURE

[1]IUCN 2015, [2]N. Am. Waterbird Conservation Plan, Kushlan et al. 2002, [3]Milko et al. 2003, [4]CESCC 2011.

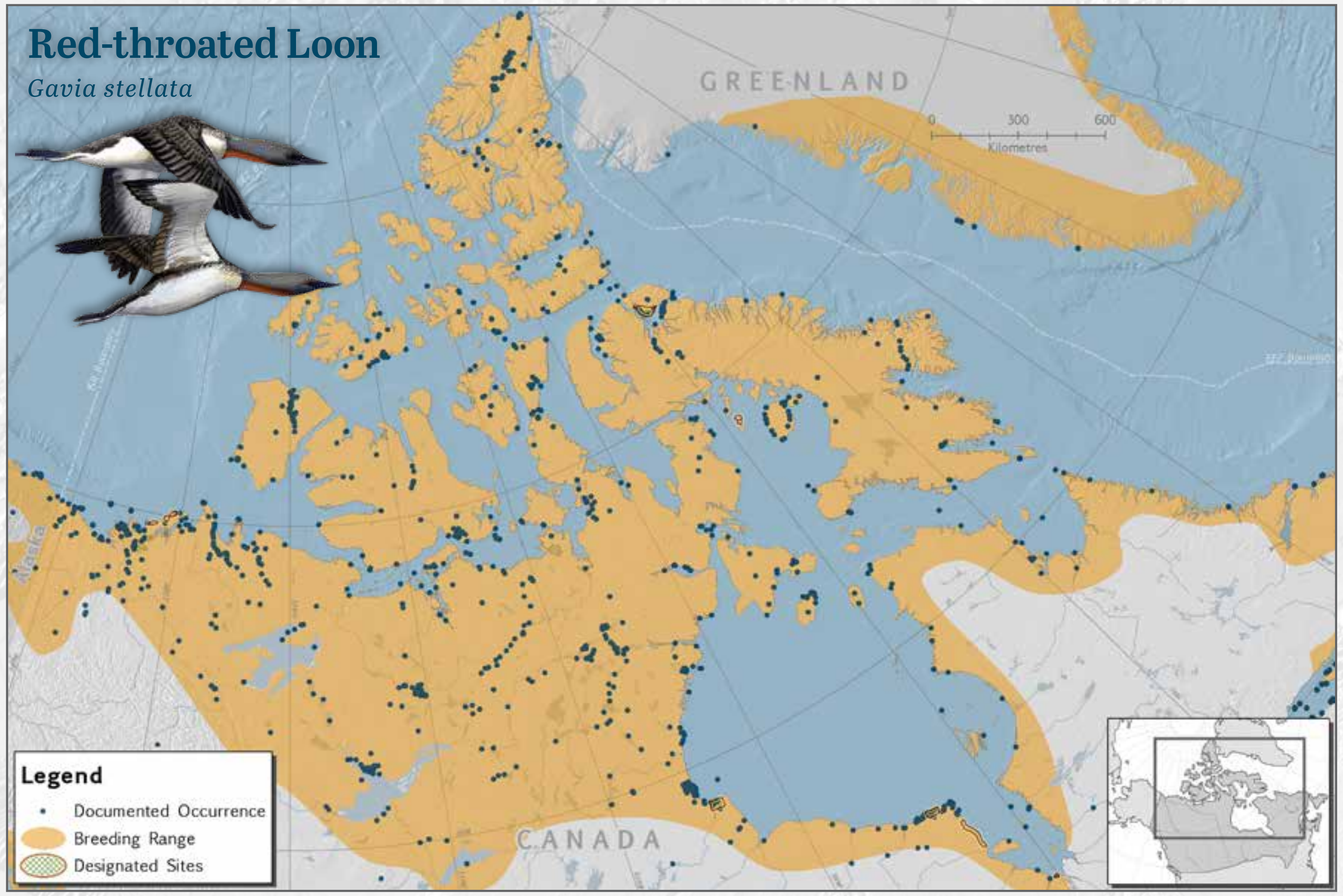
Gaps in current knowledge

There is little to no information on the current survival or harvest rates for these species across their ranges in the Canadian Arctic. Distributional information is limited spatially and temporally, and based largely on local Indigenous knowledge, historical sightings, and expert opinion. There have been no broad-scale systematic surveys targeted at these species; thus reliable information on distributions and population sizes and trends is lacking. The long-term continental data that exists suggests little change in Pacific Loon and Red-throated Loon populations and a moderate decrease in Yellow-billed Loons. Some satellite tracking of Yellow-billed and Red-throated Loons has taken place in recent years in western Canada and the United States.

Above: Pacific Loon and chick. (photo: Michael S. Quinton)

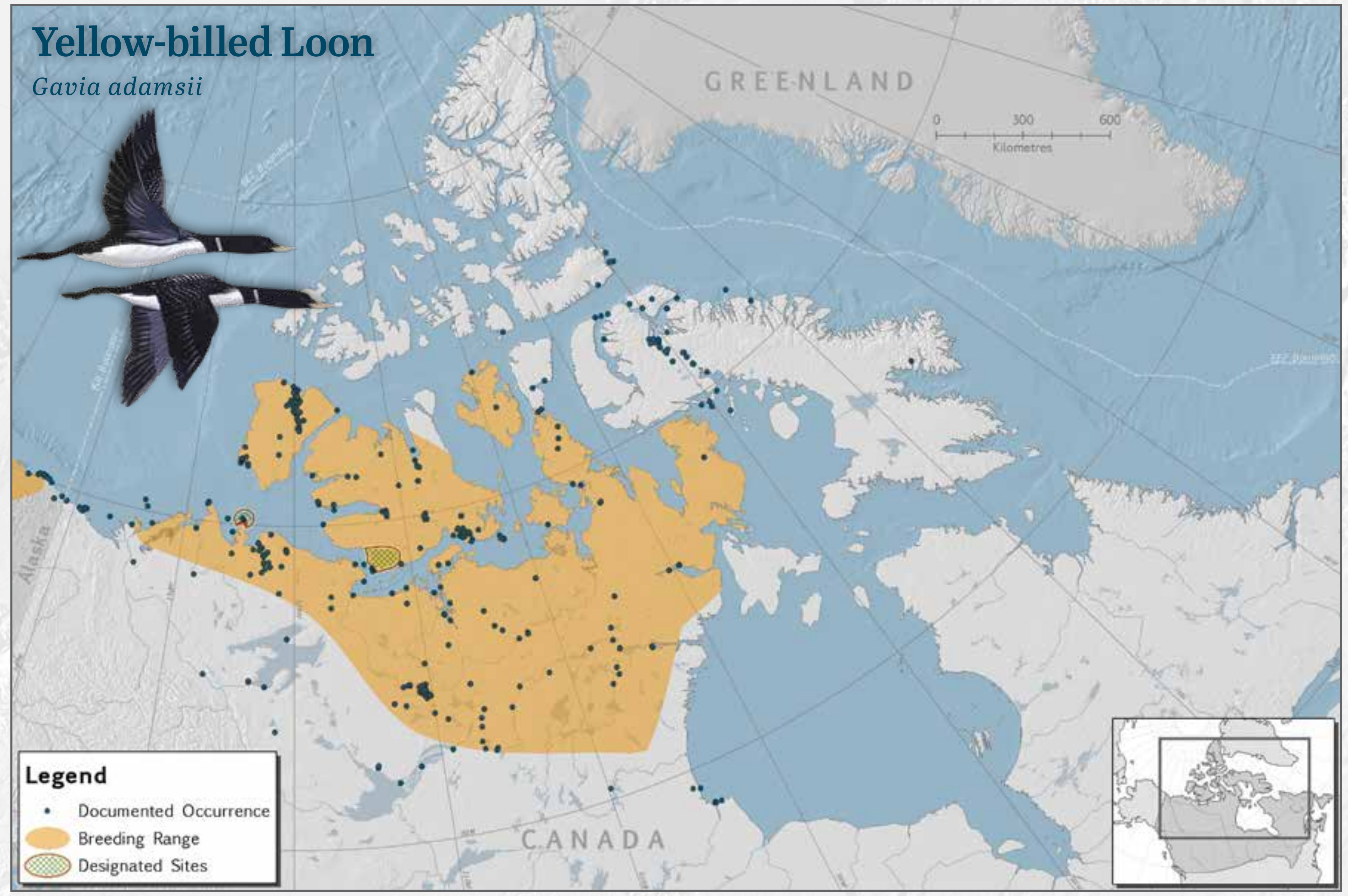
Top left: Loons commonly appear in carvings, other crafts, and traditional stories, suggesting a strong spiritual connection with Indigenous peoples. (print: Mayoreak Ashoona, Tuulirjuaq [Great Big Loon], 2009 Stonecut & Stencil, 102.3 x 74 cm, reproduced with the permission of Dorset Fine Arts)

Top right: Incubating adult Red-throated Loon. (photo: Wayne Lynch)



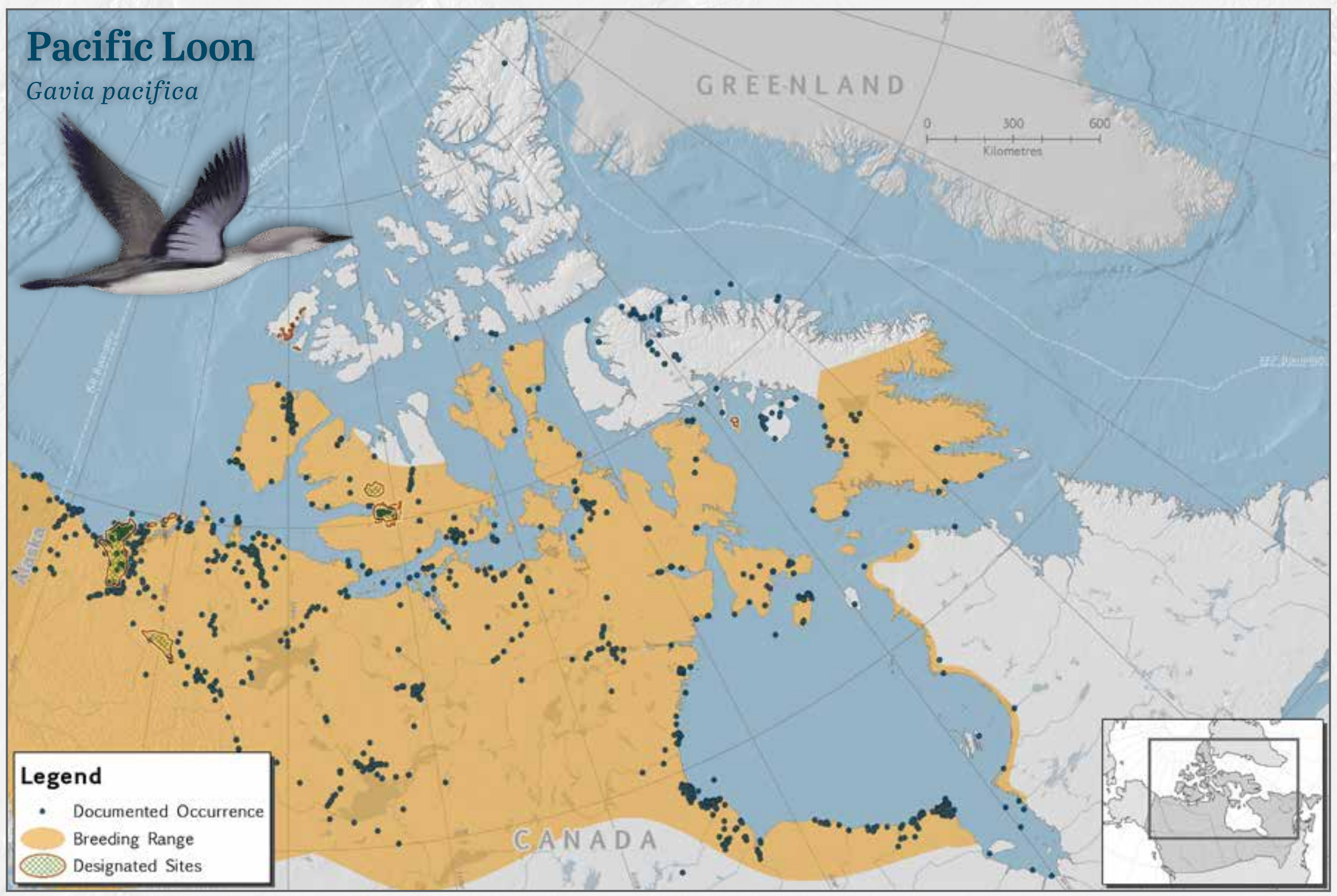
RED-THROATED LOON DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility) 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.D*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*



