NATIONAL GEOGRAPHIC

RESOURCE LIBRARY I ACTIVITY : 1 HR 15 MINS

Understanding Keystone Species

Students examine the real scientific questions that led to the discovery of keystone species and scientists' better understanding of trophic cascades. Then, students follow the experimentation process of an ecologist researching biodiversity and how the eradication of one species can impact an entire ecosystem. Finally, students apply this knowledge to their selected biome research.

GRADES

6, 7, 8

SUBJECTS

Biology, Ecology, Conservation, Earth Science, Climatology, Oceanography, Social Studies, Civics

CONTENTS

2 Links, 3 PDFs, 1 Resource

OVERVIEW

Students examine the real scientific questions that led to the discovery of keystone species and scientists' better understanding of trophic cascades. Then, students follow the experimentation process of an ecologist researching biodiversity and how the eradication of one species can impact an entire ecosystem. Finally, students apply this knowledge to their selected biome research.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/understanding-keystone-species/

DIRECTIONS

***From Pandas to Polar Bears: Hope for Earth's Imperiled Species* Unit Driving Question**: *How can we, as planetary stewards, take an active role in saving species from extinction?*

***Drivers of Extinction* Lesson Driving Question**: *Why is it important to prevent species extinction?*

1. Prepare students for a take a stand activity about the importance of funding research for species that are on the brink of extinction.

- To begin, survey the class by asking: *How many of you have ever seen a live sea star?* and *What do you know about sea stars?*
- If not mentioned by a student, explain that a large portion of the sea star population has been mysteriously dying.
- Show the video *Why Are So Many Starfish Dying?* After watching, have students turn and talk to respond to the question: *Why does it matter that sea stars are dying?* Select a few students to share their partners' ideas about the question.
- Tell students that a congressman from Olympia, Washington, wanted Congress to set aside $12 million dollars to coordinate research among federal agencies and create a marine disease emergency fund that would accept public donations for efforts to address starfish wasting disease.
- Brainstorm with students how Congress currently spends money. (Possible answers: military, highways, Social Security, and schools.) Then ask: *Should Congress take $12 million from their budget, or away from these other things, and prioritize sea star research?*
- Identify one side of the room as the *For* side and the opposite side as *Against*. Have students move to the side of the room that represents their opinion.
- Once students are on their self-selected side, have them pair up with another student in the group to discuss their reasoning.
- Call on several students who are for and ask for their reasoning, and then do the same for students who are against.

2. Students watch a video on trophic cascades and keystone species.

- Distribute a copy of the *Keystone Species and Trophic Cascades* handout to each student. As a class, watch this video from Howard Hughes Medical Institute (HHMI), *Some Animals Are More Equal Than Others: Keystone Species and Trophic Cascades* (19:28). Have students complete the handout while watching the video.

- After watching the video, have students revisit the original question: *Should Congress take $12 million from their budget and prioritize sea star research?*
- Again, have students choose the side of the room that represents their opinion, for or against, now that they've seen the video. Count the number of students on each side of the room.
- Call on several students who changed their minds to explain what information helped them change their thinking.

3. Students use what they learned to describe the impact of the loss of their species on other species and the biome.

- Have students read the *Role of Keystone Species in an Ecosystem* article at the appropriate reading level.
- Using this reading and their notes from *Keystone Species and Trophic Cascades,* ask students to determine the role of their species in the biome (such as predator, herbivore, keystone mutualist, umbrella species). Have research teams meet and discuss the role of their species and predict the potential impact of the loss of their species.
- Students record their ideas in Step 3 of their *Investigating an Endangered Species and its Biome* handout.
- Based on what they have learned, direct teams to respond to the lesson driving question: *Why is it important to prevent species extinction?*
    - Instruct teams to discuss the question and compile their responses on a piece of chart paper that is titled with the driving question.
    - Have one person from each team share their responses with the class.

Tip

Step 1: If students are unable to answer the question about federal funding, help them identify other things the government spends money on, like highways, schools, the military, or other relevant services. Then ask: *Should Congress take money away from one of these other priorities so they can protect sea stars?*

Tip

Step 2: Watch the video ahead of time and mark appropriate moments to pause the video to allow students to ask clarifying questions and record answers on the *Keystone Species and Trophic Cascades* worksheet.

Tip

Step 3: If students are having difficulty understanding the impact of the loss of their species, encourage students to argue with research team's predictions related to the potential loss of a species. Encourage students to ask questions or make counterpoints that would force a group to reconsider their thinking.

Informal Assessment

Investigating an Endangered Species and its Biome: Review the investigation document as students are working or by collecting at the end of class to ensure that students are gathering the type of information that will lead them to understand their species' place in the food web, drivers causing the species' demise, and the potential consequences of the species loss, as well as ideas for preventative measures.

