**SEAKEEPERS DIGITAL LESSON PLANS**
EDUCATIONAL OUTREACH PROGRAM

THE INTERNATIONAL SEAKEEPERS SOCIETY

# LESSON 14:

# ARCTIC EXPLORATION & POLAR ECOSYSTEMS

# SeaKeepers Digital Lesson Plans

## Lesson 14: Arctic Exploration and Polar Ecosystems

**This activity was created in partnership with DISCOVERY Yacht Yeva's captain, Ella Hibbert, as part of SeaKeepers' Inspirational Figures lesson plan series for educational engagement on virtual platforms.**

**Activity:** Arctic Exploration and Polar Ecosystems

**Preface:**

Our oceans face many threats today, including climate change and pollution. In order to protect and preserve our oceans, we need to understand these threats and how the oceans respond to them. The International SeaKeepers Society supports marine research and education by connecting scientists with yacht owners, creating research opportunities for scientists to better understand our oceans – and to create plans to protect them.

Inspired by DISCOVERY Yacht Yeva's voyages across the Arctic Circle, this lesson immerses students in the polar environment, introducing the native species that live here and how both local vessel users and global ocean stewards can better protect these fragile ecosystems. Many species are native to and only live in the Arctic Circle, collectively interacting to survive in this often hostile and rapidly changing frozen landscape. Students are invited to explore the Arctic through the eyes of DISCOVERY Yacht Yeva, using her experiences and encounters to enhance their understanding of this unique polar ecosystem.

**Objectives:** Students participating in this lesson should see improvement in the following areas:

- Investigate the different types of habitats and species found in the Arctic Circle.
- Discover how species interact with each other and the environment to survive in the Arctic.
- Taking inspiration from DISCOVERY Yacht Yeva's experiences, learn how to better protect Arctic habitats and ecosystems.

**Age Group:** Key Stage 3

While this lesson plan was produced by SeaKeepers UK Chapter, our lessons are available and applicable to students globally. For further information on which education curriculum standards this lesson meets for your region, please reach out to programming@seakeepers.org

**Estimated time:** 70+ minutes

**Required Materials:**

Students do not need any background knowledge of the Arctic or polar ecosystems to take part in this lesson. Teaching resources are included for this lesson, but feel free to use other materials you may have to explain these concepts. To create their maps, students will need:

- Paper (either blank or with a printed map of the Arctic Circle)
- Pens/pencils
- Erasers

- Rulers (optional)
- Recyclable materials (optional - if the students wish to make 3D maps)
- Printed images of Arctic animals and plants (optional - if the students wish to use these instead of drawing their maps)
- Pre-cut paper speech bubbles (optional - if the students do not wish to create these themselves)

**Lesson Breakdown:**

- Introduction to Arctic habitats and the various animals and plants that are a part of the polar ecosystems, through the eyes of DISCOVERY Yacht Yeva (20 minutes)
- Activity: Create an interactive map of DISCOVERY Yacht Yeva's route showing which Arctic habitats and polar species she might encounter along her voyage. Describe the ways that she can best protect each habitat/species as she travels to limit her environmental impact (30+ minutes)
- Wrap up Discussion (15 minutes)
- Clean up (5 minutes)