YELLOW-BILLED LOON DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility) 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*



The occurrence points on these maps show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect either a lack of data or an absence of birds. Designated Sites are important bird areas and key habitat sites; these are recognized areas that support larger numbers of individuals of one or more species during one or more periods of the year and can include aggregation areas, colonies, nesting, feeding, brood rearing, molting, staging, migration or wintering.

PACIFIC LOON DATA SOURCES

- *Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. http://www.iobis.org; GBIF (Global Biodiversity Information Facility) 2016. Retrieved from: http://www.gbif.org/*
- *Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.*
- *Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

ARCTIC-BREEDING SEABIRDS

Northern Fulmar, Ivory Gull, and Thick-billed Murre

Natural history

Most seabird species are slow-maturing, relatively large-bodied birds, with high adult survival and low reproductive rates. The three species included here are all very different in behavioural and ecological traits, but all are highly reliant on the Arctic. All three species are colonial, and nest in remote areas, mostly on sheer cliffs close to productive Arctic waters, especially polynyas, which are important foraging areas. Fulmars and murres have a few very large Arctic nesting colonies (more than 10,000 birds) that are well known in Canada, and it is relatively straightforward to monitor these sites. Conversely, Ivory Gulls *(Pagophila eburnea)* nest in small colonies (fewer than 60 birds) in extremely remote habitats as disparate as flat gravel barrens, well inland, or the rugged faces of nunataks (bare rock on cliffs or mountains), which makes them difficult to locate and monitor.

Distribution

All three exhibit a circumpolar distribution, and in Canada are most commonly found in the eastern Arctic. Northern Fulmar *(Fulmarus glacialis)* colonies are generally distributed up the eastern side of Baffin Island to the Lancaster Sound and Jones Sound area. A few small colonies (fewer than 80 birds) also exist in Newfoundland and Labrador. Thick-Billed Murre *(Uria lomvia)* colonies are largely found in northern Hudson Bay and the Hudson Strait, and northern Baffin Bay and Lancaster and Jones Sounds. Both of these species are also found in large colonies in Alaska. In North America, however, Ivory Gulls nest exclusively in northern Nunavut, particularly around the Lancaster Sound region.

In terms of annual movements, Ivory Gulls are fairly distinct again, remaining further north and closer to pack ice year-round, while Northern Fulmars and Thick-Billed Murres move to more southerly, open waters. Northern Fulmars breeding in the Canadian High Arctic generally migrate out to the Labrador Sea and the northwest Atlantic Ocean via Baffin Bay and the Davis Strait. Thick-Billed Murres also migrate through Baffin Bay and the Hudson Strait to the Davis Strait, on their way to more inshore areas and bays around Newfoundland and Labrador, with smaller numbers along the coast of southwest Greenland, and south along the US coast as far as the mid-Atlantic region.

Importance to Inuit

Seabirds and their eggs are harvested across the circumpolar North. Although Northern Fulmars are harvested in some northern nations (e.g. the Faroe Islands), they are rarely taken in the Canadian Arctic. The Thick-Billed Murre is the most frequently harvested seabird in the Canadian North, and its eggs are collected for food in early summer at easily accessible colonies (e.g. Digges Sound). Thick-Billed and Common Murres *(Uria aalge)* are also heavily harvested off the coast of Newfoundland and Labrador in winter, with up to 200,000 birds taken there each year, mostly (around 95%) Thick-Billed Murres. Despite being legally protected, Ivory Gulls are still harvested in small numbers in northwest Greenland and the Canadian Arctic, although probably only opportunistically.

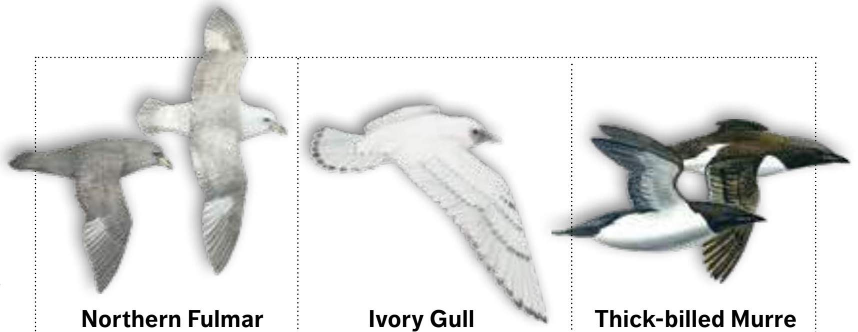


Table 1: The global and continental conservation status of selected seabirds.

	Northern Fulmar (*F. glacialis*)	Ivory Gull (*P. eburnea*)	Thick-billed Murre (*U. lomvia*)
Global Conservation Status[1]	LEAST CONCERN	NEAR THREATENED	LEAST CONCERN
Continental Conservation Needs[2]	MODERATE CONCERN	MODERATE CONCERN	MODERATE CONCERN
Canada (Wings Over Water)[4]	NOT CURRENTLY AT RISK	HIGH CONCERN	MODERATE CONCERN
Canada Conservation Status (wildspecies)[3]	SENSITIVE	AT RISK	SECURE

[1]IUCN 2015, [2] N. Am. Waterbird Conservation Plan, Kushlan et al. 2002, [3]Milko et al. 2003, [4]CESCC 2011.

Adult Ivory Gull bathing on the Arctic pack ice. (photo: Philip Mugridge)

Above left: Thick-billed Murres on an ice floe (photo: Design Pics Inc). Above right: Northern Fulmar gliding above sea water. (photo: Arterra Picture Library)

Conservation concerns

All three of these seabird species, emblematic of the Canadian Arctic, are considered to be "of conservation concern" continentally (see Table 1). The Ivory Gull is also listed as "high conservation concern" globally ("near threatened"). Surveys in the Canadian Arctic in 2002–11 suggested that the number of Ivory Gulls declined about 80% in just 20 years, and traditional knowledge suggests that declines may extend over a longer time period than this. Long-term monitoring of a limited number of Thick-Billed Murre colonies suggests population trends have remained relatively stable overall. The Northern Fulmar population at Prince Leopold Island, however, appears to have declined over time.

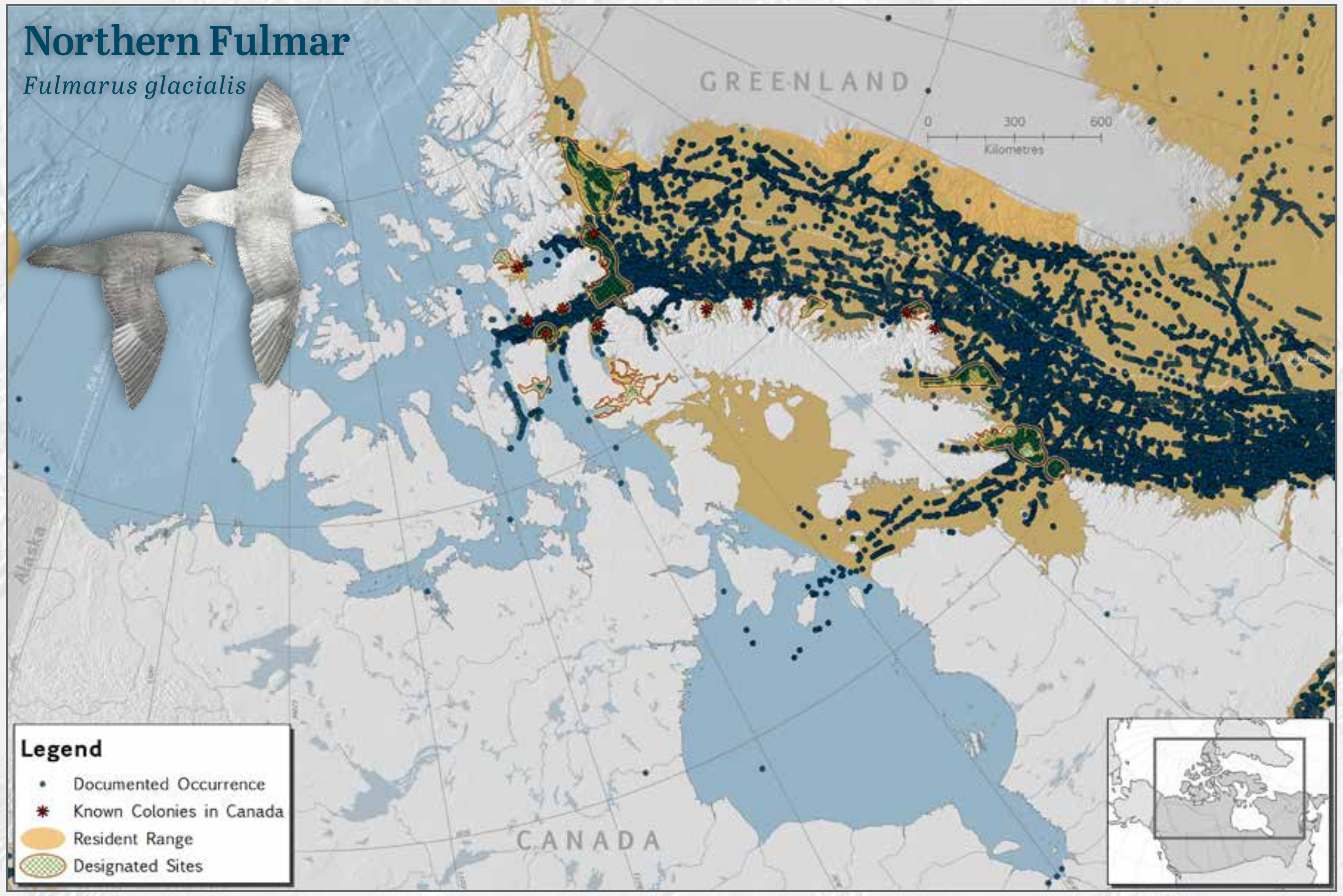
The drastic decline in Ivory Gulls in recent years has yet to be fully explained, although environmental contaminants, particularly mercury, may play an important role. Murres and fulmars are also subject to contaminant loading, especially of pollutants associated with plastics.

