



Follow That Fox!

Teacher Guide

Students use tracking data collected by Argos satellites to follow the longest known journey of an arctic fox. By learning about the life history of the arctic fox, students use data to hypothesize about animal behavior and write the story of the traveling fox.

Grade Level: Upper elementary

Learning Goal

- Students learn how satellites and tracking data can be used to help understand how animals live in the wild.

Learning Objectives

- Students will interpret data to better understand animal behavior.
- Students will use evidence to create a story that reflects their understanding of the connection between living things and their environment.

Educational Standards

- NGSS 4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.
- NGSS 3-ESS2-2: Obtain and combine information to describe climates in different regions of the world.
- NGSS DC LS2.A: Interdependent relationships in ecosystems
- NGSS SEP: Analyzing & Interpreting Data; Constructing Explanations; Obtaining, Evaluating, and Communicating Information
- NGSS CCC: Patterns; Stability & Change
- National Geography Standards: How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

Time:

- Parts 1 and 2 - 50 minutes
- Part 3 - 50 minutes

Materials

- Projector and computer with Internet access
- *Student Page 1: Follow That Fox!* pages 5-6
- *Student Page 2: Five Parts of the Fox's Long Journey* pages 7-9
- *Fun Fox Facts Handout* page 10
- *Slide 1: Arctic Foxes* page 11
- *Slide 2: Fox with an Argos Tracking Tag* page 12
- *Slide 3: Map of the Fox's Path* page 13
- Video: *Argos-4: Tracking from Space* (https://www.youtube.com/watch?v=aBc_MeKRMNc)
- Pencils and paper

Preparation

- Print *student pages* and *Fun Fox Facts handout*.
- Review the *Argos-4 video*, *Fun Fox Facts handout*, and *slides*.
- Prepare to project Slides 1-3 for the class.



Directions

Part 1: A Traveling Fox

1. Draw a K-W-L chart for the class to use during the lesson and introduce the chart if students are not familiar with it.
 - K-W-L charts include three columns or areas to document what the class: Knows (K), Wants to Know (W), and Learns (L)
2. **Know:** Ask students what they know about arctic foxes. Adding student ideas to the Know area of the chart.
 - If students don't mention it, add to the Know area that arctic foxes live in the Arctic (the area surrounding the North Pole) so they are adapted to live in extreme cold.
 - Share the images of arctic foxes on *Slide 1* and ask students what they observe. The photos show that there are two different types of arctic fox. One with darker fur and the other with lighter-colored fur, which is white in the winter.
 - Tell students that today we are going to learn the story of an arctic fox who made the longest trip ever recorded, traveling 4415 km (2743 mi) over 76 days.
 - Show *Slide 2*, which shows the fox with her Argos tracking tag. This fox was a young female. Explain that researchers used technology to learn about the journey of this arctic fox. They attached a tracking tag to the fox that was monitored from space by satellites. This allowed them to track where she went.
 - Share a map of the Arctic and orient students to the region including:
 - Spitsbergen, Norway, where scientists first encountered the fox
 - Ellesmere Island, Nunavut, Canada where the fox ended her journey
 - Show the video *Argos-4: Tracking from Space* which explains how animals with tags are tracked using satellites.
 - Add the information about the fox's travels to the Know section of the chart.
3. **Want to Know:** Ask students what they want to know about this fox and her journey. Record student questions in the Want to Know area of the chart.
4. Pass out *Student Page 1*. Students will answer questions using information from the Know section of the K-W-L chart and the student page.
 - Give students time to calculate this and answer Question #1. Check for understanding by having a few students share their answers. (4415 km distance traveled divided by 76 days is an average of 58 km per day.)
 - In Question #2, students will make a hypothesis about the path that the fox took.
 - Students will consider the environment that the fox traveled through while answering Question #3.
5. Bring the class together to discuss.
 - **Ask students:** What was it like for her on her journey?
 - Looking at the map, students should notice that she would have to travel across the sea.
 - They might note that she would have to find food, water, and shelter along the way.
 - Allow students to share their ideas about the fox's path with a partner. Then share that the distance between her start to the end points is 1789 km, but the fox traveled 4415 km. Ask students what they think this means. (This fox did not travel in a straight line.)
6. **Learned:** Refer back to the "Want to Know" questions on the chart to see if we have answered any of them. If so, add to the answers to the Learned area of the chart.