Extending the Learning

Civics Extension: Look at information about the federal budget and what $12 million looks like relative to everything else. *How much do we spend on the military? Healthcare? Education? Is $12 million "a lot"?*

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology
- Conservation

Earth Science

- Climatology
- Oceanography

Social Studies

- Civics

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Multimedia instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Information, Communications, and Technology Literacy
    - Media Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Leadership and Responsibility
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Evaluating
  - Understanding

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
• **CCSS.ELA-LITERACY.WHST.6-8.9:**
Draw evidence from informational texts to support analysis, reflection, and research.

THE COLLEGE, CAREER & CIVIC LIFE (C3) FRAMEWORK FOR SOCIAL STUDIES STATE STANDARDS

• **D4.6.6-8:**
Draw on multiple disciplinary lenses to analyze how a specific problem can manifest itself at local, regional, and global levels over time, identifying its characteristics and causes, and the challenges and opportunities faced by those trying to address the problem.

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Chart paper

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Monitor/screen, Printer, Projector, Speakers

PHYSICAL SPACE

- Classroom

GROUPING

- Heterogeneous grouping
- Large-group instruction

- Large-group learning
- Small-group learning
- Small-group work

RESOURCES PROVIDED: UNDEFINED

- National Geographic: Why Are So Many Starfish Dying?
- HHMI: Some Animals Are More Equal Than Others: Keystone Species and Trophic Cascades

RESOURCES PROVIDED: HANDOUTS & WORKSHEETS

- Keystone Species and Trophic Cascades
- Keystone Species and Trophic Cascades Key
- Investigating an Endangered Species

RESOURCES PROVIDED: ARTICLES & PROFILES

- Role of Keystone Species in an Ecosystem

BACKGROUND & VOCABULARY

Background Information

To understand potential trophic effects, one must understand the different levels within a food chain. A food chain outlines who eats whom. A food web is multiple food chains within an ecosystem. Each organism in an ecosystem occupies a specific trophic level or position in the food chain or web. Producers, who make their own food using photosynthesis or chemosynthesis, make up the bottom of the trophic pyramid. Primary consumers, mostly herbivores, exist at the next level, and secondary and tertiary consumers (omnivores and carnivores) follow. At the top of the system are the apex consumers: animals who have no predators other than humans.

A trophic cascade is an interaction in the food web triggered by the addition or removal of top predators and involves changes in the relative populations of predators and prey in that food chain. This often results in dramatic changes in an ecosystem's structure and balance. For example, in a three-level food chain, an increase (or decrease) in carnivores causes a decrease (or increase) in herbivores and an increase (or decrease) in primary producers such as plants and phytoplankton.

A keystone species is an organism that helps define an entire ecosystem. It is often, but not always, a predator. Without its keystone species, the ecosystem would be dramatically different or cease to exist altogether. Sea otters, for instance, are a keystone species in their aquatic biome. Sea urchins, the spiky organism carried by this sea otter, eat kelp. Sea otters eat sea urchins, preventing the overpopulation of urchins from destroying the ecosystem. If sea otters cease to exist in this biome, kelp will eventually die out as well, because there will be an increase in sea urchins that will eat the kelp until it is gone.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
apex predator	*noun*	species at the top of the food chain, with no predators of its own. Also called an alpha predator or top predator.
bottom-up trophic cascade	*noun*	ecological phenomenon in which a producer or primary consumer is removed from the environment.
consumer	*noun*	organism on the food chain that depends on autotrophs (producers) or other consumers for food, nutrition, and energy.
decomposer	*noun*	organism that breaks down dead organic material.
food chain	*noun*	group of organisms linked in order of the food they eat, from producers to consumers, and from prey, predators, scavengers, and decomposers.
Green World Hypothesis	*noun*	idea that the number of herbivores must be controlled by both the bottom up and the top down for producers, for plant life, to survive.
keystone species	*noun*	organism that has a major influence on the way its ecosystem works.
predator	*noun*	animal that hunts other animals for food.
prey	*noun*	animal that is hunted and eaten by other animals.
producer	*noun*	organism on the food chain that can produce its own energy and nutrients. Also called an autotroph.

Term	Part of Speech	Definition
scavenger	*noun*	organism that eats dead or rotting biomass, such as animal flesh or plant material.
top-down trophic cascade	*noun*	ecological phenomenon in which a top predator is removed from the environment.
trophic cascade	*noun*	ecological phenomenon triggered by the addition or removal of predators from an environment.

For Further Exploration

Articles & Profiles

- Newsela: West Coast Starfish Are Dying, But Why?
- Wildlands Network: Keystone Species and Trophic Cascades
- National Geographic: Is the Gray Wolf Still Endangered? Depends on Who You Ask.
- Yellowstone Park: Wolf Reintroduction Changes Ecosystem in Yellowstone

Instructional Content

- National Geographic: Introduction to Keystone Species

Websites

- National Geographic: Food Chains and Webs Collection

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