Gaps in current knowledge

Population trends and breeding success of fulmars and murres are generally well known, though some colonies in Nunavut have not been surveyed since the 1970s. The breeding distribution and success of Ivory Gulls are less well understood. The foraging distributions of breeding birds, moult times, migration routes, and non-breeding habitat use, as well as their demographic and/or energetic consequences, are considerably less well understood for all three species. The potential impacts of climate change, including the loss of sea ice, changes in prey distributions, and increasing disturbances in the marine environment are the largest unknowns for these Arctic seabirds.

A colony of murres on the sea cliffs of Coats Island, Nunavut. (photo: Jennifer Provencher)

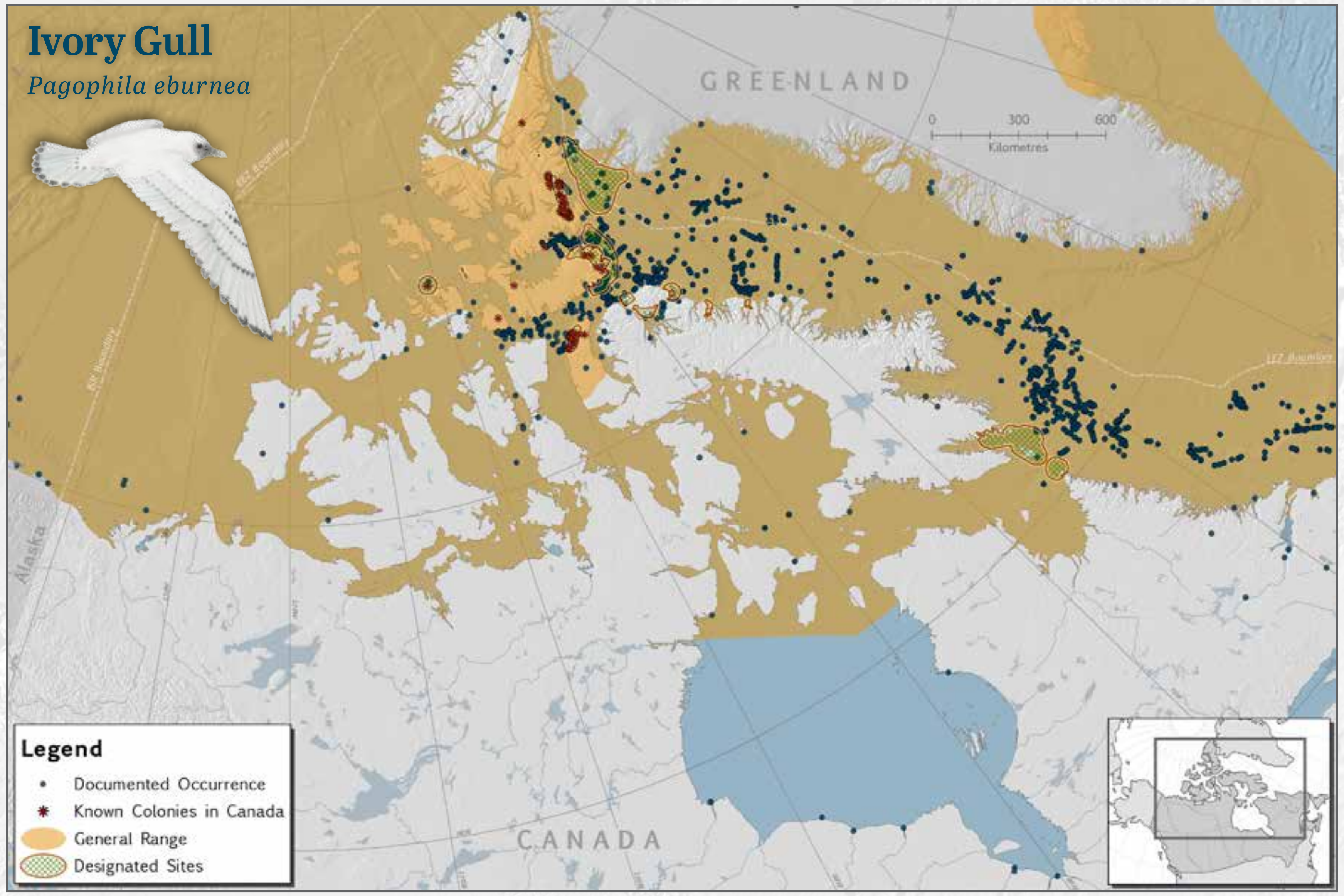
Northern Fulmar
Fulmarus glacialis



NORTHERN FULMAR DATA SOURCES

- Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/
- Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.
- Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.
- Colonies: Canadian Wildlife Service. 2016.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

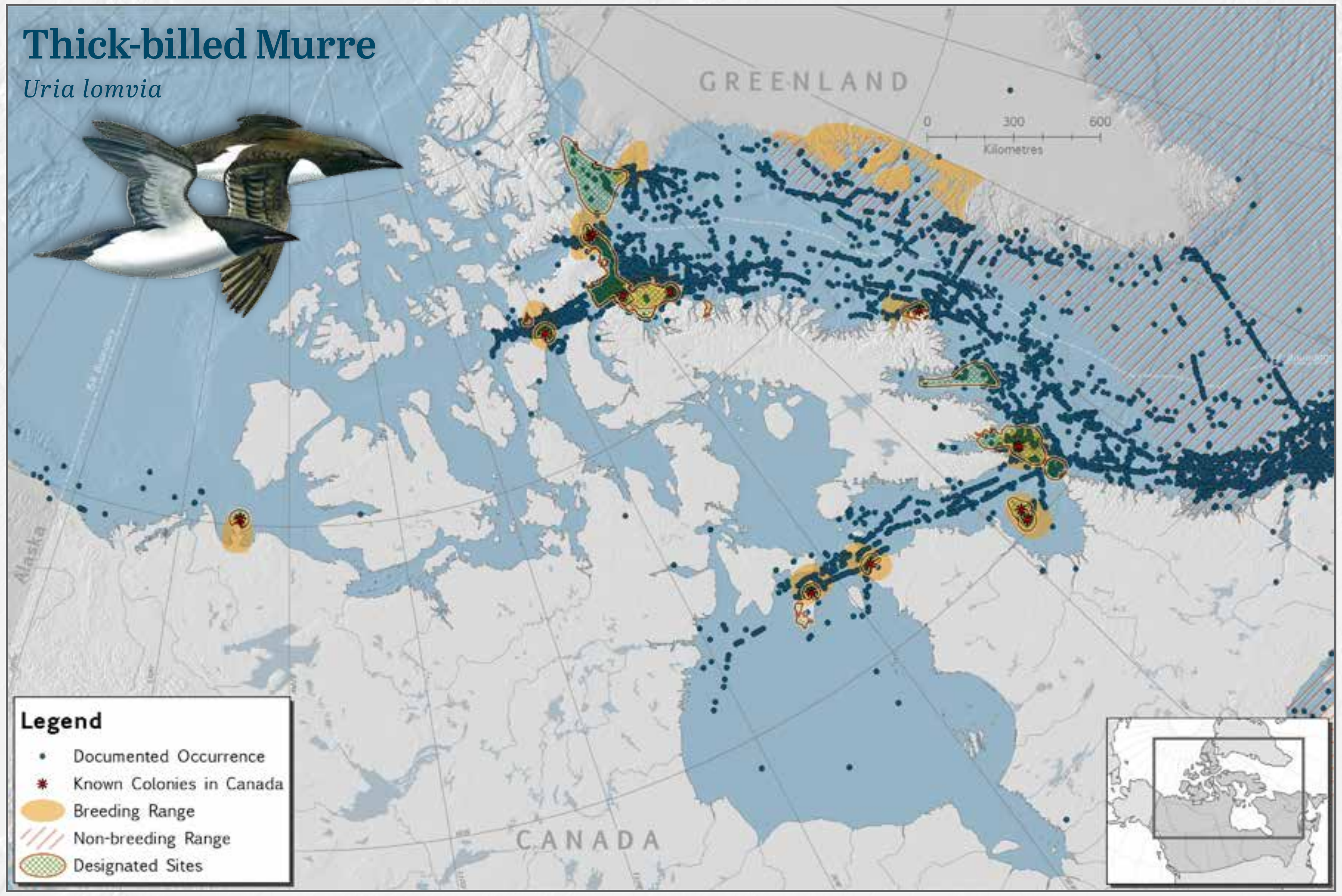
Ivory Gull
Pagophila eburnea



IVORY GULL DATA SOURCES

- Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/
- Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.
- Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.
- Nesting Colonies: Canadian Wildlife Service. 2016.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

Thick-billed Murre
Uria lomvia



The occurrence points on these maps show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect either a lack of data or an absence of birds. Designated Sites are important bird areas and key habitat sites; these are recognized areas that support larger numbers of individuals of one or more species during one or more periods of the year and can include aggregation areas, colonies, nesting, feeding, brood rearing, molting, staging, migration or wintering.

THICK-BILLED MURRE DATA SOURCES

- Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/
- Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.
- Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.
- Colonies: Canadian Wildlife Service, 2016; Canadian Wildlife Service, 2013. Nesting Colonies in NWT and Yukon.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

ARCTIC-BREEDING SHOREBIRDS

Red Knot and Red Phalarope

Natural history

Shorebirds are among the world's greatest migrants, with many species breeding in the Arctic and wintering in the fertile lowlands of the southern hemisphere, as far south as Tierra del Fuego on the southernmost tip of South America. Forty-nine species of shorebirds are recorded as regularly occurring or breeding in Canada. For 15 species that are wholly confined to the North American Arctic and sub-Arctic regions during breeding, Canada provides over 75% of their continental range. Therefore, Canada has a significant responsibility for conservation of Arctic-breeding shorebirds.

Arctic-breeding shorebirds encompass a diverse group of species with a broad range of behavioural, ecological, and life-history characteristics. They largely forage on terrestrial and aquatic invertebrates, and seeds/berries or other plant material, and use a variety of habitats—from wetlands and estuaries, brackish and freshwater ponds, marshes and boggy areas, to dry upland tundra. Species range in mass from under 40 g to over 400 g, usually initiate breeding at one to two years old, lay three to four eggs each season, and can easily live up 10 or more years.

Distribution

Where suitable habitat is available, Arctic-breeding shorebirds are broadly distributed across the sub-Arctic, Low Arctic, and High Arctic regions of Canada. During migration, Arctic-breeding shorebirds use multiple flyways to spread widely across the globe, usually stopping at a few critical coastal wetland foraging sites en route. Shorebirds depend on these specific stopover sites to refuel along their migration routes, with large numbers of Canadian Arctic breeders passing through James Bay in spring and fall. The Western Hemisphere Shorebird Reserve Network (WHSRN) exists to identify and conserve a system of key sites for migratory shorebirds across the Americas. To date, they have identified seven important sites in southern Canada, and one has been nominated in James Bay.

