CANADA'S ARCTIC MARINE ATLAS

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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.

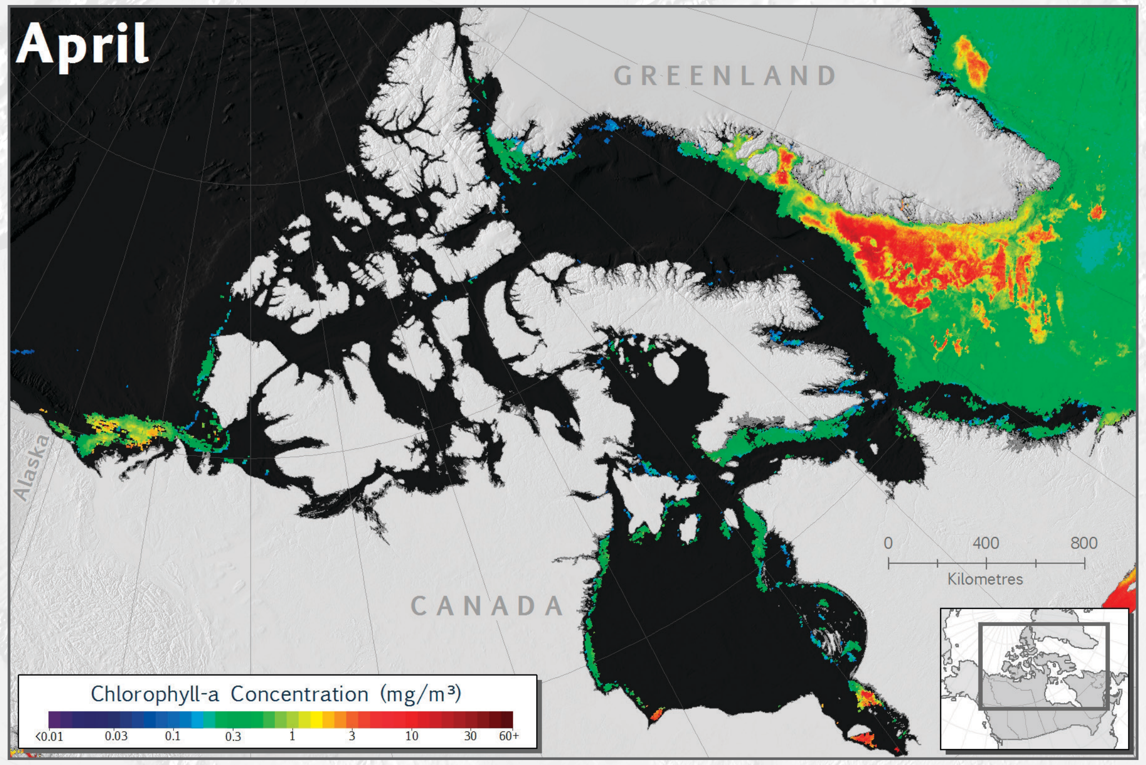
Gaps in knowledge

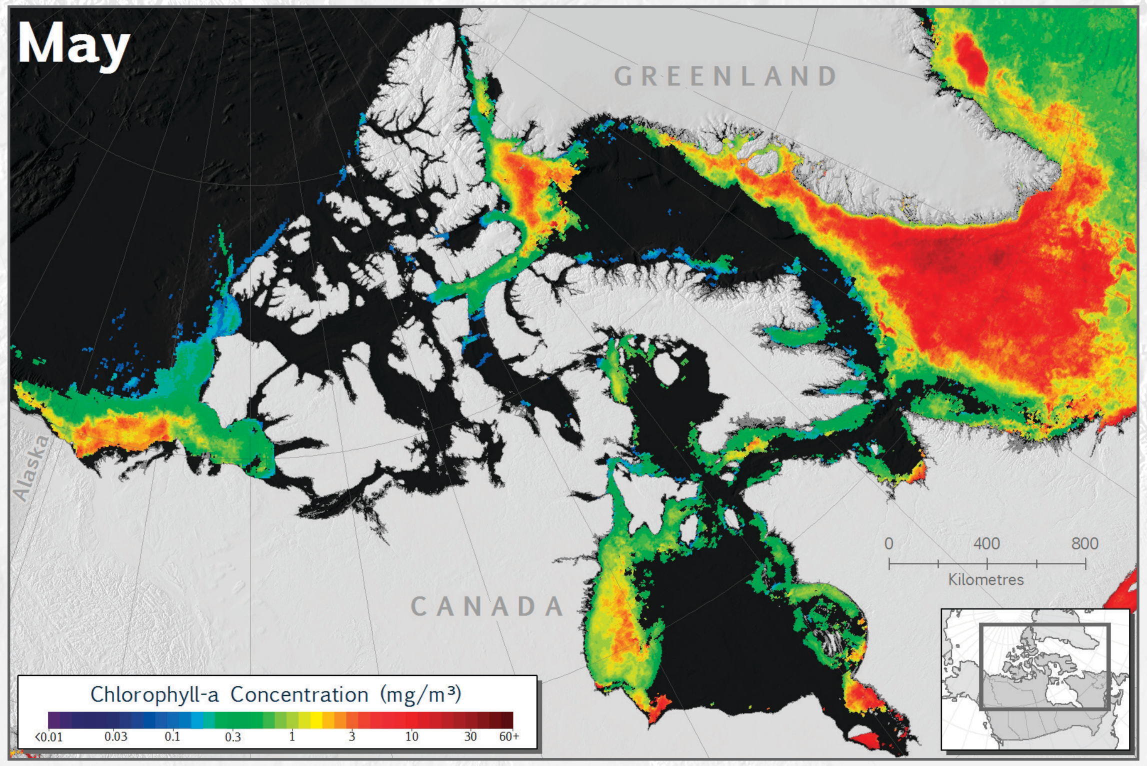
Given the importance of phytoplankton and its vulnerability to changing sea ice cover and land-based nutrients, more information is needed on year-to-year variability. Accumulation of contaminants in zooplankton is an important area of research in order to understand the impacts of consuming fish and 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.