Part 2: Using Data to Understand the Fox's Journey

1. Introduce the main question that students will explore: What was the fox doing along her journey?
 - If this question, or a similar one, is on the K-W-L chart, circle it. If not, add it to the chart.
2. Provide students with the *Fun Fox Facts* *handout*, which students will use as they consider what this fox was doing on her journey.
3. Provide students with *Student Page 2*. Orient students to the five parts of the fox's journey and explain that we know this was her path because of data transmitted from the Argos tracking tag.
 - Use a map of the Arctic to familiarize students with the locations in the five parts of the path.



- Students should add information about what conditions the fox would have been dealing with at each point in her journey in the areas titled “What was the environment like?” They should refer to the Arctic facts for seasonal conditions and the map to learn whether the fox was on land, sea ice, or glacier.
 - Students should add information about what they think the fox was doing at each stage in her journey based on the environment she was in and what is known about arctic foxes. (Students will be speculating about what the fox was doing. They can’t know for sure.)
4. Have students work in pairs to describe all parts of the journey, or split the class into five groups and assign each group a different segment. Then have each group share out to the whole class while students fill in notes on their own sheet about each segment of the fox’s journey.
 - If students need more structure, give them guiding questions such as: What did the fox eat? Was she traveling over land or ice?
 - Student responses will vary, but check that they are able to provide reasoning for their ideas about the connections between the environment, data, fox facts, and behavior.
 5. Have students draw their revised hypothesis about the fox’s path on the map at the end of *Student Page 2*. Then show the map on *Slide 3*, which shows the actual fox path plotted. Have students compare their map with the actual map.
 - An animation of the fox path in the Argos news article (see references) includes how the sea ice changed during the fox’s journey.
 6. Point out that when students made the first hypothesis of the fox’s path they only knew her start and end location. When they made their second hypothesis, they knew about five segments of her trip. The tracking data was recorded multiple times each day from transmissions between the Argos tag on the fox and satellites, providing very detailed results about the fox’s actual path. Having more data can help us better understand where the fox went.
 7. Revisit the K-W-L chart and ask students what we should fill in on the Learned column of the chart. Spend a few minutes adding learnings as a way to reflect on the day’s lesson.

Part 3: Writing a Story of the Traveling Fox

1. Share the fox pages from the *Follow Me! Argos comic* as one example of a story of the fox’s journey.
 - Explain that this fictional story is based on the fox tracking data and what we know about arctic foxes.
 - Tell students that they are going to write their own version of the fox’s story.
2. Allow students to share their ideas from their student sheet about what the fox was doing at different points in her journey. Encourage them to pull from the *Fun Fox Facts* *handout* to add detail.
3. Give students time to write up their stories. Students could create their story as a comic or as paragraphs.
4. Share the following guidelines for their story:
 - The story needs a title.
 - Include at least two fox facts within the story.
 - The story needs a beginning, middle, and end.
5. Display students’ finished stories around the classroom, or have a story time where students trade stories with a classmate to read.

Extensions:

Have students research how Arctic ecosystems are responding to climate change and make predictions about how arctic foxes might be affected by these changes. (With less sea ice, arctic foxes will not be able to travel as far.)



Background

Arctic foxes are difficult to study because they are small (about 60 cm long), which makes them hard to see from a distance, and because they live in the remote Arctic region. The coastal, blue morph fox in this study was trapped by researchers, outfitted with an Argos satellite tag, and then released. The researchers identified that she was female, weighed 1,900 grams, and they estimated that she was a juvenile based on her tooth wear. The Argos tag, transmitting to instruments aboard satellites, allowed researchers to track the fox. She left Spitsbergen (Svalbard Archipelago, Norway) on March 26, 2018, and arrived at Ellesmere Island (Nunavut, Canada) 76 days later on July 1, 2018. This is the longest recorded path of an arctic fox.