Conservation concerns

Globally, 44% of shorebird populations have declined over the last few decades. Although a number of factors are likely responsible for these declines, habitat loss in the non-breeding season and disturbance at breeding areas and critical stopover sites are believed to play important roles in these general trends. Overall, shorebirds are not an important part of the subsistence harvest across the Canadian Arctic, although adults of the largest species, such as godwits and curlews, are probably taken opportunistically.

Few Arctic-breeding shorebirds are considered to be of high conservation concern globally, probably due to their vast breeding ranges and often large populations. At the continental level, however, the situation is quite different, with many species considered to be of moderate to high conservation concern (see Table 1). The Red Knot *(Calidris canutus)*, for example, has the highest conservation profile due to a drastic and well-documented decline in the subspecies *rufa*, related to the availability of prey at a major stopover site in Delaware Bay. A widespread, and potentially just as drastic, decline in the Red Phalarope *(Phalaropus fulicarius)* is less well understood. Red Phalaropes use of offshore marine habitats during the non-breeding season, but their resource requirements and potential threats during this period are not known.

Since the 1990s, the Program for Regional and International Shorebird Monitoring (PRISM) has coordinated breeding surveys for shorebirds across the continent, including in the Arctic, to improve our understanding of population trends and distributions. The current declining trends observed in many shorebirds are of particular concern because their populations are often slow to recover, due to low reproductive rates, and, in the event of nest failure, little opportunity for re-nesting during the short Arctic summer. Being dependent on shallow water habitats during breeding, staging, and wintering, shorebirds are highly vulnerable to warming temperatures, and breed in the Arctic where the onset of climate change is expected to be most rapid. Many northern-breeding species are already showing impacts of climate change, as their arrival dates shift earlier in the season. Shorebirds have the added vulnerability of being heavily dependent on a few critical stopover sites, where they gather in very large numbers. The sudden loss of even one of these sites, due to natural or human-induced disruptions, could have far-reaching effects on their populations.

Predation on tundra-breeding birds, including shorebirds, can be extreme in years following lemming population crashes when predators, particularly Arctic Foxes, switch to alternative prey sources. Loss or degradation of breeding or foraging habitat is a common issue for Arctic-breeding shorebirds—sometimes caused by overabundant foragers, such as Snow Geese. Arctic-breeding shorebirds are also at risk from a range of environmental contaminants, particularly mercury contamination, as recent studies indicate mercury deposition and rates of methylation are increasing in Arctic habitats. Over the past century, elevated mercury deposition has led to large increases in mercury exposure for Arctic wildlife, particularly in aquatic ecosystems, with some shorebirds exceeding thresholds that have been shown to reduce reproductive success in other small avian invertivores.

Table 1: The global and national conservation status and continental conservation needs of selected shorebirds.

	Red Knot (*C. canutus*)	Red Phalarope (*P. fulicarius*)
Global Conservation Status[1]	NEAR THREATENED	LEAST CONCERN
Continental Conservation Needs[2,3]	HIGH CONCERN	MODERATE CONCERN
Canada Conservation Status (wildspecies)[4]	AT RISK	SECURE

[1]IUCN 2015, [2]Canadian Shorebird Conservation Plan, Donaldson et al 2000, [3]U.S. Shorebird Conservation Plan, Brown et al. 2001, [4]CESCC 2011.

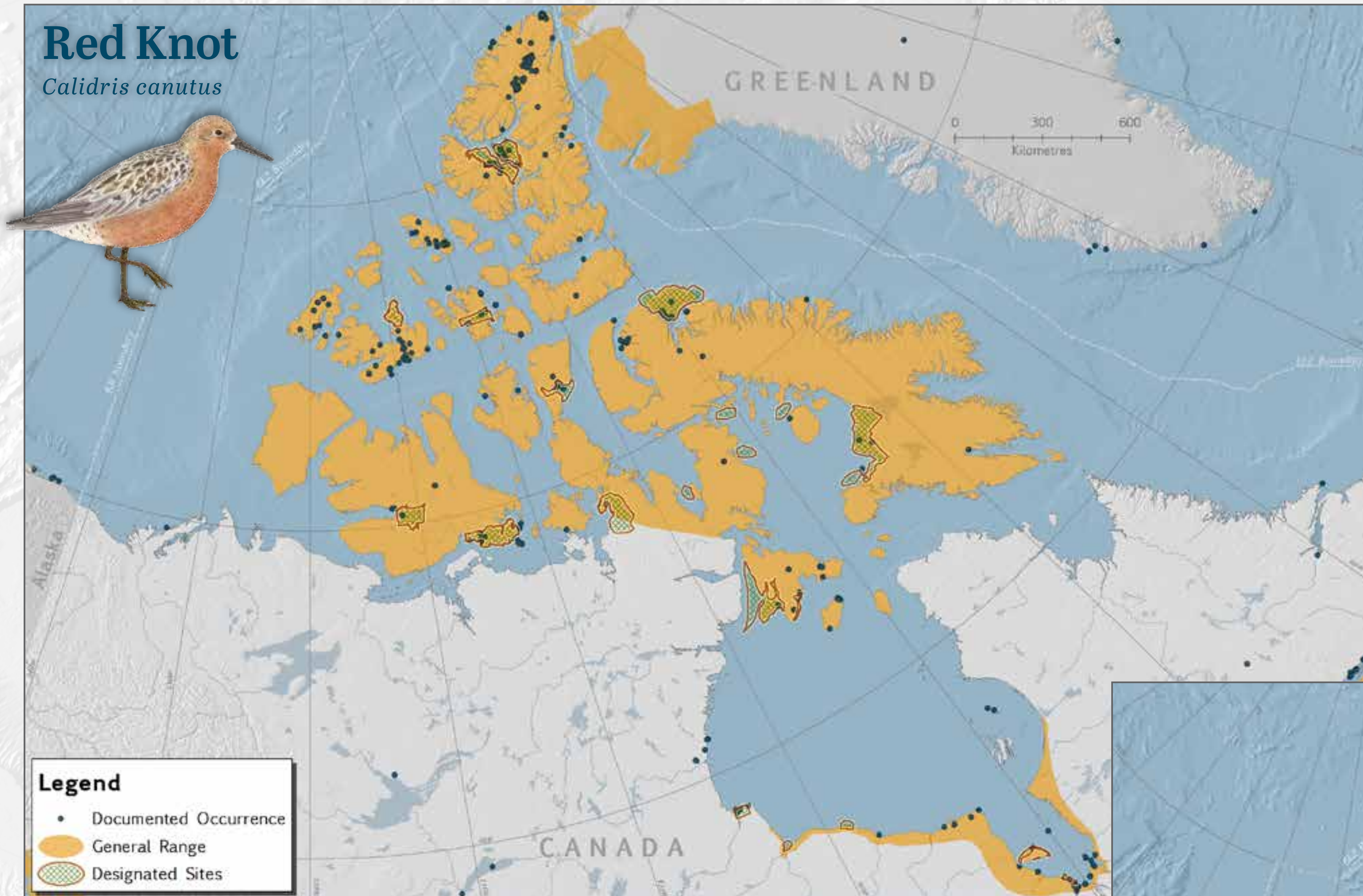
Two Red Phalaropes float on the surface of the Arctic Ocean. (photo: Ralph Lee Hopkinsk)

Red Knot perched on the tundra. (photo: All Canada Photos)

The occurrence points on these maps show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect either a lack of data or an absence of birds. Designated Sites are important bird areas and key habitat sites; these are recognized areas that support larger numbers of individuals of one or more species during one or more periods of the year and can include aggregation areas, colonies, nesting, feeding, brood rearing, molting, staging, migration or wintering.

Red Knot

Calidris canutus

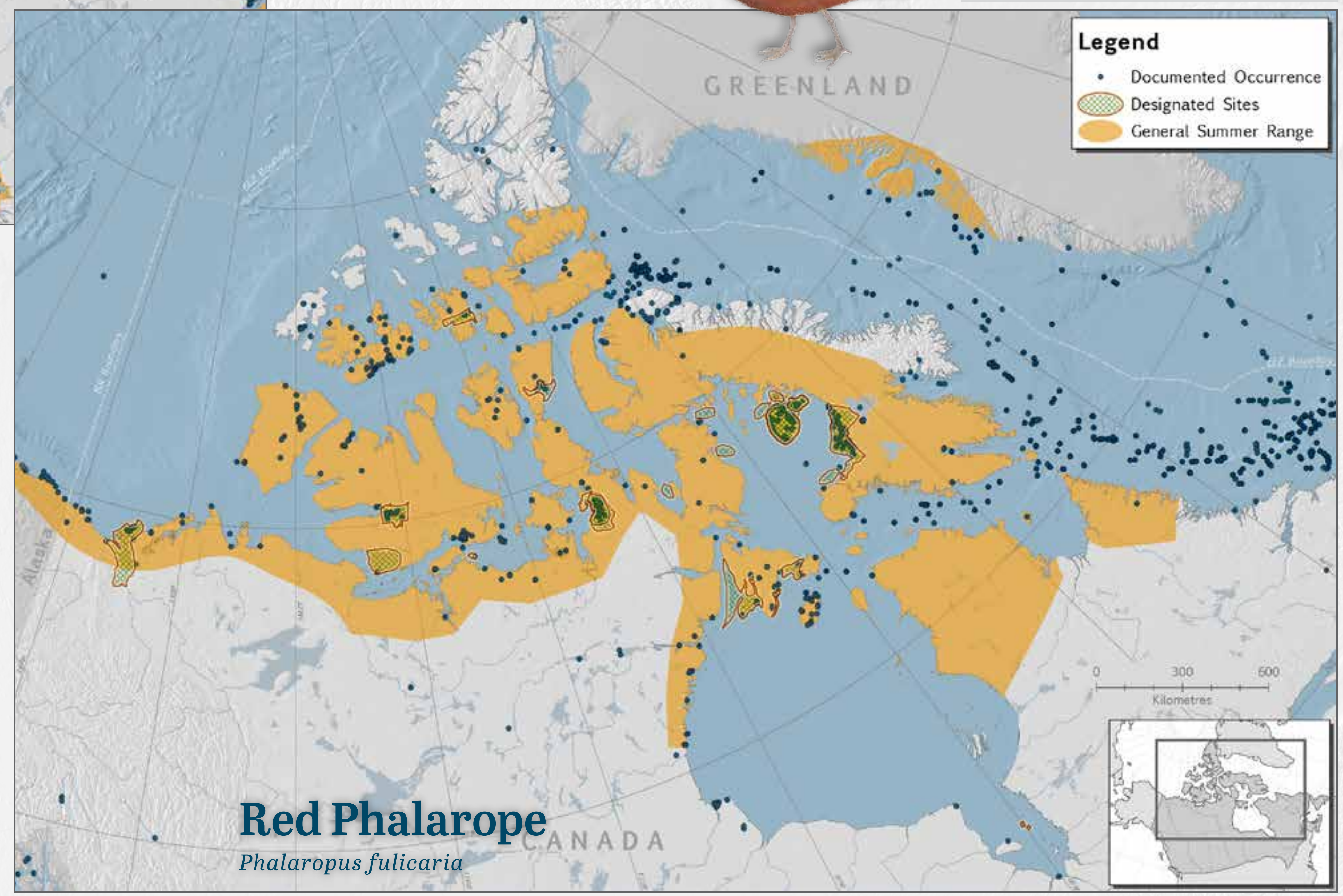


DATA SOURCES

- Documented Occurrence: GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/
- Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.; Canadian Wildlife Service. 2016.
- Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

DATA SOURCES

- Documented Occurrence: OBIS. 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Web. http://www.iobis.org (consulted on 2016/02/17); GBIF (Global Biodiversity Information Facility). 2016. Retrieved from: http://www.gbif.org/
- Range Data: BirdLife International and NatureServe. 2015. Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, USA.; Canadian Wildlife Service, 2016.
- Designated Sites: Bird Studies Canada. 2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org; Canadian Wildlife Service. 2016. Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (Revised May 2016). Environment and Climate Change Canada.; Latour, P.B. et al. 2008. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut (3rd Ed.). Occasional Paper 114. Canadian Wildlife Service; Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Occasional Paper 109. Canadian Wildlife Service.
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.