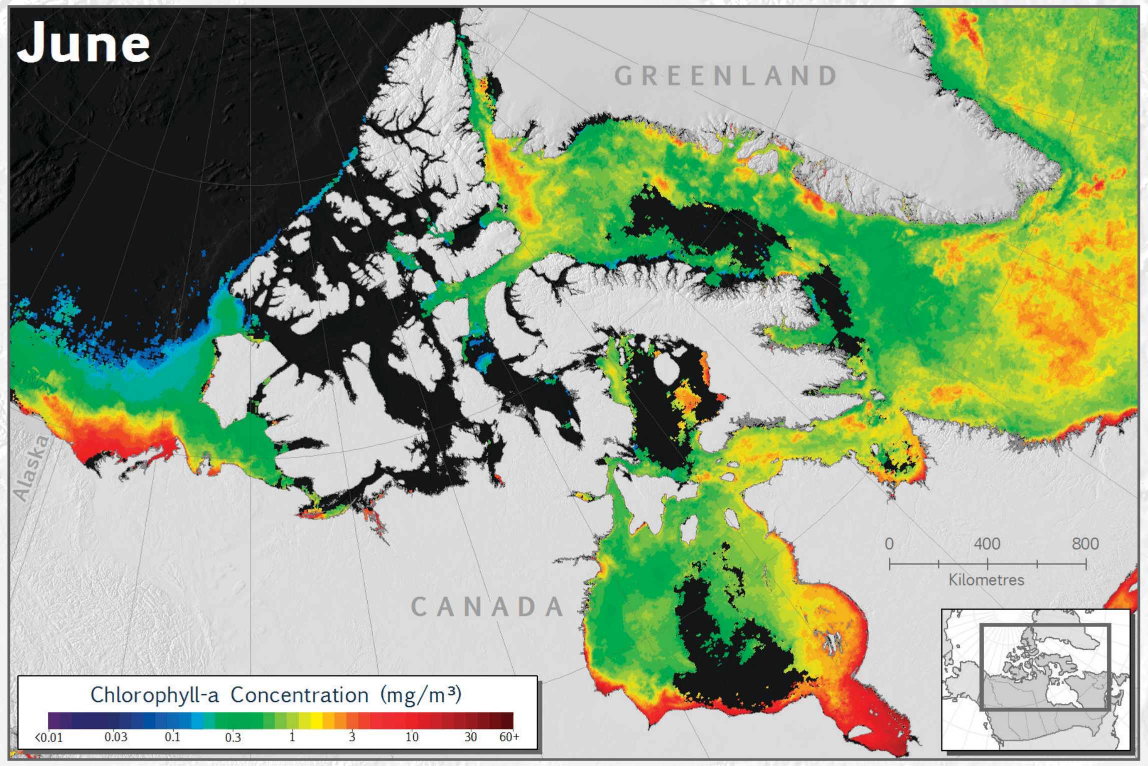
For further reading, see p. 106.