Her top speed was 155 km/day, the fastest ever recorded for this species. She traveled fastest over the Greenland ice sheet, where there was probably little food. Overall, she traveled faster over sea ice than over land. On two occasions, she slowed down on the sea ice to less than 10 km/day, perhaps because she found food (crustaceans, sea birds, and seals) within large cracks in the sea ice, or perhaps because she encountered open waters that were too wide to cross and had to wait for the ice to freeze or for the sea ice to move.

The fox in this study settled on Ellesmere Island in an area where there are lemmings, which means that she switched from a marine/coastal diet to an inland/lemming diet. She remained near the Fosheim Peninsula, at least until February 6, 2019, when the Argos satellite tag stopped transmitting.

Coastal foxes' food sources are typically stable, but they can experience food shortages during the winter, leading them to travel long distances, which is likely why the fox in this lesson took her long journey. Arctic foxes can change their diet depending on their environment, as the fox in this study must have done when she settled on Ellesmere Island, where lemmings are plentiful.

The foxes will often live in small family groups, with one breeding pair that mates for life, and a young female from the previous year's litter helping to care for the pups. They typically have just one litter per year. Young males will disperse from the nesting area soon after weaning. About 60% of arctic fox young will not survive to adulthood.

Arctic foxes have a history of roaming over sea ice, which has allowed them to breed with populations that are separated by open waters during the Arctic's summer months. As the climate warms and sea ice extent decreases, the arctic foxes will be more isolated. Warming temperatures are also causing changes in the distribution of food sources, such as caribou, which is a risk to the long-term survival of the species. However, arctic foxes are highly adaptable and today most arctic fox populations are stable, except for a few areas where fur trapping has taken a toll.

Links to Learn More

- Arctic Fox (<https://www.npolar.no/en/species/arctic-fox/>)
- From Svalbard to Canada, the long travel of an arctic fox tracked by Argos (<https://www.argos-system.org/long-travel-of-arctic-fox-from-svalbard-to-canada/>)
- Arctic fox dispersal from Svalbard to Canada: one female's long run across sea ice (<https://polarresearch.net/index.php/polar/article/view/3512/9288>)
- Unlocking the mysteries of the arctic fox (<https://www.argos-system.org/mysteries-arctic-fox/>)
- Argos 4: Tracking from Space (https://www.youtube.com/watch?v=aBc_MeKRMNc)
- How Argos System Works (<https://www.argos-system.org/using-argos/how-argos-works/>)
- Quick Facts About Sea Ice (<https://nsidc.org/cryosphere/quickfacts/seaice.html>)

NOAA and CNES have been partners in the Argos data collection system since 1978. For NOAA's latest contribution to the Argos system, NOAA has partnered with CNES to host their Argos-4 instrument aboard a commercial satellite. NOAA is working with USSF to utilize their hosted payload solutions contract and selected General Atomics and their Orbital Ted Bed-3 satellite to host the Argos-4 instrument.

This activity was developed at the UCAR Center for Science Education as an outreach effort of the Argos program under award NA21OAR4310383 from the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA or the U.S. Department of Commerce.