Red Phalarope

Phalaropus fulicaria

MARINE MAMMALS OF THE ARCTIC

Introduction

Currently there are 21 species of marine mammals made up of six pinnipeds (seals and Walrus) and 15 cetaceans (whales, porpoises, and dolphins) that are regularly seen or have been known on occasion to enter Canadian Arctic waters. Of these, eight commonly reside in the Canadian Arctic year-round. These species are Ringed Seal *(Pusa hispida)*, Bearded Seal *(Ergnathus barbatus)*, Hooded Seal *(Crystophora cristata)*, Harp Seal *(Pagophilus groenlandicus)*, Harbour Seal *(Phoca vitulina)*, Walrus *(Odobenus rosmarus)*, Beluga Whale *(Delphinapterus leucas)*, Narwhal *(Monodon monoceros)*, and Bowhead Whale *(Balaena mysticetus)*.

Ecological significance

Arctic marine mammals play a significant role in the northern marine environment at all levels of the food chain. They feed both as top predators at the apex of the food chain on other marine mammals (Killer Whales consuming Belugas, for example) and large fish (Narwhals eating Greenland Halibut, *Reinhardtius hippoglossoides*) as well as on much lower trophic levels (Bowhead eating copepods). It is unknown what effect changes in numbers of marine mammals or the introduction of new species into the Arctic will have on the ecosystem.

Cultural significance

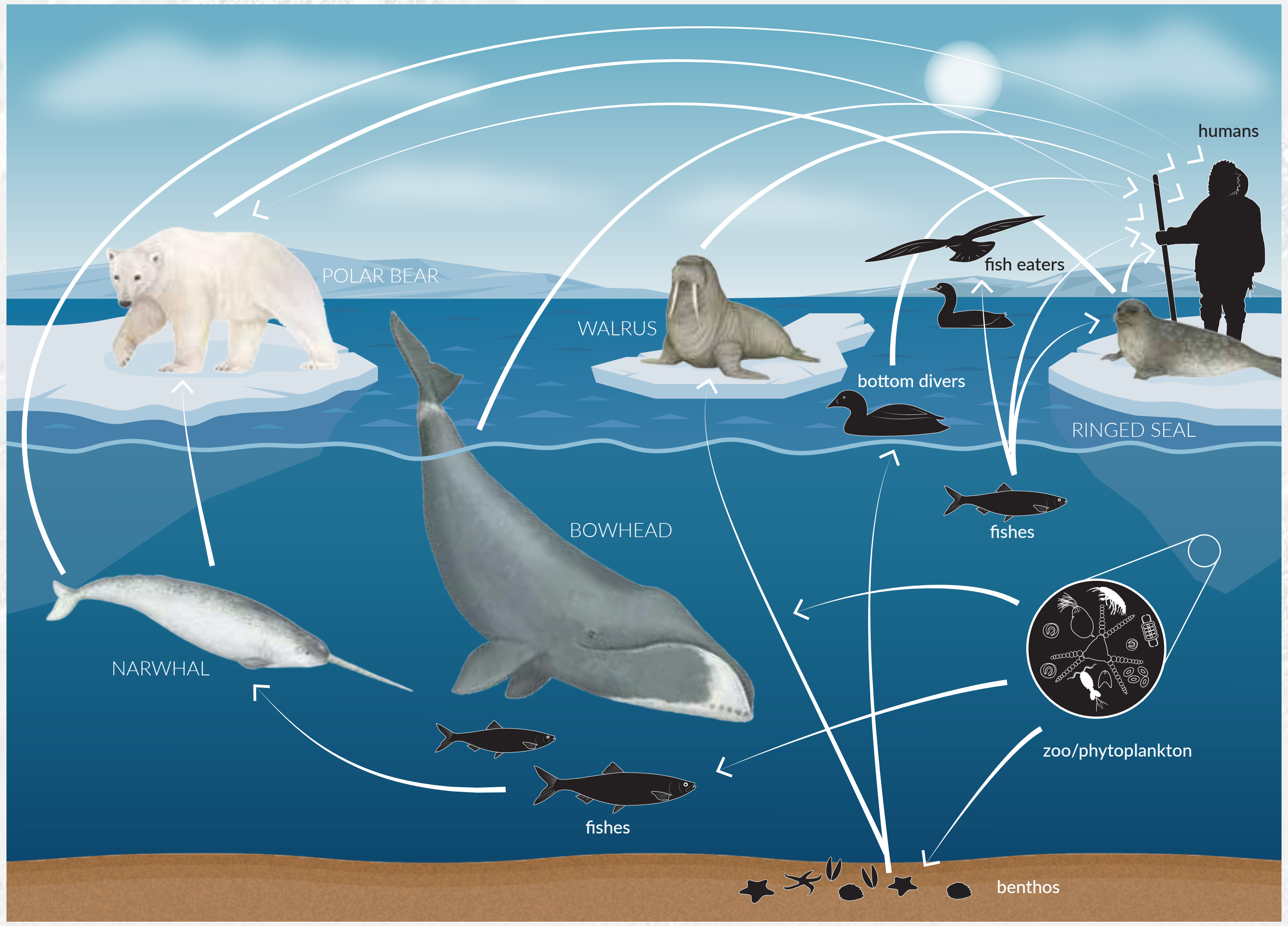
Marine mammals have historically been and continue to be significant culturally and economically to the North. Harvested in all seasons, they are an important part of a traditional subsistence diet that provides nutritional food sources as well as materials used in daily life, such as skin and furs. In addition to personal and community use, products made from marine mammals, such as Walrus or Narwhal tusk carvings, are sold commercially and contribute to the local economy; however, the economic value of whales to northern communities remains chiefly as a local food source. Harvesting quotas exist for some species by region, which are managed by federal and local governments in collaboration with hunters and trappers organizations.

Conservation concerns

Loss of sea ice will reduce habitats for some marine mammals, create new habitats for others, and likely alter patterns of productivity, resulting in changes to the food web structure. The continued exploitation of non-renewable resources in the North will create economic opportunity but also environmental disturbance through noise, pollution, and the potential for accidents. Marine mammals are iconic species and often indicators of ecosystem health, reflected both in their abundance and in concentrations of environmental pollutants in their bodies. Loss of sea ice resulting in changes in habitat and the subsequent accessibility of the North to humans will arguably be the largest threat to Arctic marine mammals in the near future.

Bowhead whale near Bylot Island, Sirmilik National Park, Nunavut. (photo: blickwinkel)

ARCTIC MARINE MAMMALS SIMPLIFIED FOOD WEB



This simplified food web shows the movement of energy through key Arctic marine mammal species. The overlapping network of food chains shows how each species is interconnected.

Gaps in current knowledge

There is little data on the presence or absence of many marine mammal species in much of the Canadian Arctic, and the abundance, trends, and ecological interactions of most species are poorly understood, but knowledge is improving. Research in the Arctic is limited due to the cost of conducting research and the inaccessibility of marine mammals in large portions of their range. Specific research gaps are addressed for each species in the individual species pages that follow.

Rationale for selected species

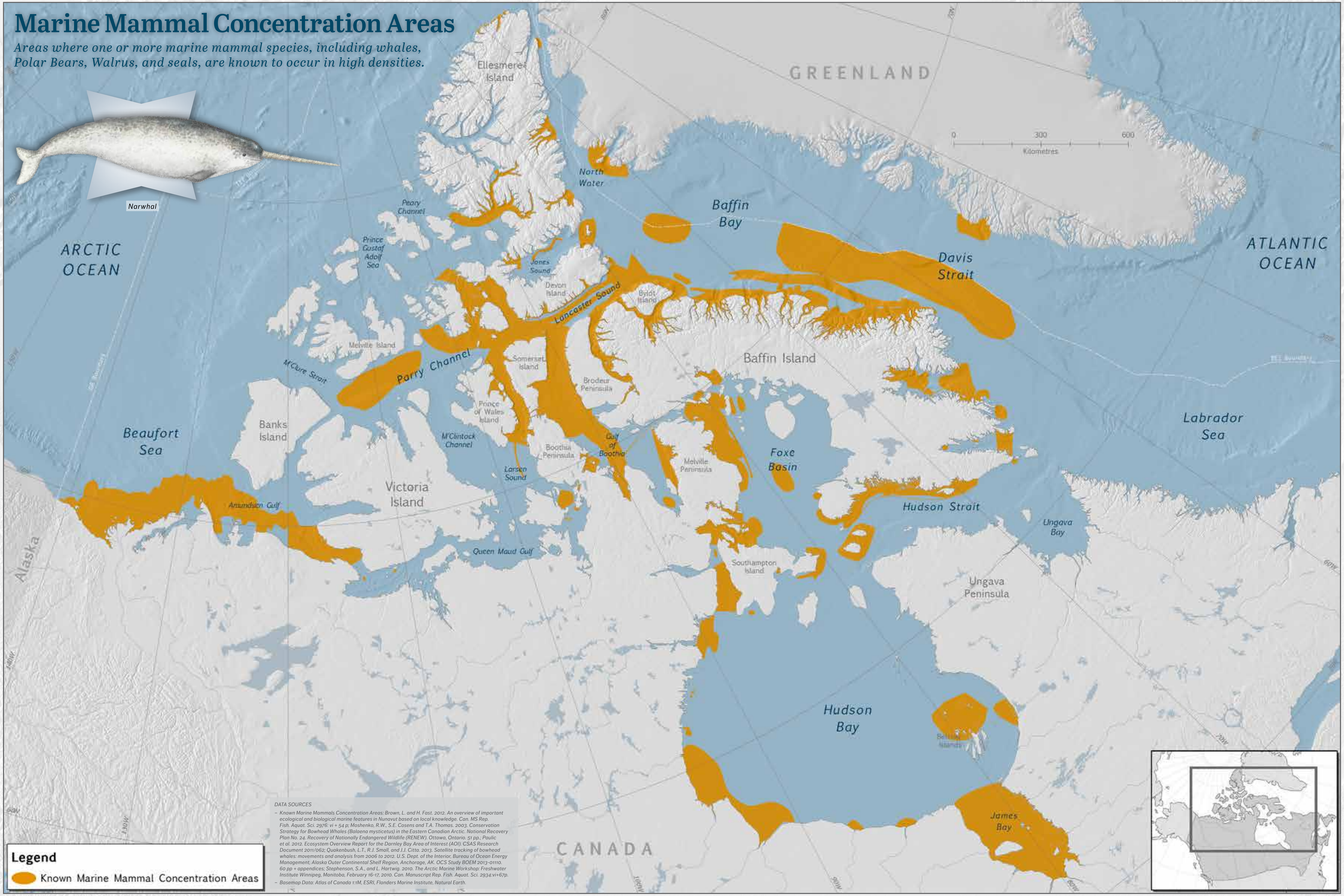
Six species are highlighted in this section due to availability of distribution data and their cultural and economic significance to the North: Bowhead, Beluga, Narwhal, Ringed Seal, Walrus, and Polar Bear.