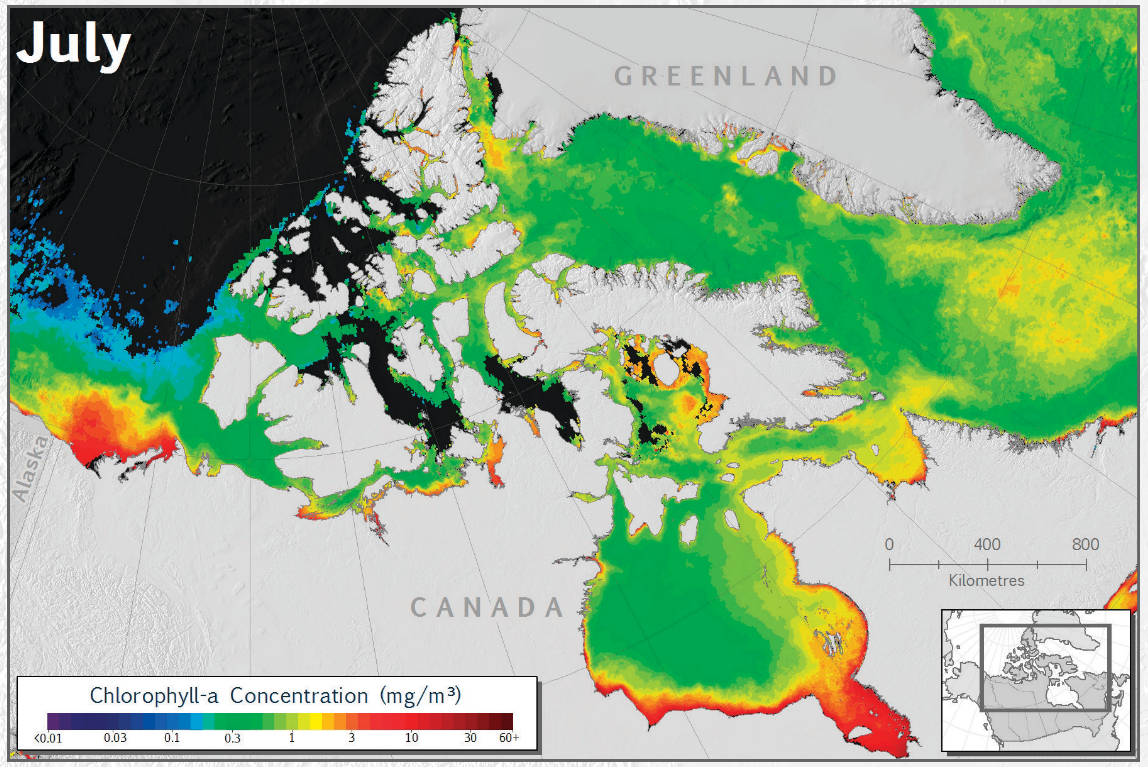
Monthly Chlorophyll-a Climatologies

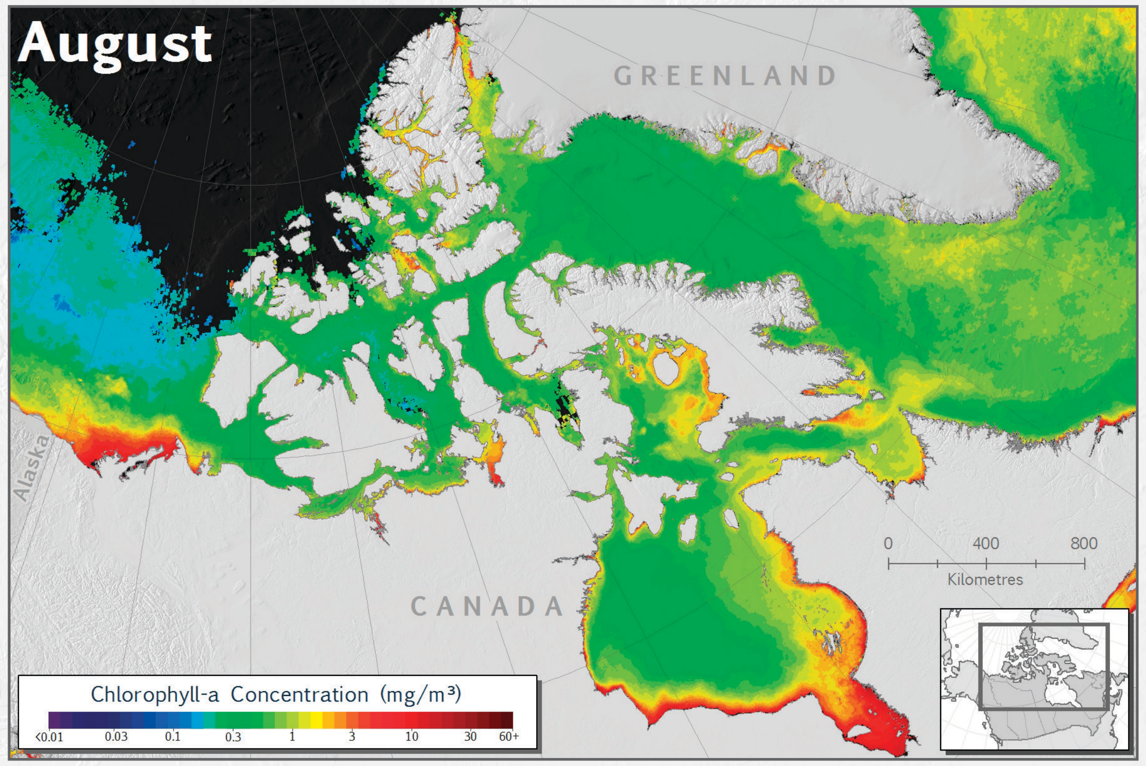
The series of maps below shows the monthly average chlorophyll-a concentration in the Canadian Arctic based on satellite imagery. Chlorophyll is the green pigment in phytoplankton, so areas with high chlorophyll concentrations are places where phytoplankton are growing. Phytoplankton can be seen blooming 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.

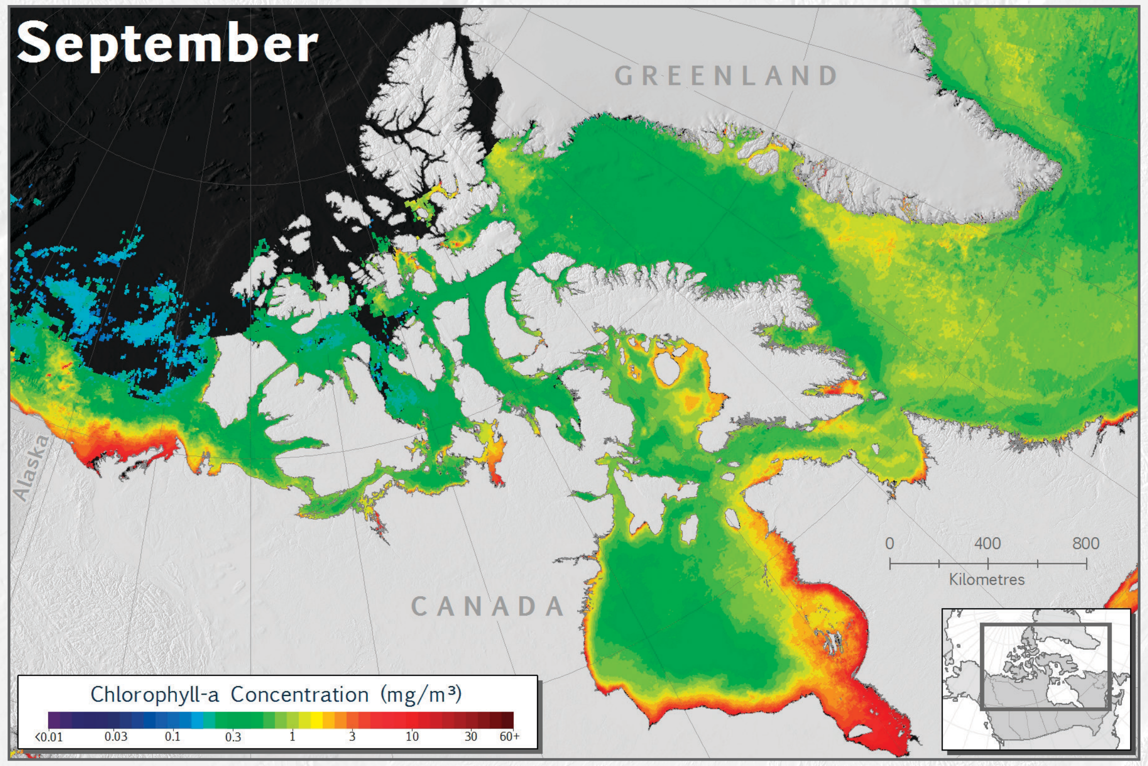












Black Shading = no data

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.*

KELP

BOTTOM OF THE FOOD WEB

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

Arctic Kelp

Natural history

Kelp (of the order Laminariales) are large brown seaweeds. Kelps are made up of three parts: blades, stipes, and holdfasts. The blades look similar to leaves and turn sunlight into energy and oxygen. Stipes raise the blades into the water column, and the holdfasts keep kelp attached to the seafloor. Some species also have gas-filled bladders that allow them to float. Kelp grows very quickly and creates some of the most productive habitats in the world. Kelp get their nutrients from the surrounding seawater and most species live 3-5 years.

Like forests on land, groups of kelp can grow together to form a kelp forest. Kelp forests are a source of shade, food, and protection, which support many animals. Kelp forests can cover large areas, grow up to 10 metres high, and contain many different species of fish, snails, crabs and other marine creatures. The common species of kelp in the cool water and Arctic regions of Eastern Canada are sea colander kelp (*Agarum clathratum*), winged kelp (*Alaria esculenta*), *Laminaria solidungula*, and sugar kelp (*Saccharina latissima*).