**Lesson Vocabulary:**

- **Biodiversity** – the existence of a wide variety of plant and animal species in their natural environments, which is the aim of conservationists concerned about the indiscriminate destruction of rainforests and other habitats.
- **Biome** – a major ecological community, extending over a large area and usually characterized by a dominant vegetation.
- **Bycatch** – the unwanted fish and other marine creatures trapped by commercial fishing nets during fishing for a different species.
- **Endemic** – native and restricted to a certain place.
- **Food Web** – a system of interlocking and interdependent food chains (a series of organisms each dependent on the next as a source of food).
- **Glacier** – a slowly moving mass or river of ice formed by the accumulation and compaction of snow on mountains or near the poles.
- **Habitat** – the natural home or environment of an animal, plant, or other organism.
- **Ice Floe** – a sheet of floating ice.
- **Ice Sheet** – a layer of ice covering an extensive tract of land for a long period of time.
- **Iceberg** – a large floating mass of ice detached from a glacier or ice sheet and carried out to sea.
- **Megafauna** – the large mammals of a particular region, habitat, or geological period.
- **Northern Hemisphere** – the half of Earth that lies north of the equator, an imaginary line that circles the planet halfway between the North and South Poles.
- **Permafrost** – a thick subsurface layer of soil that remains below freezing point throughout the year, occurring chiefly in polar regions.
- **Photosynthesis** – the process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide and water. In plants, this process generally involves the green pigment chlorophyll and generates oxygen as a by-product.
- **Phytoplankton** – plankton (the small and microscopic organisms drifting or floating in the sea or fresh water) consisting of microscopic plants.
- **Primary Productivity** – the rate at which energy is converted into organic substances by primary producers through photosynthesis or chemosynthesis, forming the base of the food chain.
- **Pump-out Facility** – a designated location, either on land or water, that provides a means for safely removing and disposing of sewage from boats, typically from holding tanks or portable toilets, preventing the discharge of untreated waste into waterways.
- **Sea Ice** – frozen seawater that floats on the ocean surface, forming and melting entirely within the ocean, unlike icebergs which originate on land.

- **Species** – a group of organisms that can interbreed and produce fertile offspring, forming a distinct group reproductively isolated from other groups.
- **Wastewater** – any water that has been used and contaminated onboard the vessel, including blackwater (waste from toilets), grey water (from sinks and showers), and bilge water, which is often contaminated with oil.

**Lesson Introduction/Overview:**

**What is the Arctic Circle?**

The Arctic Circle is a region that surrounds the northernmost point on Earth, the North Pole, and ranges down to the southern tip of Greenland. As the Earth's axis is on an incline, the Arctic Circle points away from the sun during the winter months, causing less direct sunlight to reach the region with days of complete darkness, and towards the sun during the summer months, leading to slightly milder temperatures. The region is therefore characterised by extreme cold, frozen ground and large seasonal variations, featuring glaciers, icebergs and vast amounts of sea ice. A diverse range of habitats have formed and adapted to these conditions, creating a unique landscape that supports a wide range of specialised Arctic biodiversity.

**Which habitats and species are found in the Arctic Circle?**

The Arctic is home to a diverse range of species due to the large variety of habitats available, each with unique characteristics that provide specific benefits to those that call it home.

The Greenland Ice Sheet is the second largest ice sheet in the world, spanning 1.7 million square kilometres across nearly 80% of the largest island on Earth. Ice sheets are defined as land-based masses of glacial ice that move downhill under their own weight, often towards the ocean. Although ice sheets are not highly populated with marine wildlife, they support the marine food web by providing nutrients to the producers at the base, and a unique hunting habitat for the predators at the top.

> Over millions of years, snow has fallen in the Arctic and been regularly compressed by gravity to form ice sheets. As they form, nutrients, such as iron and silicon, are absorbed from the ground below into the sheet, enriching the frozen freshwater with biologically-valuable elements. During the Northern Hemisphere summer, ocean and air temperature rise causing the surface of the Greenland ice sheet to melt, releasing these essential elements into the marine environment. Phytoplankton at the base of the food web use these nutrients to increase their rate of photosynthesis and subsequent population growth, forming phytoplankton blooms. These blooms can be so large that they can be seen from space! This surge in primary productivity attracts additional consumers to the region, such as endemic bowhead whales, enabling the Arctic marine food web to thrive and support a wide range of biodiversity.
>
> Polar bears are most commonly found where Arctic sea ice is abundant, as they utilise these solid floes for hunting marine megafauna. However, where sea ice is scarce, polar bears rely on the Greenland ice sheet to hunt seals and provide food for their young. In southeast Greenland, a unique population of polar bears have adapted their hunting technique to use ice melanges (a mixture of sea and glacial ice that have broken off glaciers and the Greenland ice sheet) instead of sea ice floes as platforms to observe the ocean and ambush their prey. By living in or near glacial fjords, these polar bears are able to hunt even if sea ice floes are not available, allowing the population to survive in an increasingly challenging habitat.

