

CANADA'S ARCTIC MARINE ATLAS



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Inside cover: Topographic relief of the Canadian Arctic



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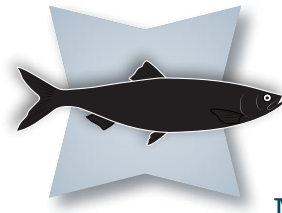
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MARINE AND ANADROMOUS FISHES OF THE ARCTIC

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

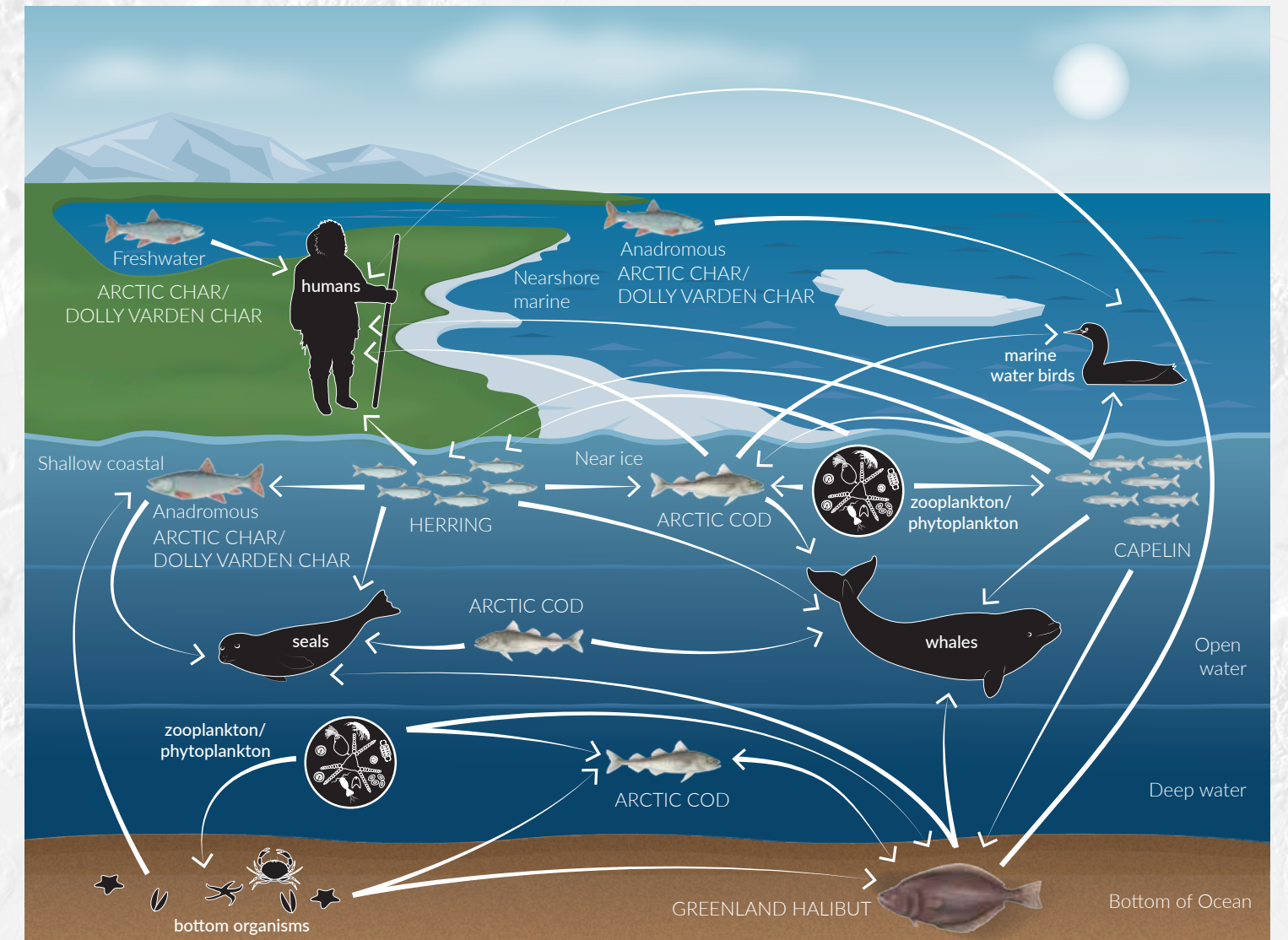
Fishing has long been an important part of Inuit culture and lifestyle. Freshwater, anadromous, and ocean fishes were captured year-round, with major fishing efforts occurring in the spring and fall when the fish were migrating back to their spawning and overwintering grounds in large numbers. Today, 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.