For further reading, see page 111.

Muktuk (whale skin and blubber) of Bowhead, Beluga, and Narwhal (left to right). (photos: Vicki Beaver, Louise Murray, Yvette Cardozo [left to right])

Marine Mammal Concentration Areas

Areas where one or more marine mammal species, including whales, Polar Bears, Walrus, and seals, are known to occur in high densities.



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- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.

BALEEN WHALES

MARINE MAMMALS
- ➨**Baleen Whales**
- Toothed Whales
- Pinnipeds
- Carnivores

Bowhead Whale

Natural history

The Bowhead Whales *(Balaena mysticetus)* is the longest-living mammal on Earth and many are believed to live longer than a century, with one documented animal estimated to be 211 years old. Adult Bowheads have an average length of 15 to 18 m—the females are larger than males—and can weigh up to 100,000 kg. The Bowhead Whale has a large head taking up about a third of its body, it has no dorsal fin, and it has the thickest blubber of any animal species, which helps it survive in cold waters. With its strong body and big head, the Bowhead can break through ice more than 20 cm thick to form a breathing hole, and can dive under water for 30 minutes at a time. Bowheads have strong acoustic abilities that help them communicate with one another and navigate through extensive ice.

Bowhead Whales become sexually mature around 25 years of age. Females give birth approximately once every three years, with a gestation period of 12–16 months. Their calves are born a brownish-black in colour, changing to black as adults with white areas near the chin and tail. Bowheads eat by swimming forward with their large mouths open. Their diet consists mainly of zooplankton that they filter through hair-like material in their mouths called baleen.

Distribution

Bowhead Whales stay in the Arctic year-round, preferring straits, bays, and estuaries. Bowheads tend to be found at the edge of the ice much of the year, migrating north and south as the ice expands and retracts throughout the seasons. They are primarily found in Canadian, American, Russian, and Greenland waters. In Canada, Bowheads inhabit Baffin Bay, the Arctic Archipelago, and the Beaufort Sea.

Importance to Inuit

Traditionally, the Bowhead was an important animal for Inuit. A successful harvest would benefit the entire community with food, tools, and a source of light and heat from the oil in the blubber. Intense commercial whaling significantly reduced the Bowhead population. It has taken many decades for the population of the Bowhead to improve. In recent years, Inuit hunting has become much more sporadic, with a few taken per year in Nunavut on a rotating basis among communities.

Conservation concerns

The Bowhead Whale is a legally protected species in Canada's Arctic waters. In 2009, Canada also created the world's first Bowhead Whale sanctuary, Niginganiq, in Nunavut's waters near the community of Clyde River (Kangiqtugaapik). An international moratorium to stop commercial hunting of the Bowhead signed in 1966 has helped the population recover over the last several decades.

Facing Page: Bowhead whale breaching in the Northwest Territories. (photo: Kelvin Aitken)

Right: Bowhead Whale jaw bone, Kekerten Historic Park, Qikiqtaaluk Region, Nunavut. (photo: Trevor Taylor)

Gaps in current knowledge

Bowheads are largely solitary animals who sometimes travel in small pods. Much information has been gathered from ice-based observations, satellite transmitters, aerial surveys, and sampling from hunted animals. Inuit knowledge has provided a great deal of information about local migration patterns, behaviours, and changes over time. Better technology, such as aerial drone surveys, will help give researchers more information on the Bowhead's movements, better tracking of individual whales, and a deeper understanding of the conservation needs for this largest year-round resident of the Arctic.

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- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

TOOTHED WHALES–1

Beluga Whale

Natural history

The Beluga Whale *(Delphinapterus leucas)* is a medium-sized toothed whale measuring up to 5 m in length and weighting up to 1,500 kg. A long-lived and slow-reproducing species, Belugas are thought to have a lifespan of 60–70 years and give birth to a single calf every two to three years. Belugas are born pink or brown, turn dark grey within a few weeks, and gradually turn white as they reach maturity. They are considered generalist feeders and have a varied diet of small fish and crustaceans such as Arctic Cod *(Boreogadus saida)*, capelin *(Mallotus villosus)*, and shrimp *(Pandalus borealis)*. Migrating seasonally, Belugas select both shallow water and deepwater habitat and have been recorded diving over 1,000 m in search of prey. Belugas use sound and echolocation to communicate, navigate, and search for food. As an ice-associated species, Belugas are considered to be highly sensitive to climatic changes and changing ice conditions due to their preference for dense pack ice in winter. The most recent global population estimate is near 200,000.

Distribution

Belugas have a circumpolar Arctic and sub-Arctic distribution and occur in high densities in the western and eastern Canadian Arctic. There are seven stocks identified in Canadian waters totalling an estimated 142,000 animals, with more than half of these residing in Hudson Bay in the summer. Migration occurs seasonally with animals generally moving toward estuaries and open water in summer, foraging grounds in fall, and mobile pack ice for the winter.

Importance to Inuit

Harvested in summer and during spring and fall migration, Belugas are important to the culture, economy, and food security of Inuit communities in Nunavut, Nunavik, and the Inuvialuit Settlement Region. Muktuk, or skin and blubber, is a favourite traditional food item across the North.

Conservation concerns

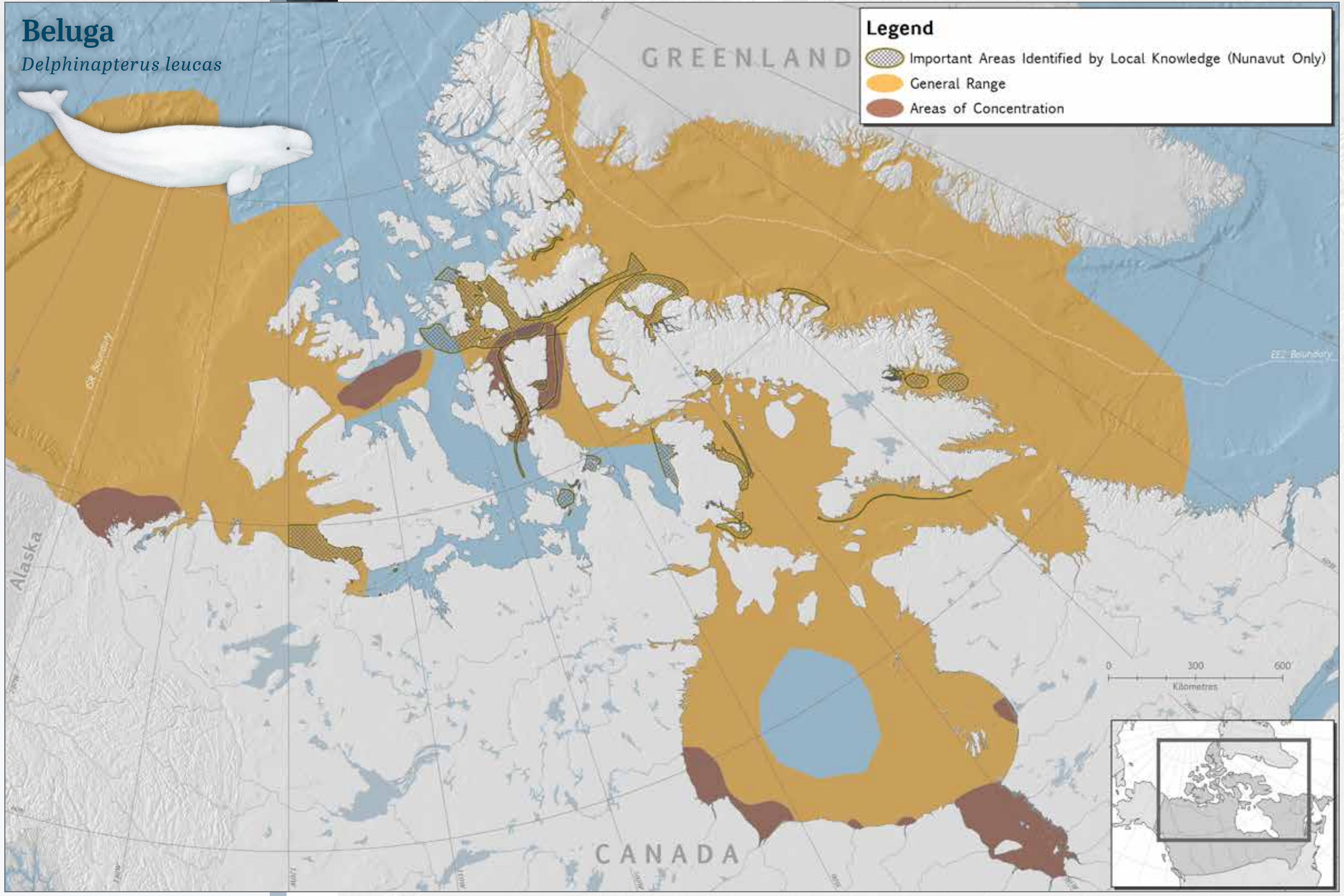
The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses Beluga health by population. Current conservation status ranges across populations from “not at risk” (eastern Beaufort Sea) to “threatened” (Cumberland Sound) to “endangered” (Ungava Bay). Threats to Beluga populations include habitat degradation, contaminants, hydroelectric development, hunting pressures, and anthropogenic disturbance such as noise pollution and vessel traffic.

Gaps in current knowledge

Many gaps exist in our understanding of basic Beluga biology as well as population dynamics and habitat requirements. For example, Belugas in the High Arctic and in Hudson Bay occupy shallow waters and estuaries in the summer, but the definitive reason for this is still unclear. It is also unknown if some populations overlap seasonally, which is especially important to understand in relation to mating season and harvests. Belugas, like other Arctic marine mammals, are difficult to study due to their remote habitat and the lack of daylight in their winter habitat. Recent aerial surveys and satellite telemetry work in the Beaufort Sea, High Arctic, and Hudson Bay will aid in our understanding of habitat needs as it relates to conservation.

Facing Page: Beluga whale rubbing its skin in the shallows near Somerset Island, Nunavut. (photo: Art Wolfe)

Right: Aerial view of Beluga travelling up a lead, Lancaster Sound, Nunavut, (photo: Doug Allan)



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- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

TOOTHED WHALES–2

Narwhal

Natural history

The Narwhal *(Monodon monoceros)* is a medium-sized toothed whale measuring up to 5 m in length, excluding the tusk. Males weigh an average of 1,600 kg and females an average of 900 kg. The characteristic tusk, an erupted tooth that can reach 3 m in length, is found mainly in males but can occur in females. Similar to Belugas, Narwhals are long-lived species, thought to have a lifespan of up to 90 years, and give birth to a single calf every two to three years. Animals are born dark grey and turn black and white as they age with a black and white mottled pattern on their backs and white on the underside. They consume a small variety of fish and invertebrates including halibut, Arctic Cod, and shrimp.