When temperatures drop below 0 degrees Celsius in the Arctic Circle during the Northern Hemisphere winter, the ocean surface freezes. This frozen water is called sea ice, and provides both benefits and challenges to many animals that reside in Arctic waters, including various whale and seal species.

Narwhals, sometimes known as “unicorns of the sea”, spend their entire lives in the Arctic Ocean. As they have no dorsal fin (the fin on the top of their body), they are able to sit directly against the sea ice and shelter from predators such as Orca, whose large dorsal fin is blocked by the frozen water. However, narwhals are marine mammals, so must regularly breathe air from the atmosphere in order to survive. Large expanses of sea ice therefore inhibit their survival, as they prevent them from surfacing. They rely on cracks or “leads” to provide an opening that allows them to breathe successfully. Arctic sea ice therefore provides them with both sufficient protection from predators and access to vital oxygen supplies, enabling them to thrive in this frozen marine landscape.

Ringed seals are the best-adapted to live on ice of all seal species. They rely on the ice for raising their pups, resting and feeding. Like narwhals, they are marine mammals, therefore rely on atmospheric oxygen for breathing. When they dive below the sea ice in search of food, such as small crustaceans or fish, they are able to create their own breathing holes in the frozen water to ensure their survival. They are also able to use these holes to escape from underwater predators, such as killer whales. However, they are the most common prey for polar bears, therefore are not necessarily safe on the sea ice either. Ringed seals breed annually, nursing their pups on the sea ice as their white, woolly fur is not yet waterproof, therefore they cannot survive in the water for a few weeks until they grow their adult coat. By using the sea ice to raise their young and as a platform to access the marine environment, ringed seals rely on this highly variable and increasingly threatened habitat for their survival in the Arctic Circle.

The tundra, a large, open expanse of land that is characterised by cold temperatures and permafrost, is seasonally inhabited by many migratory seabirds that use this area for breeding and raising their young. Arctic tern flock to the Arctic tundra during the Northern Hemisphere summer (May-August) and build their nests close to the sea so they can provide their chicks with sufficient food. Their black cap and grey and white plumage allow both adults and juveniles to blend into this largely barren landscape, camouflaging them from predators such as owls, raptors and gulls, before they return to the Antarctic for the remainder of the year.

Although corals are more commonly associated with tropical equatorial waters, the Arctic is home to many cold-water coral reefs, such as Rost Reef, Lofoten, Norway, that are rich in biodiversity. Unlike their tropical counterparts that rely on sunlight and algae for growth, cold-water corals live in deep, dark waters and feed on plankton and nutrient particles by filtering ocean currents. Because of this, cold-water reefs are often found in nutrient-rich regions with accelerated water movement, such as seamounts (underwater mountains) or along the continental slope (where the seafloor tilts down, causing the waters to become gradually deeper). These reefs provide shelter for multiple species, including the commercially important Pollock and Cod, protecting them from predators. Although cold-water reefs provide these species with a refuge from natural predators, their populations still remain at-risk of harm from human activities.

**Why are Arctic species and habitats threatened by human activity?**

Human activities are causing the planet to warm, a phenomenon known as Global Warming. This increase in atmospheric temperature is significantly exacerbated in the Arctic, transforming this frozen landscape into a milder environment with greater sea ice and glacier melt, and warmer ocean temperatures. These environmental changes are forcing species to either rapidly adapt to these new conditions or undertake migratory shifts in order to survive. For example, the decrease in sea ice has forced polar bears to spend more time on land and less time hunting seals at-sea, increasing their risk of starvation and their likelihood of being poached. On the contrary, narwhals rely on the sea ice for protection from predators, thus the loss of sea ice increases their risk of predation and therefore population decline.

