# UNIT STORYLINE

**Unit Question:** What will happen to Arctic bear populations as their environment changes?

## Lesson Set 1: What is happening with Arctic bear populations?

<table>
<thead>
<tr>
<th>Lesson Question</th>
<th>Phenomena or Design Problem</th>
<th>What we do and figure out</th>
<th>How we represent it</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LESSON 1</strong></td>
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</table>
| Lesson Set 1    |                             | We investigate changing Arctic environmental conditions and their relationship to Arctic bear populations. We read about polar, brown, and black bears and consider how they may adapt to changing conditions. We investigate the stability of Arctic bear populations in different regions of the Arctic. We develop and share initial models about the future of different polar bear populations. We develop our DQB and figure out: | - The coverage and duration of Arctic sea ice is changing, leading to less sea ice habitat for polar bears in areas with seasonally available ice.  
- Polar bears are adapted to the Arctic ecosystem and rely on Arctic sea ice.  
- Based on their adaptations, the polar bears are most at risk for population declines as the environment changes.  
- Based on their adaptations, brown bears may expand their range as the Arctic warms.  
- Polar and brown bears are likely to interact more as the environment changes. | ![Illustrations created by OpenSciEd in Biorender.com](https://biorender.com) |

**Guiding Questions:**

- How do changes in climate affect bear species coming together for the first time in the Arctic?

**Anchoring Phenomenon:**

*The sighting of 3 bear species in one location in Canada for the first time may be related to the effect of climate change.*

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*Navigation to Next Lesson:* We decide to investigate how polar, brown, and black bears interact because changes in climate may make that more likely to occur in the future.
### LESSON 2
**Lesson Set 1**

2 days

**How and why are bear species interacting and why might brown bears dominate?**

**Investigation**

<table>
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<th>Arctic bear population interactions are complex.</th>
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We decide to investigate interactions between black, brown, and polar bears. We investigate thermoregulation to figure out why polar bears might run away from brown bears. We construct claims about what will happen in polar and brown bear interactions in the future. We wonder about other similarities and differences between the bears. We figure out:

- In interactions with brown bears, polar bears are submissive.
- When polar bears exercise, they overheat easily.
- Their adaptations, including a variation of the NOS3 gene cause polar bears to get hot.
- Other mammals, like humans, can regulate heat through sweating and other mechanisms.
- Polar bears can cool off when there is snow, but without it they get too hot and pass out.

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### LESSON 3
**Lesson Set 1**

2 days

**How similar/different are the polar, brown, and black bears?**

**Investigation**

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We decide to investigate how similar/different the three species of bears are. We investigate similarities and differences in anatomical evidence and realize it is hard to figure out how the bears are related. We decide to use DNA evidence and build a tree of the polar, brown, and black bears with five other bear species. We figure out that polar bears are most similar to brown bears and that they shared a more recent common ancestor than they do with other bears. We figure out:

- We have evidence that polar, brown, and black bears have a lot of similarities and differences based on anatomy and behavior.
- We can use trees to communicate our hypotheses about relationships among bear species.
- Polar bears and brown bears are more genetically similar to each other than they are to any other bear species.
- Polar bears and brown bears share a more recent common ancestor than they do with other bears.

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### Navigation to Next Lesson: We figure out that polar bears overheat easily, and that can affect their interactions with brown bears. We wonder about other similarities and differences between the bears.

### LESSON 3
**Lesson Set 1**

2 days

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### Navigation to Next Lesson: We figured out that polar bears and brown bears shared a common ancestor and wonder what happened to cause them to split.
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<tr>
<td>3 days</td>
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The Arctic has undergone cycles of glaciation.

We review the mechanism of natural selection and use it to connect evidence at different scales to explain how polar and brown bears split from a common ancestor. We investigate evidence from glacial cycles, fossils, and allele variations. We develop and revise an argument to explain the speciation of polar and brown bears. We decide to use what we know about the impact of glacial cycles on bears in the past to figure out what will happen to Arctic bears in the future. We figure out:

- The Arctic has undergone glacial and interglacial periods, creating selective pressures for bears.
- Small bear populations may have been isolated in areas that kept ice year round during interglacial periods.
- Natural selection acted on genetic variations present in isolated populations of bears over thousands of generations.
- Speciation occurred in the common ancestor bear after thousands of generations, leading to polar bears that are adapted to polar environments and brown bears that are adapted to nonpolar environments.

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<td>Common ancestor bears evolved in the Arctic, which is currently experiencing glacial conditions. They may not be able to survive in the nonpolar conditions that are warming.</td>
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LESSON 5
Lesson Set 1
1 day

What will happen to Arctic bear populations as their environment changes?