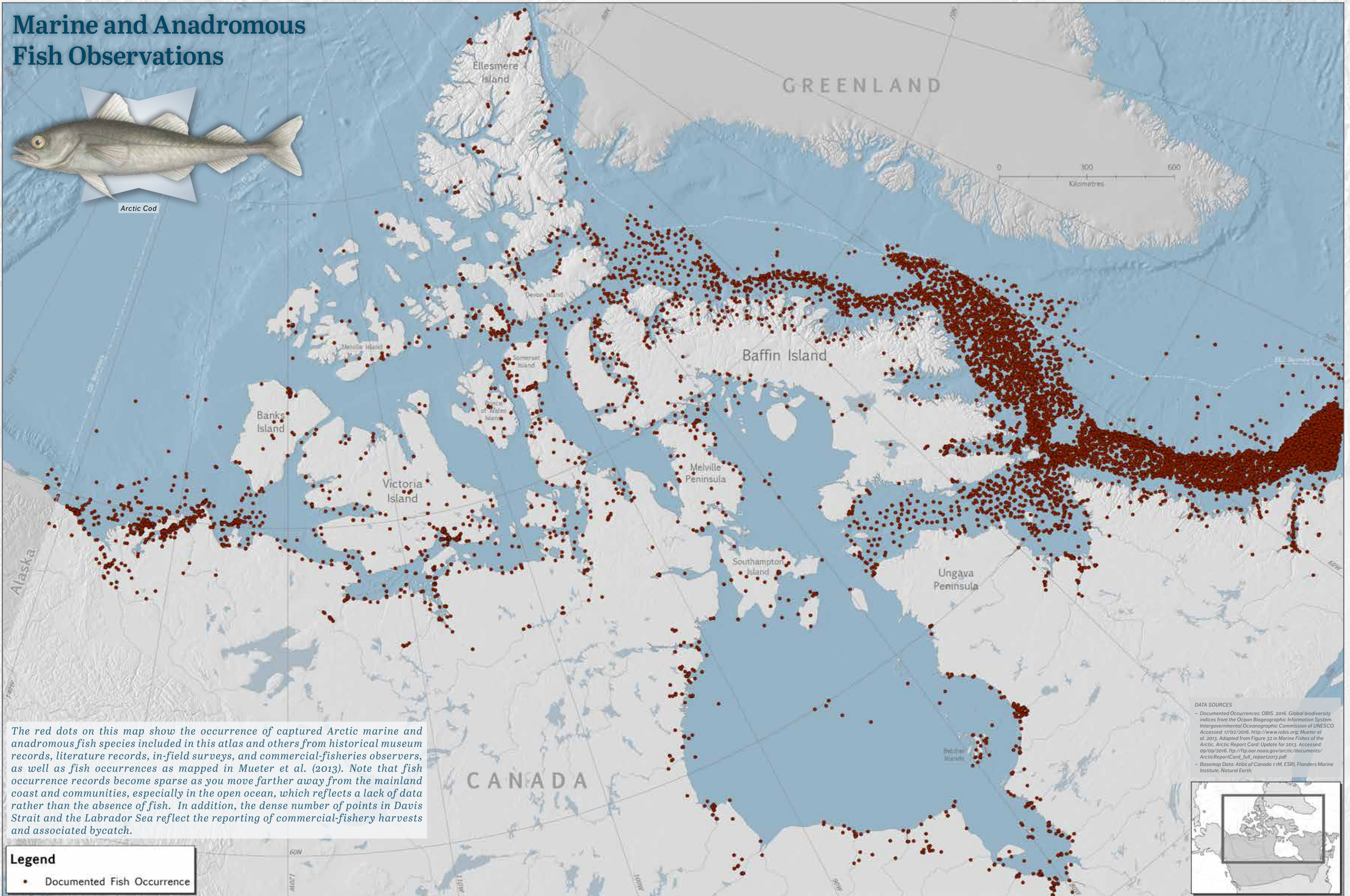


An Arctic Tern (*Sterna paradisaea*) holding a Capelin flies above Hubbard Point along Hudson Bay. (photo: WorldFoto)

Marine and Anadromous Fish Observations



Arctic Cod



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.