Where previously large ice floes made the Arctic largely inaccessible from the ocean, sea ice loss has greatly increased channel sizes, enabling more vessels to explore. Some vessels, such as DISCOVERY Yacht Yeva, are keen to learn more about this biome and raise awareness for the environmental threats it faces, however,

the majority aim to use this region for exploitative purposes, such as establishing quicker shipping routes, oil drilling, mineral mining, and industrial development. By increasing Arctic vessel traffic, marine megafauna will be at greater risk of harm from vessel strikes, entanglement and poaching, leading to populations becoming endangered and potentially facing extinction. This is of particular concern for endemic species, such as bowhead whales, narwhals and beluga, that are only found in this region, as Arctic population declines could be terminal for the species.

If vessel access to the Arctic increases, another form of human activity that will threaten Arctic species and habitats is bottom trawling. Bottom trawling is a destructive method of fishing, whereby a weighted net is dragged either directly along or slightly above the seafloor. This non-selective fishing method captures all marine life within the tow region, irrespective of whether it is the target species or not. Unlike selective fishing measures, such as pole-and-line fishing or baited traps, bottom trawling is extremely harmful to the marine environment. Dragging the weighted net along the seafloor destroys all seabed features present, including cold-water coral reefs, leading to extreme losses in biodiversity. Similarly, the bycatch of marine megafauna, such as seals, can greatly affect the Arctic food web, as a decline in their population size reduces prey availability for those predators further along the chain.

It is important that both Arctic vessel users and the wider public are aware of how their individual actions can impact these fragile ecosystems, and the potentially detrimental consequences of remaining oblivious. Using sustainable boating practices, raising environmental awareness and implementing new conservation measures are key to ensuring the long-term protection of Arctic ecosystems for future generations.

**How can Arctic explorers like DISCOVERY Yacht Yeva better protect the local polar environment?**

DISCOVERY Yacht Yeva, captained by solo sailor Ella Hibbert, will circumnavigate the Arctic Ocean in 2025 to raise awareness about global climate change and the endangerment of the Arctic. To use her words “If we were doing our best to protect the Arctic, Ella’s intended trip wouldn’t even be feasible”.

To better protect marine ecology while traveling through the Arctic, vessels should always be aware of their surroundings and make small changes to avoid disturbing or harming wildlife whenever possible. Vessels pose a great threat to marine megafauna, and nesting and breeding seabirds. As such, boaters should maintain a safe distance from wildlife at all times - at least 100m from all whales, 50m from seals and seabirds, and 50m from any resting animals. If an animal moves towards the vessel, slow down, be predictable and allow it to safely pass. Anchoring can also impact seafloor habitats; therefore, boaters should use proper navigational resources to determine where they should anchor their vessel, making sure to avoid fragile habitats with sensitive or slow-growing species.

Boaters like Ella also need to limit their vessel’s pollution to reduce their environmental impact. Before beginning their journey, boaters can equip their vessel with storage tanks to prevent the need for overboard disposal of wastewater, including bilge water (dirty water that collects at the bottom of the boat’s hull), grey water (any water from sinks, showers and other washing facilities) and blackwater (sewage from onboard toilets). Once stored, this wastewater can be disposed of at a later date at a marina pump-out facility, protecting the marine environment from unnecessary harm.

To further limit vessel pollution, boaters can use sustainable alternatives to common plastic household items, such as reusable bottles, straws and containers, to limit the amount of single-use plastic entering the global oceans. These alternatives can be used by both boaters out on the water and by everyone at home to better protect the environment from plastic pollutants that can be ingested, entangle or otherwise harm multiple marine species. For example, Arctic seabirds can mistake pieces of plastic for food and consume these accidentally, while marine mammals can become trapped in discarded or abandoned fishing gear, causing severe injuries, suffocation or starvation. It is important that all used, damaged or broken items are

disposed of correctly when the vessel has returned to port, to ensure Arctic wildlife is not harmed by human negligence.