Distribution

Kelp forests are found in shallow oceans around the world. In the Eastern Canadian Arctic, it is estimated that kelp forests currently cover over 300,000 km² of the coastal zone; this represents 9% of the estimated global distribution of kelp.

Where kelp grows is determined mostly by sunlight, type of seafloor, nutrients, and grazers. In the Arctic, kelp is largely found along coastlines at depths of 5 to 40 metres. While many kelp forests in the world are largely found in areas with rocky surfaces, kelp in the Arctic can grow on sandy surfaces, pebbles, rocks, boulders, and even on some bedrock. Kelp forests grow in waters that range between -1°C to 1.5°C and salinity concentrations of 27 to 34 parts per thousand (ppt). In the winter, kelp in northern waters must survive long periods of complete darkness because of sea ice coverage and fewer sunlight hours.

Ecological significance

Kelp forests absorb carbon dioxide and nitrogen from the ocean and turn it into standing biomass. They can capture more carbon per area than some forests on land, but the exact amount varies depending on where they grow. Many fish and other species use these underwater forests for shelter and food.

Kelp also serves as an indicator for environmentally rich coastal Arctic areas. Kelp thrives in waters with lots of nutrients and can store nutrients such as nitrogen and phosphorus from upwelling events, where deep water nutrients are brought to the surface by mixing currents. Arctic ecosystems can be nutrient limited or may only be rich in nutrients some of the time. The presence of kelp in the Arctic can tell us whether an area receives nutrients or not.

Cultural significance

Kelp is part of the diet of many communities across Inuit Nunangat. *A. esculenta*, or "winged kelp," and *S. latissima* are edible fresh or dried as well as cooked. Kelp is high in calcium, copper, and chromium.

Conservation concern

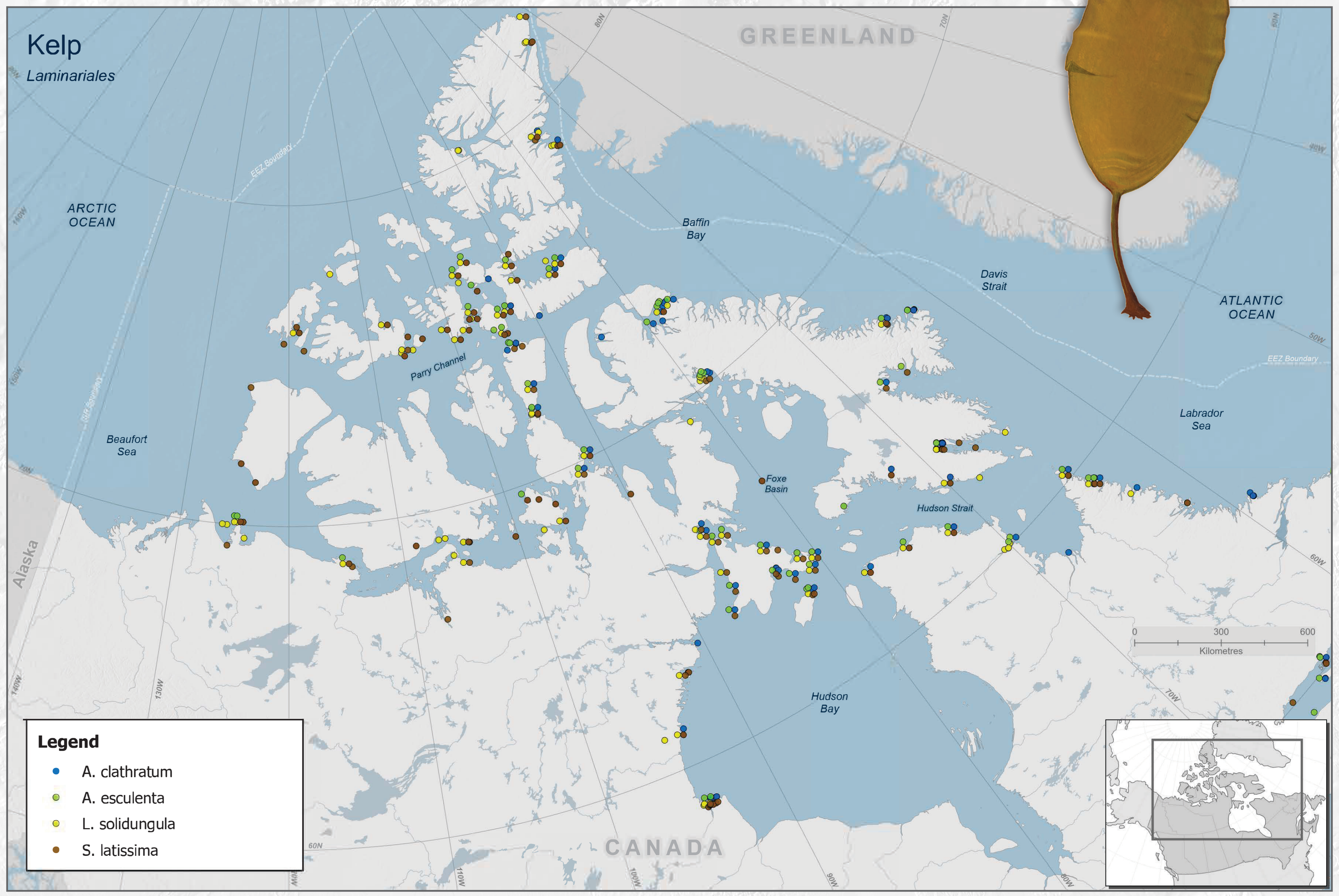
Climate change will have complex impacts on kelp in the Arctic. Some research suggests that a warmer Arctic with less sea ice may benefit kelp by providing longer periods of light and warmer waters for growth. Researchers have developed models that predict a small increase in total area covered by kelp, larger kelp forests and that kelp will grow deeper as sea ice retreats. However, increased coastal erosion from waves, rain, and permafrost thaw could bring more sediments to polar waters, increasing their cloudiness and potentially blocking sunlight needed by kelp. Overgrazing by sea urchins and coastal impacts by industry can also threaten kelp forests.

