

## Arctic Cod



### ACTIVITY TIME

20 minute lesson

Additional research time  
(teacher discretion)

Poster-making: 45-60  
minutes

### LEARNING OUTCOMES

- Describe the key characteristics and habitat preferences of a major representative species in the Arctic Ocean.
- Explain the close association Arctic cod have with sea ice.
- Solidify understanding of the natural history of Arctic cod through research, group share and poster board.



### OVERVIEW

Arctic cod, Uugaq or *Boreogadus saida*, live under the sea ice where they eat small crustaceans. They are an important species in the Arctic food web: they are one of the main links between the lower level species they eat and the higher level mammal - seabird, and fish predators - that eat them.

In this activity students work together to describe the natural history of Arctic cod and discuss the importance of this species to sea ice ecosystems and the importance of sea ice to the survival of this species.

### FLOW

1. Discuss the interconnectivity of Arctic cod and sea ice
2. Show a short video clip of Arctic cod under the sea ice
3. Student research activity
4. Group share
5. Students make poster displaying the information they gathered from their group
6. Discussion Questions

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## STUDENT OVERVIEW

### WHY?

Studying the natural history of the Arctic cod demonstrates the interconnectivity of sea ice and species' survival.

### WHAT?

- Key characteristics of Arctic cod
- Understand the relationship between the Arctic cod and sea ice
- Importance of a mid-consumer species in the health of the arctic food web

### HOW?



Discuss the importance of Arctic cod



Watch a video clip



Research a specific topic



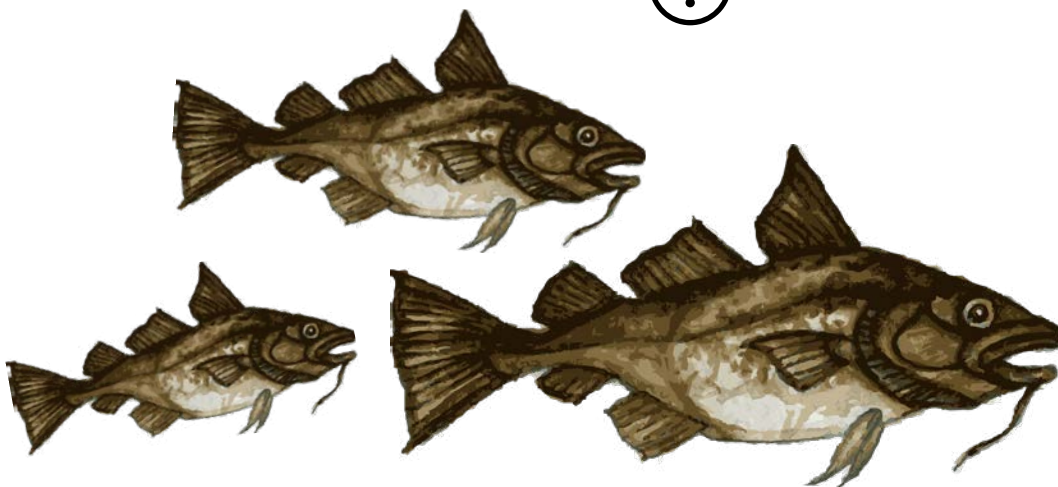
Discuss your chosen topic in small groups