To better protect the marine environment, boaters like Ella should consider the environmental impact of their vessel and do what they can to minimise ecological harm. The Arctic is fragile yet fascinating, supporting many unique habitats and enigmatic species. Ocean explorers can enjoy journeying through the Arctic while employing sustainable boating practices to prevent long-term harm to this breathtaking region.

**Activity Instructions:**

**Setup**

1. Students should either create a large map as a class, medium-sized maps in groups of approximately 3-4 individuals, or small maps on their own.
2. If as a whole class:
    a. Educators should lay a large piece of paper on the floor of the classroom.
    b. This paper should either show a printed map of the Arctic Circle or be a blank page that the educator can use to roughly sketch the region.
3. If as smaller groups:
    a. Educators should provide medium-sized pieces of paper for each group of students.
    b. This piece of paper should either show a printed map of the Arctic Circle or be a blank page that either the student or educator can use to roughly sketch the region.
4. If on their own:
    a. Educators should provide an A4 piece of paper to each individual student.
    b. This piece of paper should either show a printed map of the Arctic Circle or be a blank page that the student can use to roughly sketch the region.

**Main Activity**

5. Students should begin by drawing DISCOVERY Yacht Yeva's route on their map, showing her intended circumnavigation of the Arctic Circle (the exact route is provided in the Media section below).Groups should consider whether their boat is designed to perform a specific function, such as racing, transporting goods, recreational use, or whether they want to create a boat that could potentially be used for multiple purposes.
6. Students should discuss/individually consider the potential animals and plants that DISCOVERY Yacht Yeva might encounter on her journey. Students should either draw, create using recyclable materials, or print out images of these plants and animals, sticking them onto their map along DISCOVERY Yacht Yeva's route at relevant points.
7. For each animal/plant, students should draw/use a pre-made speech bubble and write how DISCOVERY Yacht Yeva could avoid harming them on her voyage. Students can use these examples for inspiration:
    a. Watch out for animals in the water to avoid vessel strikes.
    b. Limiting pollution, e.g. littering overboard, fuel leaks, plastic disposal.
    c. Use reusable products onboard.
    d. Don't disturb resting animals, e.g. birds on cliffs, seals on the shoreline.
    e. Avoid anchoring where the seafloor is covered in plants.

**Wrap up Discussion:**

To conclude the activity, bring the students together to share their maps with the whole class (if completing the activity as individuals or in small groups), or ask each student to share more details about the feature

that they added to the large class map (if completing the activity as a whole class). Begin a discussion with the students about their maps, focusing the conversation using these open-ended questions:

- Which animals and plants live in the Arctic Circle?
- Do these animals and plants live elsewhere on the planet, or only in the Arctic Circle?
- Which animals and plants are most at risk of harm from vessels travelling through the Arctic Circle? Why?
- How can people within the Arctic Circle, including boat users, better protect Arctic habitats and ecosystems?
- How can people outside the Arctic Circle better protect Arctic habitats and ecosystems?

For more information, here are some useful websites:

DISCOVERY Yacht Yeva and Ella Hibbert:

- https://ellainthearctic.co.uk/

Arctic Ecosystems:

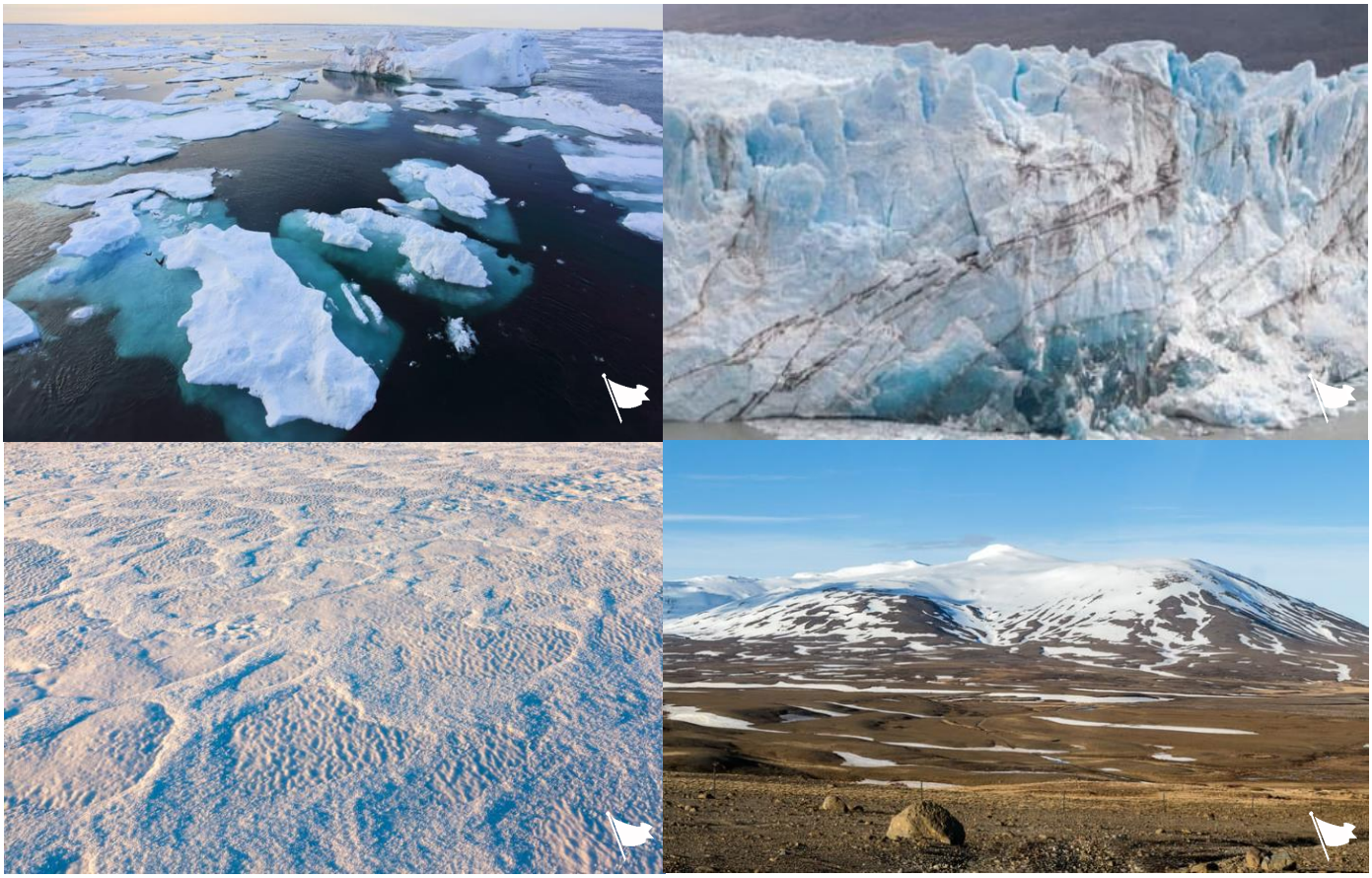
- WWF: Arctic
- The Arctic Council
- The National Wildlife Federation
- Woods Hole Oceanographic Institution