Gaps in current knowledge

Kelp forests in the Canadian Arctic have mostly been recorded through diving studies and underwater cameras, limiting the study area to human-accessible areas only. Although we know kelp forests are abundant throughout the region, few of these places have been visited multiple times. As a result, it is difficult to track long term change and we still know little about these habitats, their role in healthy Arctic coastal ecosystems, and how climate change will impact them.

Facing page: Kelp (Hedophyllum nigripes) with red algae (Palmaria sp.) growing on its stipe. White patches are scars from spore release when the kelps reproduce. (photo: Ignacio Garrido)

Laminaria solidungula

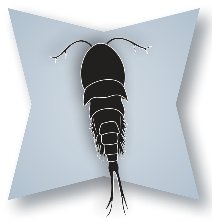


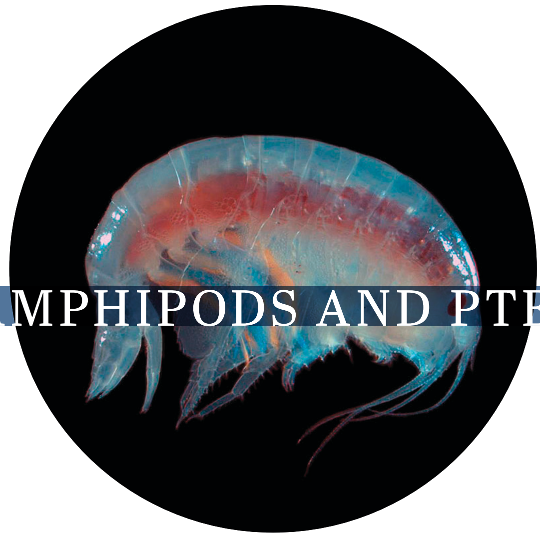
The occurrence points on this map show the location of captured specimens or observations from historical museum records, literature records, and in-field surveys. Areas of sparse points may reflect a lack of data rather than the absence of kelp.

DATA SOURCES

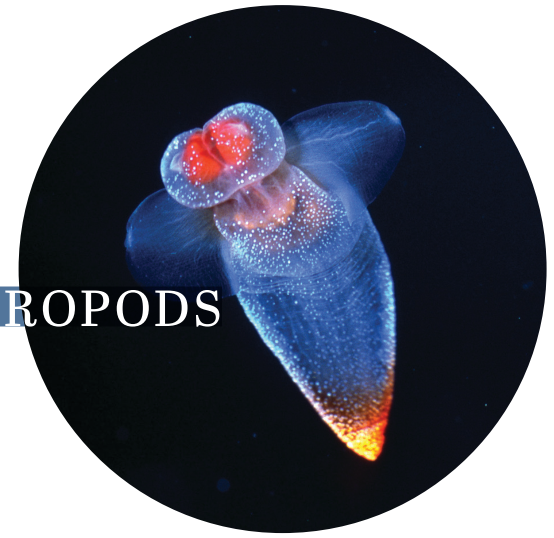
- *Kelp Occurrence Points: Goldsmit J, Schlegel RW, Filbee-Dexter K, MacGregor KA, Johnson LE, Mundy CJ, Savoie AM, McKindsey CW, Howland KL, Archambault P (2021) Kelp in the eastern canadian arctic: current and future predictions of habitat suitability and cover. Front Mar Sci. https://doi.org/10.3389/fmars.2021.742209*
- *Basemap Data: Atlas of Canada 1:1M, ESRI, Flanders Marine Institute, Natural Earth*

An Arctic sculpin sitting in an underwater forest of kelp (Saccharina latissimi). (photo: Ignacio Garrido)





AMPHIPODS AND PTEROPODS



BOTTOM OF THE FOOD WEB

- Phytoplankton
- Kelp
- ▶ **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*