Create a natural history poster

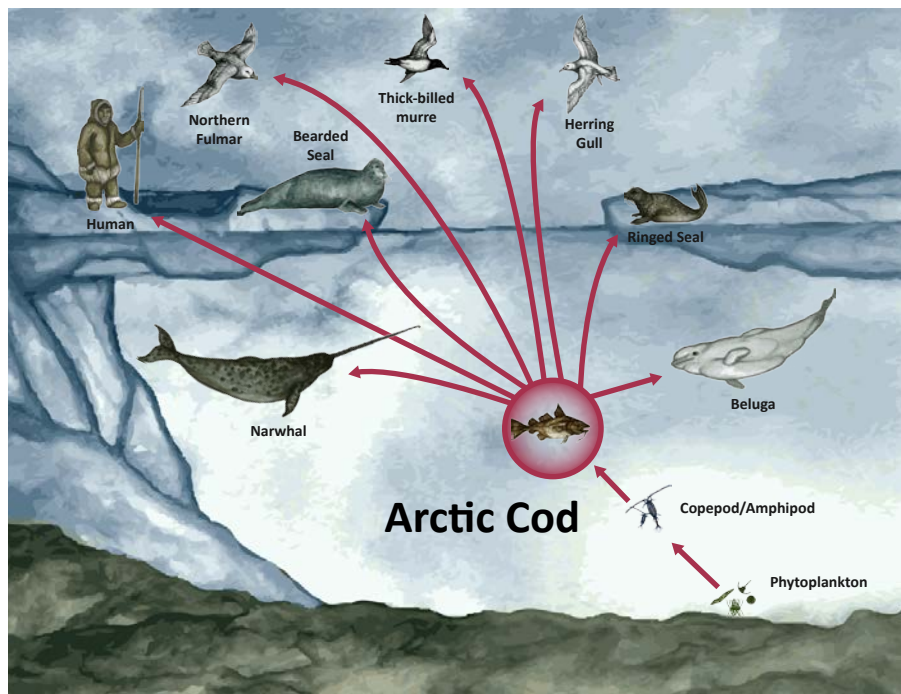


Discussion Questions



**IMAGE 1** Arctic cod (Uuaq - *Boreogadus saida*). (S. DesRoches)

## BACKGROUND



**FIGURE 1** Many different animals eat Arctic cod making them a key link in the arctic ecosystem. (S. Desroches and M. Gordon)

Arctic cod, *Uguaq* or *Boreogadus saida*, are believed to be one of the most abundant and widely distributed fish in the Arctic and are an integral part of sea ice ecosystems. When spring arrives in mid-April and early May, blooms of algae grow under the sea ice as sunlight penetrates the melting ice. These organisms serve as the basis of the food web in sea ice ecosystems. Arctic cod feed on the **copepoda and amphipods** that feed on the ice algae and each other. Because the cod are in turn eaten by many different kinds of fish, seabirds, and marine mammals, they are an important link between lower **trophic levels** and larger predators like narwhals, thick-billed murre, belugas, and ringed seals that occupy higher trophic levels.

Little is known about Arctic cod, but as sea ice conditions change, arctic climate researchers are working hard to better understand this fish species. You will work together as a class to summarize what information is known about Arctic cod, try to determine how reliant this species is on sea ice, and then make recommendations to arctic researchers on what further research is needed to better understand this species, and how it will be affected by changing sea ice conditions.

## VOCABULARY

**Copepoda & Amphipods:**

Small crustaceans that are considered part of plankton in marine environments.

**Life History:**

Summary of the changes experienced by an organism from birth until death.

**Ice edge:** The interface between sea ice and open water.

**Trophic level:** The position in a food web occupied by an organism, based on the level of separation from primary production and broken into producers (of energy and biomass) and consumers.

**Zooplankton:** Non-photosynthetic plankton (or tiny animals) that consume other organisms or their remains.



## NATURAL HISTORY

### Development/lifecycle

#### *Spawning*

Arctic cod mature between 2-3 years of age, at which time the female Arctic cod releases eggs under the sea where they are externally fertilized by male Arctic cod. A female Arctic cod spawns only once in a lifetime.

In the Canadian Arctic both egg release and fertilization by males likely occur at depths >200m. Spawning occurs from late fall and throughout the winter. The buoyant eggs then float at the ice-water interface, and larvae and juveniles grow up below the surface throughout the summer before descending at depth when the ice starts to form. The reason for fall-winter spawning is likely to ensure hatching in spring to allow the larvae to grow up sufficiently before their first winter, because a larger size for the first winter will result in better survival.

#### *Development*

Arctic cod are a small species, averaging 25 cm at full growth. The largest Arctic cod reach 40 cm.

#### *Lifespan*

Arctic Cod live 6-7 years.

### Morphology/physiology



**IMAGE 2** Arctic cod is distinguished by its slender body, forked tail, and protruding lower jaw. (NOAA)

#### *Morphology*

Arctic cod resemble other members of the cod family. It is distinguished by its slender body, forked tail, and protruding lower jaw. Arctic cod often have a brownish back, a silver belly, and a small “whisker” under their lower jaw.

#### *Physiology*

Arctic cod possess antifreeze proteins in their blood. This adaptation allows them to live in below freezing temperatures.



**Ecology: Habitat & Behaviour**

**IMAGE 3** Arctic cod possess antifreeze proteins in their blood, which allows them to live in below freezing temperatures. (Alfred Wegener Institut / H.Flores)

*Habitat*

Most Arctic cod spend the entire year in the Atlantic water mass at depths >200m. Only a small fraction of young Arctic cod (age 0-2) can be found in the ice or in coastal schools. Furthermore, coastal schools (inshore) have only been observed in summer.