Legend

- Documented Fish Occurrence

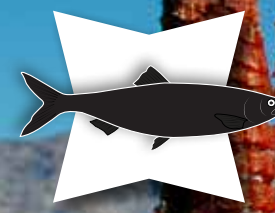
DATA SOURCES

- Documented Occurrences: OBIS, 2016. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed: 17/02/2016. <http://www.obis.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. http://ftp.oar.noaa.gov/arctic/documents/ArcticReportCard_full_report2013.pdf
- Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.





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



ANADROMOUS FISHES

- MARINE & ANADROMOUS FISHES**
- ➔ Anadromous Fishes
 - Pelagic Fishes
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 - Forage Fishes

Arctic Char and Dolly Varden Char

Natural history
Arctic Char (*Salvelinus alpinus*) and Dolly Varden Char (*Salvelinus 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.

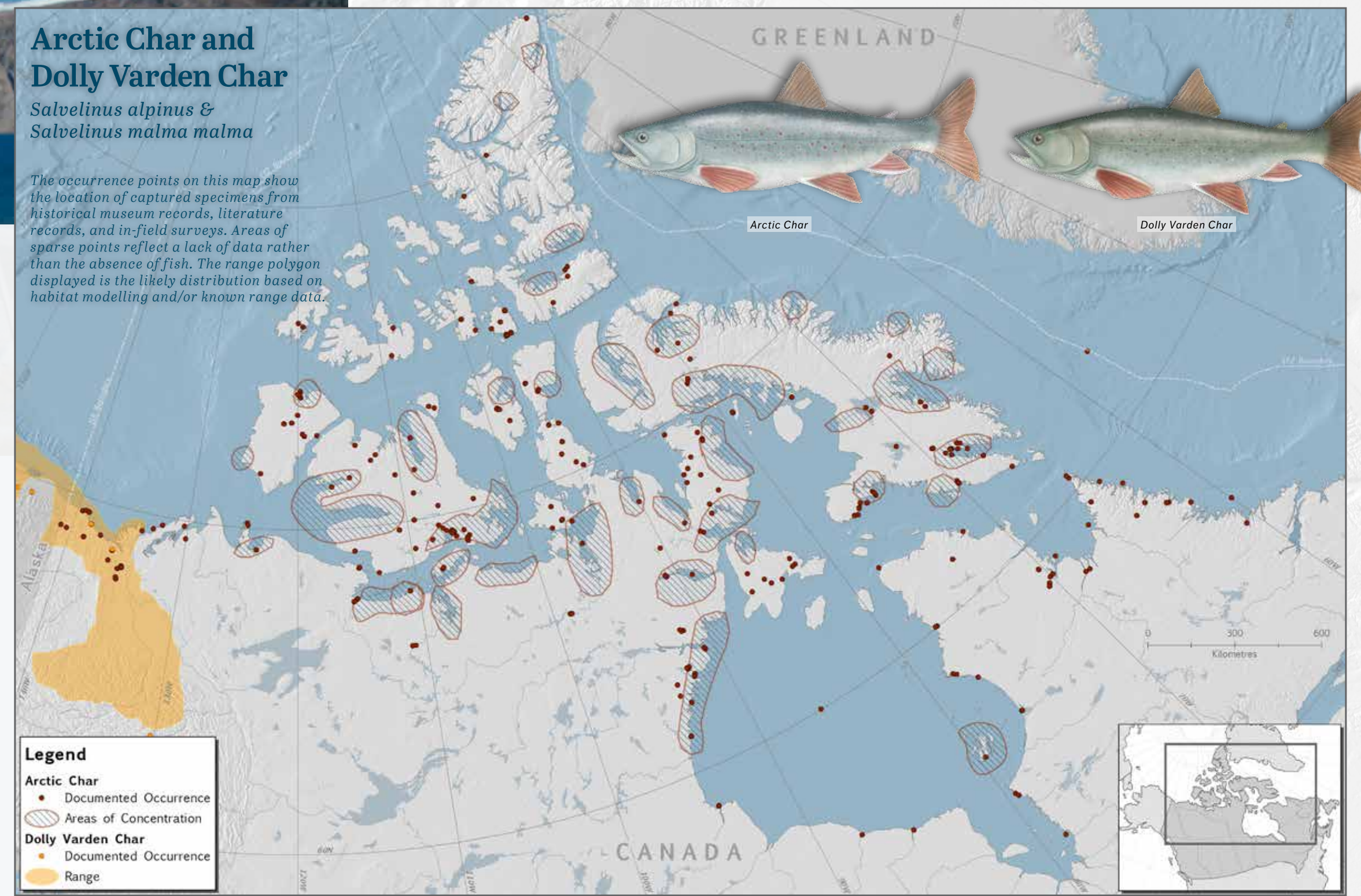
Importance to Inuit
Arctic Char and Dolly Varden Char are an extremely important subsistence resource and a nutritious food for Inuit. In Nunavut, Arctic Char is the second-most widely consumed country food after caribou and in the Inuvialuit Settlement Region it is the third-most widely consumed food 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.

