Return of the wolves: Isle Royale National Park
"Lessons from the wilderness"
Lesson 2

This lesson is designed to be used after students have viewed Part 2 of the video "Return of the wolves: Isle Royale National Park " and completed Lesson 1, as well as Parts 1 and 2 of the student video viewing guide.

NGSS Connection:
HS-L2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

**Please note that links may connect you with an English language site. Please use your web-browsers translation services to translate. **

- Primary SEP: Engaging in argument from evidence
    - Secondary SEP: Analyzing and Interpreting Data
- Primary CCC: Stability and Change
    - Secondary CCC: Patterns

Lesson Driving Questions: Is climate change becoming a limiting factor for Isle Royale wolves? If so, how will that affect the Isle Royale ecosystem?

Key Disciplinary Ideas:

- Anthropogenic changes can disrupt an ecosystem and threaten the survival of some species.
- Extreme fluctuations in climate conditions can challenge the functioning of ecosystems.
- Extreme fluctuations in the size of certain populations can challenge the functioning of ecosystems.

Key Practices and Crosscutting Concepts:

- Analyze and interpret data at multiple scales to provide evidence of anthropogenic climate change.
- Assess the logic of reasoning, including degree of change and stability, to support the claim that climate change is negatively impacting the wolf population on Isle Royale.
- Construct an explanation of the trophic cascade effect wolves have on the Isle Royale ecosystem.

Time: Three class periods

Materials:

- Projector for video
- Copies of Lake Superior Ice Coverage and Isle Royale Ice Bridge data (Appendix A)
- Graph paper, whiteboards, or poster paper with markers, or access to graphing programs such as Excel or Sheets, as needed
- Copies of the Claim, Evidence, Reasoning graphic organizer (Appendix B)

Engage	At the end of Part 2 of the video, we saw that there seems to be a connection between the Isle Royale wolves' genetic diversity and climate change. In fact, the Isle Royale wolves had been showing genetic deformities in their backbones for years, and the two remaining wolves (before reintroduction in 2019) were brother/sister AND father daughter. But why is lack of genetic diversity a limiting factor? Students watch this California Academy of Sciences video on genes and biodiversity, up to 4:00. In a whole class discussion, help students consider their initial ideas with these questions: ● What are the benefits of genetic diversity? ● What are limiting factors for genetic diversity on Isle Royale? ○ Size of population ○ Island boundary ○ Lack of ice bridges due to climate change ● Can you make an argument that climate change is becoming a limiting factor for the wolf population? ● What effect does this have on the rest of the island ecosystem? ● In order to make a decision about adding wolves to the island, we need to feel confident that the climate is changing at a larger scale, not just fluctuating slightly each year. How do we know this?
Explore	To look for evidence of stability or change in Lake Superior ice coverage, students analyze data over the past 50 years, along with the data for ice bridges forming between the mainland and Isle Royale, to look for evidence of stability or change. Using Appendix A, assign one six-year segment of Lake Superior Ice Coverage and Ice Bridge data to each of eight small groups. (Data may be broken into larger segments if you have fewer groups in your class.) In small groups, students create a bar graph of the percentage of ice coverage for their span of years. ● They should indicate years that had an ice bridge by adding a dot, color, or

	other symbol (as decided upon by the class) to the bar for that year. ● Students may use regular graph paper, poster-sized graph paper or whiteboards with graphing grids, or Excel or Sheets to create the graphs. ● Students should use pre-determined axes scales with a common format, so that when the graphs are combined, the longitudinal data is easy to analyze. Each group analyzes its small scale data set and decides whether they see stability or change - or if they are not sure. **Differentiation or Extension Opportunity:** A University of Wisconsin professor began recording Ice In and Ice Out dates on Lake Mendota in Madison, during decades of his tenure in the mid 1800's. Since then the observations have been continued by various Wisconsin researchers, providing a rare set of data that extends well over a century and a half. You may consider asking students to graph average days of ice on Lake Mendota (Madison, WI) since 1852. Consider breaking the data into seven groups of approximately 25 years each. Compare stability/change in small group graphs to the larger scale data by creating a complete graph by combining the students' small group graphs.
Explain	Starting with the earliest data, each group presents their graph and notes whether they think it shows change or stability, or if they are unsure. After sharing, groups place their graphs in a common area, in chronological order, to create a larger graph of the entire time span. When all the graphs are combined, students are asked to evaluate the whole class graph for trends in a consensus discussion. The teacher guides the discussion with questions such as: ● Does the data at a larger scale show change or stability? ● What is the trend? ● How could this abiotic part of the ecosystem affect the biotic (living) parts? ● How does the Isle Royale ice bridge data compare with the Lake Superior ice coverage data? Is using Lake Superior ice coverage data a good proxy for determining the probability of an ice bridge? ● Does the data support the scientists who recommended adding wolves to Isle Royale because it's unlikely there will be enough ice bridges in the future to sustain the wolf population and its genetic diversity? Use Productive Talk techniques during the discussion and presentations to encourage students to provide evidence for their analysis.
Elaborate	There appears to be a clear trend over time of less ice coverage on the lake. This in turn reduces the opportunity for genetic diversity, which reduces the health and number of the wolf population.

	How will that reduction in wolf population affect the rest of the ecosystem? Students watch this 6 minute video from PBS NewsHour's student reporting lab. The video describes the trophic cascade effect that wolves have on the island ecosystem. Armed with information about the benefits of genetic diversity, the relative certainty of climate change, and the trophic cascade effect, students work in small groups to complete a Claim, Evidence, Reasoning graphic organizer (Appendix B). You may wish to provide this trophic cascade graphic to students as a visual support. Consider asking student groups to present their CER organizers on whiteboards or poster paper in individual group presentations or a class gallery walk. Conduct a consensus discussion regarding the validity of the claim that climate change will negatively impact the Isle Royale ecosystem.
Evaluate	Students complete the CER in Appendix C.