Student Page 1

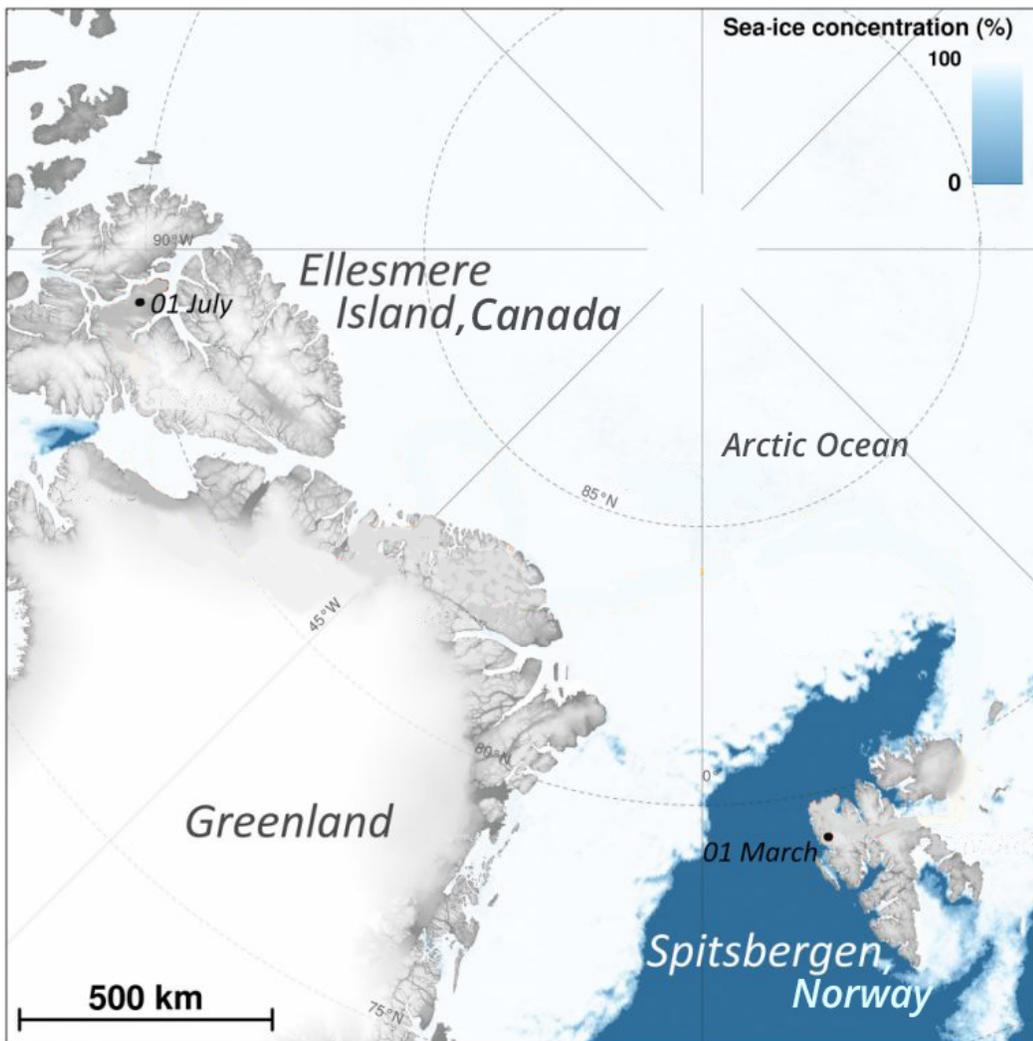
Follow That Fox!

1. How fast did the fox travel, on average?

Distance the fox traveled (km)	Number of days traveled (days)	Average distance traveled each day

2. Draw the path that you think the fox took to get from Spitsbergen to Ellesmere Island on the map below. The black dots on the map show where tracking started (01 March) and where she arrived (01 July).

My hypothesis:





3. Learn what conditions were like during this fox's journey through the Arctic. Remember that the fox was traveling over four months: March, April, May, and June.

Facts about the Arctic	
<ul style="list-style-type: none"> There is less sea ice in the Arctic during summer and fall. There is the most sea ice in the Arctic during winter and spring. 	<p style="text-align: center;">Average Monthly Temperatures in the Arctic</p> <p style="text-align: center;">*the actual temperature of each month is often higher or lower than the average temperature</p>
<ul style="list-style-type: none"> The weather is warmest when there are the most hours of sunlight in the Arctic. The weather is coldest when there is the least hours of sunlight in the Arctic. In the summer the sun doesn't set in the far north, even in the middle of the night. 	<p style="text-align: center;">Average Monthly Hours of Sunlight for the Arctic</p>

Graphs from <https://www.travelalaska.com/Planning/Alaska-Climate/Arctic>

4. Would the sea have been frozen enough for the fox to walk across during her journey? Explain.

5. When were days the longest during the fox's journey? How could long days be helpful to her?



Student Page 2: Five Parts of the Fox's Long Journey

Follow That Fox!