*Behaviour*

Arctic cod often take refuge in crevasses between ice floes and in seawater wedges. These wedges are like caves that form just below the ocean surface when sea ice melts. Arctic cod spend ice-free seasons in the Arctic Ocean where they swim together in large schools.

*Relation to Sea Ice*

Arctic cod depend on sea ice-associated organisms as a part of their diet. They also often lay their eggs under sea ice and use crevasses in the ice as protection from predators

**Ecology: Interactions with Other Species***Predators*

Narwhals, belugas, ringed seals, and other marine fish; adult cod also cannibalize smaller cod. Many species of seabirds, including Thick-billed murres have a heavy consumption of Arctic cod. Humans also eat Arctic cod.

*Diet*

Arctic cod are the largest consumers of **zooplankton** in the Arctic. Young Arctic cod will feed along the underside of sea ice. Mature Arctic cod remain at depths >200m, often near the bottom, throughout the year. This is also where they feed eating small crustaceans such as copepods and amphipods, eggs and larvae.



## Ecology: Distribution & Abundance

### *Distribution*

Arctic cod have a circumpolar distribution and have been found farther north than any other fish species – at 84°42'N (less than 600 km south of the North Pole)! Arctic cod are found as far south as Newfoundland and occasionally in the Gulf of St. Lawrence.

### *Abundance*

Unknown.

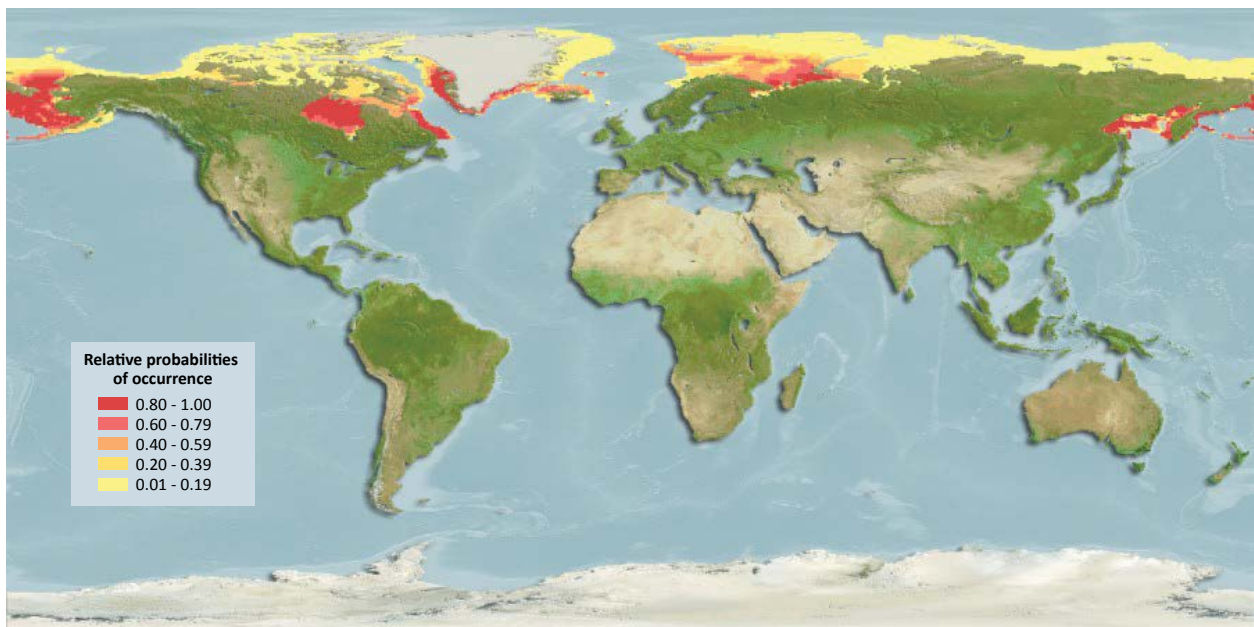


FIGURE 2 Distribution of Arctic cod. (AquaMaps<sup>1</sup>)

## PREPARATION

## MATERIALS

- Poster paper for the natural history visual reports that each group creates.

## RESOURCES

## ▶ NOAA Arctic cod videos

Videos of Arctic cod under the sea ice.

<https://arcticeider.com/links/arc01>

## NOTES

- If you are not familiar with the jigsaw-learning concept, see the links section
- If you live in a community where people fish for Arctic cod, try to arrange to have someone bring an Arctic cod into your class to share first-hand information about where they can be found, at what time of year, and how they are caught.