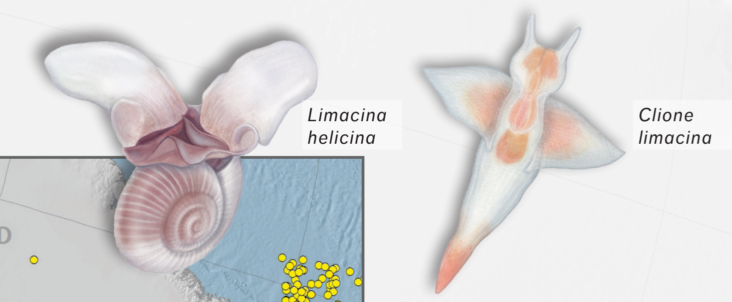
Ecological significance

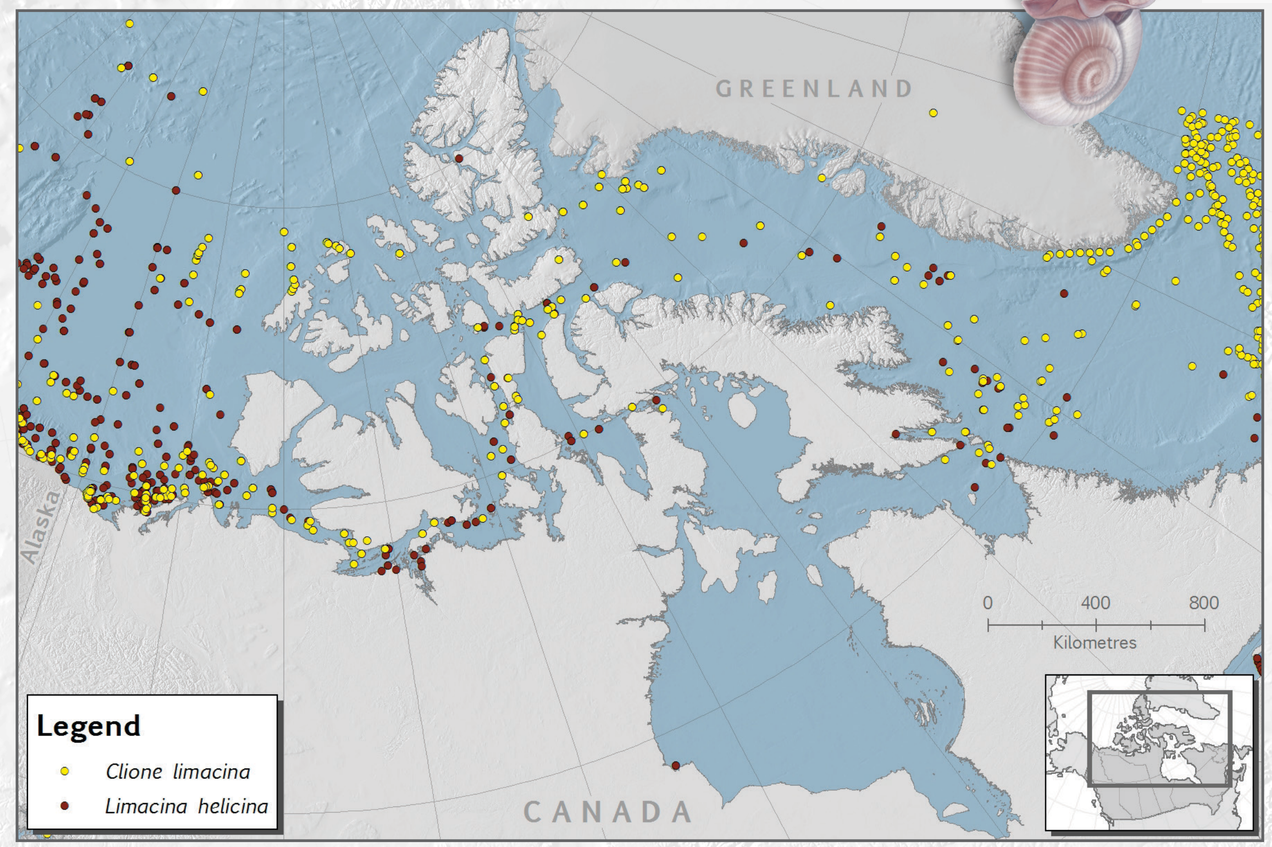
Arctic amphipods are major food source for fishes, seabirds, and marine mammals in the Canadian Arctic. They live in a variety of habitats and are thus preyed upon by diverse larger animals such as Arctic Char, Gray Whales, Bowhead Whales, and ice-associated species such as Arctic Cod and seals.

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

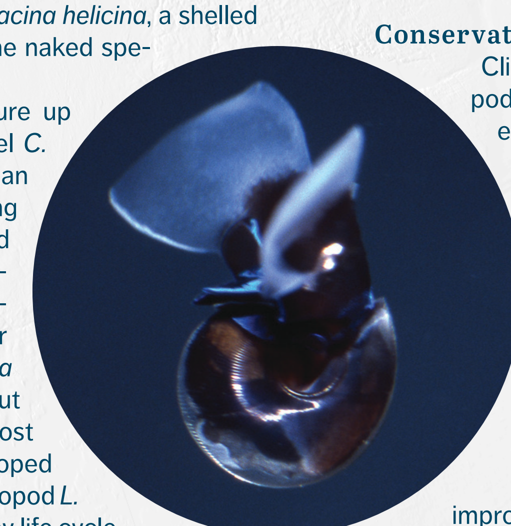
In general, information on the ecology and life cycles of most amphipod species in the Arctic is very scarce. Data on the diversity and distribution of Arctic amphipods is also lacking. A better understanding of their ecology would be useful due to their pivotal role in Arctic marine food webs, particularly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

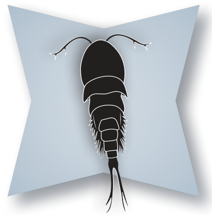
Conservation concerns

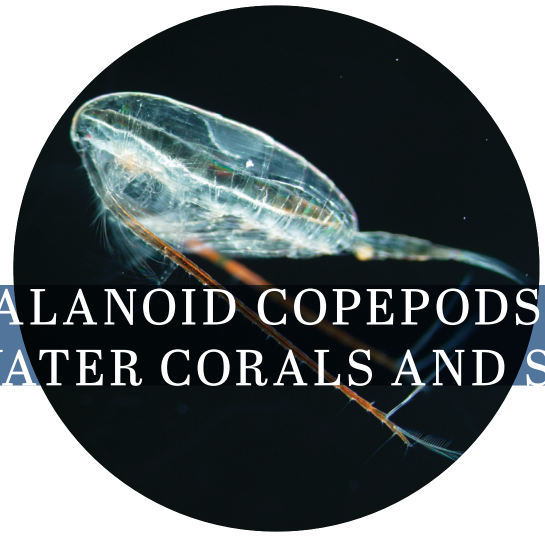
Climate change is of great concern for Arctic pteropods: ocean acidification driven by the rise in CO_2 emissions will make it more difficult for pteropods, *L. helicina* in particular, to produce their shells. Moreover, among Arctic zooplankton, pteropods were shown to have the highest levels of mercury, 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

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- ▶ **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.

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

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

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.

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

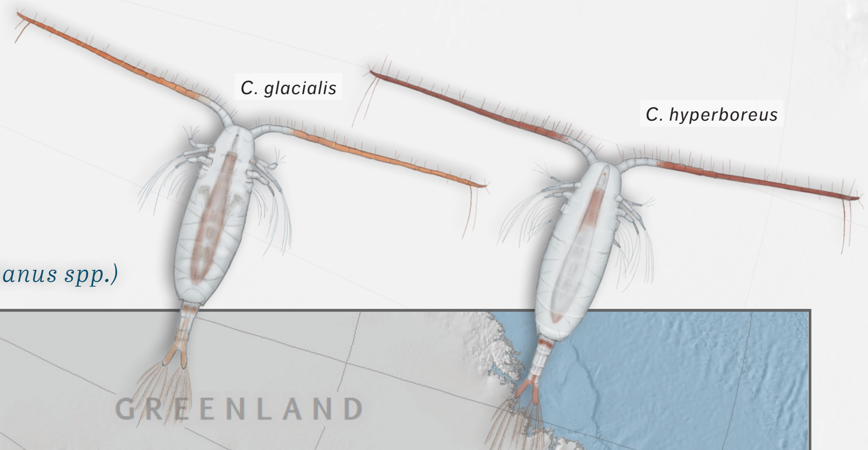
Corals provide structural habitat for many species, including commercial fish species. The relative importance of corals as habitat depends on their overall size and body structure, as well as their geographical environment. Corals anchored in soft sediment can help to ensure sediment stability.