- Use the Facts About the Arctic (on Student Page 1) and a map to describe the environment and weather during each part of the journey.
- Combine what you know about foxes from the *Fun Fox Facts* handout and what you know about the environment to describe what you think the fox was doing during each part of the journey.

Part 1		What was the environment like?
Tracking dates	March 1 - March 26	
Start location	Spitsbergen, Norway	
End location	Spitsbergen, Norway	
What was the fox doing?		

Part 2		What was the environment like?
Tracking dates	March 26 - April 16	
Start location	Spitsbergen	
Location	Greenland	
What was the fox doing?		



Part 3		What was the environment like?
Tracking dates	April 16 - June 6	
Start location	Greenland	
End location	Greenland	
What was the fox doing?		

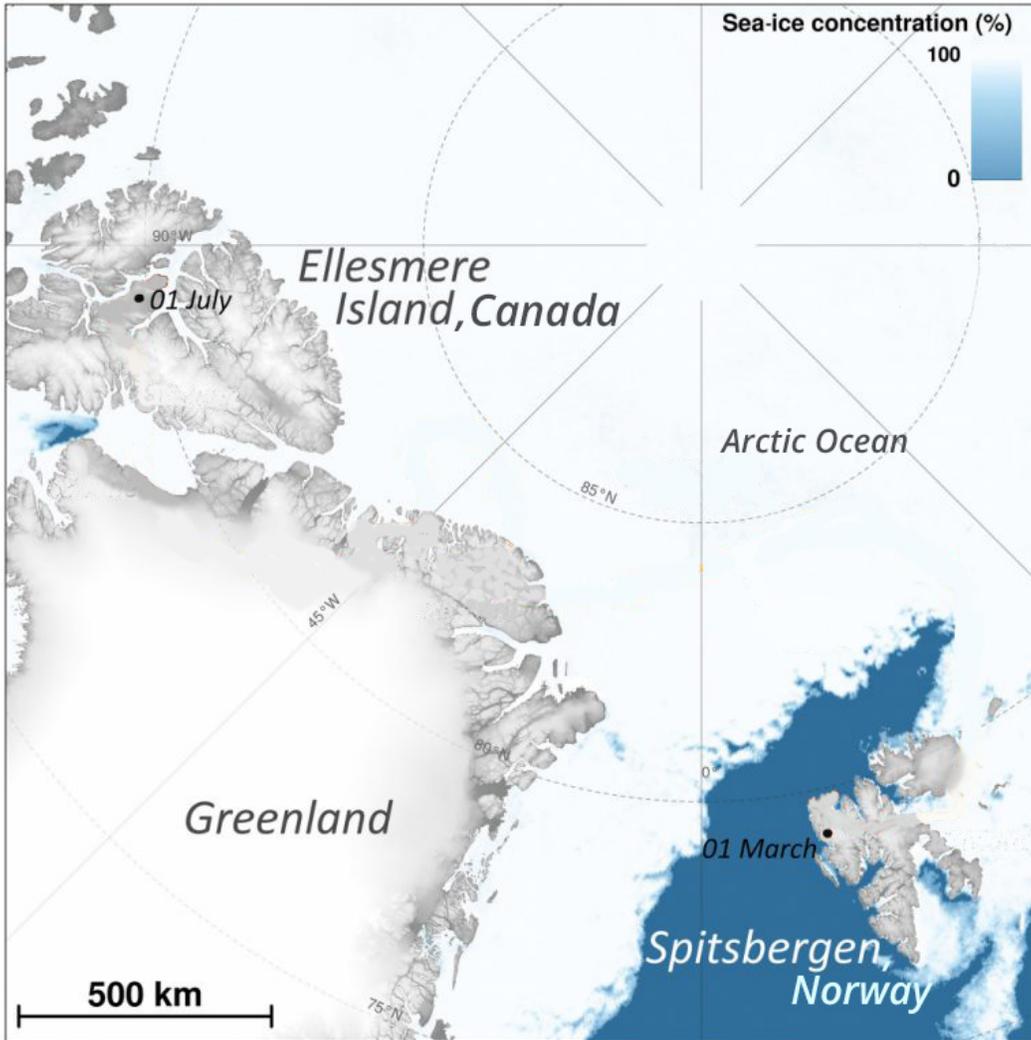
Part 4		What was the environment like?
Tracking dates	June 6 - June 10	
Start location	Greenland	
End location	Ellesmere Island	
What was the fox doing?		