Narwhals are a deep diving species that migrate seasonally and prefer deep water in summer and winter. They have been recorded diving to depths in excess of 1,500 m, and like their closest relative, the Beluga, use sound and echolocation to communicate, navigate, and search for food. The global population estimate is near 160,000, with close to 90% summering in Canadian waters.

Distribution

Narwhals are found mainly in eastern Canadian and western Greenland waters, with some in the North Atlantic as far east as Svalbard and possibly Russia. There are two stocks identified in Canadian waters totalling an estimated 142,000 animals, with the majority of these residing off the coast of north Baffin Island in the summer. Migration occurs seasonally, with animals moving into the deep waters and mobile pack ice of Baffin Bay and Davis Strait for the winter.

Importance to Inuit

Narwhals are important to the culture, economy, and food security of Inuit communities in Nunavut. Animals are mainly harvested in spring at the floe edge off north Baffin Island, and in the summer in northern Hudson Bay and off the coast of north Baffin Island. Muktuk, or skin and blubber from a harvested whale, is a traditional food item across the North.

Conservation concerns

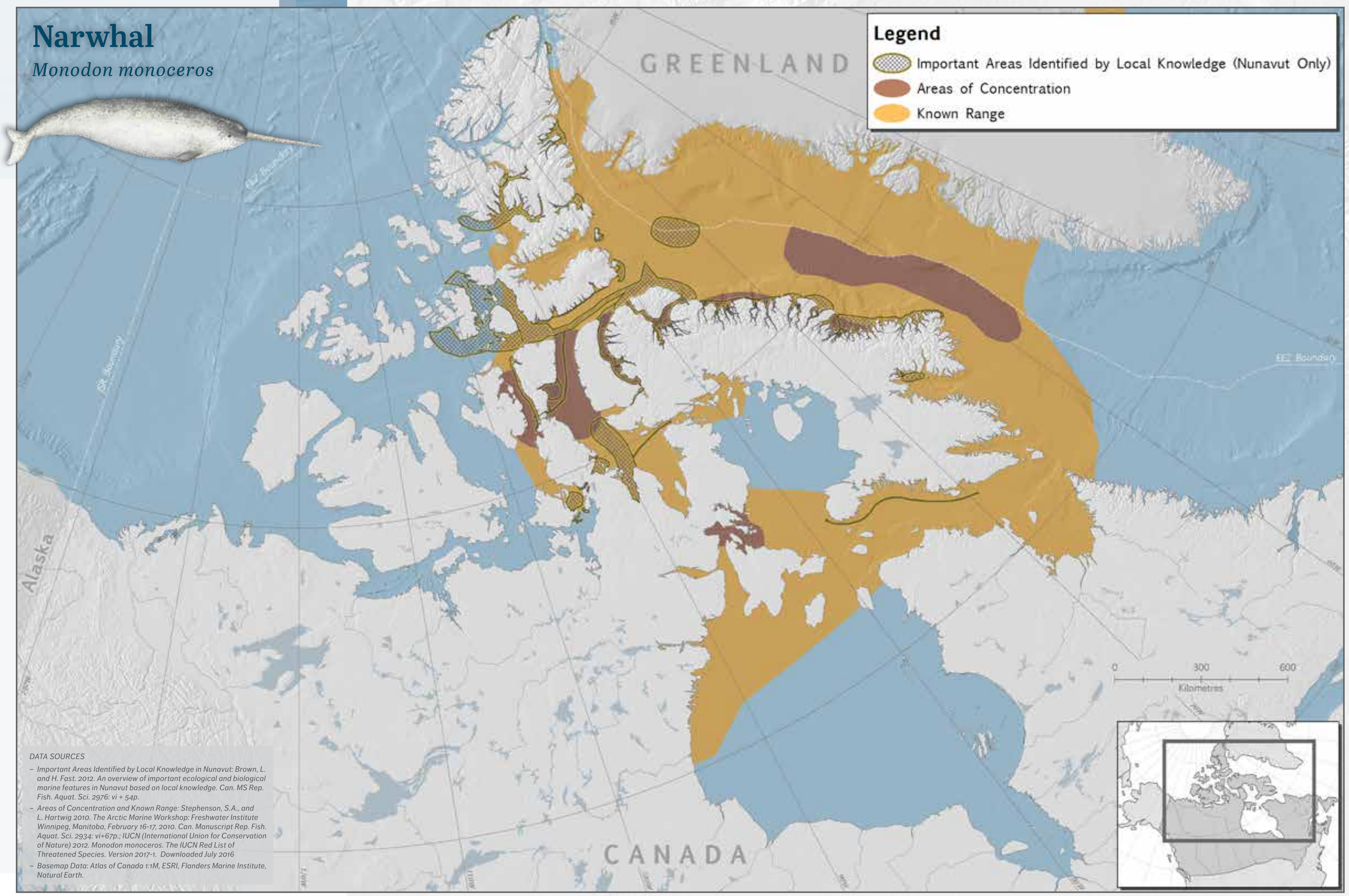
The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) considers the conservation status of Narwhal to be "of special concern." Reasons for concern include uncertainty about population numbers and trends due to limited data, levels of sustainable hunting, and potential effects of climactic changes on a highly ice-associated species with a narrow range in prey species. Anthropogenic disturbance in the Arctic, including shipping and seismic work, may also be threats to a species that, like other many other cetacean species, is dependent on sound for communication and locating prey.

Facing Page: Narwhals surfacing near Baffin Island, Nunavut. (photo: Eric Baccega)

Right: Narwhal pod swimming near the surface, Pond Inlet, Lancaster Sound. (photo: Oceans North)

Gaps in current knowledge

Many gaps exist in our understanding of Narwhal populations, their habitat, and their prey, due to the difficulty in accessing many sites in summer and winter. For example, Narwhal prey data is mainly gathered from the stomach samples of seasonally harvested animals as well as inferred from the depths they have been recorded diving to in the winter. It is also unknown if animals summering off the north coast of Baffin Island are distinct sub-populations that return to the same fjords each year and winter in distinct areas or if considerable mixing is taking place, which is important for establishing harvest quotas. Recent aerial surveys and population estimates have been undertaken in both summering regions; however, due to incomplete aerial survey coverage in some years and few surveys in total, reliable trends are not possible without further years of data.



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PINNIPEDS–1

Walrus

Natural history

The Walrus *(Odobenus rosmarus)* is a large brown pinniped recognizable by its tusks, white vibrissae or whiskers, and size. Adult males measure up to 3.6 m and 1,400 kg and females up to 3.1 m and 800 kg. Tusks are upper teeth that develop in males and females and can reach just under half a meter in length. Walruses are considered mature between the ages of 5 and 12 years and give birth to a single pup approximately every three years. They consume mainly clams but are also known to eat Arctic Cod *(Boreogadus saida)* and invertebrates. Their main predators are Polar Bears and humans.

Distribution

Atlantic Walruses *(O. r. rosmarus)* are found in the eastern Canadian Arctic and Greenland. Pacific Walruses *(O. r. divergens)* occur in the Bering and Chukchi Seas and occasionally in the Beaufort Sea. Five populations are recognized in Canada for management purposes based on geographical distributions and genetics.

Walruses are most often found at ice edges in winter and on pack ice or island or coastal habitats, called haul-out sites, in summer. They prefer shallow waters for access to preferred prey and are often found in areas shallower than 100 m.

Importance to Inuit

In areas where Walruses exist in the Canadian Arctic, they have been an important food source for Inuit. In the past, groups of Inuit used to survive on Walrus. Walruses are still harvested as an important source of country food. One way of preparing Walrus meat is to allow it to ferment in a burrow in the permafrost for up to two years. The ivory tusks of the Walrus have been reported to be used to make hunting tools and weapons by Inuvialuit, Inuit of Igloolik, Baffin Island, and Labrador.

Conservation concerns

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Walrus as "of special concern." Knowledge of population size and structure, hunting pressures, and vulnerability to disturbance are reasons for the conservation designation.

Gaps in current knowledge

Little is known about population numbers of the Walrus at this time, and populations may be threatened by hunting, noise disturbance, and industrial activities. The Walrus survival rate, sustainable harvest rate, or rate of removal are also unknown for the currently defined populations. The effects of climate change and reductions in sea ice on Walrus populations are also unknown.

Facing Page: Underwater view of Walrus and sea ice in Frozen Strait, Nunavut. (photo: WorldFoto)

Right: Walrus meat laid out on the beach after a hunt, Igloolik, Nunavut. (photo: Louise Murray)

DATA SOURCES
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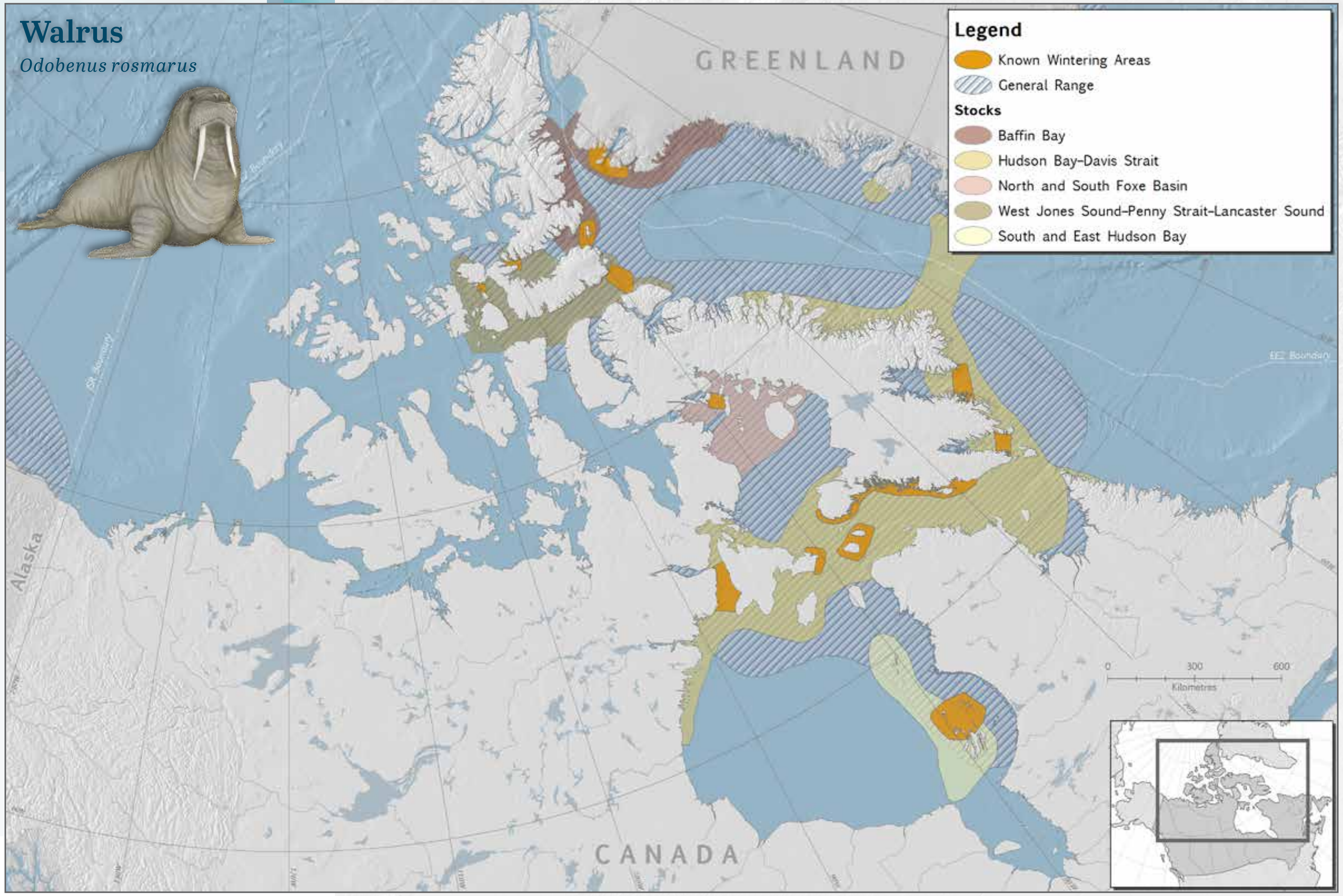