Arctic Char and Dolly Varden Char

Salvelinus alpinus & *Salvelinus malma malma*

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 is the likely distribution based on habitat modelling and/or known range data.



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

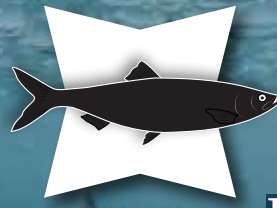


Gaps in current knowledge

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>
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- 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). Narwhal 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 cre-

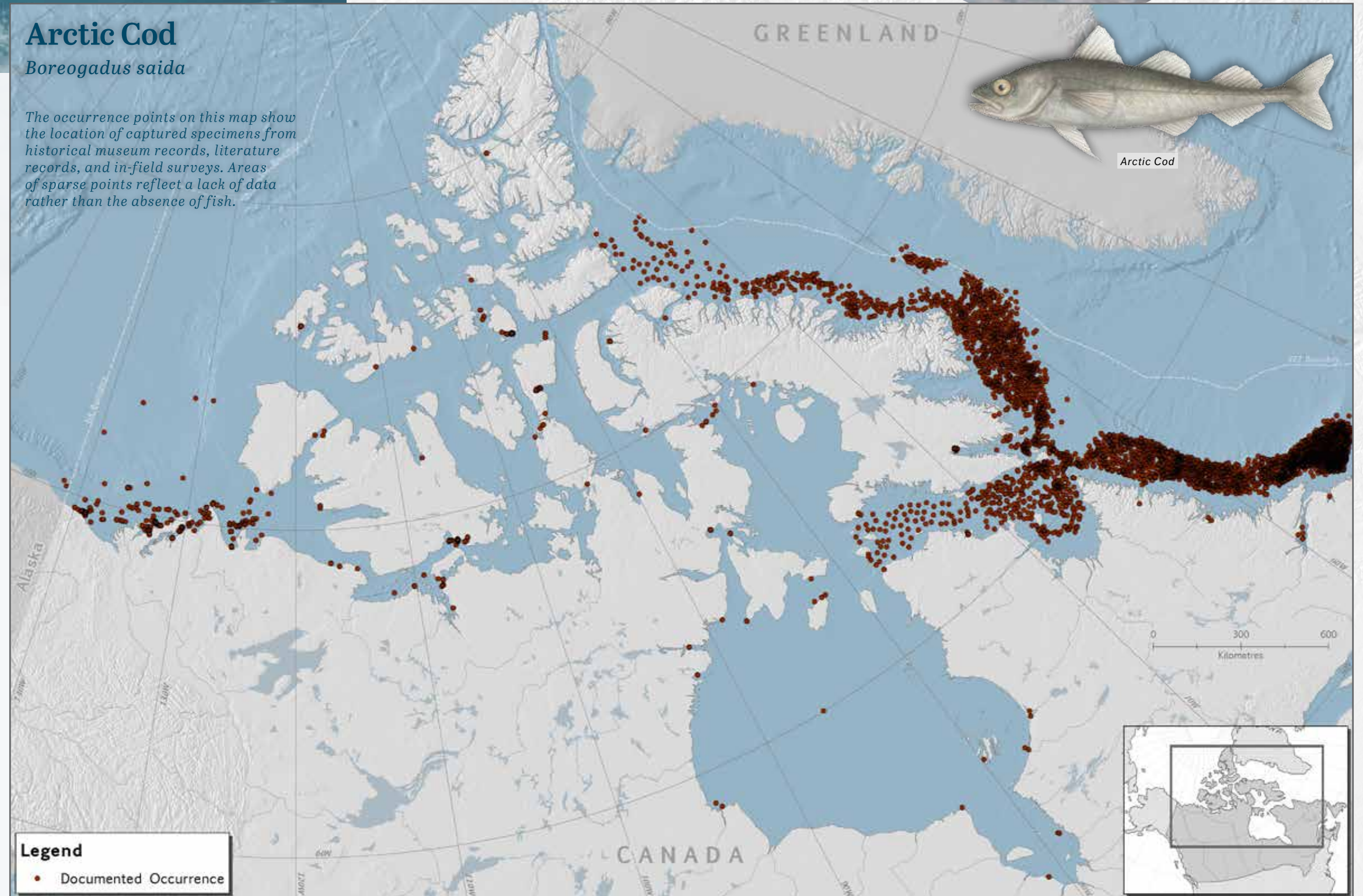
ates lower pressure at the water's surface, which then draws deeper water to the surface), and invasive species will affect their abundance. Despite the research that is being conducted on this species, much is yet to be learned about their life history and abundance, and other basic aspects of their 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)