**Media:**

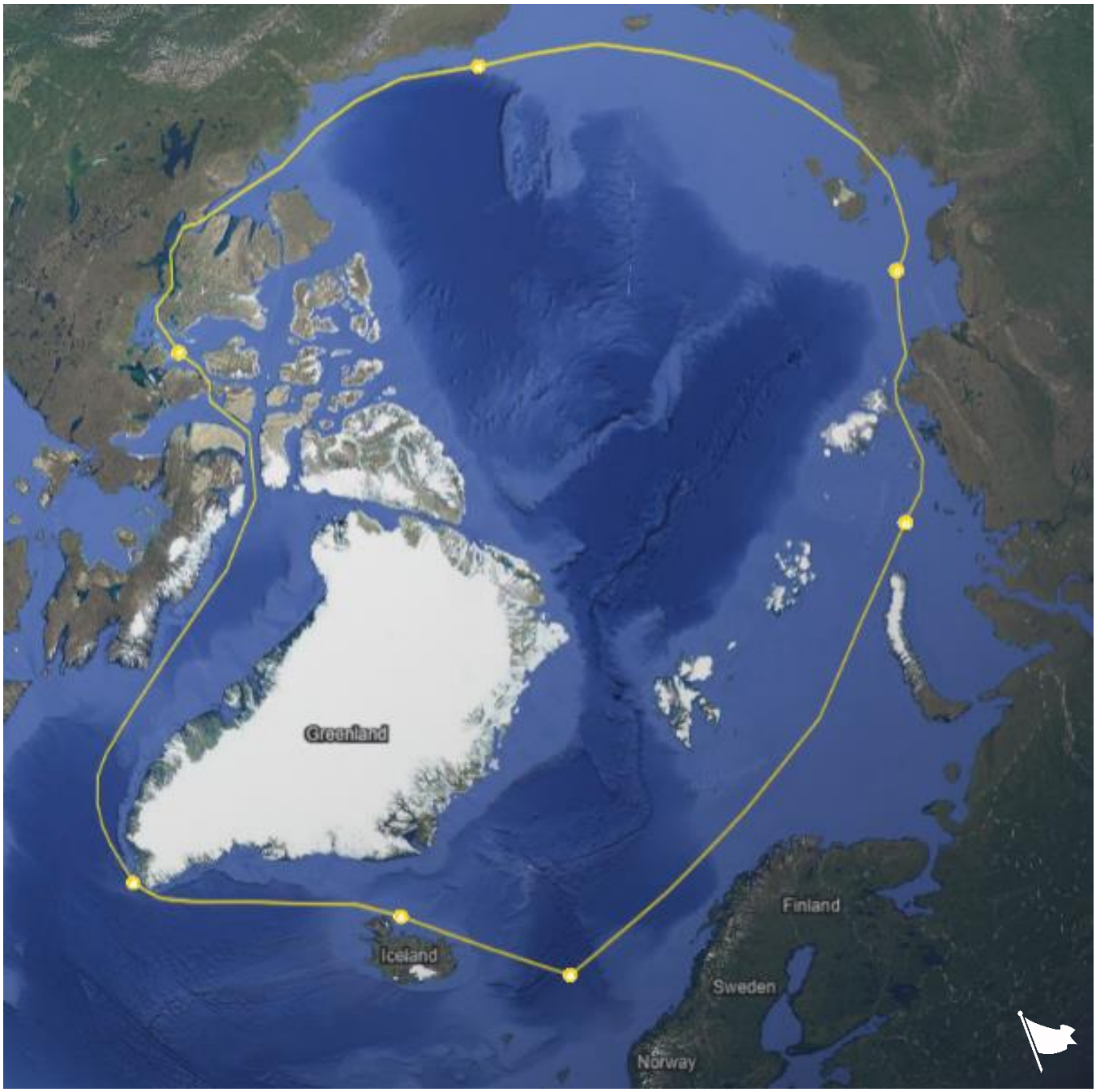


**Ella Hibbert and DISCOVERY Yacht Yeva**

**Arctic Biodiversity (Arctic Tern, Orca, Polar Bear and Ringed Seal)**



**Arctic Habitats (Sea Ice, Glacier, Ice Sheet and Tundra)**




**Map of DISCOVERY Yacht Yeva's Arctic Circumnavigation Route**

*Ella' start point is at 66.5°N latitude of the Arctic Circle between Norway and Iceland. Then, around Iceland, southern Greenland, the Northwest Passage through Canada, across Northern Alaska, and into Russian waters. Crossing the Laptev and Kara seas (Northeast Passage) and eventually back to her starting point near Norway.*