## PROCEDURE

1. Introduce the lesson by explaining to students why Arctic cod are an important part of Arctic sea ice ecosystems – review the [Background](#) (pg. 3).
2. Show the [NOAA arctic cod videos](#) (pg. 7) of Arctic cod schools at rest in seawater wedges under sea ice. Explain that despite their importance to sea ice ecosystems, there is still relatively little known about Arctic cod.
3. Divide the class into groups of 5 students (if there are too few students to be split into groups of 5, have smaller groups study more than one subject). Each group (the “jigsaw group”) will be responsible for producing a diagram of the natural history of the Arctic cod. Within a group, each student will choose one of the following topics to research:

**Morphology/Physiology**

- What do Arctic cod look like?
- What makes them unique?

**Development/Lifecycle**

- How large are the fish/eggs at each stage?
- When do events like spawning occur?
- How long do the eggs take to develop and hatch?

**Ecology: Distribution & Abundance**

- Where are Arctic cod found? Draw a diagram to show whereabouts.
- How many Arctic cod are out there?

**Ecology: Habitat & Behaviour**

- Where do Arctic cod live within the ocean?
- Do they live in the same area throughout the year?
- Throughout their life?
- What is known about their behaviour?

**Ecology: Interactions with other Species**

- What do Arctic cod eat?
- What or who eats Arctic cod?
- Do they compete with other fish species for resources?



- Once each student knows what topic they are responsible for researching, give them time to do so online (in addition to the information from the Natural History section of this lesson plan). Challenge students to also consider local and Inuit knowledge by speaking to parents and community experts. Students could interview an expert community member if available.
- When students have completed their research, reorganize them into “specialist” groups; all those students working on the Morphology/Physiology section will work together, all those working on the Development/Lifecycle section will work together, etc. In these groups, students will synthesize the information they have gathered and then prepare to report back to their original jigsaw group.
- In the jigsaw group, each student should present what they have learned about their topic. Then the group will work together to create a poster that summarizes the natural history of Arctic cod.