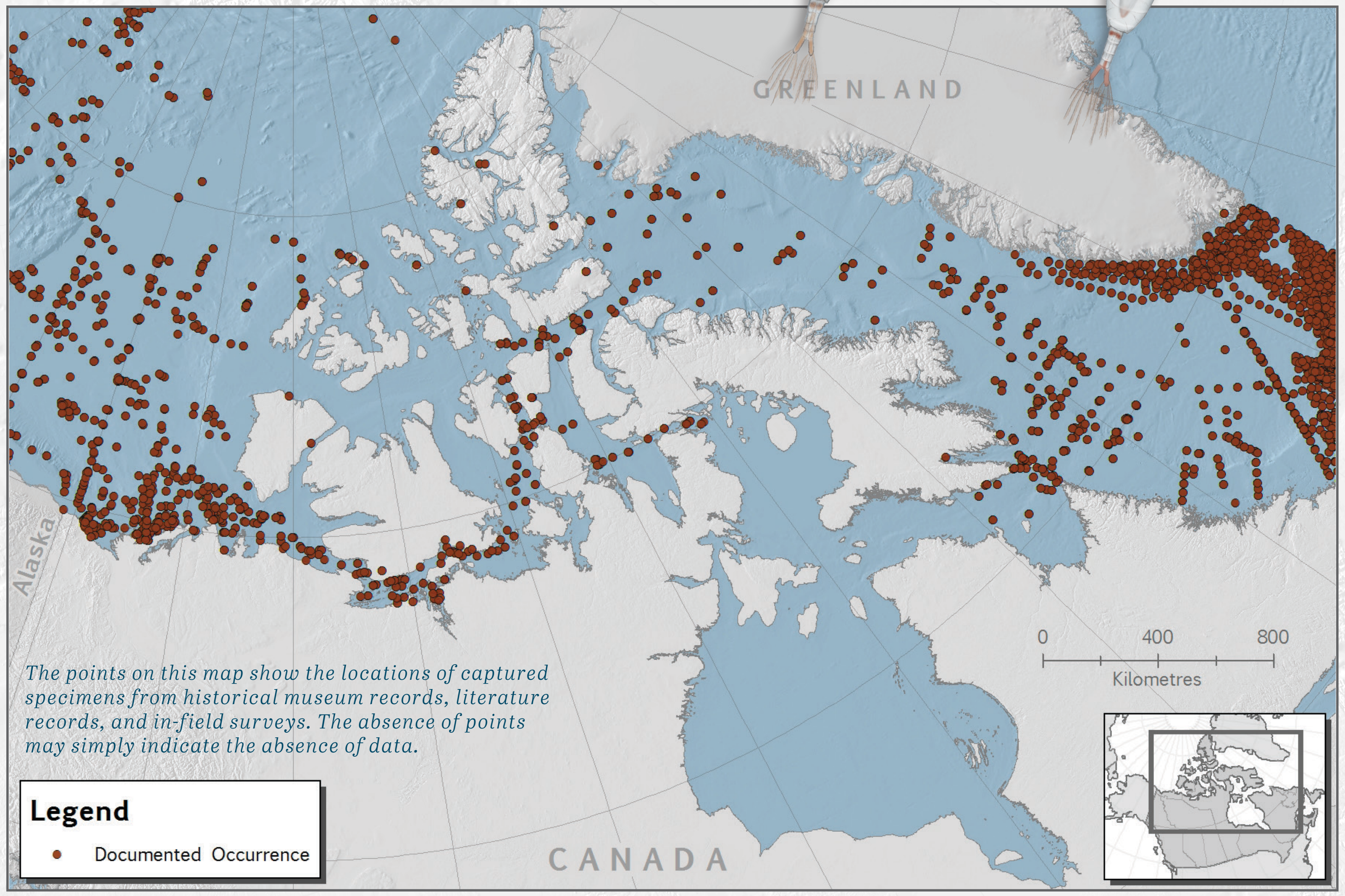
Conservation concerns

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.