PINNIPEDS–2

MARINE MAMMALS
- Baleen Whales
- Toothed Whales
- ➡ **Pinnipeds**
- Carnivores

Ringed Seal

Natural history

The Ringed Seal *(Pusa hispida)* is a small seal averaging 1.5 m in length and weighing between 50 and 70 kg. Born white, Ringed Seals turn grey with age. Adult Ringed Seals are dark grey with light rings on the dorsal side and silver on the ventral side, or underside. Ringed Seals are considered mature between the ages of five and seven years and give birth to a single pup in March or April, although timing of pupping varies across the Arctic. They consume a variety of fish and invertebrates including Arctic Cod, sculpins, mysids, and shrimp. Ringed Seals are thought to have a lifespan of 25 to 30 years. Their main predators are Polar Bears and humans.

Distribution

Ringed Seals have a circumpolar distribution occurring in all parts of the Arctic Ocean. They are an ice-associated species, maintaining breathing holes in the ice, unlike other seal species, and creating lairs under the snow on the ice surface for giving birth and nursing young. Ringed Seals use shore-fast ice or stable pack ice in winter and are thought to disperse to forage during the open-water season.

Importance to Inuit

Ringed Seals are an important part of diet in the Arctic and are harvested year-round. Part of a traditional food source, all parts of the seal are consumed and pelts are used to make boots and clothing.

Conservation concerns

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Ringed Seals "not at risk." Changes in the marine environment and increases in shipping and development in the North, however, may be cause for concern.

Gaps in current knowledge

Population numbers of Ringed Seals are largely unknown and difficult to assess due to their small size, large range, and habitat preference. Population size has been inferred in some areas based on Polar Bear density, as well as the number of breathing holes within a portion of seal habitat. Without reasonable population estimates it is difficult to assess the species's response to loss of seasonal sea ice and increased ship traffic as sea ice declines.

Facing Page: Ringed Seal basking in midday sun on an ice floe in Hudson Bay. (photo: Mike Macri, macriphoto.ca)

Right: Ringed Seal skins drying, Pond Inlet, Lancaster Sound. (photo: Oceans North)

DATA SOURCES
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- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*

CARNIVORES

MARINE MAMMALS
- Baleen Whales
- Toothed Whales
- Pinnipeds
- ➨**Carnivores**

Polar Bear

Natural history

The Polar Bear *(Ursus maritimus)* is the largest four-legged carnivore in the world. Females weigh an average of 400 kg and male bears can weigh up to 800 kg. Females reach reproductive maturity at four to six years old and on average give birth to two cubs every three years. Adult Polar Bears have a very high survival rate and adults can live to the age of 25. Polar Bears are adapted to the Arctic environment with dense, water-repellent white fur, a thick layer of fat, and a streamlined body and large front paws for swimming. The Polar Bear's diet consists primarily of Ringed Seals, and they occasionally kill Bearded Seals, Walruses, Beluga Whales, and Narwhals. When on land in summer, especially in the southern portions of their range, Polar Bears will consume fish, eggs, kelp, lemmings, carrion, and berries. The global population estimate is approximately 26,000 bears, with about two-thirds living in Canada.

Distribution

In Canada, Polar Bears are found primarily in coastal regions from Yukon to Newfoundland, and from James Bay to the islands of the Canadian Arctic Archipelago. Seasonal movements of Polar Bears depend on the areas where they and their prey reside. Because of their close relationship with seals, their movements tend to follow the same patterns as seals' movements; the bears follow the seals northward in mid-winter and through the springtime along the land-fast ice and floe edge.

Importance to Inuit

Polar Bear is an important resource for the Inuit, playing a role spiritually, as part of a subsistence diet, and in the local economy. Polar Bears are hunted for their pelts and meat in parts of the Arctic. The meat is usually baked or boiled in a soup or stew. The sale of a Polar Bear pelt as well as guided sport hunting can be a source of income for Inuit families.

Conservation concerns

The Polar Bear is vulnerable to changing sea ice conditions associated with climate change. This is the main reason the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Polar Bear as "of special concern" in 1986. Melting sea ice is a major and long-term threat to Polar Bears. It affects them directly by loss of ice habitat, and indirectly by changing prey availability, reducing access to historical habitat, and exposing them to more human activity, including industrial development and shipping.

Facing Page: A Polar bear on annual ice, Cape Churchill, Manitoba. (photo: Sergey Uryadnikov)

Right: Polar Bear swimming near Harbour Islands, Repulse Bay, Nunavut. (photo: Paul Souders)

Gaps in current knowledge

Canada expects to have up-to-date estimates for all its Polar Bear populations and sub-populations by 2018. Although Polar Bears are well studied and monitored in many areas of the Arctic, gaps in knowledge persist with respect to the likely impact of multiple stressors on Polar Bear populations. The cumulative effects and the interaction between stressors, including climate change, contaminants, disease, and increasing human activities, have not been well studied, and the likely impact to Polar Bears remains unknown.

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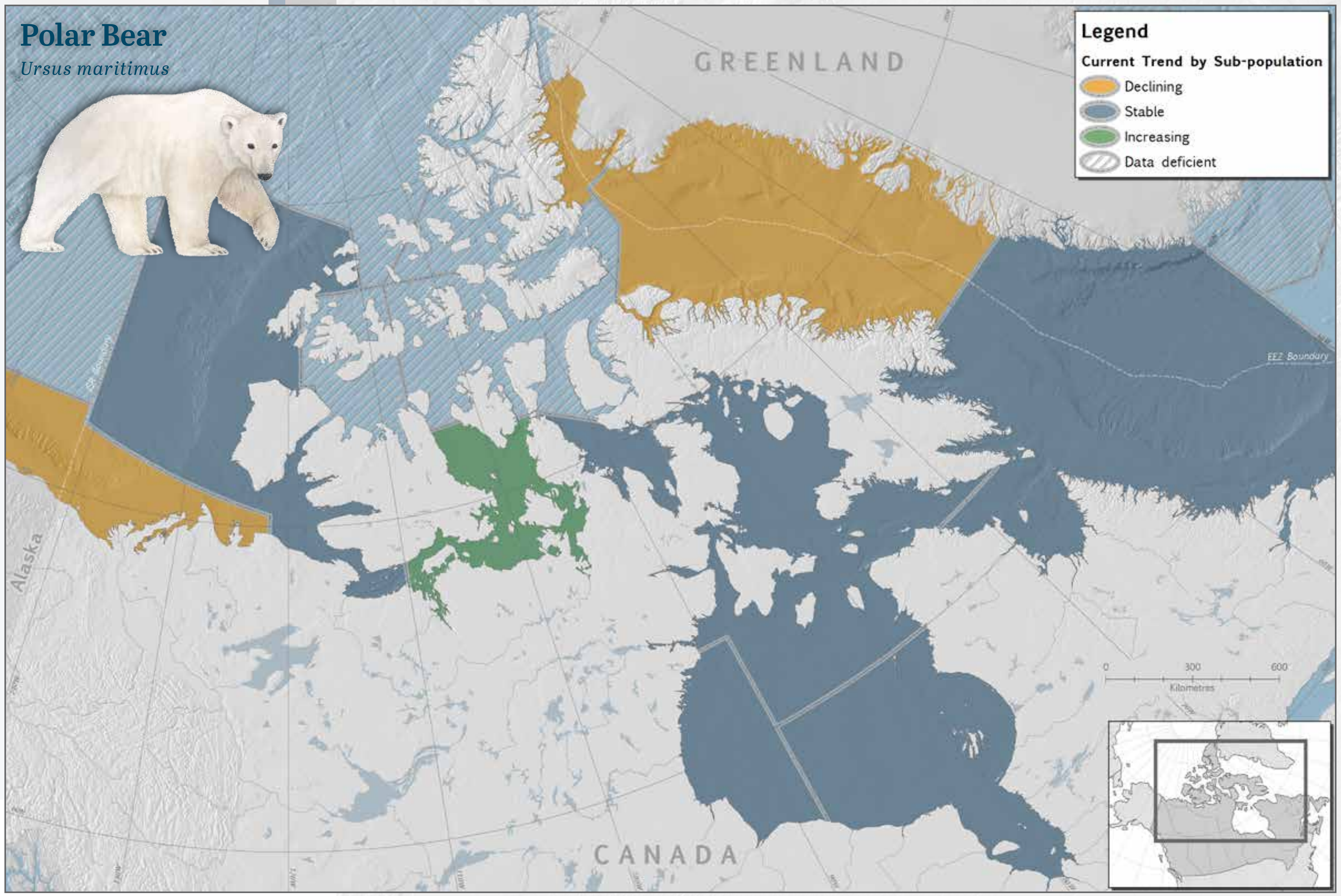
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.*



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A NOTE ABOUT THE DATA

The data for this Atlas were compiled predominantly from publicly available sources, including government reports, scholarly journals, and online databases. We have emphasized the use of observational data; modelled data were used sparingly. We invite interested readers to check the Map Data Source listings to see where data for each of the maps were acquired from. The purpose of this Atlas is to illustrate national-level data and trends. More localized data is available from scientists and experts in the field. The references listed at the end of each section provide a good starting point for those interested in more detailed data.

Furthermore, there are many more species present and factors at play in the Canadian Arctic marine environment than could be illustrated in this Atlas. The Atlas focuses on several key aspects to provide an introductory overview of the region.

MAP PROJECTION

All maps except for those in the Physical Oceanography chapter utilize an Albers Equal Area projection and NAD83 datum, with a central meridian of 120°W and standard parallels of 60°N and 75°N. This projection was used to minimize areal distortion while maximizing the view of Canada's Arctic coastline.

In the Physical Oceanography chapter, an orthographic projection (WGS84) centred on 120°W and 60°N was used to optimize the capture of higher latitudes north of Ellesmere Island.

DATA DISCLAIMER

These maps were produced as part of the Atlas and were created for illustrative purposes only. The spatial and temporal accuracy of the map's contents are not guaranteed.

Environmental Benefits Statement

By using paper made with 10% post-consumer recycled content, the following resources have been saved.

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Environmental impact estimates were made using the Environmental Paper Network Calculator. For more information visit http://calculator.environmentalpaper.org

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