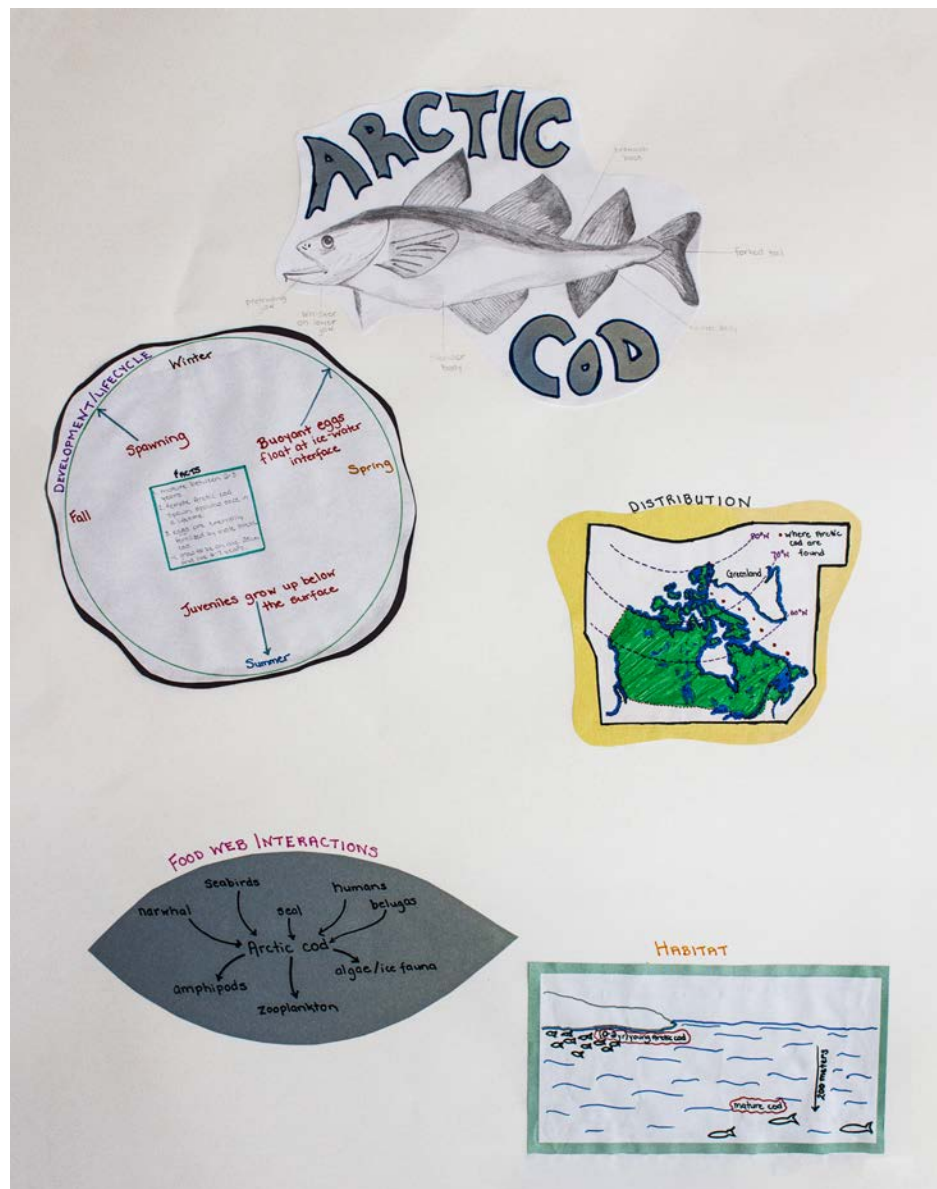


IMAGE 4 Exemplar of a life cycle poster.





## DISCUSSION QUESTIONS

1. Is it useful to understand the natural history of Arctic cod? Why or why not?

*It is important to determine the potential impact that changing sea ice conditions will have on this important member of sea ice ecosystems. Recent research on thick-billed murre by Dr. Anthony Gaston of Environment Canada and Jennifer Provencher and others (profiled in many of the seabirds lesson plans) indicates that the diet of thick-billed murre has changed in the last 20 years from a diet of predominantly Arctic cod to one that now includes much more capelin, a fish associated with warmer water and ice-free conditions. Discuss as a class whether students think Arctic cod will decrease in abundance along with the disappearance of summer sea ice.*

2. What aspects of the natural history of Arctic cod need further investigation from your perspective? Why?

- *Abundance - useful to have a base number when monitoring changes in the population size*
- *The change in seal diets from cod to shrimp*
- *Ice changes*



**IMAGE 5** Arctic cod, *Boreogadus saida*, swimming among sea ice north of Barrow, Alaska. (E.Siddon, NOAA/UAF)

## EXTENSIONS

**Natural History Comparison**

Have students compare the natural history of the Arctic cod to the Arctic char by making Arctic char natural history posters as well. Arctic char spend part of their life in freshwater and part of their life in saltwater. See <http://www.dfo-mpo.gc.ca/Library/284796.pdf> for background information from the Department of Fisheries & Oceans Canada on Arctic char.

**Local Knowledge Discussion**

How do you think scientists learn about Arctic cod? How do you think people that live in northern communities like Inuit learn about Arctic cod? Explore the differences and similarities between local knowledge and scientific knowledge. Use Background Information for Teachers in the Links section to guide your discussion.

**Current Scientific Knowledge**

Have students look online to see what questions researchers are trying to answer about Arctic cod.

**Morphology Comparison**

Find pictures of other species of cod and look at the shape of the mouth. How is this different from the Arctic cod? Why do you think there are differences?

Most cod are bottom feeders and the opening of their mouth points downwards. Arctic Cod are different than other cod species as they often feed on the underside of the ice, which is why the opening of their mouth is angled upwards.

## LINKS

 **Jigsaw Activity**

How to run a jigsaw activity

<https://arcticeider.com/links/arc02>

## ARCTIC COD BASIC DETAILS

 **FishBase**

<https://arcticeider.com/links/arc03>

 **Canada's Polar Life**

<https://arcticeider.com/links/arc04>

 **Arctic Ocean Diversity**

<https://arcticeider.com/links/arc05>



## SOURCES

Cover photo “An Arctic Cod rests in an ice-covered space.” Alaska, Beaufort Sea, North of Point Barrow. by Shawn Harper, NOAA, 2010. [https://commons.wikimedia.org/wiki/File:Expl0392 - Flickr - NOAA Photo Library.jpg](https://commons.wikimedia.org/wiki/File:Expl0392_-_Flickr_-_NOAA_Photo_Library.jpg). Used under CC BY 2.0, <https://creativecommons.org/licenses/by/2.0>.

1 Kaschner, K., K. Kesner-Reyes, C. Garilao, J. Rius-Barile, T. Rees, and R. Froese. 2016. AquaMaps: Predicted range maps for aquatic species. World wide web electronic publication, [www.aquamaps.org](http://www.aquamaps.org), Version 08/2016.

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