Calanoid Copepods *Calanus species*

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



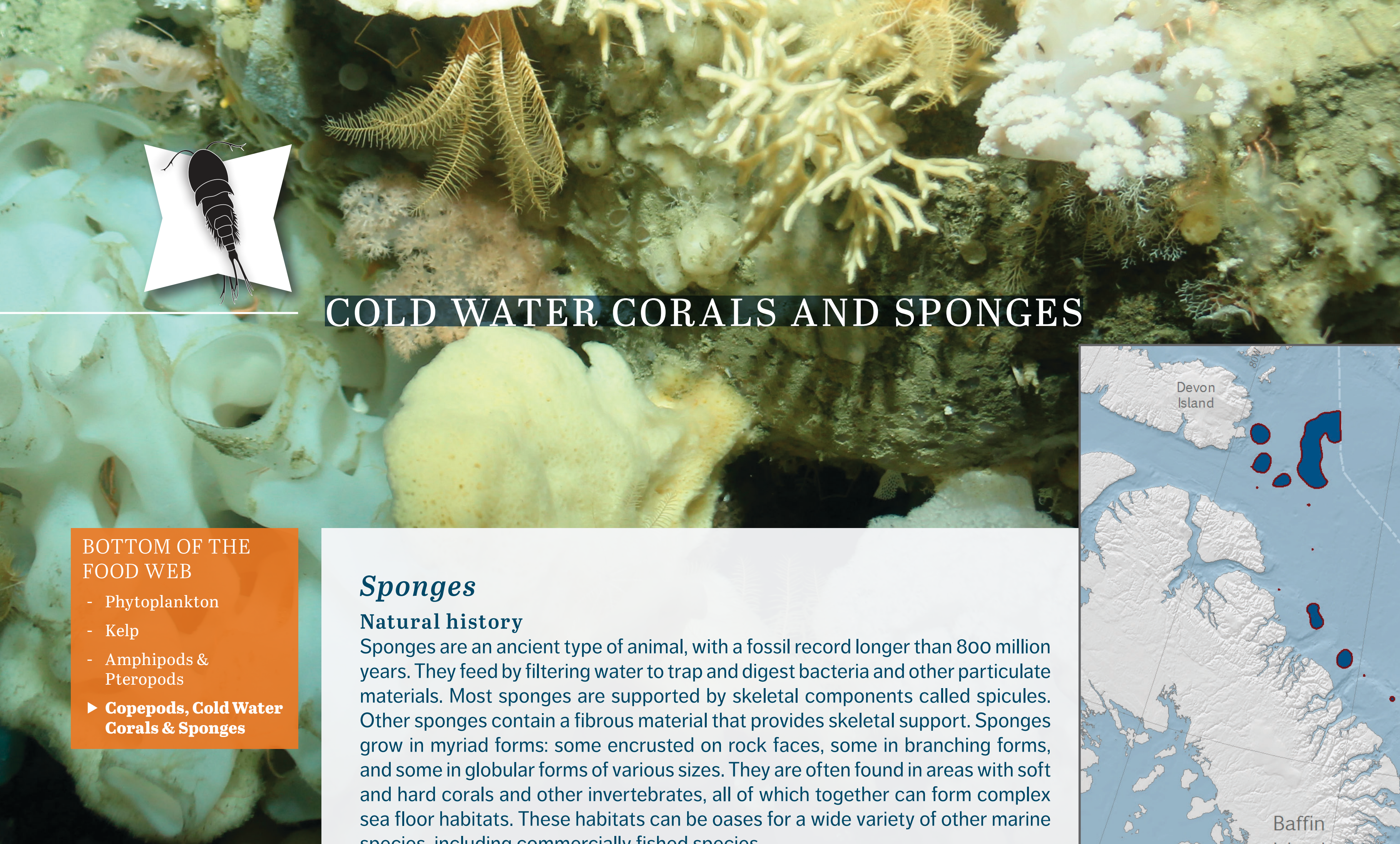


The points on this map show the locations of captured specimens from historical museum records, literature records, and in-field surveys. The absence of points may simply indicate the absence of data.

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.*

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
- Kelp
- 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

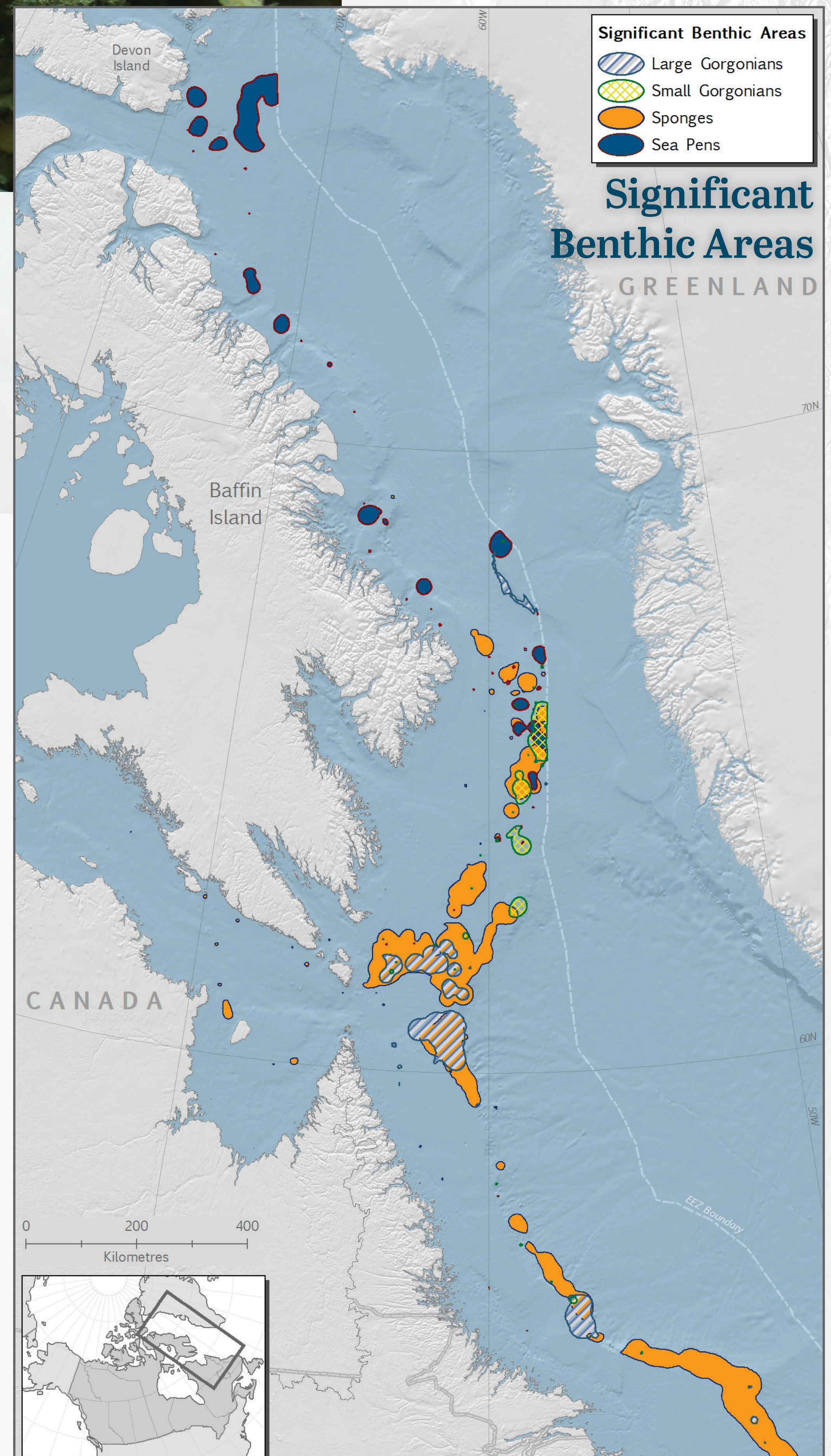
Sponges can be damaged by bottom trawling, and recovery rates for Arctic species are unknown. Fishing trawls have caught up to 8,000 kg of sponges at a time in the Davis Strait / Saglek Bank area, primarily those in the Geodid family. Encrusting species and those that are low growing or round are less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

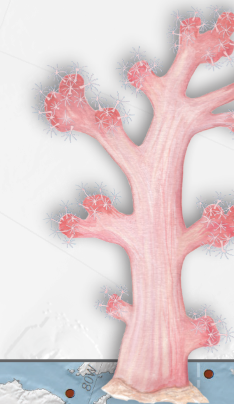
Gaps in current knowledge

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.*