Appendix A: HS Student Worksheet L2-A

Lake Superior Historical Maximum Ice Coverage

(Rounded to nearest 5%)

Year	1973	1974	1975	1976	1977	1978
% Ice Coverage	70	75	65	50	95	90

Year	1979	1980	1981	1982	1983	1984
% Ice Coverage	95	80	85	85	20	90

Year	1985	1986	1987	1988	1989	1990
% Ice Coverage	80	90	15	65	80	80

Year	1991	1992	1993	1994	1995	1996
% Ice Coverage	90	70	75	95	30	100

Year	1997	1998	1999	2000	2001	2002
% Ice Coverage	90	10	20	35	50	10

Year	2003	2004	2005	2006	2007	2008
% Ice Coverage	95	50	55	20	55	60

Year	2009	2010	2011	2012	2013	2014
% Ice Coverage	95	30	35	10	40	95

Year	2015	2016	2017	2018	2019	2020
% Ice Coverage	95	20	20	80	95	20

Ice Bridges

Decade	Years
1970	1970, 1971, 1972, 1974, 1977, 1979
1980	1982, 1985, 1988
1990	1991, 1994, 1996, 1997
2000	2008
2010	2014, 2015, 2018

Appendix B: HS Student Worksheet L2-B

Claim, Evidence, Reasoning Statement

<table>
<tr><td colspan="2">Claim: Climate change will negatively impact the ecosystem of Isle Royale.</td></tr>
<tr><td colspan="2">Scientific principles:
Lack of genetic diversity can be a limiting factor for a population.
An island boundary can be a limiting factor for a population.
Climate change can affect the boundaries of an island ecosystem.
In some ecosystems, changes in the population of one species can have a trophic cascade effect on the community.</td></tr>
<tr><td>Evidence: (List data and facts about climate change and Isle Royale populations and ecosystem.)</td><td>Reasoning: Use your evidence AND the scientific principles above to explain why your claim is correct.</td></tr>
</table>

Claim, Evidence, Reasoning Statement

Teacher Version

Student Answers May Vary

<table>
<tr><td colspan="2">Claim: Climate change will negatively impact the ecosystem of Isle Royale.</td></tr>
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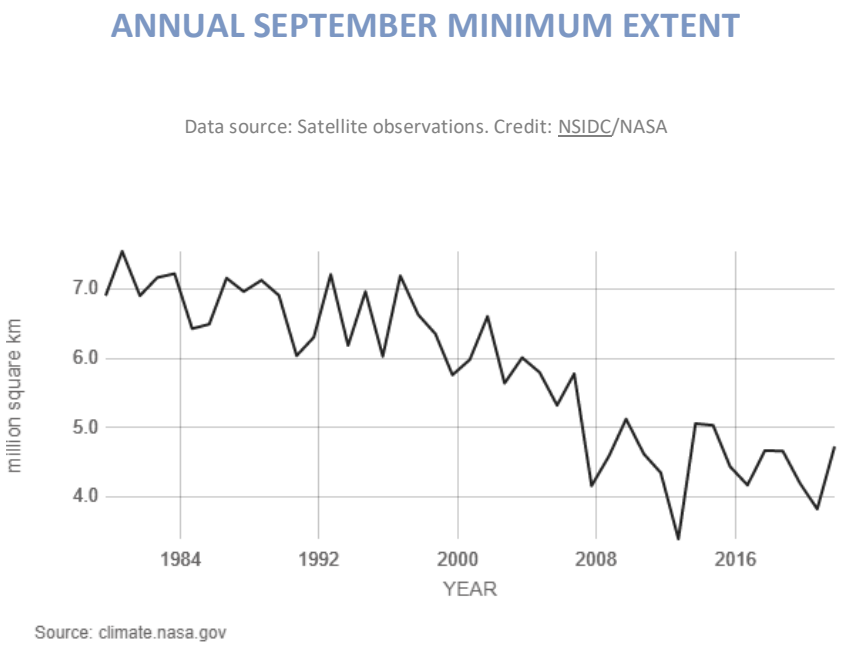
An island boundary can be a limiting factor for a population.
Climate change can affect the boundaries of an island ecosystem.
In some ecosystems, changes in the population of one species can have a trophic cascade effect on the community.</td></tr>
<tr><td>Evidence:</td><td>Reasoning:</td></tr>
</table>

Appendix C: HS Student Worksheet L2-C
Polar Bears and Arctic Ice

Polar bears are an apex predator in the Arctic ecosystem. They rely on Arctic ice to reach their main prey, which is seals. Arctic seals eat cod fish, which feed on krill (small shrimp-like organisms). The krill eat zooplankton, which in turn feed on ice algae - tiny photosynthetic organisms that live under the Arctic ice.

Below is a graph from NASA's climate division showing measurements of Arctic ice over the several decades. NASA has calculated a rate of decline of 13% per decade.



Source: https://climate.nasa.gov/vital-signs/arctic-sea-ice/

Use this information to construct an explanation of how the changing climate may cause a significant change in the Arctic ecosystem.

Claim, Evidence, Reasoning Statement

<table>
<tr><td colspan="2">Claim: Climate change will cause changes in the Arctic ecosystem.</td></tr>
<tr><td colspan="2">Scientific principles:
Significant changes in climate conditions can cause significant changes in ecosystems.
In some ecosystems, changes in the population of one species can have a trophic cascade effect on the community.</td></tr>
<tr><td>Evidence: (List data and facts.)</td><td>Reasoning: (Use evidence plus scientific principles to support the claim.)</td></tr>
</table>