The Wolves of Isle Royale

HOW TO USE THIS RESOURCE

The image for this resource, a sequence of three images showing wolves hunting moose on Isle Royale, an island in Lake Superior, can serve as an anchoring phenomenon to explore the key concepts described below. The pedagogical practice of using phenomena to provide a context for understanding science concepts and topics is an implementation practice supported by the Next Generation Science Standards (NGSS). Phenomena are observable occurrences that students can use to generate science questions for further investigation or to design solutions to problems that drive learning. In this way, phenomena connect learning with what is happening in the world while providing students with the opportunity to apply knowledge while they are building it.

The "Implementation Suggestions" and "Teaching Tips" sections provide options for incorporating the images into a curriculum or unit of study and can be modified to use as a standalone activity or to supplement an existing lesson. The student handout includes reproductions of the images and the "Background Information" section.

KEY CONCEPT

A. On Isle Royale, wolf and moose population sizes can directly influence one another, in addition to influences from available resources. Physical and biological factors affect each population's carrying capacity.

NGSS PERFORMANCE EXPECTATIONS

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

BACKGROUND INFORMATION

For almost 60 years, scientists have been examining the relationship between wolves and moose on Isle Royale National Park in the longest continuous predator-prey study in the world. Moose likely came to Isle Royale, an island about 580 square kilometers in size in Lake Superior, in the early 1900s by swimming from the mainland. Without any predators around, the population shot up and then crashed in 1934 as the moose depleted the food available to them on the island. A wolf population was established on the island in the late 1940s, probably after crossing an "ice bridge" from the mainland. In 1958, scientists started monitoring the cyclical rise and fall of moose and wolf numbers, with one population influencing the other, but also responding to other factors, such as disease, tick outbreaks, severe winters, and immigrant wolves. The wolf population grew to as many as 50 individuals in 1980, and 24 wolves lived on the island as recently as 2009.

The number of wolves has steadily declined since 2009. In recent winters, few wolves have immigrated to the island, resulting in higher rates of inbreeding and accompanying higher wolf mortality rates. Climate change has resulted in a steady reduction in ice cover over the Great Lakes. Currently, the wolf population is down to two individuals, making their local extinction likely. Without wolves, the already-large moose population is on track to double in the next few years. The moose are likely to repeat the pattern from the 1930s, decimating their diet of native vegetation. The National Park Service will soon decide whether to introduce 20 to 30 new wolves to the island.

IMPLEMENTATION SUGGESTIONS

The following suggestions outline several options for incorporating the images into a unit of study as the anchoring phenomenon:

Engagement, establishing prior knowledge, and providing context:

- Tell students that they are going to be examining pictures of two populations of animals interacting.
- Give students the image of "wolf and moose 1." Use a think-pair-share protocol to have them make observations about what's happening in the image. Record class observations, noting when students make similar observations.
    - Observations may include the following: Several wolves appear to be chasing one moose; each wolf is walking or running in snow; the wolves are following the moose in the snow in line with one another (helping to facilitate the others' movement); and some of the trees in the surrounding area appear to have needles/are evergreens.
    - For students who are unfamiliar with walking or running in snow, it may be helpful to compare it to walking or running in water or sand.
- Ask students to predict what might happen next to both the moose and wolves. Student predictions will generally include one of three outcomes: the wolves will catch the moose and either the moose will escape from them or the moose will be injured or killed; or the wolves won't catch the moose.
    - It may be helpful to give students a template on which to record their predictions such as the one provided in the student handout. Once students have recorded their predictions, ask a few students to share them.
    - Ask students to consider the "costs" to each animal for each potential outcome of this interaction. Students may struggle with the idea of cost, so it might be helpful to specify that you're referring to energetic costs (such as spending energy in escaping predators or in chasing prey that eventually escape) or trade-offs (time spent escaping predators cannot be used for rest or foraging).
- Give students the second two images (wolf and moose 2 and 3) and have them make observations and discuss using similar strategies to those described for image 1. Clarify that these images show one potential outcome of the wolf-moose interaction, and that other predictions students made (such as the moose escaping) are equally valid. In fact, most wolf-moose encounters (approximately 94 percent) end with the moose escaping.
- Ask students to consider the following questions: "What effect would you predict wolf populations have on moose populations?" and "What effect would you predict moose populations have on wolf populations?" To help students generate answers to these questions, have them represent their predictions graphically, such as using arrows, symbols, relative sizes, or other means of representing the relationship between the two populations.
- Tell students that they will be representing their predictions graphically.
    - Give students a blank set of axes such as the one in the student handout and ask them to predict population numbers for moose and wolves over time, specifying that each should be represented by two different colors, line types, or symbols, with an initial population of 500 moose and 20 wolves.
    - Students may also struggle with graphing using two different axes scales. Specify that they will just be showing each population's effect on the other rather than representing population size in absolute numbers.
    - Students may represent these population interactions incorrectly at this point in a lesson sequence: they may show each population growing or decreasing infinitely; the wolf population as being greater in numbers than the moose population; etc. These graphs represent initial models of population interactions and will be refined through further exploration as shown below. An example graph can be found here: http://www.isleroyalewolf.org/data/data/home.html

Exploration, assessment, and extension:

- Explore/Investigate: In this Click & Learn [https://www.hhmi.org/biointeractive/population-dynamics], students investigate two models of population growth and factors that limit population growth. It may be helpful to simplify the math in the accompanying worksheet, depending on the course.
    - This Data Point activity [https://www.hhmi.org/biointeractive/serengeti-wildebeest-population-regulation] has students consider the effect of a viral disease, rinderpest, on wildebeest populations. The data show how wildebeest populations increased exponentially in the absence of rinderpest but later stabilized due to other limiting factors.
        - It may be helpful to have students use a technique like the Identify & Interpret strategy [https://www.hhmi.org/biointeractive/blog/using-the-identify-and-interpret-strategy-with-data-points] to unpack this Data Point and/or the graph that's included in the student worksheet for the Click & Learn.
        - Alternatively, show students the graph with only the wildebeest's exponential growth shown (to the mid-1970s) and ask them to predict what the growth on the rest of the graph shows. It may also be helpful for them to consider what measures wildlife managers might take in seeing an herbivore species increase so rapidly.
- Assessment: Students can return to their original wolf-moose population models to revise them based on what they've figured out about population growth, limiting factors, and carrying capacity. If this lesson sequence precedes discussing energy transfers among trophic levels (for example, the "10 percent rule"), students may still be unclear as to why prey species outnumber predator species. Capturing their misconceptions and remaining questions will be helpful in transitioning to discussing trophic levels and the 10 percent rule.
- Extension:
    - Students often have the misconception that trophic interactions alone affect population sizes. The suite of trophic cascades resources can also show students how both trophic and nontrophic interactions may affect populations.
    - Students may also assume that predators' sole effect on prey species numbers will be in terms of killing/consuming prey. Another Data Point activity [https://www.hhmi.org/biointeractive/cougars-and-trees-trophic-cascade] shows the effects of cougars in Zion National Park on cottonwood tree populations. Development in the park caused cougars to avoid certain park areas, increasing mule deer (one of the cougar's prey species) activity and decreasing cottonwood tree populations.

TEACHING TIPS

- Present students with the image(s) first, before they read the background information.
- Background information may be edited to support student proficiency, course sequence, etc.
- The image(s) may be projected in lieu of handouts.
- Pair or group students to work through one or more of the implementation suggestions.

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