Arctic Cod

Boreogadus saida

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.



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.obis.org>
 - Basemap Data: Atlas of Canada 1:M, 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)

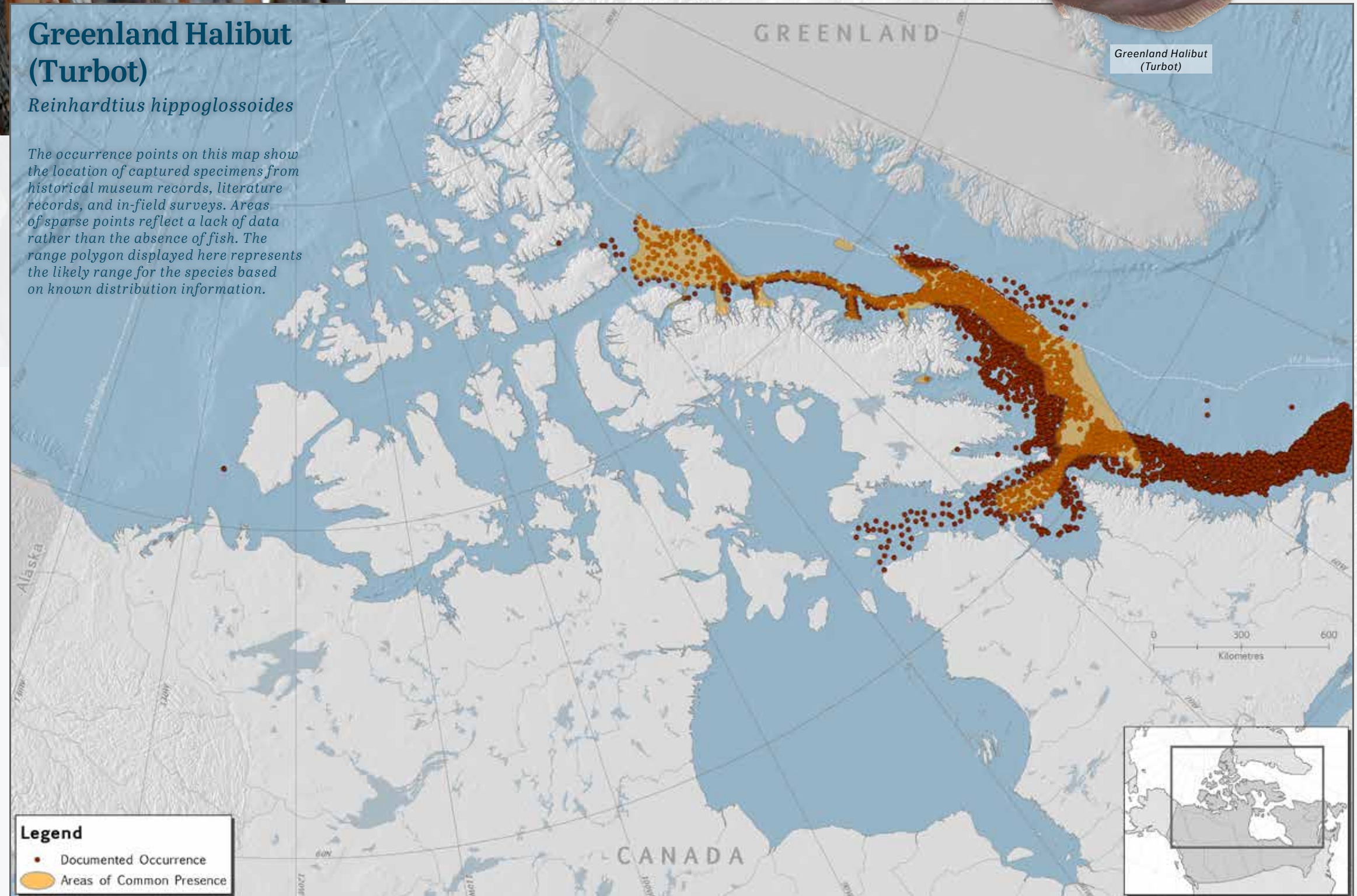


Greenland Halibut (Turbot)

Greenland Halibut (Turbot)

Reinhardtius hippoglossoides

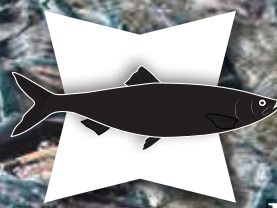
The occurrence points on this map show the location of captured specimens from historical museum records, literature records, and in-field surveys. Areas of sparse points reflect a lack of data rather than the absence of fish. The range polygon displayed here represents the likely range for the species 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.obis.org>
