Return of the wolves: Isle Royale National Park
"Lessons from the wilderness"
Lesson 3

This lesson is designed to be used after students have viewed Part 3 of the video "Return of the wolves: Isle Royale National Park" and completed Lessons 1 and 2, as well as the student video viewing guide.

NGSS Connections:
HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

- Primary SEP: Designing solutions
    - Secondary SEP: Constructing explanations and arguing from evidence
- Primary CCC: Stability and change
    - Secondary CCC: Cause and effect

Lesson Driving Question: What is the best response to changes in the Isle Royale ecosystem?

Key Disciplinary Ideas:
- Sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.
- Humans can design and implement solutions to counteract their effects on ecosystems.
- When evaluating solutions it is important to take into account a range of criteria and constraints.

Key Practices and Crosscutting Concepts:
- Construct explanations of how and why ecosystems change, and how they can be made more resilient to restore stability.
- Generate and apply a list of criteria and constraints to analyze strengths and weaknesses of a proposed solution, and use the analysis to provide an evidence-based decision.

Time: Three class periods

Materials:
- Projector for video
- Copies of Appendix A and B if desired

- Poster paper or whiteboards and markers
- Copies of Criteria and Constraints tables (Appendix C)
- Copies of the Four Actions Considered (Appendix D)

<table>
<tr><td>Engage</td><td>Teacher Note: If your students are proficient in using criteria and constraints, you may choose to skip to the Elaborate activity. If they have little to no exposure to the engineering concepts of criteria and constraints, use the Engage, Explore, and Explain activity here to introduce them.

Students are presented with an imaginary scenario: Our class has won a local contest and the prize is pizza for lunch here at school next week, delivered by the local pizza restaurant of our choice, for up to $150.

Where should we get our pizza from?

At table groups, students discuss and each table agrees on one pizza place. The teacher asks for the pizza recommendations and the reasons why the group chose that restaurant.</td></tr>
<tr><td>Explore</td><td>The teacher notes that there are many different opinions on the best place for pizza. How could we come to class consensus on just one place?

Student groups list their considerations in two columns on a whiteboard or Appendix A. What requirements does the pizza restaurant choice HAVE to meet? What would be nice for them to offer?</td></tr>
<tr><td>Explain</td><td>Student groups share their lists. The teacher records a class consensus list on poster paper or projects it electronically, asking for clarifications and making suggestions as needed. Ideally the class list will look something like this:

<table><tr><th>Nice to Have</th><th>Must Have</th></tr><tr><td>Hot
Fresh
Variety of crusts
Variety of toppings
Extra cheese, etc.</td><td>Be local
Offer delivery
Be open during lunch
Be able to feed all of us for $150 or less</td></tr></table>
Ask students to consider that they have just created lists of criteria and constraints to design a good solution. The Nice to Haves are criteria - they are desirable attributes that can be ranked (okay, good, best). The Must Haves are constraints - it doesn't</td></tr>
</table>

<table>
<tr><td></td><td>matter how hot and fresh the pizza is if the solution doesn't meet the constraints of delivery, budget, and being open during lunch.

Criteria and constraints are engineering tools used to evaluate solutions to problems in a logical and reasoned way.</td></tr>
<tr><td>Elaborate</td><td>Students are now going to evaluate the potential solutions that were considered by the National Park Service in 2019 to address the problem of the dwindling and inbred wolf population on Isle Royale. They will generate lists of criteria and constraints, and compare them to the NPS list. The class may vote to add criteria and/or constraints of their own. Then, they will apply their lists to descriptors of the four solutions proposed by the NPS to select the best solution.

Students start by viewing this 14 minute National Geographic video titled "Quest for Survival," listening for potential criteria and constraints for solving this problem. What do we want to happen with the ecosystem? What must happen with any solution?

After viewing the video, in small groups, students again generate criteria and constraints for solving the problem of the dwindling wolf population. What do we want to see happen in a successful solution? What must happen to be a successful solution? Student groups may use Appendix B or may record their thoughts on a whiteboard or poster paper. This may be a good time to use Three stay, One stray as a routine to help students refine their ideas as they work in small groups.

Student groups then share their lists of criteria and constraints, listening for commonalities. The teacher helps students generate a class consensus list, which may look something like this:

<table>
<tr><th>Criteria</th><th>Constraints</th></tr>
<tr><td>Stabilize the moose population
Stabilize the wolf population
Retain forest health
Keep the wilderness untouched as much as possible
(Other concerns students may have, such as managing populations of beaver, maintaining recreation for people, etc. may be listed here)</td><td>Must prevent the ecosystem from extreme change
Must protect the trees/landscape</td></tr>
</table>

Student groups are given an adapted list of criteria and constraints from proposals that were generated by the NPS for use in their decision making process with scientists and with the public (Appendix C). The class may vote to add to the criteria or constraints, using their class list, if they'd like.</td></tr>
</table>

	Then, using Appendix D, student groups evaluate each of the four NPS solutions. They should come up with a criteria total score, as well as note any solutions that did not meet one or more constraints. (Consider providing four copies of the criteria and constraints tables to each group if you'd like them to record scores directly on the tables.) Small groups then share out their recommended solutions and the class comes to consensus on the best solution. Did the class choose the same solution as the National Park Service? (Proposal B?)
Evaluate	The NPS, upon advice and input from researchers, scientists, and the public, chose Alternative B in 2018 and has been introducing wolves to Isle Royale since then. Students should compose a letter to the National Park Service Midwest Regional Director in support of their solution for restoring the Isle Royale ecosystem (or expressing concern, if the student disagrees), using evidence and reasoning gathered through the consideration of criteria and constraints.

