



Environmental Sciences 11 Teacher Resource- Keystone Species

Curricular Outcome: Environmental Sciences 11 “Complex Roles and Relationships Contribute to Diversity of Ecosystems”

Core Concepts:

Keystone species

Biodiversity

Ecosystem Resilience

Sustainability

Human impact

Ecological balance

Learning Outcomes:

Students will:

Explain the role of keystone species in maintaining stable ecosystems

Evaluate how the loss of a species affects the health of an ecosystem

Investigate relationships between biodiversity and sustainability

Predict ecological consequences related to environmental change

Big Questions:

Why are some species more important than others?

How do environmental decisions affect ecosystems?

What happens when keystone species disappear?

What can humans do to protect ecosystems?

Introduction:

Hook: Before beginning, give students this introductory scenario. You have \$10 million, and mammoth, wolf, and caribou populations are all declining. Which species is most important to save?

Take a vote on what species everyone picks. Compare these results to the results you will collect after research has been conducted.

Now tell students: Imagine you have been given a job by a government organization as part of an environmental advisory team. Unfortunately, species in Beringia are struggling due to climate change, habitat loss, and human activity. Funding is limited, and **you can only save one species.**

The decision to save a particular species may seem easy at first. Perhaps you want to save the largest species, the most populous species, or the seemingly most important species. However, ecosystems are complex. Some species play huge roles in their ecosystems that their population size might not suggest. Removing any single species can cause changes to plants, animals, habitats, and the survival of ecosystems as a whole.

In this activity, students will investigate Ice Age species, examine their roles, and make a recommendation on which species should receive conservation funding. After students make their decisions, they will explore what happens when that species disappears and whether or not their choice maintained a healthy ecosystem.

The goal is not to save a species; it is to maintain the stability of an entire ecosystem.

Main Activity:

Divide students into five groups. Each group will receive an information portfolio and will complete independent research on one of the following species: mammoths, bison, caribou, wolves, and scimitar cats. Each information portfolio will include information such as population size, habitat needs, role in the food web, ecosystem services, and fun facts. At this time, students will not know which species is the keystone. Students will complete an evaluation of their species while developing their understanding of the respective species' role.

Once students have a firm foundational understanding of their species, groups will form arguments for the funding decision. For example, the mammoth group may argue that mammoths are habitat engineers who maintain the grasslands and support biodiversity; meanwhile, the wolf group may argue that without these predators, primary consumers would experience a population boom, which could be detrimental to the ecosystem in other ways.

Students will then vote individually on which species they think should be saved. They cannot vote for their own group.

Now, either as a class or in their groups, students will figure out what would happen if the selected species were the only one to survive. Students are tasked with determining what consequences this would have not only on the surviving species, but also the ecosystem. Students can use the internet (or AI, where applicable) to find relevant information on what could happen in the ecosystem. Students should research vegetation, herbivores, predators, and Ice Age humans to determine how this species' survival would unfold.

After students have developed frameworks on the lone surviving species, reveal the true primary Ice Age keystone species in Beringia: **The Woolly Mammoth**.

Firstly, the mammoth maintained grasslands. They consumed huge amounts of grass, shrubs, and trees. They were also constant grazers, which led to them trampling vegetation, and played a massive role in cycling nutrients in the environment. If mammoths were not there to play this role, shrubs and forests spread, grasslands shrink, and there would be a significant habitat change for other species. Scientists believe that Woolly Mammoths were fittingly key contributors in maintaining the "Mammoth Steppe" that stretched across Beringia and the northern hemisphere.

Mammoths also created habitat for other species. Their movement, feeding, and trampling processes allowed space for grasses to grow, which also prevented woody plants from taking over. This created feeding opportunities for smaller herbivores such as bison, horses, and caribou who benefited from mammoth activity.

The carcass of a mammoth was also a key supporter of other species. When a mammoth died, scavengers and predators benefited from the meat, bones, and other resources in the body of a mammoth. A single mammoth carcass supported many organisms, and with no regard for spoiling, could feed a human for 1-2 years.

The loss of mammoths upon extinction significantly shaped the Beringian ecosystem. When mammoths disappeared, grasslands declined significantly due to the lack of grazing. This led to a heavy increase in the coverage of shrubs and trees, marking a key structural ecosystem change. Species were then forced to adapt to the lost grassland habitat. These are only a few reasons scientists argue mammoths were ecosystem engineers and keystone species.

Students should have been able to come up with a pathway similar to this when researching what would happen upon the disappearance of mammoths:

Mammoths removed

Grasslands shrink

Bison populations decline

Predators lose prey

Less overall cycling of matter

Ecosystem becomes less stable and more susceptible to damaging change.

Reflection Activity:

Feel free to use as many or as few of these questions as you'd like.

Which species did your group research?

Before the reveal, who did you believe was most important to the Beringian ecosystem?
Why?

How did your opinion change after learning about the mammoth's ecosystem role?

Describe one ecosystem change that could have occurred when mammoths went extinct.

Create an ecosystem chain reaction using information from the activity.

(General Ex.): Species disappears → Habitat changes → Another species declines →
Ecosystem stability decreases

Why/how did the extinction of mammoths affect species that didn't directly interact with mammoths?

What challenges do governments face when deciding which species to protect?

Should conservation efforts focus on protecting certain species or entire ecosystems?

What surprised you about today's activities?

Briefly explain why woolly mammoths were a Beringian keystone species.

What advice would you give to someone looking to protect an ecosystem.