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 - Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth.



FORAGE FISHES-1

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

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

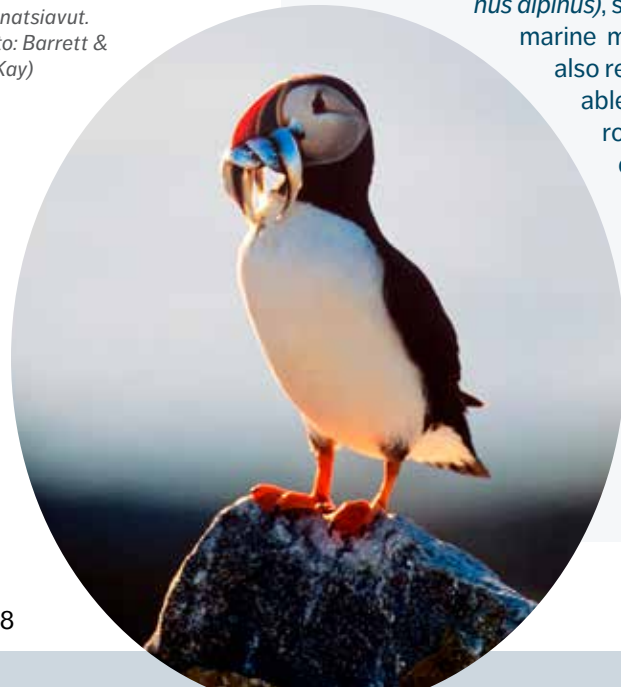
Capelin are an important part of the Arctic marine food web as they are the main forage species for many larger predatory fish such as cod (family Gadidae) and anadromous Arctic Char (*Salvelinus alpinus*), sea birds such as Thick-Billed Murres and marine mammals such as Beluga Whales. They also represent 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.