Appendix A: Student Worksheet L3-A

Pizza for Lunch!

What do we need from the pizza restaurant? What do we want? List attributes of a good pizza solution here.

Nice to Have	Must Have

Appendix B: Student Worksheet L3-B

Building Ecosystem Resiliency on Isle Royale

Criteria What would we like to see in a successful solution? (Can be ranked no change, better, best)	Constraints What are things we must see in a successful solution? (Yes/No)

Appendix C: Student Worksheet L3-C

National Park Service

Criteria and Constraints

(Adapted from their Environmental Impact Statement)

Criteria

Criterion	0	1	2
Stabilize moose population	Moose population would likely increase, followed by a large-scale starvation event.	Moose population continues to fluctuate at current rates but does not increase to the point of collapse.	Reduce and stabilize the fluctuations of the moose population.
Stabilize wolf population	Wolf reproduction would be unlikely because of low genetic diversity and inbreeding. Original population of wolves likely to disappear.	Small numbers of introduced wolves would result in a lower genetic diversity in the short term.	Island wolf numbers increase quickly. Genetic variation increases quickly.
Maintain the untouched wilderness character of the island (no human technology, machinery, etc.)	The wilderness character of the island will be impacted.	If action occurred, the wilderness character of the island would be impacted.	Little to no impact to wilderness character. Remains “untouched.”
Other:			

Constraints

Constraint	Yes	No
Stabilizes the island ecosystem, improving resiliency		
Retains forest components (trees do not get over browsed)		
Other:		

Appendix D: Student Worksheet L3-D
Actions Considered

Alternative A: No Action	*Under the no-action alternative, wolves would not be introduced to the park.* **Pro**: Least impact to wilderness. **Cons**: **Island Ecosystem**: broad changes to forest composition and structure could be further influenced by climate change and increased plant consumption. **Moose**: Without wolves, moose population would likely increase and could deplete their food source. A large-scale starvation event could possibly occur. **Wolves**: Original population would likely disappear from the island. Presence of wolves on the island would depend on natural immigration, which is unlikely due to reduction of ice bridge formation because of global climate change. Wolf reproduction would be unlikely because of low genetic diversity and inbreeding.
Alternative B: Immediate, limited introduction of new wolves	*Under alternative B, the park would introduce wolves over a 3-year time period. After the third year, if an unforeseen event occurred (disease or mass deaths), wolves may be supplemented for an additional 2 years. No wolves would be introduced after 5 years from the first introduction.* **Pros**: **Island Ecosystem**: Restore an apex predator and the process of predation to the island. Retain forest components. **Wilderness**: Restore an ecological function (predation) on the island and benefit the natural quality. **Moose**: Reintroducing predation to the ecosystem would reduce the fluctuations of the moose population. **Wolves**: Island wolf abundance and distribution would increase. Genetic variation would increase with the aim to delay any potential future inbreeding problems **Cons**: **Wilderness**: The wilderness character of the island would be impacted. This alternative includes the use of radio collars and mechanized transport that impact the untouched and undeveloped qualities of wilderness.

Alternative C: Immediate introduction of new wolves, with potential addition of more wolves in the next 20 years	*Under alternative C, wolves would be immediately introduced with the possibility of more introductions over a 20-year period.* **Pros**: **Island Ecosystem**: Restore an apex predator and the process of predation to the island. Retain forest components. **Wilderness**: Restore an ecological function (predation) on the island and benefit the natural quality. **Moose**: Reintroducing predation to the ecosystem would reduce the fluctuations of the moose population. A smaller number of wolves would be introduced, allowing some predation. Future introductions of wolves would be allowed to manage the moose population as needed. **Wolves**: Relocating a lower number of wolves would best reflect a natural migration event. This would result in a lower genetic diversity in the short term. The NPS would have the ability to relocate wolves and increase diversity as needed. **Cons**: **Wilderness**: The wilderness character of the island would be impacted. This alternative includes the use of radio collars and mechanized transport that impact the untouched and undeveloped qualities of wilderness. Additional impacts to wilderness could occur depending on the number of introduction events.
Alternative D: No immediate action, with allowance for possible future addition of wolves	*Under alternative D, the park would continue to monitor conditions and take no immediate action but allow for future introductions of wolves to Isle Royale.* **Pros:** All pros are depending on if future action occurs. Pros would be similar to alternatives B and C. **Wilderness**: If action did not occur, nature would be allowed to take its course without human influence. **Cons**: All cons depend on if future action occurs. **Wolves**: A delayed response could lead to the original wolf population disappearing and new wolf relocations would possibly establish a new, genetically different, population. **Moose**: A delayed response could lead to the moose population continuing to increase until a possible moose population collapse due to starvation or winter moose ticks causing illness. **Wilderness**: If action occurred, the wilderness character of the island would be impacted. This alternative includes the use of radio collars and mechanized transport that impact the untouched and undeveloped qualities of wilderness. Additional impacts to wilderness could occur depending on the number of introduction events.