Putting Pieces Together

Students put the pieces together and revise their model to explain what will happen to Arctic bear populations as their environment changes.

We develop a Gotta-Have-It Checklist and revise our initial consensus model using new evidence. We revisit the DQB and answer questions we have figured out, notice what questions are left unanswered, and add new questions. We figure out:

- Polar bear populations will decline in the future because they evolved with adaptations for Arctic environments. When removed from those habitats, they overheat and cannot outcompete brown bears for food.
- Arctic brown bear populations will increase in the future as there is less ice and they can use aggression and genetic diversity to find food, survive and reproduce in more areas on land in the Arctic.

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Illustrations created by OpenSciEd in Biorender.com

Navigation to Next Lesson: Students use their understanding of how bear populations adapted to major changes in climate in the past to help them understand what might happen to Arctic bear populations in the future.

Navigation to Next Lesson: We wonder how quickly the Arctic climate is warming now compared to other interglacial periods and if polar bears will be able to evolve through natural selection quickly enough to adapt to those changes.
Lesson Set 2: What will happen to Arctic bear populations in the future?

### LESSON 6

**Lesson Set 2**

**1 day**

**Lesson Question:** What will happen to bear species in the Arctic in the future?

**Investigation**

We decide to investigate what will happen to polar bears in the future as the Arctic environment changes. We figure out the climate is likely changing too fast for polar bears to evolve and adapt to environmental changes. We wonder about other possibilities for polar bears and hear about a case where polar bears and brown bears mated and produced hybrid offspring. We use a model to generate evidence to help us predict hybrid fitness in the future. We wonder if polar bears could go extinct.

**What we do and figure out**

- The Arctic climate is likely changing too quickly for polar bears to adapt.
- Polar and brown bears may interact and mate with each other.
- We can use a model to generate evidence to support predictions.
- If polar and brown bears mate, some polar bear genes may not be lost.

### LESSON 7

**Lesson Set 2**

**2 days**

**Lesson Question:** How do past patterns of extinction help us understand possible consequences of extinctions now and in the future?

**Investigation**

We investigate extinction rates for the whole Earth and wonder how this compares with events in the geologic past. We investigate the five mass extinctions in Earth's history and figure out that in each, a major event precipitated a significant shift in climate. We connect what we learned in the past to what is happening today and update our Progress Trackers.

**What we do and figure out**

- Five times in Earth's history, significant environmental changes that resulted in major shifts in global climate caused the extinction of at least 75% of all species.
- Extinction is a significant threat to biodiversity, which is necessary for ecosystem resistance.
- There are similarities between environmental conditions that caused the mass extinctions and Earth today.
- Unlike the previous 5 mass extinctions, current extinctions are primarily caused by human activities.

### Navigation to Next Lesson:

We figured out repeating patterns in the causes for mass extinctions. Many of those causes are happening today and threaten biodiversity. We wonder if we should protect species, like the polar bear, from extinction.
**LESSON 8**
Lesson Set 2
3 days

**What are our options for protecting species from extinction and should we implement them?**

**Investigation**

People approach protection of species at risk from extinction in different ways.

We research and evaluate solutions people have used to protect species from extinction and present what we learn. We discuss if these solutions could work to protect the polar bear and if people should intervene. We write an individual argument with our position on whether we should do something to save polar bears from extinction. We figure out:

- Options for protecting endangered species from extinction include habitat conservation, breeding programs, species relocation, long-term storage of genetic material, and others.
- Not all species at risk of extinction can be protected in the same way.
- Protecting species from extinction requires huge inputs of time, money, resources, and collaboration.
- Protecting polar bears from extinction is difficult because they are large, long-lived, reproduce slowly and cannot survive in warm climates.

Navigation to Next Lesson: We came up with an argument about the future of the polar bear and want to see if we have now answered all of our questions on the DQB. We will apply what we learned to a new phenomenon.

**LESSON 9**
Lesson Set 2
2 days

**Can we use everything we have figured out about speciation to explain a new phenomenon?**

**Putting Pieces Together**

Bumble bees may be at risk of extinction.

We complete a Transfer Task to evaluate claims about ways to protect endangered bumble bees to demonstrate how what we figured out throughout the unit about finding common ancestry, biological evolution, and extinction applies to other systems. We figure out:

- Wild bumble bee populations are in danger from pathogens, pesticides, and climate change.
- To protect the wild bee population, we need to eliminate the use of pesticides, reduce the number of managed honey bee hives, and maintain genetic diversity of bee populations.

Navigation to Next Lesson: This is the last lesson in the unit.

**LESSONS 1-9**
19 days total