Part 5		What was the environment like?
Tracking dates	June 10 - July 1	
Start location	Ellesmere Island	
End location	Ellesmere Island	
What was the fox doing?		



Use the data about each part of the journey to draw the path that you think the fox took to get from Spitsbergen to Ellesmere Island on the map below.

My new hypothesis:





Fun Fox Facts

Student Handout

1. Arctic foxes can survive temperatures as cold as -50 C (-58 F). They have fur on the soles of their paws, which keeps them warm. Their ears and muzzle are short which helps them not lose heat.
2. The fox in our story is a young female. She was likely born near to where she was first caught and fitted with her tracking collar.
3. Arctic foxes live for 3-6 years, though many foxes don't survive to adulthood. Female foxes are able to have pups when they are around 10 months old. Often a female fox will help take care of other pups in her family instead of having pups of her own.
4. There are two types of arctic foxes that have different colors of fur.
 - Most arctic foxes have white fur in winter and brown and yellow fur in summer. These are called white morph foxes.
 - Some arctic foxes, called blue morph foxes, have gray fur. Their fur is a little bit lighter in color during the winter than in the summer. The fox in our story is a blue morph fox.
5. Arctic foxes live in two environments:
 - Coastal: Foxes that live along the coast eat marine life (fish, shellfish, waterbirds). Blue foxes are rare, but there are more of them living near coasts than elsewhere.
 - Inland: Foxes that live inland eat birds and small rodents, such as lemmings. There are more foxes with white fur living inland.
6. Arctic foxes are both predators (hunting for food) and scavengers (eating what they can find).
 - They can switch between coastal diets and lemming diets depending on the environment.
 - Scavenged reindeer carcasses are also an important food source for the arctic fox.
 - In winter, when food is scarce, arctic foxes sometimes follow larger predators, like polar bears, to scavenge their left-overs. They'll even head out onto the sea ice to look for leftover food that a polar bear caught.
7. The fox that was tracked traveled at different speeds during her journey. She moved at about 31.4 km/day while traveling over land. While on the ice she moved at an average speed of 65.4 km/day. Two different times while on the ice she slowed down to less than 10 km/day.
8. Some foxes stay in the same area for their whole lives, only taking short day trips out onto the sea ice to find food. Other foxes are nomadic, meaning that they travel over large distances.
9. Arctic fox mating season is from the end of February until the middle of April. The mother fox is pregnant for about 52 days, and then gives birth to a litter of five or six pups in a den. Pups are usually born in May or early June.
10. A fox will use the sea ice to migrate to new areas, to reach different populations of foxes, or to find food.
11. Sea ice can move very quickly which can help the fox to travel faster, and sometimes help them find food from holes in the ice. But sometimes the fox can become stranded on the sea ice for days.



Slide 1: Arctic Foxes

Follow That Fox!



Credit: Jon Leithe/Norwegian Polar Institute



Credit: Jon Aars/Norwegian Polar Institute



Slide 2: Fox with an Argos Tracking Tag

Follow That Fox!



Credit: Elise Strømseng/Norwegian Polar Institute



Slide 3: Map of the Fox's Path

Follow That Fox!



Credit: Arnaud Tarroux/Norwegian Institute for Nature Research (NINA)