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

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

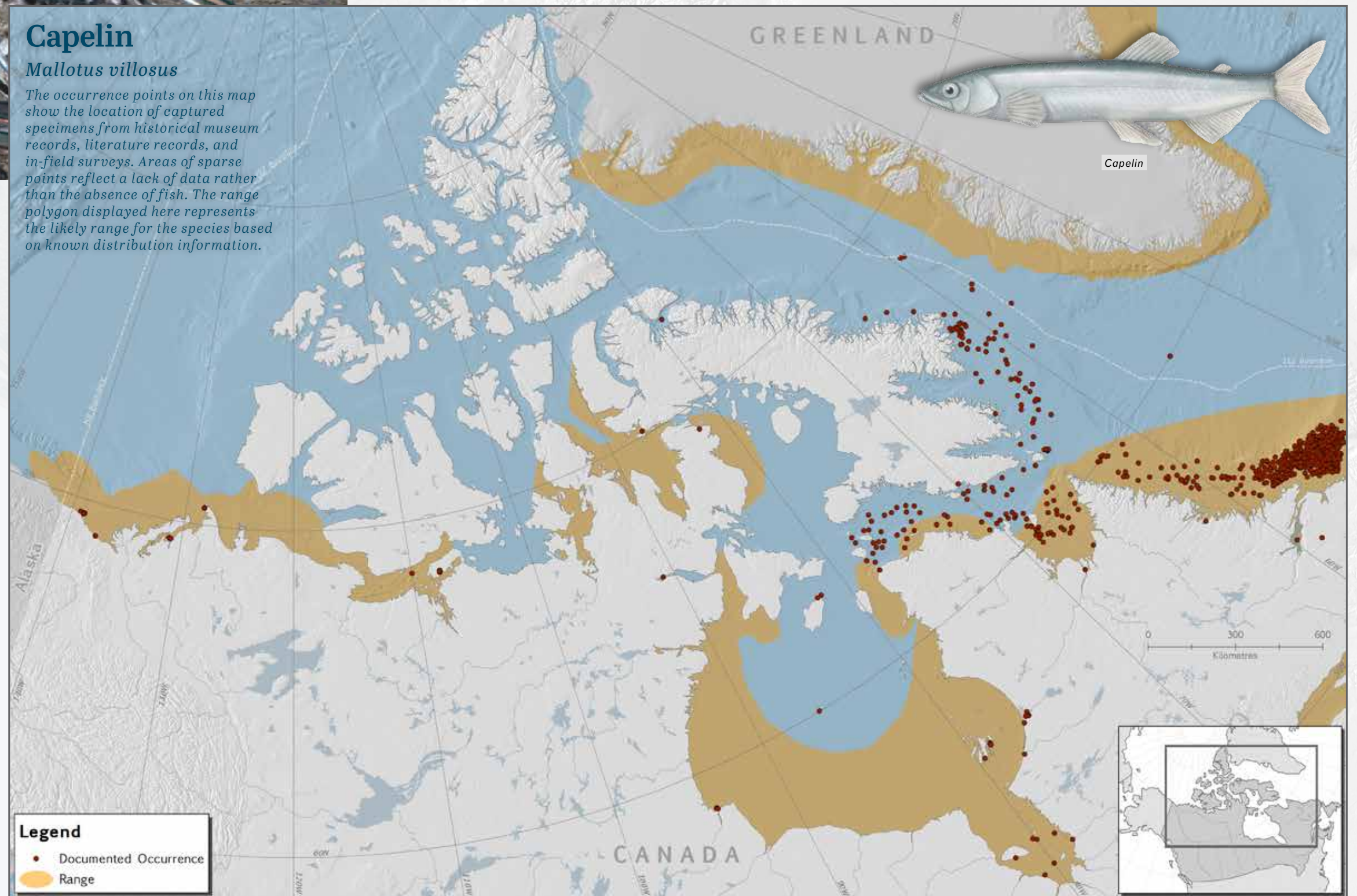


Facing page: Male and female Capelin during spawning season. (photo: Rolf Hicker)

Capelin

Mallotus villosus

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.



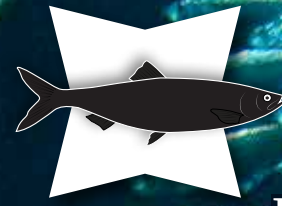
before. While this may be beneficial for the predators of Capelin mentioned above, it can be detrimental for species that may be displaced, such as Arctic Cod (*Boreogadus saida*).

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.

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



FORAGE FISHES-2

MARINE & ANADROMOUS FISHES

- Anadromous Fishes
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- ➔ Forage Fishes

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 pallasii*) 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.

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.

Atlantic and Pacific Herring

Clupea harengus & *Clupea pallasii*

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.



Legend

Pacific Herring
 ● Documented Occurrence

Atlantic Herring
 ● Documented Occurrence

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



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

FURTHER READING

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